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CONTENTS.

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The Advancement of Science in South Africa.

TWENTY-FOUR years ago the British Association visited South Africa for the first time, and now, by invitation of the South African Association for the Advancement of Science, the parent body is again in Cape Town. Mr. Jan H. Hofmeyr's inaugural address, which is printed in the supplement to this issue of NATURE, indicates the remarkable advances made since 1905 in South Africa in almost every branch of science. Mr. Hofmeyr very properly recognises the great service of the late Sir David Gill to science in South Africa in the early part of this century. Without him there would have been no body in South Africa corresponding to the British Association, for to him, and to a lesser extent Sir Charles Metcalfe, the existence of the South African Association is largely due. Sir David was not only a great astronomer, but also a very inspiring and attractive personality.

In 1905 there were four separate States, each enjoying, under the Crown, a very large measure of independence. Two of them, the Transvaal and the Orange Free State, as a result of the war, were still under Imperial tutelage, but in 1907 they were given full respionsble government. It cannot be truthfully stated, however, that these four States formed a very happy family ; indeed, the exact converse was the case, but in 1910 all came together and formed what is now known as the Union of South Africa. It was then that the real advances in scientific work started, for, thanks largely to a bulging Transvaal treasury, government departments were properly staffed with scientific workers. When it obtained responsible government in 1907 the Transvaal showed the way, possibly because it had the necessary money, and the world-renowned Veterinary Station at Onderstepoort to which Mr. Hofmeyr refers was actually planned before union took place.

Twenty-four years is not a long period, but possibly no other country has experienced such changes within a similar time. Governmental changes have already been indicated, but the whole country's physical aspect has altered almost beyond recognition. Vineyards, orchards, plantations, and trim homesteads now abound where formerly there was nothing but bare veldt. The flocks of sheep and cattle have increased beyond the wildest dreams of those who can recall the conditions of 1905. It is true that ostriches, thanks to fickle fashion, have decreased for the moment, as have also Angora goats, but the nuclei of potentially important industries still remain. Great stretches of country which were deadly to man and beast are now being successfully farmed and healthy children are being reared. The fight against animal and plant diseases has been waged without ceasing and, thanks to the vigilance of an alert staff of scientific workers attached to the agricultural department, great victories have been won. In this connexion the work of Lord Milner must never be forgotten, for it was he, and no other, who laid the foundations of a scientific agricultural policy the results of which are so apparent to-day. This fight has been waged in the laboratories as well as in the veldt. Twenty-four years ago South Africa was importing many of its everyday food requirements, such as butter, cheese, and bacon. To-day she is exporting all these and many others, but she has still to import a considerable proportion of her wheat.

Sir Thomas Holland, the new president of the British Association, will find much to interest him in his own line of work, for in spite of the triumphs of agricultural science, South Africa is still in the minds of the public mainly a producer of gold, diamonds, and, to a minor extent, of platinum. The Geological Survey, from the merely material point of view, has brought much wealth to the country as a whole through its discoveries and surveys, and in Northern Rhodesia a most ambitious scheme of geophysical survey is now being undertaken. Two years ago, at the Empire Mining and Metallurgical Congress held in Canada, Sir Thomas delivered an epoch-making address in which he advocated the necessity of making a review of the mineral resources of the Empire, and though nothing tangible has resulted, his views have not been forgotten; and South Africa, which is probably as well known geologically and mineralogically as any other country in the world, is still capable of springing mineralogical surprises which increase her potential wealth. It is true that many, indeed most, of the discoveries have been made by the old-time prospector, but it looks as if the new geophysical methods were likely to oust that picturesque character from his most interesting occupation.

Then, although the Rand and Kimberley are still the most important mining centres, they have ceased to be the only ones. Indeed, it looks as if Northern Rhodesia will at no distant date rival the Rand with regard to the value of its output of copper and other metals and minerals. But throughout the Union itself there are many centres of mining activity concerned with the actual mining and subsequent treatment of coal, platinum, chrome, asbestos, mica, tin, manganese, magnesite, beryl, and other minerals of minor importance.

Not many years ago, the exports from South Africa were made up almost entirely of gold and diamonds, but to-day the agricultural products, as Mr. Hofmeyr points out, very nearly equal in value the mineral exports, and it is anticipated that at no distant date they will even exceed them. These great advances are undoubtedly due to the application of scientific principles, and although the amount of research work carried out in the laboratories of the four teaching universities of the country is comparatively small at the moment, that work is undoubtedly of paramount importance to South Africa itself.

Mr. Hofmeyr refers with justifiable pride to the great advances which have been made in university teaching—advances in which he himself took no mean part. There is, however, just a doubt as to whether they have not been too rapid for a country which, after all, has a white population of only a million and a half. Probably they were inevitable, as the distances between populous centres are very great, and there has always existed a healthy provincial patriotism which has made for duplication of services generally. There are, for example, two well-equipped medical schools when probably one is quite sufficient for the country's requirements. There is also overlapping in certain specific subjects. If, in the fullness of time, one of the existing universities could be developed for research and post-graduate teaching, the country would undoubtedly be the gainer. At present there is too much teaching and too little research, and yet, as has already been indicated, the output is quite considerable South Africa is fortunately very rich in historical archives, and thanks to Mr. Graham Botha, Sir George Cory, Prof. Eric Walker, and many other earnest workers, these are being rescued from comparative oblivion and made public.

Then, again, thanks to a few ardent workers inside and outside the universities, the origins of the native races, their languages, their folk-lore, and their customs, are being studied to-day as never before. The natives are being rapidly civilised, their old tribal customs are gradually dying out, and the authority of the chiefs, except in the native reserves, has practically disappeared. Nothing quite satisfactory has yet taken its place. The black man is South Africa's greatest problem to-day. All others fade into relative insignificance, and it will take the combined wisdom of both the dominant races to reach a solution. The members of the British Association cannot be expected to grasp all the ethnological, economic, and political aspects of this great and most difficult problem in the short time at their disposal, but they can at least regard it from an entirely detached point of view.

Those who were living in South Africa at the time of the last meeting there of the British Association wondered very naturally what would be the effect of that very inspiring experience. They felt that they were on the eve of great happenings, but no one could predict what these would be.

Looking back, we find it difficult even to-day to assess the benefits which accrued to the country as a whole. Both visitors and hosts were undoubtedly inspired by the interchange of thought and experience, and it was surely no coincidence that, immediately after the visit, South Africa as a whole set out to wage scientific warfare on its all too numerous pests and parasites, to discover the possibilities of new forms of agriculture, and to inaugurate a more extensive geological survey campaign. The people as a whole, and those who were responsible for the government of the country, had their thoughts very definitely directed to the application of scientific endeavour.

Those who live in South Africa, and those outside it who endeavour through sheer love of that great country to keep in touch with its many problems, again feel that they are on the eve of great happenings. What they will be no one can say, but the members of the British Association will find a better educated community, a more receptive public, and a greater appreciation of the benefits of science among all classes than on the last occasion. They will also find a very healthy spirit of nationalism, developed largely since the War, but finding expression in all walks of life. Nevertheless, they are assured in advance of a hearty welcome from all sections of the community, and we have no doubt that not only will the present visit be as inspiring as the last, but also that its results will be infinitely more beneficial, not to South Africa alone, but to the whole of the British Empire and to the world at large.

The British Association when it visits an outpost of the Empire acts as a catalyst; little is known about the methods whereby these mysterious bodies exercise their equally mysterious effects, but they are nevertheless perfectly definite. South Africa is a splendid field for this catalyst, and we are sure that the stimulus afforded by the present meeting will be felt for many years.

A Classic of Physics.

The Collected Works of J. Willard Gibbs. In 2 vols. Vol. 1: *Thermodynamics.* Pp. xxviii + 434. 15*s.* net. Vol. 2: Part i., *Elementary Principles in Statistical Mechanics*; Part ii., *Dynamics, Vector Analysis, and Multiple Algebra, Electromagnetic Theory of Light, etc.* Pp. xviii + 207 + vi + 284. 15*s.* net. (New York, London and Toronto: Longmans, Green and Co., Ltd., 1928.) 2 vols., 25*s.* net.

THE writings of Gibbs on thermodynamics and statistical theory were far and away the most complete of the early presentations of those subjects, but there must be many with a good knowledge of the theories who have never consulted the originals. As his works have long been out-of-print, the editors have performed a most valuable service in bringing out the present two volumes. They are beautifully printed, and the editors are to be congratulated on having adopted the right method for the re-issue of a classic; a commentary will certainly be useful, and one is to be composed by a number of authorities, but the present books are not disfigured by footnotes in the manner so often practised by energetic but injudicious editors.

It is well known that Gibbs's work did not meet with great appreciation for many years, and after reading his papers it is interesting to consider why. We can imagine some elder of the Connecticut Academy after one of their meetings telling him as delicately as possible that he could not understand what the " Heterogeneous Equilibria " was about; and then Gibbs would go home and amplify it, expecting thereby to make it as clear to others as to himself. The result is that, once the chief idea is grasped, the whole is discussed in such great detail that it could scarcely be improved in ease or clearness. The whole trouble is at the beginning, and depends on the reader being able to *feel* the meaning of $d\epsilon \geqslant t d\eta - p dv - \mu_1 dm_1 - \mu_2 dm_2 - \ldots$ (Gibbs always considers the case of inequality with care), and for most of us it is unfortunately a considerable step from admitting the logic of the equation to the intuitive understanding of it. It is hard to see how amplifying his introduction would have helped; what is needed is habit of thought, and this can only grow with the lapse of time. His first paper on thermodynamics was published in 1873, two years before the great paper, and the right answer to anyone who complains about the " Heterogeneous Equilibria " is to advise him to spend, like Gibbs, two years over its preliminaries.

The same qualities appear in the "Statistical Mechanics". There is the same novelty in the initial idea of a *canonical ensemble*, and the same admirably lucid and detailed account of its consequences, leading gently towards the principles of thermodynamics—with at the end a clear perception of the difficulties of radiation. It is always interesting to ask any physicist whether he prefers Gibbs's foundation of statistics or that based on the ideas of Maxwell and Boltzmann. Everyone agrees that an assumption must be made somewhere, but different qualities of mind like to take it differently. Some prefer to follow Gibbs in the conception of the *canonical ensemble*, a very explicit assumption, but one which is not obvious enough to be classed as axiomatic—especially as he uses it in Chap. xv., where the rather abstruse conception of the thermodynamic potential seems to spring complete out of nothing. Others prefer to go behind the *canonical ensemble* by using the *microcanonical*, in which the systems considered all have the same energy and number of atoms. There is no doubt that this idea is more easily grasped and is more plausible, but closer examination shows that it merely conceals the same fundamental difficulties rather more deeply. Gibbs discusses it in one chapter, but his treatment is only really to show that it approximates to the *canonical.* With modern technical methods the *microcanonical ensemble* is as easily discussed as the other, and presents us with the temperature and potentials as obvious mathematical consequences of the calculus; it is tempting to believe that if Gibbs had known of this calculus he would have put the *microcanonical ensemble* in a more prominent position.

These two great works show Gibbs's main character, a capacity for quietly puzzling out a whole field of thought entirely by himself, and getting it into perfect order. That was his main quality, but it was made possible for him by a second quality, and one rather unexpected in a man whose whole work was devoted to natural philosophy. This is a capacity for deep symbolism, and in reading his work we have the feeling that he got more enjoyment out of this mathematical quality than from its physical applications. This is exemplified in the "Heterogeneous Equilibria" by the masterly way in which he handles the variational symbols d, δ, and D (but never ∂). The same mathematical taste comes out even more strongly in his papers on vector analysis, which are the only ones in which any trace of personal feeling appears.

It is one of the perversities of humanity, that we get more excited about notations than about the things they represent. Gibbs's vector notation was attacked by Tait, who championed Hamilton's quaternions with a very undue asperity, and Gibbs's reply, though much more restrained, was largely a counter-attack on Hamilton. The symbolism of vectors has gone through many changes, and even now we can scarcely pronounce a final judgment. The quaternion certainly has a much more limited scope, for though it is better than other methods to deal with rotations, it cannot represent tensors; and it has a brutal directness which must have been repugnant to the symbolic mind of Gibbs. His method, on the other hand, started from the very broad ideas of multiple algebra, and was based on the 'dyadic', essentially a tensor. A few years ago it would have been said that neither of them was the right notation, certainly not the quaternion, and scarcely the dyadic; for, if we want to go beyond the mere idea of vectors, we had better be able to describe tensors of any rank, which can be done admirably by the use of subscript letters. But, curiously enough, in the last year both Gibbs and Hamilton have been reinstated, Gibbs because his notation is that of matrices, which play such a part in the quantum theory, and Hamilton, because the quantities used in expressing the 'spinning electron' have a peculiar quaternion-like flavour and are quite unlike ordinary vectors.

After reading through all Gibbs's works one is naturally drawn to make an estimate of what were the peculiar qualities of the man. A rough dichotomy of great men of science can be made into those who achieve their greatness by understanding things, and those who achieve it because they know what they do not understand. The first type, of which Kelvin was an example, seems to have been born with a direct comprehension of some part of Nature and only has to grow up in order to explain it. The second type works in quite a different way, by puzzling out the things it does not understand. Rayleigh was of this type, and so was Gibbs, and it is interesting to remember that Kelvin did not think much of Gibbs's work. But though we have likened him to Rayleigh, there was a very great difference between them; for Rayleigh wanted to understand anything that turned up, whether it was the general theory of radiation or how much grease there is on clean water, whereas Gibbs was only interested in principles, and undertook the more practical of his works merely in order to convince others that his principles were useful. It is this steadfast study of broad principles that constitutes his greatness.

The Hellenic Society, 1879–1929.

The Journal of Hellenic Studies. Vol. 49. Part 1. Pp. 139 + xcvii + 6 plates. (London: Macmillan and Co., Ltd., 1929.) 21*s.* net.

THE celebration of the fiftieth anniversary of the Society for the Promotion of Hellenic Studies in June last has been made the occasion for the publication of a history of the Society, which appears as a supplement to the recent issue of the Society's journal. The task of telling the story could have been entrusted to no more competent author than Mr. George Macmillan. He is one of the few remaining original members, he acted as honorary secretary from the inception of the Society until 1919, and is now its honorary treasurer; but beyond this the idea of the formation of such a society was his, and it was due to him and to Prof. Sayce, with the staunch support of Mr. (afterwards Sir) Charles Newton, that the Society came into being in 1879. Mr. Macmillan had also profited much by the support and advice of M. Gennadius, then Minister for Greece in Great Britain.

It is perhaps not easy in these days, when societies seem to spring up with comparatively little effort, to realise the courage required in the 'seventies to carry through such an undertaking as the formation of a society for the study of such a subject as ancient and modern Greek language and culture. Further, the invitation to join the Society was originally issued only to those who had been in Greece—not in those days a very large number. When once it was constituted, however, the committee was to have the power "to elect such other persons as are interested in its objects". The response to the personal appeal issued by Mr. Macmillan and Prof. Sayce was immediate and enthusiastic, and almost at once the numbers grew to beyond their hopes. The early lists of supporters comprise the flower of British classical scholarship; but the immediate success of the Society and the wise administration of its affairs, which have placed it in the front rank of the learned societies of Great Britain, were due to the energy and never-failing enthusiasm of Mr. Macmillan, ably seconded by Sir Charles Newton.

Mr. Macmillan's history of the Society falls into two parts. The first part covers up to the year 1904 and was originally written for the twenty-fifth anniversary. Although this is only reissued in order to make the survey of the whole period complete, it may not be out of place to recall some of the activities for which the Society was directly responsible or with which it has been associated, as a reminder of the debt owed by scholarship to those who have been responsible for its policy and administration. Foremost among such activities is the *Journal of Hellenic Studies*, of which the first volume appeared in 1880. Some anxiety was expressed at the time lest the venture might fail to maintain its vigour after the first interest had died away. These fears were ill-founded. The *Journal* has had among its contributors such men as Schliemann, Colvin, Imhoof Blumer, Sir W. M. Ramsay, Sir Arthur Evans, and D. G. Hogarth, to name only a few—men whose reputations are imperishable while the life and literature of ancient Greece are of account in intellectual culture. Many of the contributions to its pages will be of supreme authority, each in its special branch of study, for generations, and the frequency of the references to the *Journal* in standard works, in classical studies, and in archæology bears witness to its repute.

Among the original purposes of the Society was the publication of copies and photographs of Greek monuments and inscriptions of all kinds. It was also intended to assist travellers and students by providing or arranging for the provision of certain facilities and conveniences in Greece itself. Herein lay the germs of the most useful and fruitful of the activities undertaken by the Society. On one side it came to take an active part in promoting the exploration of the ancient sites of Greece and Asia Minor; on the other, it brought the full weight of its influence to bear on the movement, initiated by Sir Richard Jebb, for the foundation of the British School of Archæology in Athens, and, at a later stage, to assist in founding the sister School of Archæology in Rome. Even before the foundation of the School in Athens in 1886, the Council in 1881 had helped to finance W. M. Ramsay in an archæological expedition to Asia Minor by voting £150 for the expenses of a draughtsman. The results of this expedition encouraged the Council to further efforts, and an Asia Minor Exploration Fund was instituted to carry on the work. This was the first only of a number of funds for similar purposes. Grants were made for work at Naukratis, Thasos, in Caria and on the site of Alexandria. A Cyprus Exploration Fund, established in 1886, was followed by a Cretan Exploration Fund in 1899 under the direction of Sir Arthur Evans, Dr. D. G. Hogarth, and Mr. R. C. Bosanquet. The important results to follow on this last undertaking need no emphasis; but they stimulated the British School to undertake a Cretan excavation of its own at Palaekastro in 1902.

The history of the Society between 1904 and the present year is a record of steady work and expansion stimulated by the discoveries of Sir Arthur Evans in Crete and of the members of the British School both in Crete and on the mainland. The work was sadly interrupted by the War and the Society paid its toll from among its younger members. The special knowledge of the Near East possessed by members of the Society and of the British School was an asset in the Eastern theatres of war, of which full advantage was taken and the nature of which is perhaps only imperfectly realised.

In 1908 the library had grown beyond the capacity of its original quarters in the premises of the Royal Asiatic Society at 22 Albemarle Street, and in the following year it moved to 19 Bloomsbury Square. In 1910–11 the premises were extended to accommodate the offices of the British Schools at Athens and Rome, and, by a wise decision, a common library and collection of photographs and lantern slides for the three bodies was formed. It was not long, however, before this arrangement led to the necessity for still further increase in accommodation, and latterly a house has been acquired in Bedford Square, as is recorded in the Report for 1925–26, where the Society is likely to remain for at least another generation.

In these days, when interest in classical scholarship in the narrower and more restricted sense is thought to be on the wane, the prosperity and growth of the Society for the Promotion of Hellenic Studies may be taken as a gratifying sign that the culture of the Mediterranean, so important in the history of civilisation, still holds its own in the interests of an influential section of the community. We wish the Society an increasingly prosperous and productive future.

The Subject Index to Periodicals.

The Subject Index to Periodicals, 1927. Issued by the Library Association. Pp. x+299. (London: The Library Association, 1929.) 70*s*. net.

THIS Index was commenced in 1915 as a successor to Poole's Index, which had ceased some years earlier. The present volume sets out to arrange alphabetically by subjects the more important articles in some 600 periodicals, mainly in the English language and of a general character, covering the principal English scientific and technical periodicals, but excluding most of the specialist and semi-technical periodicals and foreign scientific and technical journals. The Index caters only for such inquiries as may be expected to confront a general librarian. From this point of view it is very well done, the get-up is excellent in every way, and, considering the labour of compilation, which is only to be comprehended by those who have undertaken similar work, the price is not high.

The only serious blemish one can find in the work is the system of alphabetical subject headings, devoid of even a rudimentary classification, in which confusion appears in the garb of simplicity. It is doubtful, in view of the intricate network of cross-references required, whether there is any less labour involved in compiling the Index on this principle rather than on a classified system; whilst the labour thrown on to the searcher, who must progress painfully through the tortuous labyrinth of cross-references, is augmented disproportionately. The preface states that the alphabetical headings of the Library of Congress have been used in the main. It would have been advantageous to employ the Library of Congress Classification itself, or, better, a classification which is comprehensive enough to permit periodical literature to be classified—such as the Universal Decimal Classification.

The faults in the Index, which even the most cursory examination reveals, are those that are inseparable from the system adopted, and which no reasonable amount of care on the part of the collaborators could have avoided, namely, the juxtaposition of incongruous subjects, and the separation of related ones. The entry, under the heading "Cells", together with articles on living cells, of a paper on the geometrical properties of space—stackability of tetrakaidecahedra—is reminiscent of the bibliographer's classification of "Lead, kindly light" with "Lead pipes". If one would study the properties of living cells, one finds two papers under "Cells", with cross-references to "Embryology", "Golgi Apparatus", "Karyokinesis", "Plant Cells" and "Tumers", and under each of these headings there are several further cross-references, and so on. Would one investigate the acoustics of buildings; from "Acoustics" there is a reference to "Sound", and vice versa. "Acoustics" leads to "Architectural Acoustics", where one finds eight papers, and to "Music: Acoustics", with no papers. From "Sound" one reaches "Music: Acoustics" again, thence coming back to "Architectural Acoustics", but with a reference also to "Echo", where two more papers are found, though no reference to the Albert Hall echo occurs here. This must be found under "Albert Hall". But a reference to that heading is given under "Architectural Acoustics". This heading also leads to "Buildings: Sound-proofing", with three papers, and "Church Architecture", with two. Looking for articles on geophysical prospecting, one finds none under "Geophysics", but there is a cross-reference to "Prospecting" where there is one article. This leads to "Electrical Prospecting", with one more, and thence to "Torsion Balance" with another article. There is no reference to a paper on "Applications of sound-prospecting to geophysics", which is listed under "Sound: Propagation". If the subject were more comprehensive, the maze of cross-references would be still more bewildering, leading in the end to the collection of references to the papers of only a single year.

In spite of the system, however, the work should be recommended as a very useful index for the general librarian and for the reader who does not need to exhaust his subject.

S. C. Bradford.

Our Bookshelf.

Field and Colliery Surveying: a Text-book for Students of Mining and Civil Engineering Surveying. By T. A. O'Donahue and T. G. Bocking. New and revised edition. Pp. xvi + 327. (London: Macmillan and Co., Ltd., 1928.) 10*s.* 6*d.* net.

This book has been reprinted, sometimes with additions and revisions, no less than thirteen times. Past success guarantees the success of an able revision. The size of page of the present edition has increased by some fifteen per cent, and there are fourteen more pages, while much of the groundwork in geometry and mensuration has been wisely omitted to make room for descriptions of improvements in surveying instruments and methods. The original author has been joined by Mr. T. G. Bocking, a surveyor well known not only in practice but also by his important contributions to the periodical press and to the *Transactions* of the Institution of Mining Engineers. Both authors are prominent in the mining profession: both have had experience as examiners; the collaboration is therefore a happy one and is also to be welcomed because, while one author obtained his early experience in the north, the other has had experience both as a civil and mining engineer mainly in the midlands and the south. This revision has purged the book of some localisms of practice and provincialisms of expression.

The book should now be fairly representative of the survey practice in many British coalfields. But it is clearly not a complete exposition, and the only excuse for its sub-title is that it will be useful to pupils of firms styling themselves "Civil and Mining Engineers". The preference of Mr. Bocking for his three-tripod theodolitic outfit is made clear, but this scarcely warrants the extreme brevity of the treatment of the Galletly modification; and his curt dismissal of one-tripod outfits in a few lines is regrettable. His generalisation that "a surveyor should learn to dispense with this additional complication (a centring device) and become experienced in setting up expeditiously and accurately without it" is only valid for three-tripod outfits; applied to one-tripod outfits, it is a case of Bocking *contra mundum.* For such devices abound: every firm of instrument-makers of whatever nationality manufactures them; and they are universally adopted underground and generally for surfacial surveys.

The selected instance of a traverse of 8505 ft. with closing errors of $e_x = -1{\cdot}79$ ft., $e_y = -0{\cdot}96$ ft., $e_z = \pm 0{\cdot}26$ ft. does not prove the excellence of Mr. Bocking's outfit and method, for accidental errors are most commonly mutually destructive, and the most probable aggregate of such errors is zero; what it does show is lack of sympathy with the modern practice of teaching university students to test the performances of instruments from statistics by averaging, or by the method of least squares, and thus more rapidly and surely to arrive at conclusions which the surveyor anciently formed from the impressions of a lifelong experience!

L. H. Cooke.

Probleme der kosmischen Physik. Herausgegeben von Prof. Christian Jensen und Prof. Dr. Arnold Schwassmann. Band 11: *Das Zodiakallicht; sein Wesen, seine kosmische oder tellurische Stellung.* Von Dr. Friedrich Schmid. Pp. x + 132 + 4 Tafeln. (Hamburg: Henri Grand, 1928.) 10·50 gold marks.

This excellent series of monographs serves a valuable purpose in providing separate works on many interesting natural phenomena, and not least in the case of those of minor interest, the literature of which is fragmentary and widely scattered; workers in other fields can turn to these books with fair confidence that they will find all the important facts and theories concerning the respective subjects. In particular this is the case with the volume under review, which appears to be almost the first book expressly devoted to the zodiacal light; the author is an enthusiastic student of the subject, and has observed it systematically for nearly forty years. The volume is of great interest both on the side of observation and on that of theory; it may be hoped that it will lead others to observe the zodiacal light regularly, especially since the way in which the position and form of the light vary with the latitude and longitude of the station of observation is not yet adequately known.

The main theoretical question involved in the subject is whether the rarefied matter which, by reflection of sunlight, produces the zodiacal light, is distributed throughout the solar system up to or beyond the earth's orbit, or whether it is merely a terrestrial appendage. The author argues cogently for the latter view; he regards the zodiacal light as the highest and last twilight bow produced by the bending of light in the earth's atmosphere. The theory implies an immense extension of the earth's atmosphere, with an oblateness in a plane coinciding more nearly with the ecliptic than with the equator, and therefore not explicable merely by the rotation of the outer atmosphere with the rest of the earth.

In the discussion of this part of his subject the author's speculations range rather widely, but the atmosphere presents us with so many inescapable riddles that the addition of one more, relating to its most inaccessible regions, is only in keeping with its character. The terrestrial origin of the zodiacal light is rendered more probable by the existence of a zodiacal light associated with the moon.

The Problem of Motor Transport: an Economic Analysis. By Christopher T. Brunner. Pp. 187. (London: Ernest Benn, Ltd., 1928.) 12*s*. 6*d*. net.

EVERY return of motor traffic in every country shows an ever-increasing number of cars and lorries in use, and though it was only in 1907, as we are reminded by Mr. Brunner, that Mr. Asquith referred to motor-cars as "a luxury which is apt to degenerate into a nuisance", the petrol-driven vehicle is bringing about a change in our modes of travel comparable only to the revolution effected by the railway. Mass production places the motor-car at the service of the man of modest means, and if he cannot afford a car himself, he is a customer of the bus and charabanc owner.

Motor transport problems are therefore always with us, and to those who want a general review of them a better book than Mr. Brunner's would be hard to find. It does not tell the reader how to choose or run a car, but it tells him something about the questions of taxation, traffic, rail and road competition, the economics of special motor roads, why railway companies retain horses, and how roads are maintained. Incidentally, on p. 120 the author tells us that the idea of tarring roads originated with a workman of Hythe, who tarred the road in front of his own house at his own expense. Hythe boasts of being the birthplace of one great pioneer, Sir Francis Pettit Smith—'Screw' Smith—the chief promotor of screw propulsion, and there is a tablet in the High Street to his memory. If Mr. Brunner is correct, Hythe should certainly tell us the name of this workman who has been a benefactor to millions of motorists, and to still more millions of pedestrians.

Das Prinzip der kleinsten Wirkung von Leibniz bis zur Gegenwart. Von Adolf Kneser. (Wissenschaftliche Grundfragen: Philosophische Abhandlungen, herausgegeben von R. Hönigswald, Band 9.) Pp. ii+70. (Leipzig und Berlin: B. G. Teubner, 1928.) 4 gold marks.

THIS pamphlet deals with the principle of least action, chiefly from a philosophical and historical point of view. A few pages are given to the mathematical aspect, which the author, who has written on the calculus of variations, is exceptionally well qualified to discuss. It is often asserted that the principle was due to Maupertuis, but it is here shown that the idea was enunciated much earlier by Leibniz. His arguments were of a theological nature, and might not appeal to present-day scientific workers, but it is remarkable how much of the work of Einstein and others is in the form that Leibniz asserted could be given to every physical law.

Strangely enough, Prof. Kneser, while discussing the use of the principle of least action in the theory of relativity, says nothing of the important part that it has played in establishing the new science of wave mechanics. It was the analogy between the principle of least action and Fermat's principle of least time that suggested an analogy between mechanics and optics, and led de Broglie and Schrödinger to such important results.

H. T. H. P.

The Tragedy of the Italia: *With the Rescuers to the Red Tent.* By Davide Giudici. Pp. viii+216+34 plates. (London: Ernest Benn, Ltd., 1928.) 12*s*. 6*d*. net.

THE author of this book is an Italian newspaper correspondent who was the only journalist on board the *Krassin*, the Russian ice-breaker that took a prominent part in the rescue of the crew of the *Italia* airship off Spitsbergen in the spring of last year. His story is supplemented by accounts of several of the survivors. The *Italia* was wrecked off North East Land on a return flight from the North Pole. The cause of the disaster is not clear, but the result of it was the loss of seventeen lives, including that of Capt. R. Amundsen, who gallantly flew to the rescue, and the expenditure of large sums of money on search expeditions. In these operations the *Krassin* took a notable part. The ship was well handled, but her consumption of fuel, as much as 150 tons a day in open water, limited her sphere of work, and she was unable to force a passage in ice more than about six feet in thickness. In her second voyage, in September, the *Krassin* crossed the unexplored seas north of Giels Land on the way to Franz Josef Land. No new land was found.

Typical Flies: a Photographic Atlas of Diptera. By E. K. Pearce. Series 3. Pp. xv+64. (Cambridge: At the University Press, 1928.) 10*s*. net.

THIS atlas is intended to help the beginner and attract attention to an order of insects the study of which is hampered by the lack of elementary treatises. Like its predecessors, it is essentially a picture book and its object is to illustrate typical British flies by means of annotated half-tone figures. The venation and general appearance of many Diptera are well portrayed by this method, and comparisons with the illustrations should enable the beginner to sort out a considerable proportion of his specimens into their major groups. In the case of the more striking examples, generic or, here and there, specific identifications are also possible. The atlas is uniform with its predecessors, and the standard of execution of the attractive plates is well maintained.

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.*]

Diffraction of X-rays by Two-Dimensional Crystal Lattice.

Under this title, W. Linnik, of the Leningrad Optical Institute, described in a recent issue of Nature (April 20) an effect obtained with copper $K\alpha$ radiation and a mica crystal. A narrow beam of X-rays was passed through a cleavage plate of mica, which had previously been heated to redness and cooled. A photograph of the diffracted beam showed a series of spots, the arrangement of which is attributed by Linnik to the action of very thin layers of the crystal as independent *two-dimensional* gratings. It is supposed that " the space effect will be destroyed by the incoherence of waves produced by scattering from incorrectly spaced layers ", the heat treatment having broken up the mica into very thin plates without disturbing their orientation. The arrangement of the diffracted beams corresponds to the pseudo-hexagonal network of points at intervals of 5·2 A. in the cleavage plane (001), which is so striking a feature of the mica structure.

I do not think it is necessary to postulate diffraction by a two-dimensional lattice in order to explain Linnik's results ; they can be ascribed on the other hand to diffraction of the familiar type by the three-dimensional crystal grating, provided that one may assume the mica to consist of a number of flakes not quite parallel to each other. The normals to these flakes have a random orientation about a certain mean position, though the flakes themselves retain their relative position in the sense that there is no rotation of one flake over another around the mean normal.

To test whether such a structure of the mica plate would produce the effect observed by Linnik, the following experiment was tried by Mr. W. H. Taylor and myself. A cleaved section of muscovite mica, 0·6 mm. in thickness, was set up approximately normal to a narrow beam of molybdenum K radiation. During the exposure of a photographic plate, the section was rotated over a small range around both horizontal and vertical axes normal to the X-ray beam. The effect of this double rotation is to make the normal assume in turn all positions within a small solid angle extending five degrees in every direction from its mean position. The resulting photograph (Fig. 1), while showing more spots owing to the shorter wave-length, has precisely the same appearance as that published by Linnik. There is a complete and fairly uniform series of spots such as would be made by a two-dimensional grating, though in this case the crystal was quite normal and there is no reason to ascribe the effects to anything but the familiar three-dimensional diffraction. When kept stationary the crystal gave a Laue pattern ; when heated this was partly replaced by the pattern of Fig. 1, though we did not succeed in obtaining so symmetrical a pattern with the heated crystal as that obtained by Linnik.

This simulation of a two-dimensional grating effect can be readily understood if the mechanism of diffraction is considered. Two of the three conditions for the diffraction of a monochromatic beam are imposed by the spacing of the points on the basal net (the cleavage plane (001)). Thus any diffracted beams which appear must have such positions as are to be expected from this two-dimensional grating. It can readily be calculated that the slight rocking to and fro of the mica does not appreciably affect these positions, a result familiar in the optical grating when the angle of diffraction is small. The third condition for diffraction is achieved by the oscillation of the crystal. Owing to the great length of the c axis (20 A.) a very slight rocking of the crystal (or warping of its surface) will suffice to bring points in successive c planes into such a relative position that reinforcement takes place.

To put this more precisely, when a point on the plate is formed by reflection from the plane (hkl), its

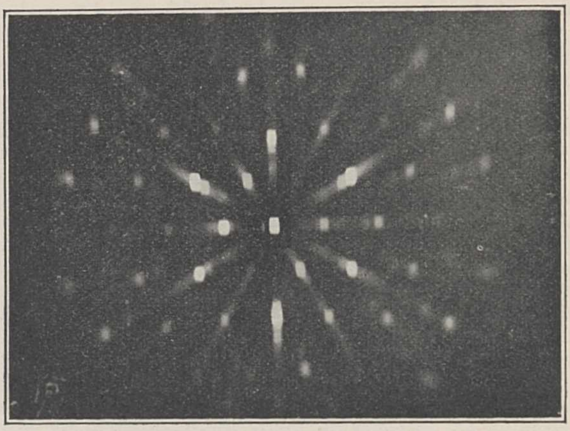

Fig. 1.

position only depends on h and k, being independent of l if second-order corrections are neglected. A rocking of $6\frac{1}{2}°$ in every direction ensures that, for every value of h and k, some plane hkl comes into position for reflection. If h and k are large, many values of l are possible, and the corresponding spot is due to the superposition of several diffracted beams.

It is interesting to follow the changes to be expected as the wave-length is shortened. The spots will crowd towards the centre and form a more and more regular triangular pattern. Each outer spot is formed by the co-operation of a number of planes differing in index l ; hence an average between weakly and strongly reflecting planes is struck and the outer spots will be regular in intensity. The photograph will in fact repeat all the features shown in the results of Kikuchi (*Japanese Journal of Physics*, **5**, 2 ; 1928) on the diffraction of electrons by mica, quoted by Linnik. Its appearance can be readily explained by the familiar laws of diffraction by a three-dimensional grating, assuming a slight random warping of the mica planes. It is not necessary either in the case of electron diffraction or X-ray diffraction to assume that the crystal acts as a two-dimensional grating.

W. L. Bragg.

University, Manchester,
June 29.

Asymmetry in the Radiation from the Hydrogen Atom in the Electric Field.

In my monograph " Axialität der Lichtemission und Atomstruktur " (Polytechnische Buchhandlung A. Seydel, Berlin, 1927) I have discussed a case of asymmetry of radiation ; if atoms of an element, say of helium, pass through a gas such as hydrogen, under certain conditions for some spectral lines of the moving atoms the radiation in the direction opposite to the movement is more intense than in the direction of the moving atoms. This phenomenon is one of the facts on which I have based the conclusion that the atoms of the chemical elements have an axial structure and that the emission of light from a single atom is of vortical structure (*Lichtwirbel*) (cf. my monograph "Atomstruktur und Atombindung", Polytechnische Buchhandlung A. Seydel, Berlin, 1928).

Guided by this idea of axiality of atomic structure and emission of light, I have recently discovered an asymmetry in the radiation emitted by atoms in an electric field. Certain lines of the radiation emitted along the axis of a superimposed electric field have different intensities in the two directions of this axis or, more generally, different intensities for the two sides of the plane perpendicular to this axis.

The most important of my observations were made on the hydrogen lines $H\alpha$, $H\beta$, $H\gamma$, and $H\delta$ for the case of the emission along the axis of the superimposed electrical field, and show the following general phenomena.

There are emitted along the axis of the electric field those components of the hydrogen lines which appear electrically normally vibrating to the axis of the field when the axis of vision is normal to the axis of the field. This holds for the components displaced towards the red ('red') and also for the components displaced towards the violet ('violet'); however, the violet components are emitted more intensely in the direction of the field than in the opposite direction, while, on the contrary, the red components are emitted more intensely in the direction opposite to the field than in the direction of the field. This phenomenon explains an observation made independently by Mr. Wierl, that for the line $H\gamma$ in the case in which the axis of vision is opposite to the direction of the field, the violet components appear more intense than the red components.

This asymmetry of radiation of the hydrogen atom in the electric field is incompatible with the Bohr-Epstein-Kramers theory and with the Heisenberg-Schrödinger theory of the intensity of radiation of the hydrogen atom in the electric field, as also with the Sommerfeld theorem, founded on this theory, on the symmetry of the hydrogen atom; for these theories require that the intensity of the radiation should be symmetrical to the plane normal to the axis of the electric field. J. Stark.

Grosshesselohe-München, June 28.

The 'Absolute' and 'Relative'.

It might serve a useful scientific purpose to point out some remarkable anomalies that have resulted from attempts to deduce philosophical conclusions from the findings of pure scientific research. Modern science has as yet no philosophy of its own, but the significance of its great achievements *experimentally* cannot be interpreted legitimately by means of the *speculative* philosophy of the school-men. Much attention has been paid to the general reader by writers who try to explain physical phenomena 'philosophically' without a clearly defined technical vocabulary. That such attempts have been premature and ill-considered is evident by the confusion in the minds of many persons, lay and scientific, as to the future of science.

For example: some statements in Nature (June 22, p. 954) concerning "Psychological Conceptions in Other Sciences" are so alarming as to cause one to inquire whether it be the intention of workers in pure research to cease work and shut up their laboratories. Even though the conditions that determine quantum 'jumps' cannot be detected by instruments at present in use, are *we* entitled to jump to the conclusion that "structure and entities [now under observation are] in themselves unknowable and unimaginable"? Have we, indeed, reached the limit of possible human knowledge? The remark above cited is prefaced by the statement of Dr. Myers that "with the development of knowledge, ideas of the 'absolute' have been gradually replaced by those of the 'relative'". Further *development* of knowledge seems doubtful if individual entities are in fact unknowable! However, conceptions of 'relativity' appear to dominate the field, at present, to such an extent that one almost questions the sincerity of the search for a unitary field theory to synthesise relative conditions. Is it a really serious quest or merely a competition *pour passer le temps*?

While illogical, this attitude is consistent with the spirit of an age that would repudiate the principle of cause and effect physically as morally. Still, the innate tendency of the human mind to seek for a 'cause' cannot be wholly repressed. Some types of mind feel compelled to account for the behaviour of the blind forces of Nature, regardless of the temporary experimental *impasse*; and they have arbitrarily attributed to these forces a power of choice and self-direction supposed to be exercised by human beings. There is no scientific 'cause' behind the electron! Physical phenomena occur as and when a 'decision' is made by a capricious entity or electron which, like a god of popular mythology, has the power, apparently, to act as it 'chooses' or 'prefers', whatever the environmental conditions. Surely this is suspiciously like absolutism in the sense understood by democratic entities?

To speak, however, of having 'ideas about the absolute' is one of the many contemporary illustrations of a contradiction in terms. To conceive it possible to form *any* idea to represent the absolute is the cardinal error of theological and idealist philosophies the absolute deity of which is a decidedly relative individual discarded by science some generations ago.

In the article (Nature, June 1 and 8), "Einstein's and other Unitary Field Theories: An Explanation for the General Reader", Prof. Piaggio refers to Newton's belief in absolute rotation. As the great Newton cannot have been an illogical thinker, it should be worth while to examine the basis of this belief. We who function in finite, relative matter are unable, obviously, to contact, record, or describe an infinite, absolute energy, if such there be. But, though we cannot imagine a state of rotation *per se*, physics, to be logical, must postulate a perpetual, self-generating motion as the uncreated, causeless cause of known and knowable material velocities. *In-finite* (without end or beginning), *when ascribed to energy, means ceaseless*, that is *without intervals*—a state that cannot be conceived mentally but, nevertheless, a logical and necessary hypothesis. For, if there be no such absolute perpetuity or infinity, how do relative conditions come into existence and how are they maintained in their interrelated activities?

While research is inducing a greater respect for the scientific knowledge of former ages, no investigation has been made by science into the philosophical rationale of the ancient arts of alchemy, astronomy, medicine, psychology, etc. Consequently, we attribute ideas of popular religions to the ancient scientific philosophers whose only deity was absolute motion. "Everything is full of gods," Thales said, because 'gods' and 'atoms' were synonymous terms. It is possible that there may be renewed appreciation of Newton's science when his philosophy is understood.

W. W. L.

June 23.

New Fixatives for Plant Cytology.

FOR the study of somatic chromosomes a fixative is required that penetrates quickly, but does not shrink the cytoplasm; that spreads the chromosomes for counting, and gives clear definition of constrictions and trabants. Carnoy spreads the chromosomes out well, but most of the definition is lost. Flemming and its modifications are most useful, giving very good results, but there are some plants for which they are not suitable. Some plants, however, cannot be fixed well by any of our present methods.

In the course of work with *Primula sinensis* a number of fixatives were tried, among others the following new formula, which was found to give excellent results:

1 per cent Chromic acid	90 c.c.
Potassium bichromate	1 gm.
Sodium sulphate	0·5 gm.
Urea	1 gm.
5 per cent Glacial acetic acid	10 c.c.
2 per cent Osmic acid	15 c.c.
Distilled water	45 c.c.

The method employed is similar to that used with Flemming solution. Material is immersed in the solution for several minutes under an air pump to remove air and to aid penetration, and then it remains in the solution for a further twelve hours. After imbedding in paraffin, cutting and mounting in the usual way, the slides are bleached in 1 part hydrogen peroxide in 10 parts 70 per cent alcohol for two to three hours. They are then placed in an iodine solution for a minute or two to remove any remaining bichromate. Material can be stained with gentian violet (Newton's method), hæmatoxylin, or other cytological stains in common use.

Excellent results have been obtained with *Papaver*, *Melandrium*, *Datura*, and *Pentstemon lævigatus* (with 96 chromosomes), and a comparative test of several fixatives, namely, Zenker, Flemming, Kihara, Navashin, and Allen's Bouin upon *Matthiola* ovaries, favoured my fixative both in regard to penetration and spreading of the chromosomes. For *Pisum* pollen mother-cells, whole buds are fixed in Carnoy for about 30 seconds; the Carnoy is then poured off and the fixation continued in the above fixative. This method is similar to Kihara's.

Although not used extensively on pollen mother-cells, the fixative has given good preparations by the smear method. The following, however, was found better for *Matthiola* pollen mother-cells:

1 per cent Chromic acid	90 c.c.
Potassium bichromate	3 gm.
Sodium sulphate	1 gm.
Urea	1 gm.
2 per cent Osmic acid	20 c.c.
Distilled water	50 c.c.

A third fixative used successfully with the smear method for pollen mother-cells is a mixture of Allen's Bouin and Champy in equal proportions. This was found useful for *Campanula* and *Solanum* species. The smeared slides, after washing and taking up through alcohols, must be left from two to three hours in a saturated solution of lithium carbonate in 70 per cent alcohol to remove any remaining picric acid.

L. LA-COUR.

An Isotope of Carbon, Mass 13.

THE bands belonging to the Swan spectrum of carbon appear in the vacuum electric furnace at about 2400° C. At temperatures above 2600° they are strong and clear-cut, even the band at λ6191, difficult to obtain in the carbon arc, being well defined. It has been noted by one of us, during a variety of electric furnace investigations, that plates on which the band at λ4737 is very strong showed a faint band, not to be ascribed to a ghost, about 7·5 A. to the red of the strong band. The carbon arc shows a scattered structure in this region, which is suppressed in the furnace. It has, however, thus far failed to give the faint band, which in the furnace spectrum shows a distinct structure, essentially identical with the structure of the main band.

The recent discovery of isotopes of oxygen makes it very probable that other similar elements contain isotopes in small quantities. We have accordingly measured this faint band very carefully, using a first order exposure of a 15 ft. concave grating, the furnace being at about 2800° C. It is now generally agreed that the Swan bands are due to the neutral C_2 molecule, presumably $C^{12}-C^{12}$. We find that the new faint band corresponds quantitatively to that which should be given by an assumed $C^{13}-C^{12}$ molecule. The constants of the Swan band system are known with great precision ("Int. Crit. Tables", **5**, 411, and J. D. Shea, *Phys. Rev.*, **30**, 825; 1927), and an accurate comparison with theory is therefore possible. With data of the precision now becoming available for oxygen, as well as in the present case, it is necessary to avoid various approximations which have commonly been used in previous work on isotopes. This will be fully discussed in later publications.

Because of irradiation due to the strong band, it is to be expected that the measured distance between the two *heads* will be slightly *smaller* than the calculated isotope shift for the head. This is in fact the case, this distance being measured as 2·020 mm. ($=$ 7·520 A. $=$ 33·44 cm.$^{-1}$) as compared to a calculated isotope shift of 2·028 mm. (33·58 cm.$^{-1}$). Fortunately, however, it is possible to distinguish six individual lines in the very faint isotope band. These have been identified as the unresolved triplets P_{26} to P_{31} (Shea's nomenclature). In the comparator P_{30} and P_{29} could be measured with reasonable accuracy, P_{28} and P_{27} less reliably, P_{26} very poorly, and P_{31} not at all. The corresponding triplets in the main band (also unresolved) could be measured with great precision. The observed isotope shifts in millimetres for P_{30} to P_{26}, with the calculated in parenthesis in each case, are 2·059 (2·0515), 2·049 (2·0473), 2·037 (2·0429), 2·033 (2·0395), and 2·044 (2·0373) respectively. Multiplication by 16·58 gives the shift in cm.$^{-1}$. The two good lines (P_{30} and P_{29}) give an average measured shift 0·082 cm.$^{-1}$ too large. Although with the present available data the fact may have no significance, it is interesting to note that this small discrepancy may be cancelled by assuming 12·0000 and 13·0026 for the two masses.

This 1-0 band (λ4737) is especially favourable for showing the faint isotope molecule, when one considers photographic intensity, position with respect to other bands (particularly CN), and size of the shift. We shall endeavour to get better plates, showing the isotope effect in other bands, and also showing more detailed fine structure. The present evidence seems, however, fully sufficient to establish the existence of an isotope of carbon, of mass 13. We cannot at this time make any statement as to its relative abundance, except to say that the isotope band is hundreds of times as faint as the strong band.

ARTHUR S. KING.
Mount Wilson Observatory,
Carnegie Institute of Washington.
RAYMOND T. BIRGE.
Physical Laboratory,
University of California,
June 24.

A Spinning Target X-ray Generator.

It is a well-known fact that the energy density, that is, the energy per unit time and area in the focus of an X-ray tube, cannot be raised indefinitely owing to the extreme heating and consequent deterioration of the target surface. The input limit has been calculated for the usual type of X-ray tube in a previous paper (*Proc. Roy. Soc.*, A, vol. 117, p. 30; 1927).

In many applications of X-rays it would be very valuable to work with higher energy densities than those which had been used so far. This requires a method of removing the heat more radical than has been hitherto adopted. A simple way for doing this is

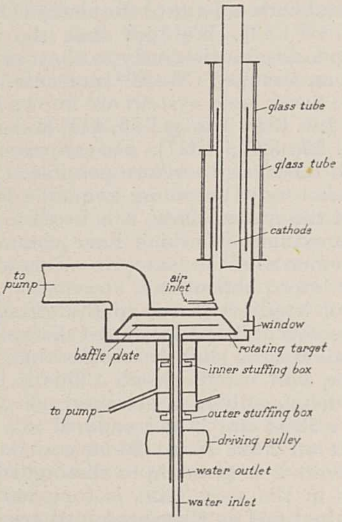

FIG. 1.

to produce the focus on the periphery of a rotating disc. The theoretical discussion which will shortly appear shows that the input limit can be raised as follows:

$$W_{\substack{\text{max.}\\ \text{rotating}}} = W_{\substack{\text{max.}\\ \text{rest}}} \times \sqrt{\delta \cdot \frac{\rho \cdot c}{k} \cdot v}$$

where $W_{\substack{\text{max.}\\ \text{rotating}}}$ = maximum input for a rotating target, $W_{\substack{\text{max.}\\ \text{rest}}}$ = maximum input for a target at rest, c specific heat of the anticathode material, k thermal conductivity, ρ density, δ radius of the focus in cm., v velocity of the target at the focus. This equation only holds if the expression under the square root is large compared with unity.

The use of the rotating disc avoids excessive local heating, but it is still necessary to remove the heat from the cathode as a whole, and this can be done by a water-cooling system.

An experimental X-ray plant embodying these principles of design has been built in the Davy-Faraday Laboratory. The target of the generator as shown in the diagram (Fig. 1) consists of a hollow copper disc with a bevelled surface on which the cathode rays impinge at about 5·5 cm. distance from the centre of the disc. The disc is mounted on a hollow shaft and rotates with about 2000 rev. per min. The cooling water is fed into the hollow target through a small tube inside the shaft and is directed against the inner cooling surface of the target by a baffle plate. The outlet is formed by the concentric space between the inlet tube and the inner wall of the driving shaft. The generator is permanently connected to a high-speed pump, and the pressure is regulated by a needle valve. The maximum input which the generator should stand according to calculations is about 5 kilowatts with a focus of 1 mm. diameter.

The generator was first tested on a high-tension plant which consisted of two large induction coils capable of standing an input of more than 20 kilowatts and operated by a specially constructed Wehnelt interrupter. The peak potential, judging from the spark gap, varied between 30 and 100 kilovolts. On one occasion, the input in the primary circuit being then about 30 kilowatts, a groove was cut in the disc of about 1 mm. width showing that a sharp focus must have been obtained in this experiment. Measurements of the actual energy striking the target were not made in this preliminary test. The X-ray energy must have been considerable, and visual observations of powder rings and of patterns due to reflections by a single crystal could be made on a fluorescent screen quite easily.

A second test was carried out at lower voltages, using this time a completely rectified supply. The generator ran very steadily at 25,000 volts and 100 milliamperes; at 19,000 volts and 200 milliamperes the discharge began to be unstable. This was possibly due to the heating of the cathode, the cooling of which depended entirely upon radiation in these preliminary tests.

I have been assisted in this work by Mr. R. E. Clay. A detailed description of the generator will be given later. I wish to express my thanks to the G.E.C. Research Laboratory in Wembley for letting me use their large high-tension D.C. plant.

ALEX. MÜLLER.

Davy-Faraday Laboratory,
Royal Institution,
June 27.

The Origin of Variations.

An article by Sir Oliver Lodge, dealing with the extracts from the Hooker Lecture on "The Origin of Adaptations" which were published in NATURE for June 1 (p. 841), appears in the issue for June 29 (p. 982). It is very gratifying that the lecture has aroused the interest of so distinguished a physicist, and I can assure him that all biologists will welcome his intervention and value the analysis of their problems to which he has given expression. With much of his article I am in full agreement, and for the rest, two quotations will perhaps most briefly make my position clear. The first has appeared on the title-page of every issue of NATURE since its first number was printed in 1869:

"To the solid ground
Of Nature trusts the mind that builds for aye."
—WORDSWORTH.

The second, in lighter vein which Sir Oliver Lodge with his keen sense of humour will appreciate, is from Prof. Eddington ("The Nature of the Physical World", p. 21):

"It does not seem a profitable procedure to make odd noises on the off-chance that posterity will find a significance to attach to them."

The course deprecated by Prof. Eddington seems to be the very one which Sir Oliver Lodge advises biologists to follow. With Wordsworth's lines he will, I imagine, be willing to express agreement, and they have this advantage that, perforce, he must abstain from making square-bracketed insertions which would upset the poet's rhythm, to say nothing of changing his meaning.

E. J. ALLEN.

Marine Biological Laboratory, Plymouth.

IN a stimulating article in NATURE of June 29, p. 982, Sir Oliver Lodge makes the following statement: "We know, however, that [germ-plasm] is modifiable by slight changes in environment." Apart from the question whether we can in reality separate germ-plasm from soma, and excluding cases of injury, I suggest that we do not know this. Do we even know for certain that the soma itself can be changed ?

In a few cases it is claimed that changes in soma have been brought about by an alteration in environment, and even that those changes are capable of being transmitted from parent to offspring. Without attempting to touch upon the question of the inheritance of acquired characteristics, I would yet point out that for every single case where environment has been intentionally changed and its effect noted, there are thousands of cases in Nature where change of environment has failed to produce any apparent modifying effect.

Personally, I do not think that there is much difficulty in accounting for the absence of the influence of change in environment, for I believe that any such influence can be selective only. Environment may be all-important as a selective influence, but as such that influence must be definitely restricted. Perhaps this conception may be made clearer by reference to a simple concrete example. Given an ordinary dice, one can turn it up several ways and thus select several numbers, but they can only range from one to six. Given the power of changing the numbers, however, and the range of selection becomes infinite. No one would deny the selective influence of environment, but I believe that its *modifying* influence has yet to be demonstrated.

A. G. LOWNDES.
Marlborough College, Wilts.

Production of High Lo Surdo Fields.

IT has already been reported in this journal (NATURE, Aug. 25, 1928, p. 277) by one of us, that the field strength in a Lo Surdo tube may be increased considerably by the simple device of using proper periodic impulses as the terminal supply. Since then the experimental arrangement has been improved so that a steady discharge may be maintained in a capillary tube the inner diameter of which is as small as 0·5 mm. for two or three hours. First, the volume of the discharge tube was increased to more than 20 litres; and secondly, only the half wave was used by taking off some of the vanes of the synchronous motor rectifier. Finally, the induction was removed from the secondary circuit. In this way the maximum voltage attained was roughly 1·2 million volts per cm.

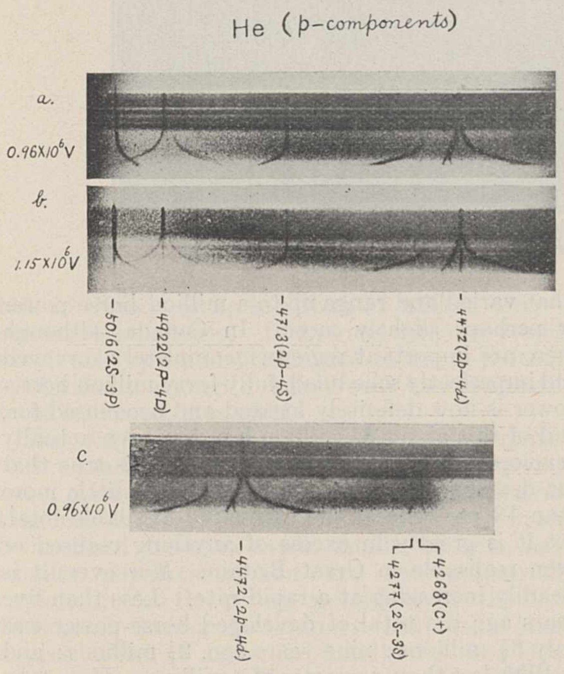

FIG. 1.

The accompanying photographs (cf. Ishida and Kamijima: Sc. Pap. I.P.C.R. **9**, p. 118) were taken by a small Fuess spectrograph. The undeflected lines in photograph *b* are the superposed zero lines. The following points may be noted:

1. The lines λλ5016 and 4922, which barely touch each other at a field of 550 kv., here cross decidedly.
2. The shorter wave component of the line λ4472 turns back to the zero line in photograph *b*, whereas the longer wave component keeps its original direction.
3. The line λ4268 of ionised carbon is deflected to the negative side.

YOSHIO ISHIDA,
SHIGERU HIYAMA.
The Institute of Physical and
Chemical Research, Tokyo, Japan.

New Bands in the Spectrum of Oxide of Lanthanum.

A SMALL portion of the spectrum of oxide of lanthanum has been known for some time. The most notable of the old measurements (v. Kayser, "Handbuch der Spektroscopie", Bd. 5, p. 666, Leipzig, 1910) refer to two groups of bands in the violet at λ4418 and λ4372, and to a pair of bands in the green at λ5600 and λ5626.

R. Mecke (*Naturwiss.*, **17**, 86; 1929) identified and measured seven groups of bands recently at λλ4372, 4418, 5600, 7380, 7403, 7877 and 7910, and Auerbach (*Naturwiss.*, **17**, 84; 1929) identified other bands in the spectrum between λ7876 and λ8638.

The spectrum of oxide of lanthanum has usually been obtained by means of the electric arc; Hartley was the only one who used the oxyhydrogen flame. But the spectra so obtained are incomplete because the necessary conditions in order to volatilise perfectly the oxide of lanthanum have never been attained. It either decomposes almost completely into metal and oxygen, or it remains partially as a very fine powder.

By means of a simple arrangement of the oxyhydrogen flame, I have been able to vaporise the oxide completely. The spectrum emitted in this state shows bands only; there are no lines or continuous background.

The spectrum has been photographed with a quartz spectrograph between λ7000 and λ2400, and shows groups of bands at λλ6540, 6154, 5866, 5600, 5380, 5178, (5058), 4582, 4543, 4531, 4418, 4372, 4357, 3708, 3671, 3620, 3612, 3566. The groups between λ6540 and λ5058 are all composed of double-headed bands; the separation of the double heads decreases from group to group as the wave-length decreases.

It is interesting to note that the presence of various bands in the ultra-violet region of the spectrum has now been established; their existence had been predicted by R. Mecke as the result of his investigation of the bands in the green and red.

GIORGIO PICCARDI.
Istituto di Chimica generale
de la R. Università,
Via Gino Capponi 3,
Firenze, June.

Recent Progress in Canadian Hydro-Electric Power Development.

By Dr. BRYSSON CUNNINGHAM.

IT is just about two years (*vide* NATURE, Aug. 27, 1927, and Sept. 3, 1927) since, on my return from a round of visits to some of the principal waterfalls and generating stations in eastern Canada, I described the situation in the Dominion as regards the development of its water resources for power purposes. It will probably be of interest at this stage to recount the progress which has been made during the intervening period, particularly as it continues to be of a very notable and far-reaching character. The statistics used for the purpose and the tabular information incorporated in this article have been derived from recent reports issued by the Water Powers Branch of the Canadian Department of the Interior.[1]

In order to appreciate fully the importance of water power development in Canada, it is necessary at the outset to bear in mind two salient facts; first, that the Dominion as a whole, and particularly its two chief industrial and manufacturing provinces, Quebec and Ontario, are very favourably endowed with abundant natural sources of water power; and secondly, that these same two provinces are singularly lacking in geological deposits of coal. Distinguished as the Acute Fuel Area, the two provinces, comprising the bulk of the population and the predominant share of commercial, mining, and manufacturing interests, would be lamentably crippled in their activities were it not for the fortunate compensation. Water power, therefore, is an essential feature of the industrial development of the Dominion.

FIG. 1.—Hydro-electric installation (540,000 h.p.) at Isle Maligne, Lake St. John, Province of Quebec. (By courtesy of the High Commissioner of Canada.)

In Great Britain, developable water power supplies are relatively meagre and of an insignificant order. Estimates of the aggregate are somewhat varied and range up to a million horse-power or perhaps slightly more. In Canada, although there are important regions incompletely surveyed and imperfectly scheduled, fully forty million horse-power is now definitely located and accounted for, and of this about $5\frac{1}{2}$ million h.p. has been actually developed up to the present time. It is true that the developed horse-power amounts to little more than 13 per cent of the estimated available total, yet it is greatly in excess of anything realised or even realisable in Great Britain. Moreover, it is steadily increasing at a rapid rate. Less than five years ago the total of developed horse-power was only $3\frac{1}{2}$ millions; nine years ago, $2\frac{1}{2}$ millions; and in 1900, less than a quarter of a million. If we take the rate of progress (nearly 500,000 h.p. per annum) which has obtained during the last five years, another decade will suffice to see more than ten

[1] No. 1227, Water Power in the Mineral Industries of Canada. No. 1231, Water Power in the Pulp and Paper Industry of Canada. No. 1242, Hydro-electric Progress in Canada during 1928. No. 1253, Water Power Resources of Canada.

million horse-power in operation. Fig. 1 illustrates a single development of 540,000 h.p. carried out within a period of five years.

From the economical point of view, the present achievement and its future possibilities are specially noteworthy. It has just been pointed out that the provinces of Ontario and Quebec, covering an area of well over a million square miles, are practically destitute of internal coal supplies, and are dependent on external sources for mineral fuel. On a reasonable computation under existing conditions, each installed water horse-power is the equivalent of six tons of coal per annum. This means that at the present time there is a saving in coal consumption in Canada of no less than 33 million tons—a remarkable quantity. In districts with coal readily obtainable by mining, the consideration to industry is significant enough ; where coal has necessarily to be imported, it is vital.

The only European countries which compare with Canada in intensity of water power development per head of population are the Scandinavian kingdoms and Switzerland. Norway, Sweden, and Switzerland are each much smaller in area, have smaller populations, and are less industrially exploited. In the return published by the U.S. Geological Survey in January 1927 (the latest figures which I have at hand) the developed water horse-power of Norway is given as 717 per thousand of the population, of Sweden as 223 per thousand, and of Switzerland as 476 per thousand. At the present time the average for Canada is 554 per thousand. In certain provinces the ratio is much higher ; for example, in British Columbia it is 952, and in Quebec 902. In Yukon and the North-West Territories, where the population is scanty and there are heavy demands for power for low-grade gold mining, the figure is as high as 1039.

Perhaps a fairer and more apposite comparison would be with the United States, where, reduced to the same basis of computation (ordinary six months' flow and 80 per cent turbine efficiency), the developable horse-power may be put at about 60 millions. The quantity actually developed at the present time is 13½ millions, equivalent to 127 per thousand of the population.

Fig. 2.—Two hydro-electric power stations on Gatineau River, Province of Quebec. Farmers' Rapids (120,000 h.p.) in foreground ; Chelsea Dam (170,000 h.p.) beyond. (By courtesy of the High Commissioner of Canada.)

Table I. below shows the available and developed water power in the respective provinces of the Dominion of Canada as determined to Jan. 1, 1929. Compared with the similar table to January 1927, published in Nature in August 1927, there is an increase of nearly two millions in the available 24-hour horse-power at ordinary minimum flow, of more than one million horse-power for the same 24-hour period at ordinary six months' flow, and of rather more than three-quarters of a million in the horse-power of actual turbine installations. It will be noted that the provinces of Ontario and Quebec possess more than 60 per cent of the available power and more than 80 per cent of the installed power.

Comparison of the corresponding figures for available horse-power at ordinary six months' flow with those of turbine horse-power at sites where generating plant is actually installed, shows the turbine installation to be 30 per cent in excess of the scheduled available quantity, and this has proved to be good commercial practice. Hence, it is reasonable to apply a similar percentage

Table I.

Available and Developed Water Power in Canada.

Jan. 1, 1929.

Province.	Available 24-hour Power at 80 per cent Efficiency.		Turbine Installation, H.P.
	At Ordinary Min. Flow, H.P.	At Ordinary Six Months' Flow, H.P.	
British Columbia	1,931,000	5,103,500	554,792
Alberta	390,000	1,049,500	34,532
Saskatchewan	542,000	1,082,000	35
Manitoba	3,309,000	5,344,500	311,925
Ontario	5,330,000	6,940,000	1,903,705
Quebec	8,459,000	13,064,000	2,387,118
New Brunswick	87,000	120,800	67,131
Nova Scotia	20,800	128,300	74,356
Prince Edward Island	3,000	5,300	2,439
Yukon and North-west Territories	125,200	275,300	13,199
Canada	20,197,000	33,113,200	5,349,232

addition to the total of 33,113,200 at the foot of column 3, bringing it up to about 44,000,000 and justifying the use earlier in this article of the estimate of "fully 40 million horse-power" as definitely located up to the present.

The figure of 5,349,232 given as the total turbine installation horse-power to Jan. 1 last takes no account of a number of large installations which were nearing completion about that date, or of a number of others which were in the initial stages of development. It is estimated that these uncompleted undertakings will add something like 1,200,000 horse-power to the total, and there is every prospect of further important enterprises being begun. For example, the Gatineau Power Company placed six large units of generating plant, each of 34,000 h.p. capacity, in operation at their Paugan Station on the Gatineau River in September last, with provision for two additional units of the same capacity. The same Company was simultaneously installing a fourth unit at each of two other stations lower down the Gatineau River, namely, at Chelsea and Farmers' Rapids (Fig. 2). These new units were so far advanced as to be expected to be in operation early this year. At Chute-à-Carron, on the Saguenay River, works are in progress for an initial installation of four units each of 65,000 horse-power, and these are under contract to be completed by July 1931, to be followed by additional units of an aggregate of about a million horse-power.

So much for the sources and extent of generation. It will be interesting now to consider the ultimate application of this vast accumulation of motive power. There are three main sources of absorption; first, the central electric station for general and municipal purposes; secondly, the pulp and paper industry; and lastly, miscellaneous industries, including mining. The first requires little or no comment. The central station is a characteristic and outstanding feature in modern civilisation; from it radiate supplies of electricity for domestic and street lighting, for power, heating, traction, and numerous uses of various kinds. The pulp and paper industry is Canada's chief manufacturing activity. The gross and net values of production and the disbursements in salaries and wages in this industry are greater than those of any other Canadian industry, while the national output of newsprint, that is, paper prepared for the newspaper printing press, during the last completed census year exceeded that of any other country. Some of the power required for the purpose is generated directly at the mills from a local water supply, in other cases it is taken by purchase from a central station; jointly, the quantity utilised in the industry is 25 per cent of the whole output of the Dominion. As regards the mineral industries, it can be said that the profitable operation of many

Table II.

Developed Water Power in Canada.

Distribution by Industries and Per 1000 of Population.

Jan. 1, 1929.

Province.	Turbine Installation in H.P.				Population, June 1, 1928.	Total Installation per 1000 Population, H.P.
	In Central Electric Stations.	In Pulp and Paper Mills.	In other Industries.	Total.		
British Columbia	412,960	81,000	60,832	554,792	583,000	952
Alberta	34,320	..	212	34,532	631,900	55
Saskatchewan	..	..	35	35	851,000	0·04
Manitoba	311,925	..	..	311,925	655,000	476
Ontario	1,568,423	240,880	94,402	1,903,705	3,229,000	590
Quebec	2,030,850	220,810	135,458	2,387,118	2,647,000	902
New Brunswick	43,910	14,278	8,943	67,131	415,000	162
Nova Scotia	42,929	16,008	15,419	74,356	547,000	136
Prince Edward Island	376	..	2,063	2,439	86,400	28
Yukon and North-west Territories	..	..	13,199	13,199	12,700	1,039
Canada	4,445,693	572,976	330,563	5,349,232	9,658,000	554

of the Canadian mines is only made possible by the low cost at which ample supplies of power can be obtained from hydro-electric sources. Fuel power would in many cases be prohibitive. It is affirmed in one of the Government reports that without the aid of water power the mining industry of Canada could not have approached its present magnitude.

Table II. shows, as at Jan. 1, 1929, the distribution of developed water power in Canada under the three heads detailed above. Column 2 in the table includes only hydro-electric stations which develop power for sale. Columns 3 and 4 comprise the power specifically generated for the industries in question. As explained above, additional and large supplies of power are obtained by purchase from the central stations.

It is interesting to note that the total outstanding capital invested in water-power developments represents an average of 219 dollars, or about £44 per horse-power installed, including transmission and distribution—quite a low figure compared with that of other countries under similar conditions.

Fully to describe and expound the striking figures collected and published by the Canadian Government would require much more space than can be allocated to the subject here. They are eloquent of vigorous progress and unflagging enterprise. To the ordinary reader they are full of interest; to the observant visitor they are a confirmation of impressions received from numerous striking spectacles; and to the scientific inquirer they open out a vista of wonderful possibilities for a country which is yet on the threshold of its career.

The Original Home and Mode of Dispersal of the Coconut.

By Dr. ARTHUR W. HILL, C.M.G., F.R.S.

THE origin and mode of dispersal of the coconut, which is now widespread throughout the tropics of the Old and New Worlds, has long been a subject of discussion. De Candolle, Beccari, Chiovenda,[1] and others consider the coconut originated in the Indian Archipelago or in the Pacific Islands, while O. F. Cook[2] attempts to prove that its origin was in the valleys of the Andes of Colombia in South America and that it was transported thence, entirely by human agency, far and wide across the tropic seas. H. B. Guppy[3] also holds the opinion that the home of the genus *Cocos* is in America, while Geoffrey Smith[4] states, on information given him by Mr. Hedley of Sydney, that the coconut was introduced to the Pacific Islands from Mexico by Polynesian mariners. Cook asserts that it is highly improbable that sea-borne coconuts could ever be cast up on a shore in such a favourable position that they could germinate without the aid of man, and Schimper[5] considers that the coconut groves "fringing most tropical coasts have only exceptionally originated without human aid". The fact remains, however, that coconuts are the common strand palms on almost every tropical island and that they were found well-established when many of these uninhabited islands were discovered.

Another fact which lends support to the original home of the coconut being the Indian Archipelago or Polynesia is the great variety of the coconuts now found in the East. Many of these varieties have well-marked characteristics such as colour of the nuts, thickness of the husks, etc., and many of these special kinds are grown specially for religious ceremonies among the Hindus, which also points to the palm being of great antiquity in South India. The hereditary occupation of the Tiyans of the Malabar Coast also is the tapping of coconuts for toddy.[6] Then, again, the Tamil and Malayalum name for the coconut is *tengai* (*ten* = south, *kai* = fruit), that is, the fruit which comes from the south.

Chiovenda[1] (l.c. pp. 397-399) quotes a reference to the coconut in Indian medical literature, supposed to date back to 1400 B.C., and a statement of Ctesia that coconut oil was in common use in India in 400 B.C. He cites evidence that the coconut was widely cultivated in the Gangetic Plain in the first century of the Christian era, and refers also to two Arabian travellers, Abu Said and Ibn Wahab, who in the ninth century went as an envoy to China and reported that the Laccadive and Maldive Islands were covered with coconut palms, which appeared to be indigenous there. One of these travellers also made the interesting statement of the existence in India of a religious sect, which, for humanitarian reasons, introduced and propagated the coconut on those islands where it did not already exist.

The name 'coco' appears to be due to the Portuguese,[7] and they were made acquainted with the palm from their voyages in the East. The commonest word in the languages of the Pacific for the coconut is some form of the Indonesian

[1] Beccari, O. *Ann. Jard. Bot. Buitenzorg*, Supp. 3, pt. 2, 1910, pp. 799-806, and Malesia, I., p. 86. Chiovenda, Emilio, *Webbia*, vol. 5, pt. 2, pp. 359-449 (1923).

[2] Cook, O. F. *Contrib.* from U.S. Natl. Herb., **2**, p. 257 (1901), and also "History of the Cocoa-nut Palm in America", *Contrib.* from U.S. Natl. Herb., **14**, pt. 2, pp. 271-342 (1910).

[3] Guppy, H. B. "Observations of a Naturalist in the Pacific", vol. 2, 1906, pp. 67, 413.

[4] Smith, Geoffrey. "Cambridge Natural History", Crustacea, pp. 173-175.

[5] Schimper. "Plant Geography", Eng. ed., I., p. 231.

[6] See Sampson, H. C. "The Coconut Palm", 1923, p. 74 *et seq.*

[7] "The Simples and Drugs of India", Garcia Da Orta (1563), translated by Sir Clements Markham, p. 139; also "Roterio", Vasco da Gama (1498) and the book of Barbosa (1516).

Garcia da Orta generally spells the name *coquo*: "We, the Portuguese," he writes, "with reference to those three holes, gave it the name of Coco (Spanish *macoco*, for monkey-faced), because it seems like the face of an ape or other animal." With regard to other names, he says the palm is called Maro and the fruit Narel, and this word Narel is common to all, for it is used by Persians and Arabs (*narikela* Sanskrit, in Persian *nargila*, a name given to the 'hubble-bubble', or Indian smoking stand-pipe, from the shell of a coconut being generally used to contain the water through which the smoke from the tobacco bowl is sucked through a long, flexible serpentine pipe; and *nari-kela* simply means 'water spring' or 'squirt').

"Avicenna calls it Jauzialindi, which means 'nut of India' (Jauzulhindi, the Indian nut). Serapio and Rasis call the tree Jaralnare, which means 'the tree that yields Coco' (Jaralnari, the Naril tree). The Malabar people call the tree Tengamaram (the Southern Tree, *i.e.* introduced from Ceylon), and the fruit when it is ripe Tenga. The Malays call the tree Tricam (Trinarajah, 'King of Grasses,' is a Sanskrit name for the coconut palm), and the coconut Nihor."

It is also of interest (l.c. p. 141) to note that the word 'coir' comes from the Malabar Kayiru, the fibrous rind of the coconut (see also Watt, "Dictionary of the Economic Products of India").

niur (*niu*, *nu*), and everything points to these names being of great antiquity, thus lending additional support to the coconut belonging to this part of the world. Mr. S. H. Ray, in a letter to me on the matter, suggests that the fact of the coconut having other names among the Papuan and Melanesian peoples and traces of others in Indonesia seems to point to it being indigenous in the Islands.

In connexion with the Polynesian Islands being the original home of the coconut palm, Beccari (l.c. pp. 804-806), lays stress on the occurrence of the robber crab, *Birgus latro*, in these Islands. This remarkable crab is able to break open the coconut shell with its heavy chelæ by hammering with them on the 'eye hole' until a large enough opening is made for it to insert its small chela in order to extract the pulp or endosperm.[8] It also ascends the palms for the purpose of getting the nuts, and is said to put its abdomen into the shell and carry it about with it as a protection. Another interesting point suggesting that the association of the robber crab and the coconut must be of great antiquity is afforded by the fact that the crab uses the husk of the nut for lining its burrows. Beccari considers this association of the crab with the coconut affords further support to the view that the coconut originated in the Polynesian region. Geoffrey Smith, however, does not believe the association of the *Birgus* with the coconut is of very ancient origin, possibly because he accepted the information given him by Mr. Hedley, that the coconut was introduced to the Pacific Islands from Mexico by Polynesian mariners.

Although there is this remarkable association between the crab and the coconut, it is only right to point out that the crab is found on islands where there are no coconuts and vice versa, also that the crabs are commonly found on the fruit clusters of *Pandanus*, the screw pine, the individual segments of which are much chewed and squeezed by the crab.

F. W. Christian[9] gives the names *kuku* from Rarotonga and the Gilbert Islands and *kukuma* in the Marquesas for the robber crab, and also quotes the Arabic *khukum* (a crab), and the Maori *kuku* (to nip). These names suggest a possible connexion with the Portuguese *coco*. Dr. C. O. Blagden, however, who has kindly looked into the matter, has sent me the following letter, which shows that there are no grounds for connecting the name 'coco' with any native names of the crab.

On the face of it, it seems to me somewhat unlikely that the name of the cocopalm should have been derived from that of the land crab (or other crab), that preys upon it. Man is much more interested in the many uses he derives from the tree than in the crab; and the tree has, I imagine, a very much wider area of distribution than the crab.

As a matter of fact, however, the name of the tree does not, as a rule, resemble that of the crab. Its most diffused general name in the eastern islands from Madagascar to the Marquesas, is *niur*. Other names, such as *kelapa*, *kelambir*, and the Celebesian *kaluku* (of which *Koekoe*, *i.e.* *kuku*, may be either the primitive or the reduced form), are more local.

So, I should suppose, are such crab names as *kuku* and *kukuma*. In Malay and other Indonesian languages, such as Javanese, etc., there are two words:

(1) *Kuku*, claw, hoof, nail (of finger or toe).
(2) *Kukur*, claw, to claw, to rasp, probably variants of one word. (There is also a variant with a final *-t*, *kokot*, in some places.)

In practically all parts of Polynesia, from Fiji to New Zealand, and Hawaii to the Paumotus, are found derivatives of either (1) or (2) or both, in the sense of 'claw, nail, hoof', or 'to nip', and the like. As these languages tend to drop final consonants, it is difficult to say whether such words belong to (1) or (2). But apparently they do not generally mean 'crab'. It seems reasonable to connect these words with the local names of the crab. Compare Malay *ketam*, 'crab', but also 'to nip', found in several languages from Sumatra to the Philippines.

I do not think the Arabic *khukhum* can be more than a fortuitous case of resemblance. I do not know it.

As for the relation of all this to *coco*, I fail to see how it can be accepted in view of the fact that the word occurs in Vasco de Gama's Roteiro (1498) and in the book of Barbosa (1516), both written before Europeans got far enough east to reach the region where the cocopalm or nut is called *kuku*. The word seems to be quite European (Portuguese and Spanish).

The coconut is of great antiquity in Ceylon, and the earliest mention of it, Mr. Stockdale informs me, occurs in the "Mahawansa" in the reign of Dutthagamani, 101–77 B.C. Hsüan Tsang (II, p. 252), who travelled during A.D. 629–645, refers to coconuts in the Island of Na-lo-ki-lo (=Narakira—coconut=? Maldives), and says, "The people of this Island grow no grain but live only on coconuts". The Government Archivist of Ceylon also informs me that Sinhalese taxes on coconuts were in existence in pre-Portuguese times and were called *Pol watta-piediya* and *Polaya-panam* (*Pol* = coconut in Sinhalese, *watta* = garden). In Yule and Burnell's "Hobson-Jobson", the passages quoted referring to the 'Argell' or 'Great Indian Nut', from Cosmas, the Monk, *circa* A.D. 545 or A.D. 547,[10] and others lend further support to its Old World origin.

As opposed to the theory of the Polynesian origin of the coconut, Chiovenda (l.c. p. 398 and p. 449) holds the view that it originated in lands, now submerged, somewhere in the north-west of the Indian Ocean. He refers to Reinaud's records of the Indian, Albirunhi, in the eleventh century, who mentions the submergence of land in the region of the Laccadive and Maldive Islands, and of how the people of these islands, when fleeing for safety, took their coconuts with them. He also refers to fossil Cocoineæ, related to *Cocos*, having been discovered in Central Europe.

The fact that the early explorers found the Coconut palm of very limited distribution in tropical

(*Continued on p.* 151.)

[8] Smith, Geoffrey. "Cambridge Natural History", Crustacea, 4 (1909), pp. 173-175.
[9] "Eastern Pacific Lands." Appendix B, p. 234.

[10] See Yule, "Cathay and the Way Thither", i., p. clxxvi. (1866), and Cosmas, "Indico pleustes", book xi. "The Christian Topography of Cosmas", trans. and ed. by J. W. M'Grindle, p. 362 (1897). In Yule's "Hobson-Jobson", the etymology of the word 'coco' is fully discussed; see also Bayley-Balfour, *Ann. Bot.*, vol. i., p. 184, and Garcia da Orta, l.c. p. 139.

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Africa and Science.

By JAN H. HOFMEYR, President of the South African Association.

INAUGURAL ADDRESS DELIVERED AT CAPE TOWN ON JULY 22 TO THE BRITISH AND SOUTH AFRICAN ASSOCIATIONS.

TO-NIGHT I enter upon the consummation of what is at once the highest and the least merited distinction which it has been my privilege to receive. To those who called me to the office of president of the South African Association for the Advancement of Science I tender my sincere thanks. I make myself no illusions in respect of the adequacy of my claims to that honour on the ground either of scientific attainment or of services rendered to the cause of science, nor would I have our visitors remain for a moment without the knowledge that my scientific qualifications for this presidential chair are of the slightest. They are far less indeed than those of that distinguished statesman to whom, when he had remarked to the great Faraday in relation to an important new discovery in science, " But after all, what is the use of it ? " the scientist replied, " Why, Sir, there is every probability that you will soon be able to tax it."

The presidency of this Association is an honour the conferment of which upon myself has never seemed to fall properly within the scope of my ambitions ; it imposes responsibilities for the discharge of which I am all too scantily equipped ; and I can only seek to justify my election in a manner similar to that which Mr. Stanley Baldwin followed when he was chosen to be president of the Classical Association in England. I can but say that, while it is to the scientist that we look for the advancement and the progress of science, the effectiveness with which his work is brought to fruition does depend in some measure on the interest, the sympathy, and the enthusiasm with which his achievements are followed up by that army of plain, ordinary men, in which I gladly count myself a musket bearer. In no other capacity dare I venture to address you. It was once said by a literary man of some distinction that the man of science appears to be the only man in the world who has something to say, and he is the only man who does not know how to say it. There is an obvious rejoinder, that the man of letters frequently has nothing to say, but says it at great length. I dare not claim to be a man of science. I can only hope that I shall not be deemed to have qualified for consideration as a man of letters in the sense of that retort.

The honour which has been conferred upon me is the greater because of the special significance which attaches to my year of office. It is the year of the keenly anticipated second visit of the British Association for the Advancement of Science to South Africa, and for that reason my first words are, happily, words of welcome. Not merely the Association for which I speak, but also all South Africa, rejoices in the presence of the British Association and its distinguished members. To its parent body, which can look back upon all but a century of glorious achievement, this stripling Association brings its tribute of respectful admiration and goodwill. To the great organisation of scientific men, the history of which is the history of the advancement of science in Britain, which has a presidential roll adorned by names such as Brewster and Tyndall, Huxley and Kelvin, Rayleigh and Lister, this land of ours, mindful of its debt to science, conscious of the gifts that science can yet bring to it, extends the hand of friendship, in gratitude for the honour of this visit, and in appreciation of the stimulus to its progress and development which must needs attend it.

We have reason, indeed, to be grateful to the British Association for its achievement and its significance. If I might select three distinctive features in its record, they would be these. First, its contribution, direct and indirect, to those great triumphs of British science in the nineteenth century which are the possession not of an age, or of a nation, but of all time and of every land. Directly it has initiated, correlated, and contributed towards work of great scientific value; indirectly it has inspired much constructive activity, while its meetings year after year have done more than any other single factor to stimulate and hasten the onward march of science.

Next I would dwell on its maintenance of a broad view of the scope and function of science, and, coupled with that, the emphasis laid by it on the essential homogeneity of science conceived thus broadly, and the interdependence of its several branches. The Association had no lack of opposition to encounter at its coming birth. Those who interpreted science primarily in the medieval sense as being limited to the sciences of introspection had still but scant respect for the claims of the sciences of observation. When in the second year of its existence the Association visited Oxford, Keble protested vigorously against the University's reception of what he called a hodge-podge of philosophers. This hodge-podge, be it noted, included Brewster and Dalton and Faraday. But the Association did not react into narrowness. It remained true to the broad conception of *Scientia* which was held by its founders, one of whom affirmed in striking language at the first meeting, that "The chief interpreters of Nature have always been those who have grasped the widest fields of inquiry, who have listened with the most universal curiosity to all information, and felt an interest in every question which the one great system of Nature represents".

The Association has imposed no narrow restrictions on the extension of the sphere of its activity; within that ever-widening sphere it has maintained a spirit of co-operation between workers in diverse fields which has been worthy of the best traditions of Francis Bacon. It has had its reward—in greater effectiveness of work in its own sphere, and in the permeation of the kingdom of learning with the atmosphere of goodwill. By way of illustration of this last point, may I, as one whose first allegiance is to the classics, mention the fact that the roll of twenty-six presidents of the Classical Association of England includes five fellows of the Royal Society, names such as Geikie, Osler, and D'Arcy Thompson, and if it is not too presumptuously personal to refer to it, I would add, that when the South African Association elected me as its president, it chose one who was then president of the Classical Association of South Africa.

Lastly, I would select as characteristic of the British Association its success in maintaining the contacts of science with the public on one hand and the State on the other. One of the aims which its founders set forth was "to obtain more general attention for the objects of Science"; they sought to create a body which would make its appeal to the educated public as a whole, to fashion an instrument for the interpretation of the sometimes highly technical results of scientific investigation to the man in the street. They realised that the scientist received much from the public, that to the public he must freely give, and that the giving would not be without its due reward of new inspiration and renewed enthusiasms. There were some who opposed the nascent Association in the fear that science might degrade itself by making too popular an appeal. That fear has been belied in the passing of the years. The Association has kept touch with the public, it has "demonstrated to all men that science is thinking with them and for them", it has secured their interest and their sympathy, but it has never paid for that achievement the price of a lowering of its aims or of its standards. It is its success in this respect that has secured for it the prestige which has enabled it time and again to stand forth as the ambassador of science to the State, and so to play an important part in initiating and furthering enterprises of great national and scientific significance.

For these reasons and for much else, South Africa is proud and happy to be able to welcome and do honour to the British Association for the Advancement of Science. We welcome it the more heartily because of our consciousness of the greatness of our indebtedness to the first visit of the Association twenty-four years ago. To that visit, with which there will always be linked a name honoured in the history of South Africa, as it is in the annals of science—I refer to Sir David Gill—this country still looks back with grateful recollection. It marked the commencement of an epoch in our scientific history, the epoch of the consolidation of the position of science in South Africa.

Progress of Science in South Africa.

Let us view the position of science in our country as it was in 1905. On the academic side it is the nakedness of the land that chiefly impresses us. South Africa then had but one university, and it was in reality only a board of examiners for the candidates presented by various colleges, which were all, without exception, inadequately staffed and poorly equipped. In the subjects which fell within the scope of the Association, as it was defined in 1905, there were in all the colleges taken together in that year only forty-nine workers, thirty-three professors and sixteen others. When it is remembered that this was the total number of teachers of all branches of science spread over seven different institutions, all purporting to do university work, it is painfully obvious how little time was available for scientific research and investigation. Nor was the work done, measured in terms of the number of graduates, very impressive. The number of those who in 1905 qualified for degrees in pure and applied science was only twenty-seven.

Outside of the colleges, scientific workers were to be found mainly in government departments, then still small and inadequately staffed, and working in isolation in the four South African colonies. In most branches the State's scientific activities were still in their earliest infancy. The organisation was only just commencing to be built up. As part of these activities there fall to be mentioned the two astronomical observatories at that time in operation: the Royal Observatory at Cape Town, then already full of years and of honour, and the Johannesburg Observatory, which, thanks largely to the representations made by this Association of ours, had been established a few months before the 1905 meeting.

In regard to scientific societies there is but little to record. There was in existence in 1905 a small South African Philosophical Society (now known as the Royal Society of South Africa), the Geological Society of South Africa, the Cape Society of Engineers, the Chemical Metallurgical and Mining Society, and also this Association for the Advancement of Science, which had come into existence a bare three years previously. It was, indeed, the day of small things, and small also was the achievement which science in South Africa at that date had to its credit. If one leaves out of account the work of Sir David Gill and the scientific endeavour which had been put into the development of the gold-mining industry of the Witwatersrand, there is little indeed of permanent significance that remains.

Against this picture it is appropriate to set the picture of South African science as it will unfold itself to our visitors to-day. They will find three vigorous single-college teaching universities, which have in recent years made remarkable progress in the attainment of the standards of similar institutions in older lands, and also a federal university with six constituent colleges, which, like the single-college universities, are, in human and material equipment and in the output of the results of scientific investigation, very far ahead of their predecessors of 1905. Against the forty-nine workers of 1905 we can now set 429—134 professors and 295 others—within the range at present covered by the activities of this Association. The twenty-seven graduates of 1905 increased to 275 in 1928.

To the scientific societies of 1905 there have been added, since the last visit of the British Association, the South African Institute of Electrical Engineers, the South African Institution of Engineers, the Cape Chemical Society, the South African Chemical Institute, the Botanical Society of South Africa, the South African Biological Society, the Astronomical Society of South Africa, the South African Geographical Society, and the South African Economic Society, and this Association of ours has become an active, vigorous, and powerful body, proud of the achievements which it already has to its credit, challenging eagerly the tasks that await it in the future. The two observatories of 1905, our visitors will find, have increased to six, including the Smithsonian Solar Observatory in South-West Africa, and the equipment of these institutions includes four great telescopes, with objectives of 27 inches, 26½ inches, 26 inches, and 24 inches respectively, to which will shortly be added a 24-inch refractor and a 60-inch reflecting telescope—surely a remarkable astronomical equipment for so young a country. The stimulus of the 1905 visit, in which so many prominent European astronomers participated, has indeed borne rich fruit in the advancement of astronomical work in South Africa.

Perhaps our visitors will be impressed not least by the development and consolidation of the scientific departments of our Civil Service, by the magnificent Institute of Veterinary Research which the State has created at Onderstepoort and the effective work which through its scientific officers it is doing for the development of South Africa, and by the remarkably efficient and well-equipped Institute for Medical Research at Johannesburg, the credit for the establishment and maintenance of which falls jointly to the Government and the mining industry. Significant also of the attitude of the State to science, and full of promise for the future, has been the establishment of a Research Grant Board, which advises the Government on the practical measures necessary for the encouragement of scientific research in the Union, and acts as its agent in the distribution of grants in aid of individual investigations.

Nor have we reason to be ashamed of the positive achievements of science in South Africa during the past quarter of a century. Most impressive, perhaps, regarded cumulatively, have been the advances made in our knowledge of the diseases of plants, animals, and men, and of the methods of preventing them. In 1905 we knew practically nothing of the plant diseases of South Africa. In that year the first steps were taken towards their scientific investigation. To-day a general survey has been completed, most of the important diseases have been worked out, and a highly efficient service for combating them is in operation. In 1905 also the Transvaal Crown Colony Government voted £1500 as a first instalment towards the establishment of a laboratory for the investigation of stock diseases. From that has sprung the magnificent body of work in veterinary science which has won world-wide recognition for the Onderstepoort Institute which I have already mentioned. More recently there has been founded the South African Institute for Medical Research, to which is allied the Miners' Phthisis Medical Bureau. The researches conducted there in the control of pneumonic infection, and the advances made in industrial hygiene in the fight against silicosis, have brought great lustre to these two institutions and to South Africa.

In other fields also South African scientific workers have won recognition. In geology, marine biology, the mathematical theory of determinants, the economics of gold production, and along several other lines of investigation, important scientific work has been done in South Africa ; a succession of discoveries has been made throwing light on the origins of the human race ; and applied science has by means of the conquest of distance in this far-flung land of ours, and of the construction of important irrigation and other engineering works, contributed generously to South Africa's progress. It may, perhaps, be taken as a measure of the achievement of science in South Africa in one of its aspects that, while in 1906 the value of products of the land exported from South Africa amounted to £5,928,000, the corresponding figure for 1927 was £27,815,000.

If I were asked to select the most broadly significant feature in the development of science in South Africa since 1905, however, I think I would pick out what one might describe as its South Africanisation. In 1905 science in South Africa was in large measure exotic. The workers had come almost exclusively from other lands. They were only beginning to apply themselves to our South African problems. In many cases they had not yet acquired a South African background, or a South African outlook. In the years that have passed South Africa has claimed those workers for her own, and they have given themselves to her service. They to whom this is the land of their adoption, no less than those to whom it is the land of their birth, and whom they have taught and inspired, have made it the land of their vigorous and devoted service. In its personnel, science in South Africa has become essentially South African ; and science has given itself with enthusiasm to the problems of South Africa. It has emphasised the specific contributions of South Africa to the wider problems of science, it has applied itself to the removal of those obstacles which hamper the material development of South Africa, it has taken up vigorously the study of South African economics and sociology and anthropology. Perhaps also one may claim that it has brought to bear on scientific investigation what we regard as the distinctive features of the South African outlook—freshness and breadth of view, receptivity to new illuminations, and readiness to see old truths in new settings and in the light of their wider bearings. Is it not South Africa that has given to science and the world the conception of holism ? And there is surely no gift more worthily representative of the South African outlook at its best that we could have offered. It may indeed be that that very South Africanisation of our South African science of which I have been speaking is but another instance of the holistic principle at work.

As I speak of the South African outlook in science, I cannot but direct attention, with that deep appreciation which I know we all feel, to the masterly address which four years ago General Smuts delivered from this chair, when he demonstrated in so compelling a manner (I quote his own description of the task he set himself) " that there is something valuable and fruitful for science in the South African point of view, that our particular angle of vision supplies a real vantage point of attack on some of the great problems of science ; and that, so far from the South African view-point being parochial in science, it may prove helpful and fruitful in many ways to workers in the fields of scientific research and investigation ".

Science in South Africa, then, has made itself truly South African, and in doing so it has established itself in the admiration and affection of the people of this land. As a nation we are grateful to our scientists for their contributions to our intellectual and material progress. The liberal policy of the State in supporting scientific effort we heartily endorse; the increase in the mental stature and the prestige of the nation which science brings to us we sincerely welcome. We are proud of our South African science, not least because we know that we can regard it as distinctively ours. But while our science has been South Africanised, we can rejoice that there is nothing narrow about its South Africanism. Were it otherwise, it would have been false to the spirit of science. In applying itself to the problems of South Africa, it has succeeded in attracting the attention of the scientific world to South Africa. In that address to which I have already referred, General Smuts emphasised the fact that recent events had drawn the eyes of the world to this land of ours as a rich field for scientific investigation. "The scope for scientific work", he said, "in this department of knowledge" (he was referring more especially to human palæontology, but his words are of wider applicability) "is therefore immense; the ground lies literally cumbered with the possibilities of great discoveries. . . . Science has in South Africa a splendid field of labour; other nations may well envy us the rich ores of this great 'scientific divide' which is our heritage." Those words are well worth remembering. We speak sometimes of our wealth in South Africa—mineral wealth, agricultural wealth, potential industrial wealth—but great also is our scientific wealth, and great is the debt we owe to South African science for what it has done to reveal that wealth to ourselves and to the world.

There, then, in brief outlines, all too imperfectly drawn, is a picture of South African science in 1929. Contrast it with the picture of 1905, and you have the measure of the achievement of a great epoch. Science consolidated, science South Africanised, science recognised as of great national value, both in the spiritual and in the material spheres, science drawing to our country the eyes of the world—surely that is no unworthy achievement. As once more, after the lapse of many days, our Association makes its report to the parent body, to which it gladly pays the tribute of filial reverence, it does so with pride and satisfaction in the work of the intervening period, but also with grateful recognition of the inspiration which that visit of 1905 brought to South Africa as one of the constitutive factors in the progress of the last quarter of a century.

Leadership in Africa.

Now it has been our privilege to welcome this second visit of the British Association. Is it strange if we ask ourselves, as we gratefully remember the stimulus of 1905, what will be the stimulus of 1929? That visit had abiding results. What will be the results of this one? That visit inaugurated a new epoch. Are we not justified in believing that once again we stand on the threshold of a great advance? If that be so, what are to be the characteristics of the period on which we are now entering? What will be its achievement? In the period that followed the first visit of the British Association, we South Africanised science in South Africa. Is it too much to hope that in the next we shall Africanise it? Will not this visit perhaps give us the impulse and the inspiration to a bigger and a bolder enterprise? One of the most significant tendencies evidenced in South Africa in the last few years has been the growing consciousness of our obligations in relation to the continent of Africa. We have come to realise that the position of this European civilisation of ours set upon the verge of this great continent is a position of unique strategic importance, that it presents us with at once an opportunity and a challenge. While in the past we thought, as a nation, almost exclusively of our own problems and difficulties, we are now ceasing to limit our horizon by the Limpopo, we are beginning to envisage the task that awaits us beyond our own borders. In the mind of the nation there is being developed a new conception of South Africa, of a South Africa that consciously and deliberately seeks to play its part on the African continent, not aiming at conquest or domination, but never failing in its readiness to give its intellectual and material resources to aid all who are engaged in the task of developing this great undeveloped area of the earth's surface, which is so full of potentialities for the future welfare of the world.

If, then, South Africa aspires to leadership in Africa in other branches of activity, why not also in science? If the outlook of the nation is broadening, why should not its scientists also begin to think in continents? If as a people we are anxious to make our contribution to Africa, eager to give it of our best, rather than to get from it that which will be to our material advantage, why should not our science also become consciously and deliberately African in its outlook, its ideals, and the tasks to which it applies itself? If science has consolidated its position in South Africa, as we believe it has, is it not fitting that, with South Africa as its base, it should enter now into the new sphere of opportunity and achievement which stretches mightily outwards from its borders ?

To our visitors I look to give us the stimulus and the encouragement to that enterprise. You have come to Africa. This great land-mass which has reared itself against time's passage, almost since time's beginning, and holds inviolate so many of the records of that passage, has challenged your attention. You have come to Africa to seek new inspiration for the study of the problems that interest you, by seeing them against a different background which has for many of you an unaccustomed vastness. But while Africa was your goal, you did not think fit to enter it at the point nearest to your homes. You steamed down, day after day, skirting the long coast-line of this vast expanse of veld and forest, and have entered it by its southern gateway. For a great body of scientists it is the only point of effective entry into Africa. It is by way of this southern gateway that science itself can most effectively be made to permeate Africa. To you, having so come, to you, the ambassadors of science, I present—Africa. It is Africa and science, which, I would like to think, are to-day met together. Happy indeed should be the fruits of the mating.

Africa as a Field of Scientific Endeavour.

It is to that theme—Africa and science—that I propose now to invite your attention. What can Africa give to science ? What can science give to Africa ? Those are the questions to which I would address myself. But as I speak, I would ask you all to remember that it is for the South African scientist that the answers to these questions have primary significance. It is for him that they have significance, because for the solution of many of the problems of South Africa a greater knowledge of Africa as a whole than is at present available is essential, and the extension of that knowledge is his personal responsibility. It is for him that they have significance, because he dwells in a land which is strategically placed for attacking the problems of Africa and for drawing forth its hidden resources of scientific discovery for the enrichment of science throughout the world.

What, then, can Africa give to science ? In reply to that I can do no more than suggest some of the lines along which Africa seems to be called upon to make a distinctive contribution to science.

First there are the related fields of astronomy and meteorology. To astronomy I shall but make a passing reference. This continent of Africa, more especially the highlands of its interior plateau, with its clear skies and its cloudless nights, offers wonderful facilities to the astronomer. As proof of the necessity of utilising those facilities, especially with a view to the study of the southern heavens, I need but quote the words used by Prof. Kapteyn on the occasion of the 1905 visit: "In all researches bearing on the construction of the universe of stars, the investigator is hindered by our ignorance of the southern heavens. Work is accumulating in the north, which is to a great extent useless, until similar work is done in the south." Africa has to its credit considerable achievements in the past in the field of astronomical research. The increased equipment now available should make it possible to increase greatly the amount of systematic work now being done, and to offer important contributions to astronomical science.

Probably of greater importance is the work waiting to be done in meteorology. Few branches of science have a more direct effect upon the welfare of mankind—that is a lesson which we in South Africa should have learnt only too well—but in few has less progress been made. In meteorological work Africa is probably the most backward of the continents. It is not so long since Dr. Simpson of the London Meteorological Office declared that, save from Egypt, his office received practically no meteorological information from the great continent of Africa. Moreover, the backwardness of meteorology is in large measure due to the intricacy of the problems involved, and the necessity of having world-wide information made available. The problems of meteorology are emphatically not the problems of one country or of one region. The South African meteorologist must see his problems *sub specie Africae* (the seasonal changes in South Africa depend on the northward and southward oscillations of the great atmospheric system overlying the continent as a whole) ; and quite apart from what he can learn from the rest of Africa, the Antarctic regions have much to teach him. But while the development of meteorological research throughout Africa is of supreme economic importance for Africa, Africa in its turn has its contributions to make to other continents. In particular should we not forget the close inter-relation of the meteorological problems of the lands of the southern hemisphere. The central position of Africa in relation to those lands gives not only special opportunities but also special responsibilities for meteorological observation and research. For the sake both of South Africa and of science in general, I would venture to express the hope that this second visit of the British Association will give as powerful a stimulus to meteorology as did the first to astronomy.

Next, I would refer to Africa's potential contributions to geological science. Africa is a continent, portions of which have always had a special interest for the geologist because of the great diversity of the geological phenomena manifested, and the vast mineral wealth which, as its ancient workings so abundantly prove, has attracted man's industry from the very earliest times. But in our day the opportunities which it offers to the geologist to make contributions to the wider problems of science are coming to be more fully realised than ever before. Of special interest in this connexion is the light which African geology, more especially in the form of the study of ancient glacial deposits, can throw on the Wegener hypothesis of continental drift. In the past our geologists have thought mainly of the correlation of our formations with those of Europe. It is time that they paid more attention to their possible affiliations with those of the continents to east and west of us. If geology can establish the hypothesis that Africa is the mother continent from which India, Madagascar, and Australia on one side and South America on the other have been dislodged, it will give a new orientation to many branches of scientific activity. For that investigation also Africa occupies a central and determinative position in relation to the other continents, such as we have noted to be the case in the sphere of meteorology.

There are many other geological problems on which Africa can probably shed much light. There is, for example, the constitution of the earth's deeper sub-strata, in regard to which, as Dr. Wagner has recently pointed out, the study of the volcanic Kimberlite pipes, so numerous throughout Africa south of the equator, and of the xenoliths they contain, including the determination of their radium and thorium contents, may be of the greatest significance. There is the possibility that the exploitation of Africa's great wealth in potentially fossil-bearing rocks of presumably pre-Cambrian age will yet yield us remains of living beings more primitive than any yet discovered ; there are the great opportunities of study which the African deserts offer in the field of desert geology and morphology, and there is the assistance which African geology has rendered to vertebrate and plant palæontology, and can render to African anthropology in the investigation of this great museum of human remains and relics which we call the continent of Africa.

I pass on to medical science. I have referred already to the contributions to the study of the problems of industrial medicine and hygiene which the special circumstances of the South African gold-mining industry have made possible. Those contributions have, we may well hope, but prepared the way for advances of a revolutionary character in the early detection, prevention, and treatment of all forms of respiratory disease. But even greater are the opportunities which the continent of Africa offers for the study of tropical diseases, of which it may well be described as the homeland. In Africa there have been, and necessarily must be, studied the problems connected with malaria, blackwater fever, sleeping sickness, yellow fever, and many other scourges of civilisation, and from Africa there may well come hope and healing for mankind.

There are other problems of medical science for the study of which Africa is uniquely fitted. There are the physiological questions, important also from the political point of view, which bear on the fitness of the white races to maintain a healthy existence in tropical surroundings, at high altitudes, and in excessive sunlight. For these investigations the diversity of conditions prevailing in the various regions of the African continent make it a magnificent natural laboratory. There is the elucidation of the factors which account for the varying susceptibility of white and coloured races to acute infectious diseases, tuberculosis, and certain types of malignant disease, together with the light which such elucidation may throw on the physical and chemical composition of the human body.

Lastly, I would mention the exploration of that most interesting borderland between psychiatry and psychological science by an analysis of the mentality of the diverse African peoples. That investigation has an important bearing not only on the limitations and capacities of racial intelligence, but also on the methods which the ruling races in Africa should follow in seeking to discharge their obligations towards their uncivilised and unenlightened fellow-Africans.

Closely linked with medical science is the study of animal biology. In some instances the problems of the two branches of science are to be approached along parallel lines ; in others biological investigations are fundamental to the growth of medical science ; of no less significance is that unity which there is in Nature, making it possible for the truths of animal biology to be translated into facts concerning mankind. In the African continent there is no lack of opportunity to advance science by physiological inquiries into animal structure, by the isolation of the parasites of human and animal diseases, and by the tracing of the life-histories more especially of the minuter forms of animal life. "Nowadays," in the words of Prof. J. A. Thomson, "the serpent that bites man's heel is in nine cases out of ten microscopic." But scarcely less important are the extensive facilities which Africa still offers for the study of the habits and behaviour of the larger mammals. The naturalistic study of these animals, not as stuffed museum species, but in the laboratories of their native environment, has received all too scanty attention from the scientist, and this is a reproach which African science, with its rich dowry of mammal and primate material, may confidently be expected to remove. Nor will this study of animal behaviour, especially of those animals which approach nearest to the human type, be without its bearings on our investigations of the workings of the human mind.

If in this hasty survey I may take time to mention one more point within this field, I would refer to the results which await the intensified activity of the marine biologist and the oceanographer in the as yet all but virgin territory of the African coast-line. This Association of ours has long dreamed of an African marine biological station as broad in its conception and comparably as useful from the wider scientific and the more narrowly economic points of view as those of Plymouth or Naples or Woods Hole, and withal a rallying point for the naturalist, the zoologist, the botanist, the geographer, the anatomist, the physiologist, indeed for all those workers whose diverse problems meet at the margin of the sea.

Origin of Man.

From animal biology we pass by an easy transition to anthropology, the study of man himself. Here Africa seems full of splendid promise of discovery that may verify Darwin's belief in the probability that somewhere in this land-mass was the scene of Nature's greatest creative effort. It would seem to be not without significance that Africa possesses in the chimpanzee and the gorilla those primate types which approach most nearly the form and structure of primitive man. To that must be added that in the Bushman, Pigmy, and negroid races Africa has at least two and possibly three early human stocks which are characteristically her own and belong to no other continent. No less striking is the fact that in Gibraltar, in Malta, and in Palestine, that is, at each and every one of the three portals into Africa from Europe and Asia in Pleistocene times, there have been discovered evidences of the presence of Neanderthal man. In Africa itself there was found at Broken Hill some nine years ago a skull with the most primitive or bestial facial form yet seen, and so closely akin to the Neanderthal stock as to establish firmly the expectation of finding further compelling evidence of a long-continued Neanderthaloid occupation of the African continent. The discovery at Taungs on one hand, which reaches out towards the unknown past, and the finds at Boskop and in the Tsitsikama on the other, which assist in linking up the period of Rhodesian man with the coming of the Bushfolk, open up to us, in conjunction with the aforementioned facts, a vista of anthropological continuity in Africa such as no other continent can offer. The recent investigations in the Great Rift Valley, near Elmenteita in Kenya, and the fossil discoveries on the Springbok Flats, north of Pretoria, have again fixed the attention of the anthropologist on Africa.

Nor are the data presently available restricted to these discoveries. The efforts of archæologists, and the application of improved scientific methods in excavation, are giving us stratigraphical evidence of the succession of stone cultures which is of the utmost importance. I have already mentioned the assistance which geology can render in this work, but there is needed also the co-operation of those who labour in the converging fields of anatomy, archæology, palæontology, and comparative zoology. That co-operation has already commenced. In the investigation of the Vaal River gravels it has yielded important results, and we may look forward to its continuance and expansion in the years that lie ahead. Of the importance of African anthropology for the understanding of that of Europe there can be no question. Work of importance has already been done in the study of the relations between palæolithic art in Europe and palæolithic art in Africa. The significance of these comparisons is but emblematic of the importance of similar investigations in regard to stone cultures, rock engravings, ancient mining, stone circles and ancient ruins, methods of primitive mining and agriculture, tribal organisation, laws and customs, indeed the whole range of the hitherto unexplained or partially explained phenomena of living and extinct cultures. There is no lack of avenues which the student of African anthropology may follow in the hope of finding at the end of them results of supreme value for science in general.

I would speak next of the vast field, as yet almost uncharted, of phonological and philological study. Here in Africa we have great opportunities for the examination of linguistic problems, and some of them have bearings which extend far beyond the limits of Africa. One thinks first of the opportunities which Africa offers for investigating the results of the transplantation of languages which have a long history of cultural development behind them to regions inhabited by primitive peoples. Here there are two sets of phenomena, each with its own special interest. On one hand we have the modification of the languages of those European peoples who have established themselves in Africa as permanent settled communities, under pressure of the new linguistic influences with which they have been brought into contact. Of these phenomena the study of Afrikaans offers perhaps the best examples to be found in the whole field of linguistics—its importance for the student of comparative philology is very far from being adequately appreciated. On the other hand, we have those cases where European languages have come to Africa as the languages not of settled communities, but of officials and others like them who are but temporarily domiciled in this continent, and leave no descendants behind them to carry on the process of evolution of distinctive forms of speech. Here the phenomena which are of interest to the student of linguistics are to be found in the wealth of deformation and adaptation which the native populations have introduced in their endeavours to speak the European languages of their rulers. Work such as has been done by Schuchardt in Negro-Portuguese and Negro-French opens up a wide area of most attractive investigation.

The most important task in the field of African linguistics, however, is the actual recording of the native languages in Africa, our backwardness in respect of which is a reproach to science. Such study is, of course, important in relation to Africa itself, but of even greater significance for my present purpose is its bearing on scientific problems of wider scope. In that connexion I would suggest two points. We are still only at the beginning of the study of comparative Bantu. That in due course should lead to a knowledge of Ur-Bantu. Such a study and such a knowledge will necessarily be of importance to the comparative philologist, both because of the light shed by the study of one group of languages on the study of other groups, and also because it opens the way to the investigation of the relationship of Bantu to the other African tongues, and its place in the general scheme of the languages of the world.

Of even greater interest is the study of African languages as throwing light on the interpenetrations and interactions of primitive peoples. Language is a function of social relationship, and its study is therefore of great value for ethnological and historical investigations. May I give one instance of what I have in mind? Two millennia back, south-west Arabia was the seat of the powerful commercial civilisations of the Mineans, the Sabæans, and the Himyarites, radiating eastwards to India and south-westwards to Africa. The extent of their relationship with Africa it has hitherto been most difficult to trace, but linguistic evidence may prove to be of great value. Prof. Maingard has pointed out to me that the Makaranga who live near Zimbabwe call water *Bahri*, a word closely related in form to *Bahr*, the 'sea' of the Arabs, although the Makaranga themselves are not a seaboard people, and that *Shava* is their word for 'to sell or barter', while to the Himyarites *Saba* meant 'to travel for a commerical purpose'. Not less suggestive is the study of place-names, and while I do not suggest that I have evidence on which any conclusion can be based, I do contend that these investigations may prove to be of a most fruitful character. It would be interesting indeed to see what evidence linguistics can bring in respect of the relationship of South Africa with Madagascar, and also with Polynesia through Madagascar, where the tribe once dominant politically, the copper-coloured Hova, are ethnologically and linguistically Melanesians amid the darker-hued Sakalavas and other negroid tribes. It may even be that such studies will conjure up to our minds pictures of great migratory movements with Arab dhows and South Sea proas cleaving the waters of the Indian Ocean. Only last year a canoe constructed of wood native to south-eastern Asia was found in Algoa Bay.

Finally, in this survey of what Africa can give to science I would refer, with the utmost brevity perforce, to Africa as a field, favoured as is no other, for the study of all those complicated problems which arise from the contact of races of different colours and at diverse stages of civilisation. Of those problems, ranging from the investigations of the biological factors involved in the conception of race to the practical problems of the administration of backward peoples, I need not speak. They have come to be part almost of the everyday thinking of most civilised men. What I would emphasise is that in Africa, as nowhere else, the factors which constitute these problems can be studied both in isolation and in varying degrees of complexity of inter-relationship, that in Africa we have a great laboratory in which to-day there are going on before our eyes experiments which put to the test diverse social and political theories as to the relations between white and coloured races, that in Africa there are racial problems which demand solution, and the solution of which will affect or determine the handling of similar problems throughout the world. We hear men speak of the clash of colour, and are sometimes told that Africa is the strategic point in that struggle. I think of it rather as the continent which offers the richest opportunities to those who would investigate racial problems in the true spirit of science, and so discover the solutions, which may yet enable that clash to be averted and the threat which it implies to our civilisation to be dispelled.

Science and the Future of Africa.

I have sought—briefly and all too inadequately—to indicate some of the lines along which Africa seems to be able to make a distinctive contribution to science. It remains for me, yet more briefly, to speak of Africa's challenge to science, and to seek to answer the question, What can science give to Africa? I shall not stop to emphasise the point, that the greatness of Africa's potential contributions to science, the key which perhaps she holds to the riddle of human origins, the intriguing vistas opened up in the study of her relationship with South America and Australasia with its suggestion of past continental continuity, that all these and more constitute a challenge to science to actualise those potentialities. Let me seek rather to define the twofold challenge of Africa in another way. First, Africa defies science to unravel her past. Throughout history she has ever been the continent of mystery. She was so to that pioneer of geographers, Herodotus, to whom nothing that was told him about Africa was so improbable that he declined to give it credence. She was so to the Romans, who regarded Africa as the natural home and source of what was strange and novel and unaccustomed. She was so to the navigators who did so much to break down the barrier wall between the Middle Ages and the modern world; and though in our day the geographical mysteries of Africa have in large measure been solved, the work of the prober of her scientific secrets is only beginning.

Then, secondly, Africa challenges science to define, to determine, and to guide her future. If the great resources of this vast undeveloped continent are to be made available for humanity in our own and the succeeding generations, science must make it possible for the man of European race to undertake the work of development, by showing him how to protect himself, his stock, and his crops against disease, by enabling him to conserve and utilise to the greatest extent the soils, the vegetation, and the water supplies of the continent, by bringing to bear the resources of modern engineering on the exploitation of its wealth, and not least by determining the lines along which white and coloured races can best live together in harmony and to their common advantage.

That is the challenge of Africa to civilisation and to science. It is not now thrown out for the first time; it is not the first time that it will have been taken up. It is in Africa that the Greco-Roman civilisation won some of its most glorious triumphs, in Africa that the spade of the archæologist has in our day, by uncovering great Roman towns with noble public buildings and efficient irrigation systems, provided impressive evidence of the magnitude of the achievement of Roman Imperialism. But Rome failed to conquer Africa for civilisation, and left the challenge to those who were to follow after. She failed chiefly for two reasons: the might of African barbarism and the defiant resistance of African Nature. We in our day, confronted by the same challenge, still have the same enemies, hitherto victorious, to contend against. But we meet them with the advantage of having resources at our disposal which our Roman predecessors lacked. It is to use those resources effectively that Africa challenges science.

In dealing with African barbarism we have weapons such as Rome could never dream of, and not the least valuable are those provided by the scientific investigation of the native peoples of Africa. The way to the solution of the problems presented by African barbarism is to be sought in an understanding of the character and mentality of primitive peoples, in the exploration of those regions in their social life where are to be found the factors that determine their reaction to diverse methods of administration. The study of African languages and of African anthropology is therefore fundamental to the development of the continent. For that work Africa possesses special advantages, and one can but hope that the facilities now being built up in our South African universities will be recognised in Britain and elsewhere, and become an important factor in the response of science to the challenge of Africa.

Not less formidable is the conquest of African

Nature, for the achievement of which also we in our day are far better placed than were the Romans. It is modern science which gives us that advantage. Three great tasks confront science in the conquest of African Nature. First, science must make Africa safe for the white man to live in. I have spoken of the opportunities which Africa offers for the study of tropical diseases as likely to yield results of significance for science in general. But primarily, will those results be of significance for the development of Africa ? This part of the challenge of Africa is not lightly to be taken up. Africa has taken heavy toll of science. The recent deaths in Nigeria of Stokes, Young, and Noguchi, worthy followers in the tradition of Lazear and Myers, are a reaffirmation of the gravity and insistence of that challenge. The importance for the cause of civilisation of a successful response to that challenge cannot be better illustrated than by the story of the construction of the Panama Canal. De Lesseps attempted the task and failed. For every cubic yard of earth excavated by him a human life was sacrificed to yellow fever or malaria. It was the successful attack some twenty years later, under the direction of General Gorgas, on the death-dealing mosquito, that made possible the completion of one of the most important engineering enterprises of modern times.

Secondly, science must combat the foes which have to be contended with in the development of African agriculture. Africa is prodigal indeed in the production of insect and other foes to cattle and to crops. Science is already making an effective response to this part of the challenge. But there is much that remains to be done, and we shall be none the worse for the timely realisation by the politician and the administrator of the contributions which science can make. All too often in the past, settlement schemes have been undertaken and ended in disaster in areas unhealthy to man, beast, or crops, when, if the scientist had first been called in, precautions might have been taken which would have averted the calamity.

Finally, science must harness the great resources of Africa. Here there are suggested to us all the varied contributions which the engineer can make in the work of development. Has not the Institution of Civil Engineers defined the ideal underlying all engineering activity as "the art of directing the great sources of power in Nature for the use and convenience of man" ? Africa offers abundance of opportunities for the realisation of that ideal. It is not by working in isolation that the engineer will realise it, but rather by co-operation with his colleagues in other branches of science, and by the correlation and co-ordination of the essential data which they must do so much to provide. First in the order of engineering development come the civil and mining engineers. Their tasks are the provision of facilities for communication, for health, for the conservation of agricultural assets, for the production of raw material, and for the development of mineral resources. In their train there follow, with the advent of industrial activity, the mechanical and electrical engineers. Their tasks are to make the fullest use of the revolution in ideas of transport, including transport by air, which have resulted from the perfecting of the internal combustion engine, and to secure the maximum advantage possible from cheap production and efficient distribution of electrical power. The day must come, to give a concrete instance, when the Victoria Falls, with their immense water resources, will mean much more for Africa than Niagara to-day means for America. Later still there will be called in the services of the chemical engineer, ever engaged in problems of research to ascertain the most advantageous processes of converting raw materials into manufactured articles. In all these tasks it is the South African engineer who has, under the conditions of an undeveloped land, built up a technique and practice suitable to African requirements and showing promise of wider applicability, that we may well expect to assume a position of leadership and of inspiration. These are some of the ways in which science can respond to the challenge of Africa.

The picture which I set out to portray I have now completed. I have tried to suggest something of the magnitude of the rewards which Africa has in store for the scientist who has the enterprise to adventure and the vision to see. I have sought also to be the medium of the challenge presented to science by Africa's opportunities and needs. It is a vast canvas on which I have had to work. On it I have drawn but a few sketchy outlines. Yet I hope that the vision stands out clear. I hope that I have said enough to convey the power of its inspiration. Not least do I hope that our visitors will play a great part, in the time that they will spend with us, in filling in some of the details of the picture, and in quickening and vitalising its message for the scientists of South Africa. It is to them chiefly that it makes its appeal. The development of science in Africa, of Africa by science—that is the promised land that beckons them. I believe that they will not be disobedient to the vision.

Summaries of Addresses of Presidents of Sections.[1]

Cosmical Physics.

Lord Rayleigh's presidential address to Section A (Mathematical and Physical Sciences) is entitled "Some Problems of Cosmical Physics, Solved and Unsolved". He begins by reviewing the more outstanding cases of celestial spectra which still resisted identification after the discovery of helium. He traces how the strong lines of the nebular spectrum, formerly attributed to 'nebulium', were identified by Bowen as due to doubly ionised oxygen. He then goes on to the auroral spectrum, and after describing McLennan's investigations, which have led to the identification of the prominent green line as belonging to the arc spectrum of oxygen, he discusses the problems involved in the red line of the aurora, which up to the present has not been definitely traced to its origin. A nitrogen origin appears the most probable.

The spectrum of the solar corona is also regarded as an unsolved problem. Lord Rayleigh rejects the solution proposed by Freeman, who attributes the lines to argon. It is of interest that Russell and Bowen, in a paper which has appeared in the *Astrophysical Journal* since the address was prepared, have taken the same view.

Lord Rayleigh then discusses the conditions of excitation of some of these spectra. The theory of solar corpuscular streams is briefly reviewed, and some of the difficulties which have made it necessary to modify the original form of the theory as proposed by Birkeland. Reference is made to recent observation on echoes of short wave wireless signals, which are heard after an interval of several seconds. These echoes appear chiefly during times of magnetic disturbance, and Störmer has attributed them to reflection from the corpuscular streams of solar origin which exist in the earth's neighbourhood at such times. A very recent discussion by P. O. Pedersen adopts the same view.

The nebular spectrum, it is considered, is probably excited by ultra-violet light of short wavelength. Stress is laid on the peculiar richness in ultra-violet light of the central stars of planetary nebulæ, as emphasised by W. H. Wright before the origin of the nebular spectrum was realised. The mysteries still involved in absorption by the dark nebulæ, and in the excitation of cometary spectra, are also considered.

The address then passes to the discussion of the metastable states of excitation of atoms involved in the various spectra which have been discussed. Many of the lines of the nebulæ and the green line of the aurora are of the kind forbidden by the selection rules of the quantum theory in its present imperfect form. Laboratory experiments on mercury vapour, which is more amenable than oxygen or nitrogen to this purpose, have shown the possibility of observing such lines either in emission or absorption, in regions undisturbed by extraneous electric or magnetic fields.

After discussion of a few points in connexion with the layer of atmospheric ozone overhead, the remainder of the address is devoted to considering the cosmical possibility of unknown elements of higher atomic number than uranium, the highest known terrestrially. The list of elements is practically complete up to uranium, at which point it abruptly stops. It would seem, therefore, that any process of gravitational separation which has left heavier elements in the sun's interior, while eliminating them from the earth, must have succeeded in making an extraordinary clean and sharp cut. On the other hand, it appears that uranium must be coming into existence on the sun, as its duration is small compared with the probable age of that body. The analogy of radium would lead one to assume that uranium has a parent body of higher atomic weight. But such a parent body, if it exists, is *ex hypothesi* analogous to known radioactive bodies; thus even if we postulate it, we do not get any direct support for the view that matter may exist which is capable of dissolving entirely into radiation.

The Relation of Organic Chemistry to Biology.

In his presidential address to Section B (Chemistry) Prof. G. Barger traces various trends in the development of organic chemistry, particularly in relation to biochemistry and physiology. After directing attention to the isolation by Scheele of various organic acids and his synthesis of potassium cyanide, the address contrasts the early preparative investigation of natural products by some of the older chemists, such as Fourcroy and Vauquelin, with the work of others who were primarily inter-

[1] The collected presidential addresses delivered at the meeting are published under the title "The Advancement of Science, 1929". The volume is obtainable at 6s. of all booksellers or from the British Association, Burlington House, London, W.1.

ested in theoretical questions of radicles, substitution and types. This latter work led ultimately to the theory of structure, which soon became ground common to all.

A knowledge of structure gave a great impetus to synthesis, on which important industries were based. The number of known carbon compounds increased very rapidly and is now little short of a quarter of a million, but only a small proportion of these occur in Nature and a very small proportion are of general biological interest. The first systematic investigation of a whole group of biologically important substances was that of the fats by Chevreul ; similarly comprehensive investigations of metabolic products were made later in Germany by Baeyer, Fischer, Willstätter, Wieland, and Windaus, when they applied organic chemistry to the study of the purines, sugars, proteins, plant pigments, bile acids, and sterols. A statistical analysis of papers on organic chemistry published during the last year in the *Berichte* and the *Journal of the Chemical Society* leads to the conclusion that British organic chemists are more interested in theoretical questions than their German colleagues and give much less attention to natural products.

The new borderline subject of biochemistry, based largely on the work of van 't Hoff and of Emil Fischer, may be said to have been definitely marked out early in the present century ; thus in 1906 journals devoted to biochemistry were founded in three separate countries. The biochemist is not only concerned with the properties *in vitro* and the isolation of biologically important substances ; he also studies the transformations which these substances undergo *in vivo*, when acted on by enzymes. These two sides of the subject have been called the descriptive and the dynamical. Both utilise to the full the resources of organic chemistry, its theoretical conclusions as well as its technique. In addition, the biochemist gives much attention to the working out of special methods of preparation and of analysis, required for the study of the complex problems with which he is concerned. These various aspects and relations of biochemistry are illustrated in the address by reference to recent investigations.

The taxonomic value of organic chemistry is very slight, except in the classification of bacteria, fungi, and lichens. Among Phanerogams the chief example of its utilisation is probably the genus *Eucalyptus*. The organic chemist may turn natural relationship to account in his study of alkaloids, but the systematic botanist is not influenced by their presence or absence.

Prof. Barger ends by pleading for a sympathetic teaching of organic chemistry, adapted to the needs of biological and medical students, and in this connexion quotes with approval from the presidential address to Section I by Prof. Lovatt Evans at Glasgow in 1928.

National Surveys.

The subject of Brigadier E. M. Jack's address to Section E (Geography) is national surveys. The duties and functions for which, in the opinion of the president, a national survey should be responsible, are discussed ; then the work of the various national surveys, both foreign and in the Empire ; and conclusions are drawn, with particular application to South Africa.

The main object of a survey is held to be the production of a map. The various operations necessary for this object are enumerated, and it is argued that a properly organised survey should be responsible for all these operations, from the initial triangulation to the printing, publication, and sale of the map, and its subsequent revision.

The question of maps is considered under the two main headings of cadastral and topographical. The characteristics of these two kinds of maps are described, and the opinion expressed that a national survey to be complete should be responsible for the production of both kinds.

Proceeding to a consideration of the surveys of the world, it is shown that the surveys of Europe have similar characteristics. They are mostly military in character, and their responsibility is confined to the production of topographical maps. Cadastral maps are produced by an independent department (usually financial) and are rarely published. Egypt forms a striking contrast, its survey (due to British organisation) conforming closely to the standard laid down.

In the United States various independent departments are responsible for different branches of survey. There has in the past been much independent action and doubtless some friction ; but co-ordination has now been secured by the establishment of a Federal Board of Surveys. Very much the same description applies to the surveys of Canada.

The Survey of India produces only topographical maps. In Australia and New Zealand, on the other hand, topographical mapping is much neglected. Information is given as to various surveys in the African Colonies and Protectorates. A short description is then given of the Ordnance Survey of Great Britain.

The question of countries which have a divided control of their surveys or have neglected some part is considered, and it is shown that such countries have suffered in consequence.

The position in South Africa is then considered. The recent Survey Act of 1927 has put survey in the Union in a much sounder position than it has ever been before. While responsibility remains divided between the Surveyors-General of the four Provinces and the Director of the Trigonometrical Survey, a 'Survey Board' has been established, consisting of these five officials. While this does not go so far as the Survey Commission of 1921 recommended, it is a great step forward in securing unity of control and uniformity of practice.

After touching on the difficult question of cadastral mapping in the Union, the question of a good topographical map of the country is discussed. Examples are given, taken from South Africa itself and from other countries, of the great need for such a map, and of the waste of time and money which results from the lack of it.

In conclusion, it is pointed out that South Africa has a great survey tradition, some of the finest survey work in the world having been done in the country. South Africans are urged not to lag behind, but to set an example to others ; and to be determined to have a national survey adequate to their place among the nations, and worthy of their history and great traditions.

Physiology in the Treatment of Disease.

Prof. W. E. Dixon's presidential address to Section I (Physiology) reviews briefly the history of treatment in disease from the middle of the last century, when S. Skoda and K. Rokitansky (in Austria) perfected a system of physical diagnosis which has had a practical bearing on medicine ever since. Skoda made many experiments with drugs on the patient without any expectation of producing benefit ; the patients were not improved, and Skoda thought it mattered little how the patient was treated. These views held the field even to the beginning of the present century, especially in Great Britain.

The experiments of Joig and his pupils in 1825 with camphor, digitalis, and other drugs on healthy men added nothing of value to our knowledge. Subjective sensations are produced, which are erroneously attributed to the drug which has been taken. Some experiments made with the late Dr. Rivers to illustrate these imaginary sensations were described. Such experiments on men as were made by S. Hahnemann and his pupils, by Perkin with his retractors, and by more modern physicians with their mystic apparatus, are valueless without proper controls. The influence of science on treatment is illustrated by reference to chemo-therapy and the internal secretions.

At one time hopes ran high that the chemical structure of the molecule might indicate pharmacological action. During the last fifty years, many laborious researches have been conducted with this object ; to modify the molecule that it may conform to some required action. But the mystery remains as mighty as ever. It is most probable that subtle energy factors binding the molecule—factors not displayed in a formula—control the action ; certain it is that drug action is not determined directly by chemical combination with body constituents, but rather by delicate physical processes such as those of absorption, solution, and surface tension. Illustrations are provided by action of the organic compounds, of the metals, dye-stuffs, and certain alkaloids.

In the last twenty years, much evidence has accumulated to show that the glands of internal secretion are responsible for the regulation of growth, of metabolism, and often for our appearance if not for our very character. Exaggeration or diminution in the secretion of one or other of the tissues may induce conditions so decided as to be obvious to everybody, though the effects produced by minor alterations in the co-ordination of the several secretions may not be so evident. Giants and dwarfs, unusual pigmentation and anæmia, disproportion in the growth of the skeleton, such as enlarged hands and face, bulging deer-like eyes or oriental eyes and beards in women, are noticeable to everyone ; excessive fatness or emaciation, a choleric or bucolic temperament, cause no comment, yet may equally arise in the victim from a want of co-ordination in the internal secretion.

The general outlook and significance of drug therapy was led into new channels when it was revealed that the animal body through these glands elaborates its own drugs, stores them generally at the seat of formation, and doles them out to the tissues to meet the needs of the economy. Some of these drugs are of the nature of alkaloids comparable with those elaborated by plants. It is a remarkable fact that when Nature elaborates a drug in either a plant or an animal, that drug is invariably the ideal drug for producing the action for which it is characteristic. No drug relieves pain like morphine or produces local anæsthesia so well as cocaine ; no drug paralyses the parasympathetics so perfectly as atropine or the motor nerves so effectively as curarine ; strychnine supersedes all other drugs in exaggerating spinal reflexes, and caffeine in its remarkable power of stimulating the psychical centres of the brain. Of the animal drugs, adrenaline has a superlative effect on the sympathetic system, pituitary on the uterus, and thyroxin on general metabolism.

The elaboration of the drugs in Nature is on biological lines and the key always fits the lock: it seems as if Nature always says the last word on the particular type of drug she elaborates. Certainly organic chemists have up to now done little to improve on her products.

In conclusion, Prof. Dixon remarks that science is now engaged in endeavouring to remedy the evil effects which she has produced, to which he attributes tuberculosis, rickets, and especially the neurotic tendency in the highly civilised nations.

Experimental Method in Psychology.

The topic dealt with by Mr. F. C. Bartlett in his presidential address to Section J (Psychology) is the value and difficulties of experimental method in psychology. The earliest experimentalists in psychology were physicists and physiologists, most of them with a pronounced philosophical bias. They developed methods and set up standards which in various ways have hindered the growth of psychology as a true biological science. The physicist, approaching any problem of human reaction, tends to lay the chief burden of explanation upon the stimulus, by the simplification, control, and variation of which he explains observable differences in response. The stimulus is treated as outside the response itself. The difficulties to which this may lead are illustrated by special reference to the psycho-physical methods developed by Fechner, G. E. Müller, and others, and particularly by a consideration of how 'doubtful' judgments have been dealt with in psycho-physical series.

The physiologist, approaching similar problems, tends to lay chief stress upon the response side of the stimulus reaction situation. He legitimately isolates this so far as possible, often cutting it out of its wider organic setting, and shrinking from speculation about central processes until he has learned as much as possible about peripheral processes and their mode of operation. The experimental psychologist has often tried to borrow the physiologist's terminology, but since he has to try to deal with the intact organism, the wide variability of response when it occurs in its normal setting constantly forces him back upon central processes, and he may tend to lose himself in sheer speculative physiology of the central nervous system. This is illustrated by a reference to experimental work upon the special senses.

In dealing with so-called 'higher mental processes', the experimental psychologist has again far too often attempted to imitate the methods of older established sciences. Extreme simplification of stimuli has regularly been confused with isolation of response, with disastrous results. This is illustrated by a study of the classical experiments of Ebbinghaus on memory, and by a consideration of experimental work on recognition.

Not only has the experimental psychologist been too submissive to physical and physiological methods, but also he has often been misled by the pursuit of philosophical ideals. The results of experimentation upon some special field of human reaction have frequently been elaborated into very wide systems of explanation which claim a finality that they certainly do not possess. This is considered in reference to contemporary movements, and particularly to the work of the *Gestalt* psychologists, of Prof. E. R. Jaensch, of Prof. C. E. Spearman, and of the behaviourists.

In psychology, the experimentalist is attempting to find out the conditions of the various responses or modes of conduct that make up the lives of animals and human beings. He is primarily interested in the intact organism and the intact mental life. He may gain help from a study of instances in which certain types of response have been lost, leaving still a very complex organism, or mental life, to effect a readjustment of what remains. This is clearly a very different matter from cutting out the partial response and studying that by itself. The perfecting of objective control, in a psychological experiment, does not reduce the observer to a single sense, or a single cognitive or emotional process, but, leaving him as complex a reactive agent as ever, forces him to make up on the spot a type of total reaction fitted to this special experimental environment.

The main conclusions drawn are: (1) The experimentalist in psychology is at present, and perhaps always will be, as much clinician as experimenter. He must bear in mind that the conditions of all reactions studied from his special point of view branch very widely, and that to him the study of indirect cues leading to any response may be of primary importance. (2) No experimentalist in psychology must profess, with unvarying belief, the dogma of constancy of objective conditions. Many of the most important characters that dominantly set the course of human reactions belong directly to the organism with which the experimentalist is dealing, to its immediate and remote past history, and to its present specific and general state of adaptation. These characters may be more diversified by rigidity than by variation of outward circumstances. (3) Since the psychologist is dealing with biological phenomena, he must be satisfied by stating trends, directions, proclivities, rather than dogmatic laws. (4) There is need for much more critical care than has usually been exercised before the results of specialised investigations are erected into comprehensive 'explanatory' systems.

If these conclusions are held firmly in mind, experimental psychology will yet prove equal to its task of building up a sound scientific study of complex response in animal and man.

Modern Movements in Education.

In his presidential address to Section L (Educational Science), Dr. C. W. Kimmins deals with changes in the field of education since the meeting of the British Association in South Africa in 1905. The most important development during this period has been the concentration of interest on a hitherto comparatively neglected field of investigation—the mental welfare of the pre-school child. In this connexion a brief account is given of the valuable researches on animals of Köhler and Yerkes, which throw much light on the early stages of the learning process in the child. The necessity of making the young child the object of a long series of conditioned experiments—even if this were possible—is thus obviated.

Reference is made to the great difficulty of bridging the gulf which separates the child's world from the adult world, and of thus acquiring a fairly adequate conception of the real meaning of the child's language in adult terms. The value of the work of Prof. Jean Piaget and his colleagues in helping to solve this problem is fully recognised by all students of child-psychology.

When the age is reached for compulsory school attendance, and there becomes available a large mass of valuable material for observation and experiment, the task of the investigator is rendered a comparatively easy one. In the pre-school period, however, the absence of such material under suitable conditions is a serious matter. The Fisher Act of 1918, with the prospect of the establishment of a large number of nursery schools, gave promise of removing this disability, but, unfortunately, financial difficulties prevented the full realisation of this desirable project.

Quite apart from the value of the nursery school for purposes of child study, there are many obvious reasons for pressing forward the demand for the recognition of this type of institution as a natural element in any progressive scheme of educational organisation. The nursery school links up the home with the school to the great advantage of both. Properly constituted, moreover, it may to a large extent prevent many of the maladjustments with which the school clinics and child guidance clinics have to deal. Prevention by natural means is infinitely better and far less expensive than curative processes.

The value of vocational guidance by means of appropriate psychological tests, in giving increased facilities for the more successful marketing of the produce of our schools in the future, is dealt with in some detail. The experiments carried on under the direction of the National Institute of Industrial Psychology have been crowned with considerable success. In days to come, boys and girls on leaving school will be in possession of information, based on scientific principles, which will indicate the type of employment in which they can engage with the greatest satisfaction to themselves and to their employers.

The pamphlet of the Board of Education entitled "The New Prospect in Education" is far and away the most important document which has been issued by the Board in recent years. The reorganisation of educational procedure envisaged marks a great advance. This valuable reform occupies in many ways a very prominent and honoured position among modern movements in education.

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America may be held to militate against its American origin and rather support the view that it was an introduced plant. Further evidence in support of the eastern origin of the coconut and also of its power to spread independently is afforded by the fact that several islands all grouped together bear the name Cocos Island or have a 'Cocos Bay'. These islands were apparently uninhabited at the time of their discovery and received their names no doubt owing to the fringes of coconut palms on their shores, as it was the tendency of the Portuguese and Dutch in the sixteenth and seventeenth centuries to name uninhabited islands by some distinguishing feature they presented.

Another fact which lends some support to the views of De Candolle, Beccari, Chiovenda, E. D. Merrill,[11] and others, that *Cocos nucifera* is of eastern rather than American origin, is afforded by the recent discovery of fossil nuts of a *Cocos* in the Pliocene deposits at Mangonui, North Auckland, New Zealand. These have been named *Cocos zeylandica* by Edward W. Berry,[12] and, though they are quite small, they show no marked features, except as regards size, to differentiate them from the existing genus *Cocos*.

O. F. Cook has taken infinite pains to try to prove that the Coconut palm originated in South America, but many of his arguments may equally well be used in support of its Polynesian origin. With regard to the antiquity of the palm in America, he lays some stress on the finding of a carved coconut shell in a grave in the Chiriqui district on the Pacific coast of Panama. This bowl is figured in Cook's "History of the Coconut Palm in America",[13] but it is not stated whether the grave was a prehistoric one or not. I am informed by the authorities at the British Museum that the design on the carved shell is certainly not aboriginal American, nor does it resemble anything from the East Indies at all closely. It is considered far more likely to be "a post-Spanish American product influenced by European designs such as were used by Indians in many parts of America after the arrival of the white man".

The highly polished coconut cups of Spanish South America are mentioned as a suggestive analogy, and also the similar floral patterns of modern Indian painted pottery, etc.; it is not thought that the carved shell carries any weight as evidence either for or against the American origin of the coconut palm.

The fact of the finding of some particular bowl in a country needs some further support in the way of evidence, to prove that it may be a product of the country where it has been found, since a good deal of false deduction might be based on the finding of shells of the double coconut (*Lodoicea*), in India, where they are used as drinking bowls and for other purposes.[14] Cook also attaches importance to the occurrence of coconut palms on Cocos Island, situated in the Pacific Ocean some 300 miles to the west of Panama, which since the coming of the Spaniards has not been inhabited and the coconut palms have almost disappeared. After considering the various suggestions made by Cook, there seems to be nothing against the view, held by De Candolle, that the coconut palms on this island might have been brought there by early Polynesian voyagers. From this island, or more possibly by the landing of some of these early voyagers on the Pacific coast of Central America, they became established on the mainland and were in the course of time carried far and wide.

Mr. H. C. Sampson, who carefully studied Cook's work, has kindly supplied me with the following notes:

The three main points raised by Cook are:

1. That the coconut must have plenty of soda salts for it to thrive. Therefore it must be a native of those parts of America where such alkali abounds in the soil.
2. That the coconut will not establish itself on a coast-line without the aid of man.
3. That the fibrous covering on the coconut is intended to hold a supply of moisture for the roots of the young seedling and not to act as a float.

As to 1. Coconut palms are able to stand a high percentage of soda salts in a soil provided there is very free drainage and aeration. Where these are absent the tree immediately becomes unhealthy. Tidal action on a sandy sea coast supplies the necessary drainage and aeration, hence trees on a sandy sea coast are usually healthy, while those facing a lagoon or backwater are unhealthy. Health, according to Cook, is the ability to form fruit; but this is not so. Healthy trees need never bear fruit. They will, however, bear fruit if the necessary plant food is made available to them in the soil. Coconuts will grow quite well in soils deficient in soda salts. This has been proved by the Bombay Department of Agriculture, when the Government of that Presidency was considering the question of remitting the duty on salt required for the purpose of manuring coconut trees in the Konkan and in North Canara.

I myself have seen coconuts doing very badly on soils which were inclined to be alkaline, though the trees were afterwards made to bear heavily by breaking up the alkaline pan, which one usually sees associated with such soils.

With regard to 2. I have seen self-sown coconuts establishing themselves on the cays off Belize which are being formed in the shallow water. The young palms are able to compete for light with the young mangrove which under such conditions is inclined to remain stunted. The coconut groves on the east coast of Trinidad in the region of the Cocal are undoubtedly self-sown. These are said to have originated from the wreck of a French schooner laden with coconuts. One sees the trees growing in clumps often four or five together or in close proximity, which would not be the case had they been planted by man. That coconuts do not do this more frequently is due to two causes: First, that though the seed may germinate it cannot survive where the shore vegetation is liable to overshadow the seedlings, and secondly, in the open

[11] Merrill, E. D. "Enumeration of Philippine Plants", Bureau of Science, Manila, vol. 4, pp. 70-71 (1926), also "Notes on the Flora of Manila with special reference to the introduced element", *Philippine Jour. Science*, vol. 7, pp. 168-192, 197, etc. (1912). Dr. Merrill informs me he has now altered the views expressed in his footnote on p. 192, and does not agree with Cook as to the American origin of the coconut.

[12] Berry, E. W. *American Jour. Science*, **12**, No. 69 (September 1926). Specimens of these nuts were kindly sent to Kew in March 1927, by the curator of the Auckland Museum and are now exhibited in Museum No. 2.

[13] Cook, O. F. l.c., Plate 53, p. 288; 1910.

[14] See "Treasury of Botany" and Kew Guide to Museum 2 and specimens in the Museum.

glare of an exposed beach it is not possible for the husk to retain sufficient moisture to enable the young roots of the coconut to feed on the husk.

With regard to 3. It is very difficult to get coconuts to germinate in a dry climate without initial shade and constant watering. The fruit when it is ripe gives up its moisture from the husk, and it can only get this again by coming into direct contact with moisture either from the soil or from continual rain. Thus on the sandy coast soils of Ceylon and southern India, seed coconuts have to be nearly buried in the sandy soil, which has to be kept continually moistened, and even under such conditions germination is much slower than it is in countries with a more evenly distributed and heavier rainfall.

It is clear that natural regeneration would be impossible for the coconut in a dry country such as Cook claims to be the natural home of the coconut. It seems to me much more likely that the coconut was taken to America by immigrants arriving there prior to the discovery of that continent by western civilisation than the reverse.

Turning now to the mode of dispersal of the coconut:

The sight of the Cocos-Keeling Islands, or Atolls, in mid-ocean on the direct route from Ceylon to Western Australia, and some 700 miles to the south-west of Java and the Straits of Sunda, led me to look into the early history of these Islands and search for records of the occurrence of coconuts on other uninhabited islands in the Pacific Ocean.

Coconut palms were well established on these uninhabited Islands when Captain Le Cour visited them in 1825,[15] before Captain Ross arrived there that same year, for he " carved his name on the Palm trunks ". H. B. Guppy brings together some very interesting evidence in connexion with the coconuts growing on the Cocos-Keeling Islands.[16] In a general map of the Eastern Archipelago, published in Amsterdam in 1659, they are named the Cocos Islands, showing that the coconut palm was then a feature of the group. Again, in Jan de Marre's plan of the islands in 1729, coconut palms are figured with the simple, yet probably unintentionally true, remark : " it would seem that Nature herself has produced these trees ", and in 1753 Van Keulen described them as being wooded.[17] Further, some fifteen or sixteen years before the islands were occupied (see Horsborough's " India Directory ", 1809), it is stated that they were " covered with trees, principally the Cocoa-tree " (=coconut palm).

Charles Darwin visited the Cocos-Keeling Islands[18] in the year 1836, some ten years after their rediscovery, and found them thickly covered with full-grown coconut palms. He points out that at one time they must have existed as mere water-washed reefs, and therefore " all their terrestrial productions must have been transported by the waves of the sea ". It is also of interest that Darwin refers to the occurrence of *Birgus latro* on these islands, and this suggests that both coconut and crab were brought to the islands by the same means.

From this evidence it appears certain that the coconut palms on the Cocos-Keeling Islands were established there when they were uninhabited, and there is also strong probability that they were the result of ocean-borne nuts which had drifted there, with many other seeds from the east, as Guppy points out. From information kindly supplied by the Hydrographer to the Royal Navy, I find that the general trend of the ocean currents in this region is from the east, westwards, so that any flotsam and jetsam reaching the islands would tend to come from Java or Sumatra or from the Sunda Straits.[19] It seems not unreasonable to assume that the original nuts which have given rise to the coconut groves on the Cocos-Keeling Islands reached there as ocean-borne nuts from the islands to the east, and this supposition may be held to give some additional support to the view that the islands of the Eastern Archipelago of the Pacific Ocean should be regarded as the original home of *Cocos nucifera*.

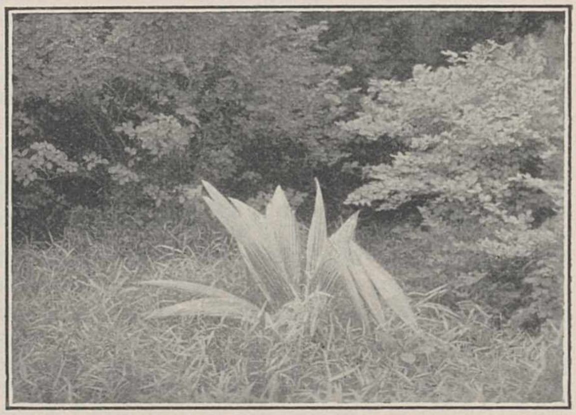


FIG. 1.—Young coconut among *Ischæmum muticum*; background, *Desmodium umbellatum*. Krakatau.

It is, of course, true that young sprouting coconuts on the strand are constantly destroyed by the land crabs, but it seems not unreasonable to assume that a few nuts, out of the many which must have been washed ashore, would have been covered by drift sand and so protected from the land crabs, and that from those which successfully germinated the dense groves of coconut palms on these and on other uninhabited islands had their origin.

Wood-Jones mentions that water-borne coconuts can be seen germinating all round the lagoon shores of Cocos Island, and adds there is " no reason to suppose that any human agency was involved in the first planting of the coconuts in Cocos-Keeling ".

The coconut palms now growing in the Bay of Cocal, Trinidad, are reputed to have resulted from nuts washed ashore from a ship wrecked on the coast, and also, as mentioned earlier, on some of the cays which are being formed off the coast of British Honduras self-sown coconuts may be seen.

[15] See Wood-Jones. " Coral and Atolls ", p. 5, p. 17; 1912.
[16] Guppy, H. B. " The Dispersal of Plants as illustrated by the Flora of the Keeling or Cocos Islands, Victoria Institute " (1890), pp. 2-5.
[17] Van Keulen's " Atlas ", vol. 6, Amsterdam, p. 19; 1753.
[18] Darwin, Charles. " Voyage of the *Beagle* ", chap. xx.
[19] Darwin, in the " Voyage of the *Beagle* ", quotes Holman's " Travels ", vol. 4, p. 378, where an account is given, on the authority of Mr. Keating, of seeds, etc., from Sumatra and Java, washed up on the Cocos-Keeling Islands. Among them were " the cocoa-nut of Balci, known by its shape and size ".

Coconut palms are also found on small rocky islets off some of the Fiji Islands, where evidently the nuts have been cast up by the sea and could never have been planted.

Guppy, in his paper on the Cocos-Keeling Islands (*loc. cit.*), produces weighty evidence to show that the coconuts there must have been water-borne and have germinated when washed up on the strand. He also brings evidence in support of the contention that the coconut is able to germinate without human intervention when washed up on Fijian beaches, whether brought down by a river or transported by an ocean current.[20]

Leguat, in his account of the Island of Rodriquez (1691),[21] says: "The sea having thrown us up some Cocos which began to bud, we planted some of the fruit some months after our arrival, and when we left the place the trees were four feet high." These nuts he believed came from the Island of Ste. Brande. There are also two islands called Coco and Cocos in this region.

A definite proof that the coconut will germinate unaided when washed ashore has been afforded in the case of the Island of Verlaten, which lies to the north-west of the Island of Krakatau in the Straits of Sunda, between Java and Sumatra. Verlaten Island, which is uninhabited and uninhabitable, was visited in April 1919 by Dr. W. Docters van Leeuwen, now Director of the Botanic Gardens, Buitenzorg, and he records,[22] with a photograph, the finding there of a coconut palm sprouting in the drift mud—an accretion of soil containing pumice stone—at only a few yards distance from the sea. This proves conclusively that an ocean-borne coconut can germinate without human aid, as Beccari asserted, and refutes the opinion of Hugo de Vries, O. F. Cook, and others.

When I was in Java in March 1928, Dr. Docters van Leeuwen very kindly gave me prints of two photographs of two young coconut palms, similar to the one on Verlaten, which he found growing on the beach of the Island of Krakatau (Fig. 1), which since the great eruption of 1883 has remained uninhabited. In one case the young palm is partly overgrown by *Ipomœa denticulata*; in the other, here reproduced, the palm is growing amongst the grass *Ischœmum muticum* and, despite the competition with other vegetation, they both appear to be holding their own quite successfully. These observations afford satisfactory evidence that ocean-borne nuts can germinate when washed ashore on an uninhabited island and become established without the intervention of human agency, and the evidence which has been brought forward may be considered to strengthen the view that the Polynesian or East Indian Islands are the original home of the coconut palm.

[20] Guppy, H. B. "Observations of a Naturalist in the Pacific", vol. 2, p. 436.
[21] "The Voyage of Francois Leguat", vol. 1, p. 65 *et seq.*, Hakluyt Society.
[22] Docters van Leeuwen, Dr. W. *Ann. Jard. Bot. Buitenzorg*, **31**, p. 114, Plate xxi.

Obituary.

PROF. L. T. HOBHOUSE.

THE death of Prof. Leonard Trelawny Hobhouse on June 21, at the age of sixty-four years, at Alençon, Normandy, is a heavy loss to science and philosophy. Martin White professor of sociology in the University of London since 1907, he has done more than anyone else in England towards the development of sociology as a scientific discipline; he has made contributions of the highest value to comparative psychology and anthropology; and his work on logic and metaphysics must entitle him to rank among the most distinguished systematic philosophers of recent times.

Already as an undergraduate at Oxford, Hobhouse was led through his interest in social reform to a deeper study of the nature of society and its relation to the wider problems of metaphysics, and throughout his life his scientific and philosophical researches were closely and intimately interwoven with his work as a politician and practical reformer. His passion for humanity and justice gave him tremendous driving power, while his love of truth and rare intellectual candour and willingness to profit from criticism and experience led him to ever fresh fields of investigation and ever deeper analyses of the foundations of knowledge. He illustrates in his life-work his own view of reason as a continuous and comprehensive effort towards harmony in experience whether in the fields of practice or speculation, and those who saw him at work, whether as a teacher, journalist, or chairman of trade boards, will have recognised in his endeavours the very same spirit which in other fields was exhibited in his persistent attempts at wider and more inclusive syntheses of the results of empirical research and metaphysical speculation.

Hobhouse laid his foundations solidly in an early work on the "Theory of Knowledge" (1896), in which he developed what may be termed an organic view of rationality which was to be the basis of all his future work. This has affinities with idealistic metaphysics but is essentially realistic. Hobhouse, indeed, may be regarded as one of the founders of modern realism, but unlike some of its more recent upholders who tend to reduce the cognitive function to a vanishing point, he seeks to vindicate the reality of mind as well as of the external world, of the self as well as the not-self, the conception of the self being built up by the same logical processes as go to the making of any other valid conception.

From his epistemological investigations Hobhouse turned to empirical research. In his "Mind in Evolution" (1901) he traces the growth of mind in the various forms of organic life, from its earliest manifestations in the gropings of unconscious effort to the full clearness of conscious purpose. This work was based on extensive experimental investigations, now generally regarded as among the most important pioneer contributions to the science of comparative psychology. Moral and social development were then studied in his "Morals in Evolution" (1906), in which he utilises on a magnificent scale the data of anthropology and history in the establishment of a social morphology indispensable to the evolutionary point of view in sociology.

Armed with the conclusions derived from these researches into empirical fact, Hobhouse returned to the metaphysical problem in his "Development and Purpose" (1913; revised and rewritten in 1927). He shows that development consists in the extension of harmony through a series of syntheses. Development proceeds by the liberation of elements originally in conflict, the building up of structures of varying degrees of plasticity and coherence. The power behind this liberation and these syntheses is mind, essentially a correlating activity, manifested in all orderly structure, but more clearly in living organisms, which are interpreted as a modification of mechanical structure by teleological factors, and eventually emerging in the form of conscious purpose in the human mind, as expressed in the advancing movement of civilisation. Mind is, on this view, not coextensive with reality, but is the principle of orderly growth within it. It is limited by the material it works upon, and its purposes themselves undergo development. His fundamental principle, which he entitles 'conditioned teleology', is examined both from the point of view of the logical requirements of systematic explanation and its value as an instrument in scientific investigation in the fields of biology and sociology.

In a further series of works collectively entitled the "Principles of Sociology" (1918–1924), Hobhouse sought once more to apply his basic conception of mind as a correlating agency to the problems of social life. In the first of these, "The Metaphysical Theory of the State" (1918), he gave what is now generally regarded as the most penetrating criticism of the Hegelian theory of the State and prepared the ground for a social philosophy which would do justice at once to individual development and the requirements of the common good. In the "Rational Good" (1921) he works out his ethical theory of the good as a harmony of mind with its objects, a consilience of all living experience in a comprehensive system of purposes. In the "Elements of Social Justice" (1922) he applies these ethical ideas to the problems of social organisation and proves their value by the light which he is able to make them throw upon the practical problems of economics and politics. Finally, in his "Social Development" (1924) he gives us a synthesis of his scientific and philosophic studies bearing on the human problem. He first studies development from the point of view of empirical science and seeks to correlate the several aspects of social change in the light of non-ethical criteria analogous to those that might be employed in the study of biology. He then turns to the ethical problem of valuation, and finally argues that social and ethical development have a common end, rooted in the fact that the good is to be found in organic harmony. Taken together, these works must assuredly come to be recognised as the most comprehensive and scientific attempt that has yet been made to trace out the working and possibilities of rational purpose in human evolution.

Prof. Hobhouse was profoundly interested in the bearings of recent developments in the physical sciences upon the nature and validity of knowledge, as will be evident to readers of the revised edition of "Development and Purpose". He intended to devote himself on retiring from the chair of sociology to work on these problems. His sudden death has deprived the world of the results of his ripe speculation in this field of thought, and this can only deepen our sense of the loss of a great thinker, distinguished alike by a rare nobility and beauty of character, and by magnificent intellectual grasp and power.

Morris Ginsberg.

We regret to announce the following deaths:

Sir Baldwin Spencer, K.C.M.G., F.R.S., emeritus professor of biology in the University of Melbourne and author, with F. J. Gillen, of works on the Australian aborigines, aged sixty-nine years.

Dr. W. J. Viljoen, Superintendent-General of Education of the Cape Province and first vice-chancellor of the University of South Africa, aged fifty-nine years.

News and Views.

In his presidential address to the British Medical Association, delivered at Manchester on July 23, Prof. A. H. Burgess reviewed some aspects of the influence of other sciences upon the practice of modern surgery. The era of 'modern' surgery was inaugurated by Lister, and the present use of aseptic methods is merely the natural advance from the antiseptic technique as originally practised: antiseptics are still used for cleansing the skin and when sepsis is already present. As a sequel to the safety engendered by the use of these methods, the surgeon has access to all parts of the body, the spinal canal and thoracic cavity as well as the abdomen. Perhaps surgery is most indebted to the two sciences of physics and physiology during more recent years: it is only necessary to mention the aid brought by radiology, and radium and light therapy, by localisation of function in the brain, by the use of blood transfusion, by the discovery of vitamin D and insulin, and by the development of biochemical methods of investigating the body's functions. Prof. Burgess recalled in some detail the influence which these various discoveries had exerted upon surgical treatment. X-rays were first used in the accurate diagnosis of injuries to the bones and in diseases of the chest, the bones being relatively opaque and the lungs transparent: where the density of neighbouring tissues is similar, it is now the practice to administer or inject either a substance which is opaque to the rays, or air, which is transparent, and so by displacing tissues or tissue fluids enables a differentiation of the organ under examination to be made from the neighbouring tissues. In Manchester, 20 per cent of patients pass through the X-ray department as compared with 1 per cent twenty years ago.

The use of radium in treatment has had a twofold influence on the surgeon: it has sometimes replaced treatment by the knife, but at others a surgical approach to the seat of disease is necessary before the radium can be usefully applied. At the present moment, opinion seems to favour reversion to the external application of radium, but using relatively enormous quantities and at a much greater distance from the skin. The practice of actinotherapy has revolutionised the treatment of surgical tuberculosis, in which disease surgical removal of damaged tissues has been replaced by immobilisation and drainage, whilst the general resistance of the body is increased by its exposure to the sun or other source of light. The story of the development of our knowledge of the localisation of function in the brain illustrates the mutual reactions of clinical medicine and experimental physiology upon one another. The first step was clinical, the localisation of the speech area by Broca and the motor area by Jackson, and was followed by the experimental investigations of Ferrier, Horsley, Sherrington, and others, so that to-day the diagnosis of the site of an injury to, or lesion of, the brain is quite precise. A similar interplay of medicine, pathology, and physiology is seen in the development of our knowledge of the functions of the thyroid gland. Work such as this and other recent advances in treatment based on joint clinical and experimental investigations serves to show the importance of co-operation between clinicians and experimentalists.

A memorial tablet to Sir Humphry Davy has just been unveiled in the Pump Room of the Wirer Endowment at Ischl in Austria, to commemorate his stay at that watering-place. The ceremony was performed in the presence of a distinguished party, including the Austrian Chancellor, Dr. Streeruwitz, who in a speech dwelt upon the gratitude the world owes to the inventor of the miner's safety lamp. It was on May 26, 1818, that Davy embarked at Dover for Naples, whither he was going to study the problem of unrolling the papyri found at Herculaneum. His journey took him up the Rhine and Danube into Austria and Hungary, and on this journey he took the opportunity of making observations of the formation of mists over rivers and lakes, which at that time was not understood. The rivers he studied included the Inn, the Ilz, the Raab, the Save, the Ironzo, the Po, and the Tiber, his results being contained in his paper to the Royal Society of Feb. 25, 1819, entitled "Some Observations on the Formation of Mists in Particular Situations".

The scientific work of the Czechoslovak biologist, J. E. Purkyně (Purkinje), like that of many other pioneers, has largely escaped attention, although a number of men of science have, from time to time, referred to the importance of his contributions to many branches of biology. Purkinje was born near Prague on Dec. 17, 1787, and died there on July 28, 1869, and on the occasion of the sixtieth anniversary of his death, Dr. O. V. Hykeš has collected and issued in pamphlet form ("Přírodovědecké práce J. E. Purkyně") a selection of comments and appreciations of his work by well-known biologists. Purkinje's researches cover subjects in microscopic anatomy, cytology, neurology, the physiology of vision and of the ear, biochemistry and anthropology. An American writer in 1899 declared that Purkinje, under the most unfavourable conditions, had laid the foundations for modern physiology. Although the compound microscope had been in use for nearly a century, his discoveries, up to 1830, were made with the aid of simple lenses, yet he was the first to use the microtome. When unable to pursue a subject exhaustively, Purkinje time and again pointed the way to a noteworthy discovery. He was the first to employ the term protoplasm and to establish the identity of structure in plant and animal cells. Purkinje's work has hitherto attracted most attention in Germany and Scandinavia.

It is generally recognised that while many local museums include a number of objects illustrating the life of the population of the area in medieval and later times, an urgent need is a national museum for England which will illustrate the traditional arts, industry, and life generally of the folk. Wales already has a national museum of this character, and there are similar collections in Ireland and Scotland. The matter is undoubtedly one of some urgency, as objects of the character contemplated are becoming more and more difficult to obtain every day. The council of the Royal Anthropological Institute, having these facts in view, has appointed a small committee to consider the position. Lord Onslow, Sir Henry Miers, and Dr. R. E. Mortimer Wheeler have accepted appointment to the committee. The Royal Society, the Zoological Society, the Society of Antiquaries, the Folklore Society, and other interested bodies have nominated, or have been invited to nominate, representatives to sit on the committee. It is hoped to hold a conference to discuss ways and means early in the autumn.

A committee has been formed to establish a Memorial Fund with which the name of the late Prof. L. T. Hobhouse may be permanently associated, to be used to assist in the perpetuation of his influence. The committee consists of Prof. S. Alexander, Sir William Beveridge, Mr. Victor Branford, Dr. Morris Ginsberg, Dr. G. P. Gooch, Mr. J. L. Hammond, Mr. J. A. Hobson, Prof. Gilbert Murray, Prof. Percy Nunn, Sir Herbert Samuel, Mr. C. P. Scott, Sir Hubert Llewellyn Smith, Sir Arthur Steel-Maitland, Prof. Graham Wallas, and Mrs. Beatrice Webb, and subscriptions may be sent to Dr. G. P. Gooch, 76 Campden Hill Road, London, W.8. It is hoped that subscribers may leave it to this widely representative committee to frame a scheme for the memorial and to decide at a later date whether the fund raised can be best used for a lectureship, scholarship, or the publication of studies in the social sciences. Dr. Morris Ginsberg, London School of Economics, Aldwych, W.C.2, has agreed to act as honorary secretary of the Fund.

An interesting suggestion for a possible origin of early Mesopotamian culture is put forward by Mr. Henry Field, of the Field Chicago Museum, in the *Times* of July 17. As a result of recent archæological survey work conducted by the Marshall Field North Arabian Desert Expeditions, it would appear that the North Arabian and Syrian deserts, which in palæolithic times were well watered, then supported a considerable semi-nomadic population, of which traces have been found in the form of palæolithic implements on several hundred sites. These range from Upper Chellean, found *in situ* at a depth of 11 feet 6 inches, to Upper Palæolithic. It is suggested that at about the time of Cro-Magnon man in western Europe, the desiccation of the North Arabian area began, and finally drove the population, by that time in a neolithic stage of culture, westwards to the Nile Valley and eastwards to Mesopotamia, where they constituted the earliest inhabitants. On the evidence of the earliest skeletal remains found in the lowest levels of Kish, it would appear that the earliest inhabitants of that area may well have been direct descendants of the Palæolithic and Neolithic peoples of the North Arabian desert.

Prof. S. Langdon, who forwards Mr. Field's letter to the *Times*, adds a much-needed caveat. While recognising the importance and the significance of the discovery of this extensive palæolithic culture of the Syrian desert, he hesitates to accept it as the source of Sumerian or prehistoric Mesopotamian culture. As he points out, it raises the question whether this culture is to be attributed to the Sumerians of Elam and of Central Asia and of the Indus Valley or to the Semites of Akkad. The excavations at Kish and Jemdet Nasr appeared to have settled this question definitely in favour of the proto-Sumerian Elamite people. Prof. Langdon emphasises the significance of the fact that while no painted pottery has been discovered in the Syrian desert within 2000 years of the date of that at Kish, in Elam and Central Asia, at water level at Kish and at plain level at Jemdet Nasr, the painted ware is accompanied by epigraphical material, seals and copper of undoubted Elamitic affinities which would all point to the proto-Sumerians of the east as the founders of this civilisation. Mr. Field's interesting suggestion may well serve to throw light on the early migrations of the Semitic peoples. It fails to withstand the weight of the evidence to which Prof. Langdon refers, which is all against a Semitic origin for the earliest culture of Mesopotamia.

The following elections have been made to Beit Memorial Fellowships for Medical Research, the place of research being given in brackets: *Fourth-year Fellowships* (value £500 per annum): Mr. R. J. Lythgoe and Mr. M. W. Goldblatt. *Junior Fellowships* (value £400 per annum): Mr. R. Hill, to investigate the specificity of hæmoglobins and the properties of cytochrome (Biochemical Laboratory, Cambridge); Dr. Ann Bishop, to complete the study on which she has been engaged during last two years of the morphology and development of *Trichomonas* of man and monkeys (macaques) in culture and to investigate other intestinal protozoa (Molteno Institute for Parasitology, Cambridge); Mr. C. L. Cope, to study the diuretic responses of normal and pathological kidneys in man to tubule diuretics (Department of Medicine, Oxford University); Dr. L. E. Bayliss, to study the metabolism of the isolated heart and kidney by means of the heart-lung and heart-lung-kidney preparation and by means of the artificial oxygenator of Bayliss, Fee, and Ogden (Department of Physiology and Biochemistry, University College, London); Dr. W. P. Kennedy, to investigate the function of the ovary (Physiology Department, Edinburgh University, and Royal Infirmary, Edinburgh); Mr. E. Boyland, to investigate the mechanism of carbohydrate metabolism, with particular reference to the phosphoric esters of yeast and muscle (Lister Institute, London); Mr. E. M. Case, to study the metabolism and thermodynamics of muscle by means of a comparative study of alcoholic fermentation by yeast and lactic acid production by muscle, and by means of a new apparatus to investigate the thermal properties of so-called 'non-irritable' muscle, concurrently with chemical analyses (Sir William Dunn Institute of Biochemistry, Cambridge); Mr. K. A. C. Elliott, to undertake studies on biological oxidations such as the oxidation of metabolites by various thermolabile and thermostable peroxidases (Biochemical Laboratory, Cambridge); Miss M. H. Roscoe, to continue investigations on the distribution of the antipellagra vitamin B2 in natural foodstuffs and a comparison with the distribution of the anti-neuritic vitamin B1 (Lister Institute, London).

In honour of the sixtieth birthday, on June 27, of Prof. Hans Spemann of Freiburg, a special number (Heft 25) of *Die Naturwissenschaften* has been issued. A portrait of Prof. Spemann precedes an article of half a dozen pages in which Dr. Otto Mangold gives an account of the main lines of Prof. Spemann's work and the results achieved. This is followed by a list of Prof. Spemann's publications from 1895 until 1929, and by a list of important investigations carried out by pupils and collaborators in more or less close relation with their master, and finally by a series of abstracts, by the respective authors, of the memoirs which form the recently published five-volume 'Festschrift' in honour of Prof. Spemann in *Roux's Archiv für Entwickelungsmechanik* (Bände 116-120). This massive 'Festschrift' and the special number of *Die Naturwissenschaften* are well-merited tributes to one who is held in the highest esteem not only for his manipulative skill, his keen powers of analysis and interpretation and his lucid exposition, but also for his great personal qualities.

The Department of Mines of the Dominion of Canada has issued its customary Annual Report for the year ending Mar. 31, 1928. This report gives evidence of the great advances made in all departments of the Canadian mineral industry. This is sufficiently shown by the fact that the value of the mineral production of Canada has quadrupled since the year 1900. A matter of special interest in this report is the reference to the memorial tablet erected by Mr. Fenley Hunter of New York City to the late Dr. George M. Dawson, at one time Director of the Geological Survey of Canada. All who either remember Dr. Dawson personally or who appreciate the admirable work which he did for the Canadian Geological Survey will be pleased to learn that this permanent memorial to him has been erected on an exceptionally suitable spot, namely, on the bank of the Liard River, just north of the boundary line between British Columbia and Yukon, in the delimitation of which Dr. Dawson's surveys have played so conspicuous a part.

THE Annual Report for 1927–28 of the Director of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington details very numerous, varied, and important work in the domain of terrestrial magnetism and electricity. The non-magnetic ship *Carnegie* was being prepared for the world-cruise now in successful progress. Owing to this the amount of field work on land was severely curtailed, but the Department carried on land observational work at its two important observatories at Huancayo, Peru, and Watheroo, Western Australia. In addition, many interesting investigations, both experimental and theoretical, were made in regard to problems of atomic magnetism, terrestrial magnetic variations, wireless propagation, the high-frequency permeability of iron, and other related topics.

IN order to centralise and arrange a methodical plan for the scientific work which is carried on in northern Norway, Svalbard, Jan Mayen, and the Arctic Sea, a Central Committee for the Scientific Institutions at Tromsö has been recently constituted, the statutes for which have now been sanctioned by the Department of Education. According to Northern News Service, the Geophysical Institute at Tromsö will act as a weather-forecasting and aurora observatory, and Prof. Krogness will have the assistance of Prof. Vegard and of other scientific men working in the north, including Mr. Soot-Ryen, who has made valuable researches into the fauna of the coasts of northern Norway. The committee's aim is to forward co-operative work between the different scientific institutions of Tromsö and the north.

ON July 19, Sir Thomas Middleton unveiled at Dishley Grange, in Leicestershire, a memorial to Robert Bakewell (1725–95), the pioneer of stock-breeding. The movement to commemorate the great English farmer was started by Prof. Scott Watson, of the University of Oxford, who had raised money in both Canada and America for the purpose. In his address Sir Thomas Middleton said that the prosperity of the nineteenth century was largely due to improvers, such as Bakewell, in the preceding century, and that his methods had influenced and are influencing stock-breeding throughout the world. Bakewell with great foresight realised that the need of the future was beef and mutton to feed the rapidly increasing town populations, and that this problem could best be met by breeding the right type of stock. Without some new means of providing meat, the industrial expansion would have been impossible. Before his time, animal breeding had been carried on in a haphazard fashion with no definite aim behind it, and it was due to the fact that Bakewell started with a clear objective that his enterprise met with such success. His aim was to obtain animals that weighed heaviest, matured earliest, and most quickly repaid the food they consumed. He obtained his best results with sheep, but also applied his principles to the breeding of cattle, cart-horses, and pigs. The prices he secured for the letting of improved sires testify to the esteem in which he was held by other farmers of his day, and the wide application of his methods by others shows that he is rightly to be considered one of the greatest agricultural pioneers of the eighteenth century. After unveiling the memorial, Sir Thomas Middleton placed a laurel wreath on Bakewell's tombstone, which lies in the ruins of the old church.

MR. JOHN PATTERSON has been appointed Director of the Meteorological Service of Canada, in succession to Sir Frederic Stupart, who retired at the end of June, after fifty-seven years' service.

PROF. F. A. E. CREW, of the Animal Breeding Research Department of the University of Edinburgh, has been elected a foreign member of the Czechoslovak Agricultural Academy.

IN view of the long-continued drought in Great Britain, the Ministry of Health has issued a "Memorandum on Water Shortage", suggesting that water authorities should lose no time in scrutinising the position and considering whether any supplementary supplies are available in their neighbourhood. Suggestions are also made for conserving existing supplies by detection and prevention of waste, temporary reduction or intermission of discharges of compensation water, and use of alternative supplies, if any. It is considered that restriction of the supply for domestic use should be resorted to only in cases of actual necessity.

THE following appointments have recently been made by the Secretary of State for the Colonies in the Colonial Agricultural Services: Mr. W. H. Edwards, lecturer in entomology and zoology at the College of Agriculture, and acting botanist and mycologist, Mauritius, to be entomologist, Jamaica; Mr. S. M. Gilbert, superintendent of agriculture, Nigeria, to be assistant director of agriculture, Trinidad; Mr. A. Pitcairn, district agricultural officer, Tanganyika, to be assistant director of agriculture, Cyprus; Mr. J. R. Mackie, superintendent of agriculture, Nigeria, to be deputy assistant director of agriculture, Nigeria; Dr. R. H. Le Pelley, to be assistant entomologist, Kenya; Lieut. J. Eaden, to be assistant manager, Experimental Fruit Farm, Sierra Leone; Mr. H. E. Green, to be inspector of plants and produce, Agricultural Department, Gold Coast; and Mr. E. Lawrence, to be district agricultural officer, Nyasaland.

A RECENTLY issued catalogue of Messrs. Francis Edwards, Ltd., 83 High Street, Marylebone, W.1, is No. 516, giving particulars of nearly 800 second-hand works relating to the Far East, *i.e.* Japan, China, Korea, Formosa, Siam, Philippine Islands, and the East Indian Archipelago.

Applications are invited for the following appointments, on or before the dates mentioned:—An assistant master, to teach engineering, at the Rochester Technical Institute and Junior Technical School—The Principal, Technical Institute, Rochester (Aug. 3). A temporary pathologist in the Public Health Laboratories of the County Council of the West Riding of Yorkshire—J. C. McGrath, County Hall, Wakefield (Aug. 3). A lecturer in mathematics in University College, Nottingham—The Registrar, University College, Nottingham (Aug. 5). A university librarian of the University of the Witwatersrand, Johannesburg — The Secretary, Office of the High Commissioner for the Union of South Africa, South Africa House, Trafalgar Square, W.C.2 (Aug. 10). A head of the Engineering Department of the Smethwick Municipal College — The Director of Education, 215 High Street, Smethwick (Aug. 12). A lecturer in agricultural botany at Armstrong College—The Registrar, Armstrong College, Newcastle-upon-Tyne (Aug. 17). Temporary assistant chemists at the Government Laboratory—The Government Chemist, Clement's Inn Passage W.C.2 (Aug. 17). Women senior lecturers in botany and microbiology, physics, zoology and physiology, and a lecturer in domestic science, at Huguenot University College, Wellington, Cape Province—The Registrar, Huguenot University College, Wellington, Cape Province, South Africa (Oct. 1). An experimental assistant at the Air Defence Experimental Establishment —The Superintendent, Air Defence Experimental Establishment, The Aerodrome, Biggin Hill, near Westerham, Kent. A woman lecturer in geography or biology with mathematics (subsidiary) at the Bishop Otter Training College for Women Teachers, Chichester—The Principal, Bishop Otter Training College, Chichester. A woman with training in pathology, biology, or physiology, and interested in poultry, for poultry research—laboratory and field work—at the Wellcome Physiological Research Laboratories—The Director of the Laboratories, Langley Court, Beckenham.

Our Astronomical Column.

Large Meteors.—An illustrated article by James Stokley, issued by Science Service of Washington, D.C., describes some of the largest meteor falls on record. There is a striking illustration of Meteor Crater, Arizona, which is 4000 feet in diameter, and strongly resembles one of the smaller lunar craters. It is now generally agreed, from the age of the trees on its rim, that this was formed by the fall of a gigantic meteor, not less than seven centuries ago. A sketch of an equal area located among the sky-scrapers of New York shows what enormous damage might be done by such falls if they came in populous districts. The largest in modern times fell in the Yenisei Province of Siberia on June 30, 1908, when the area affected was 40 miles in diameter; there was great destruction of animals and trees.

Prof. Charles P. Olivier, who is the director of meteoric observation in the United States, is quoted as saying that most of the meteors observed are moving in hyperbolic orbits. This evidently implies a much greater excess over the parabolic velocity than is found in the case of comets; the excess in these is too slight to be detected in the comparatively rough determinations that are alone possible for meteors. Hence the meteors having such speeds cannot belong to the solar system, but are merely passing through it, having had their origin somewhere in the region of the stars.

Dr. W. J. Luyten, stationed at the South African branch of Harvard College Observatory, reports that the great mass of iron recently found in that region is a genuine meteor; he estimates it at 50 tons, which would make it the largest meteoric mass known. The Ahnighito meteor, now in New York, weighs 36½ tons.

Curvature of Space.—The *News Service Bulletin* of the Carnegie Institution of Washington, No. 13, contains an article by Dr. E. P. Hubble describing the further work of Mr. M. Humason and Dr. F. G. Pease at Mt. Wilson Observatory on the radial velocities of spiral nebulæ. Note has already been made in this column of their conclusion that the apparent velocity of recession is proportional to the distance of the object, and is thus evidence of the truth of de Sitter's deduction from the theory of relativity that remote objects should have a displacement of their spectral lines towards the red.

A few months ago the highest velocity found was that of the nebula N.G.C. 7619 in Pegasus, the distance of which was estimated as 25 million light-years; it appeared to be receding at the speed of 2400 miles per second. By using very long exposures, extending to 40 hours, the spectra of three nebulæ in a cluster in Coma Berenices, near the pole of the Galaxy, have now been photographed. The distance of the cluster was estimated, by methods already described, as 50,000,000 light-years; the speeds of recession found are 4900 miles per second for N.G.C. 4860, 4600 miles for N.G.C. 4853, and 3100 miles for N.G.C. 4865. The first two support the theory of speed being proportional to distance; the third does not fit so well. Observations of other nebulæ in the region are planned; it is considered possible that N.G.C. 4865 does not belong to the cluster, but is a small nebula at a less distance.

Period of the Lyrid Meteors.—Mr. Maltzev of Leningrad has been investigating the Lyrid meteoric shower and finds a period of 29·70 years to accommodate satisfactorily some of the observations. He inquires as to where details can be found of the rich display which occurred in 1863, but there seem to be very few accounts of it. However, in the B.A. Report for 1863, p. 325, there is a note on the phenomenon by Prof. H. A. Newton which may be of some use. Mr. W. F. Denning writes that he has tried on several occasions in past years to deduce a period for the shower and found 16·1 years and 29·65 years will conform with a number of the most striking displays. He does not, however, regard them as having a perfectly satisfactory application, for they do not accommodate the various showers in 1803, 1851, 1863, and a few other returns. We require more data, and this may only be obtained by careful watches of the shower in future years. Its exhibitions during the past half a century have generally been somewhat feeble.

Research Items.

A Novel Theory of Animal Evolution.—The problem presented by the inter-relationships between the major groups of animals has been the chief stumbling-block in the path of all theories of evolution. The enormous differences between these groups as they exist to-day make a linear evolution difficult to understand, and the difficulty is increased when it is realised that, so long ago as Middle Cambrian times, the inter-relationships between the different invertebrate phyla were just the same as they are to-day. Austin H. Clark therefore suggests that at the very outset all the numerous phyla came into being not successively but simultaneously by following different paths of development from the single cell—and to this theory he gives the name primagenesis (*Jour. Washington Acad. Sci.*, vol. 10, June 1929). The abrupt discontinuities suggest that each of the phyla represents a re-combination of characters inherent in animals as a whole in a form capable of meeting the requirements of animal existence, both in internal balance and in external contacts. Apparently the focal points at which a balanced condition capable of survival and of meeting competition is attainable are rather few and are well separated from each other, for each of the phyla is widely different from the rest. The flat picture of animal life presented as a result of primagenesis serves as the ground from which various evolutionary trees, one for each phylum, rise upwards through geological time.

Mental Defectives and their Order of Birth.—Two commonly accepted theories tend to place the mentally defective child either at the beginning or at the end of the family succession. That the defective child is the first born infers that mental deficiency is a result of birth trauma; that it is the last born suggests the result of an exhaustion process. To test these popular notions, Neil A. Dayton has made a survey of 10,455 retarded children in the public schools of Massachusetts (*Jour. Heredity*, vol. 20, May 1929). In order to avoid the possibility of mixed classifications so far as intelligence was concerned, the retarded children examined were divided into two groups by sex, those with an intelligence quotient above and those below 0·70. Relatively twice as many boys (6671) as girls (3739) figured in the examinations. The families analysed contained from two to ten or more children, and the results showed no uniformity. That is to say, there is no evidence that the feeble-minded child tends to be either first or last in the family. If anything, there appears to be a slight tendency for the feeble-minded to occur in the middle of the family, particularly in the larger families. Families having a mentally defective child are larger than families having a retarded child.

Herring Research at Cullercoats.—The Report of the Dove Marine Laboratory, Cullercoats, Northumberland, for the year ending June 30, 1928, drawn up by the Director, Prof. A. Meek, shows a satisfactory progress in the work done, which is mainly the continuation of herring investigations by Mr. B. Storrow, assisted by Mrs. Cowan. Mr. Storrow deals with the shoals involving the examination of some 4000 fish from England, Scotland, and Ireland, and, in addition, about 3000 local fish were examined, and data relating to size, sex, maturity, with scale and age records, were sent to the Ministry of Fisheries. The work on herring shoals was begun in 1919, and an unbroken series of data has been secured up to the present time. In the Yarmouth fishery the 1922 year class with five winter rings is still very abundant, although it has been fished since 1925, which fact points to the original wealth of this year class noted in previous reports and predicted from the presence of young fish in spawning shoals in 1922. In 1927 there were unprecedented numbers of young mature fish with two winter rings, and the product from this spawning may be expected in 1931 in the British fishery. An important point noted in the 1928 local herring is the change in quality. In the previous year many complaints were heard as to the poor quality of the fish taken all along the coast. The season of 1928 shows a considerable difference, the fish having a large amount of fat in the body cavity, the flesh being whiter and the body plumper, with a thicker back than has ever been observed in these north-east coast herring during the past eighteen years. These are more like the celebrated ‘ west coast herring ’ and are splendid eating. Hopes are expressed that biochemical investigations should be undertaken with regard to these changes. In connexion with the scheme of co-ordinated research with the Ministry of Agriculture and Fisheries, Mr. Gill gives a report on the general hydrographical condition of the Northumberland coastal waters in 1926–28.

Protein Metabolism in Plants.—In view of the general interest of biologists and biochemists in protein metabolism, a critical review of our knowledge of nitrogen transformations in plants by Miss M. E. Robinson (*New Phyt.*, **28**, 117-149) serves a very useful purpose. The author emphasises the uncertainty which surrounds even the primary problems in this field, such as the rôle of light in protein synthesis. In the discussion of this question, an interesting fact is recorded. Abderhalden and Rona showed that *Aspergillus* could produce α-amino acids from nitrate and sucrose in the absence of light, while Bayliss remarked on the absence of cyclic compounds in these experiments. Now Miss Robinson states that tryptophane and histidine are formed under these conditions, though doubting whether it is wise to apply such results to higher green plants where light and chlorophyll may be more important. The claim of Hanning that Cruciferæ embryos can synthesise protein in cultures containing peptones and sugars serves as an example of the interesting possibilities opened up by the application of the methods of tissue culture to metabolic studies.

Bourne or Gypsey Flows.—Intermittent streams occur on dip slopes in chalk country, usually after long continued and heavy rains. They are known by different names in various parts of England, lavants in Sussex and Hampshire, nailbournes in Kent, and gypseys in the East Riding. Various theories have been given to explain their origin. In a paper in *Geography* for June, Mr. J. H. Brown describes these streams and discusses the causes of their flow and intermittency. He finds that the determining cause is the existence of underlying gault clay. Normally the rainfall can drain away through the porous chalk, but exceptional rainfall cannot drain in this way. The impervious gault clay holds it until the lower layers of the chalk are saturated. The water table rises, and where the plane intersects the valley slope a spring marks the start of a bourne. Thus a bourne may flow some months after heavy rainfall owing to a comparatively light fall which brings the water table high enough to cut the slope. There is thus no underground channel at the head of these streams. Mr. Brown gives a number of details of various bournes and discusses the reasons for the gradual decrease in their frequence of flow, which he associates with the lowering of the gault outcrop by denudation.

Temperature Changes in the Lower Atmosphere.—*Geophysical Memoirs*, No. 46, of the Meteorological Office, is devoted to "A Study of the Vertical Gradient of Temperature in the Atmosphere near the Ground", by N. K. Johnson (London: H.M. Stationery Office, 1929. 3*s*. 6*d*. net). It describes the construction, use, and results of an apparatus for measuring the temperature at three levels up to 17 metres from the ground. In the discussion, special prominence is given to the daily variation of temperature. In 1915, G. I. Taylor discussed this daily variation, using the Eiffel Tower observations, and assuming that the changes of temperature were due mainly to eddy conduction; but in 1925, S. Chapman showed that in the early morning the air temperature at certain levels on the Eiffel Tower was increasing when eddy conduction would act so as to reduce it; he therefore suggested that the temperature changes were largely influenced by long-wave radiation. This result was criticised at the time, doubt being cast on the value of the Eiffel Tower observations. N. K. Johnson concludes that his observations lend strong support to the conclusion derived by S. Chapman. A further contribution to the subject is made by D. Brunt (*Proc. Roy. Soc.*, A, **124**, 201; 1929), who criticises and modifies the equation of eddy conduction introduced by G. I. Taylor and hitherto generally used; D. Brunt also adds a new term expressing the rate of transfer of heat by radiation.

Drilling for Oil with Diamond Drills.—Of recent years a great deal has been written concerning the advantages of employing the diamond drill on oil-fields, especially for accurate exploratory work. Experience has shown, however, that the diamond drill cannot compete with rotary or standard tools under conditions of ordinary routine production drilling, but this does not detract from its value and application in other circumstances. The diamond drill is invaluable for providing geological information, owing to the continuous cores of rock obtainable by its use; such cores, properly taken, record accurately changes in the formations penetrated, thicknesses, dip, and other structural details; thus, as a test of subsurface structure, the system is probably without parallel. Another useful feature of the diamond drill is its ability to deepen rotary or cable-tool wells the diameters of which have been reduced to the minimum to which those systems have been effective; possibly its employment in the latter connexion has been more commonly sought than in cases of purely exploratory drilling. A thorough account of the diamond drilling system from the engineering point of view was given to the Institution of Petroleum Technologists recently by Mr. G. Haseldin, who based his observations largely on the behaviour of this plant in Algeria, the Punjab, and Assam. It is worthy of note that only a short time before the reading of this paper, Mr. R. T. Banks dealt with the advantages of this system of drilling in the high-pressure gas field of Turner Valley, Alberta, Canada (*Canadian Mining and Metallurgical Bulletin* for February), and recorded the attainment there of a hole more than a mile deep in one instance, also the significant fact that in this field, with only one exception, the diamond drills are operating on wells that have had to be abandoned, for some reason or another, by rotary or standard tools.

X-ray Dosage.—After the adoption of the appropriately named 'Röntgen' as a unit of X-radiation at the Stockholm Congress last year, it was found that it was apparently not possible to reproduce it accurately. The discrepancies between the units of different laboratories, of the order of four per cent, although perhaps not important for most therapeutic purposes, were nevertheless unwarrantably large; the matter has been taken up by the United States Bureau of Standards, and a report upon the problem has now been published in the form of a *Research Paper* (No. 56). It was found immediately that, for accurate work, an X-ray bulb had to be supplied with power from a direct current source of high potential. Precise details of how this can be best effected are given in the report, together with a useful photograph showing the general assembly of the generator. Even then, different saturation currents were recorded if a given ionisation chamber was used with different arrangements of the internal electric fields, and it was finally found to be desirable to resort to a null electrostatic method of measurement, the substantial accuracy of which was shown by the agreement of the results with those obtained by direct measurement with a galvanometer, in cases where the latter instrument could be applied. The error in determining the volume of ionised air has not yet been studied, but apart from this, the accuracy obtainable in the measurement of dosage is now claimed to be one per cent or better.

Sulphur Monoxide.—Prof. V. Henri and F. Wolff have described the production and partial analysis of a new band spectrum associated with sulphur in a recent paper in the current volume of the *Journal de Physique* (p. 81). It appears when a heavy oscillatory discharge is passed through the vapour of sulphur dioxide, extending from about 4000 A. to 2500 A., and has been ascribed to sulphur monoxide, the chemical preparation of which has already attracted considerable attention during the last few years. The usual information concerning the molecule has been deduced from the fine and coarse structure of the bands; the oxygen and sulphur atoms are 1·34 A. apart, and their heat of dissociation is 148 kilo-calories per gram-molecule, or a little more than half the heat of dissociation of sulphur dioxide into atoms. The excited molecule of the monoxide appears to be formed directly from the dioxide by electronic impact. Prof. Henri has included some theoretical considerations of a general nature in this paper, pointing out in particular the need for the accumulation of data for the vibrational constants of polyatomic molecules in relation to their structure.

Combustion in Electrical Discharges.—The study of the combustion of carbon monoxide and oxygen in the glow discharge which G. I. Finch and D. L. Hodge have published in the June number of the *Proceedings of the Royal Society* has brought to light some interesting facts concerning the part played by the metal of the cathode. Atoms from the surface of the latter pass into the gas under the influence of the discharge, some metals disintegrating in this way more rapidly than others, and it has now been found that in certain circumstances there is a close parallelism between the rate at which this so-called 'sputtering' takes place and the rate of combustion of the gas in the neighbourhood of the cathode. The metal atoms present in the gas evidently facilitate the union of ions of carbon monoxide and of oxygen, and the picture which is presented of their action is one in which they effectively eliminate the mutual electrostatic repulsion of the ions by forming neutral metal-gas complexes. The evidence upon which this view is based is not merely qualitative, but includes the quantitative correlation of the main facts that have been collected for cathodic combustion on one hand and sputtering on the other, good agreement between the two being obtained on the basis of a few simple assumptions. Combustion can occur elsewhere in the discharge under the appropriate conditions, and can be accelerated by other means, and the influence of moisture upon its course is to be reported upon later.

The Budde Effect in Bromine and Chlorine.—The effect of water vapour on the Budde effect in chlorine and bromine from which all impurities have been removed has been investigated by G. B. Kistiakowsky, whose results are described in the *Journal of the American Chemical Society* for May. The temperature changes of the gas on exposure to illumination were measured by both a glass manometer and a platinum resistance thermometer. It was found that no change in the Budde effect could be detected on drying or moistening pure chlorine and bromine. Attempts were made to test the dryness of the chlorine by mixing with hydrogen, in order to see if the mixture was inactive on exposure to light. It appears, however, that dry mixtures cannot be prepared in Pyrex glass, owing to the formation of water by reduction of the glass by hydrogen at the temperature of sealing.

Laminated Glasses.—The *Journal of the Society of Glass Technology*, vol. 13, No. 49, contains an interesting account by W. R. Lyttleton of the history, development, and methods of manufacture of laminated glass, which is rapidly growing in importance for use in the motor industry. Such glass consists of alternately hard and plastic laminæ welded together into one whole, and has the property of not allowing splinters to fly when it is subjected to a violent blow. Generally, either nitro- or acetate-cellulose is employed as the central plastic medium in this type of glass. The surfaces of the glass and celluloid are carefully cleaned, and in some cases the glass is coated with gelatine or cellulose varnish, before they are united by pressure. If gelatine is used as the central sheet instead of celluloid, it must be hermetically sealed between the glass sheets in order that it may retain its moisture content, without which it becomes brittle. The chief difficulties to be faced in the production of these strengthened glasses are discoloration with time and strains set up by unequal expansion of the laminæ.

Critical Temperature Measurements on Carbon Dioxide in Small Capillaries.—As a result of measurements of adsorption of carbon dioxide in silica gel, both above and below the critical temperature, it has been suggested that liquid exists in the pores of the adsorbant above the critical temperature. If this conclusion is correct, then it would appear that some increase in critical temperature should be observed in very fine glass capillaries, even though the diameters of such capillaries are much greater than those of the pores in silica gel. An attempt to determine the effect of capillary diameter on critical temperature is described by H. T. Kennedy in the *Journal of the American Chemical Society* for May. The critical temperature of carefully purified carbon dioxide was measured in capillaries ranging from 2 mm. to 0·004 mm. in diameter and was found to be independent of the size of the tube. The value obtained for the critical temperature, which is defined as the highest temperature at which a sharp meniscus can be seen by transmitted light in the field of a microscope, was $30·96° \pm 0·01°$. It is suggested that the discrepancies obtained by various workers are due to the different criteria employed to define the critical temperature.

Existence of Free Methyl.—In a recent number of the *Berichte der Deutschen Chemischen Gesellschaft* (**62**, 1335; 1929), Messrs. Paneth and Hofeditz bring forward evidence of the rather transient but definite existence of the simplest hydrocarbon radical, methyl, in the free state. This result was obtained in the course of an investigation of the mechanism of the reaction involved in the production of metallic hydrides by means of a spark discharge, a reaction which appears to necessitate the presence of a hydrocarbon. Carefully purified lead tetramethyl is volatilised in a current of pure hydrogen or nitrogen at a low pressure in a quartz-tube and at a rather low temperature. When the tube is heated with a Bunsen burner, a lead mirror is deposited and an active gas passes on, which is capable of completely volatilising a second deposit of lead previously made in the same way at a point farther from the supply. Lead tetramethyl is apparently reformed, since it in turn can be decomposed in the same way. Moreover, the distance between the mirror which is being deposited and that which is being removed may be so much as 30 cm. and the space may even be cooled, but the effect falls off very rapidly as the distance is increased. Numerous check experiments were carried out in order to show that the volatilisation of the lead is not due to the action either of hydrogen or of any of the following possible by-products: methane, ethane, acetylene, or ethylene; and the authors claim to have proved that the methyl radical is present in the decomposition product of the methide. Preliminary measurements of the rate of volatilisation indicate that the reaction is approximately monomolecular and that the 'half-life period' of the methyl in an atmosphere of hydrogen at 2 mm. pressure is about 0·006 sec. Similar effects have been obtained with bismuth trimethyl, whereas the methides of antimony and zinc both gave disappointing results. Further, it has been shown that both lead and bismuth can be volatilised as methides by the vapours from the decomposition of either lead-tetramethyl or bismuth-trimethyl. It is essential that all materials should be highly purified beforehand.

Strength of Carbon Steels for Boiler Construction.—Special Report No. 14 on Engineering Research issued by the Department of Scientific and Industrial Research (London: H.M. Stationery Office) describes work carried out at the National Physical Laboratory by R. G. Batson and H. J. Tapsell. The object of the work was to provide information regarding the tensile properties and, particularly, the limiting creep stress of low carbon steels for boiler and superheater tubes, and superheater and steam drums. Results of tests carried out at temperatures up to, in some cases, 650° C. on the limiting creep stress in tons per square inch are given for three steels containing respectively 0·10, 0·17, and 0·22 per cent carbon. The last of these materials, which is representative of steel supplied for superheater and steam drums, had a limiting creep stress of 14 tons per sq. in. at 400° C., 9 at 450°, 5·5 at 500°, and 3·5 at 550°. The two lower carbon steels at 500°, 550°, and 600° C. gave creep stress figures of 3·5 and 5·0; 1·2 and 2·2; 0·6 and 1·2 respectively. At 650° C. the 0·17 per cent carbon steel had a creep stress about half a ton per square inch. To prevent oxidation of the specimens, test pieces were coated with a few thousandths of an inch of aluminium by calorising, or with 0·01 inch nickel. It is shown that such protective coatings have no influence on the rate of creep, but provide very good resistance to scaling at the high temperatures. Unprotected samples scaled rapidly above about 570° C., particularly when subjected to excessive straining.

The London School of Hygiene and Tropical Medicine.

THE history of the London School of Hygiene and Tropical Medicine, the new home of which was opened by H.R.H. the Prince of Wales on July 18, goes back to 1921, when a committee appointed by the Minister of Health of that day, Sir Alfred Mond, now Lord Melchett, under the chairmanship of the Earl of Athlone, to report upon the needs of post-graduate medical education in London, advocated among other things the establishment of a central institute of preventive medicine. This recommendation began to bear fruit in the following year, when the Trustees of the Rockefeller Foundation in New York generously offered £460,000 for the building and equipment of such an institute, if the British Government would be responsible for its staffing and maintenance. In the course of their campaign of preventive medicine in all parts of the world, the authorities of the Rockefeller Foundation had arrived independently at the conclusion that a great teaching centre of this nature, with an international outlook, was required if the teachings of hygiene were to be adequately promulgated; and they realised that London, as the capital of the British Empire, the centre of the world's commerce, and the cradle of modern public health administration, would form the ideal site.

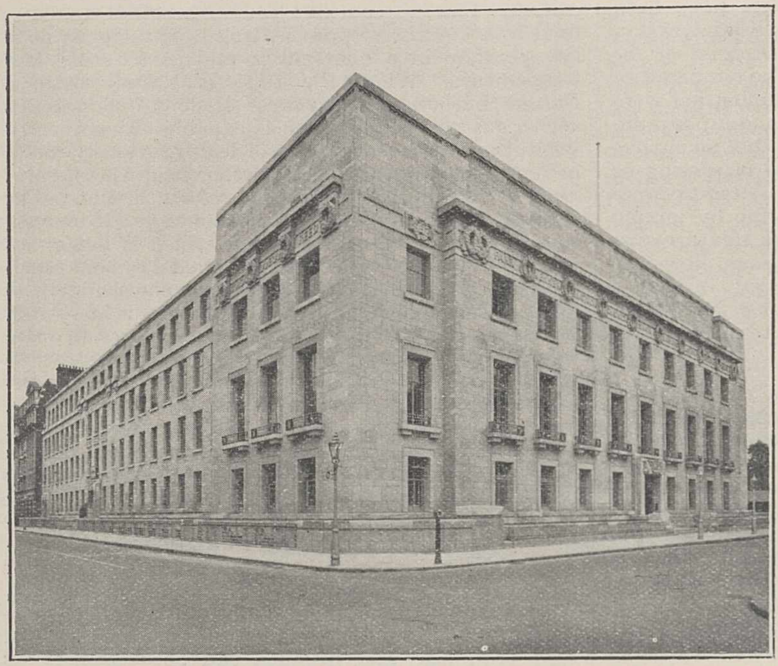


Photo.] [Walshams, Ltd.

FIG. 1.

Thirty years ago, as is well known, Mr. Joseph Chamberlain, when Colonial Secretary, at the instance of Sir Patrick Manson, founded a school for the study of the diseases of the tropics; and the London School of Tropical Medicine so established, first at the Albert Docks and, since the War, at Endsleigh Gardens, always under the ægis of the Seamen's Hospital Society, has rendered constant service to the Empire. Negotiations with the Seamen's Hospital Society led to the absorption of this school into the new institute; and in August 1924 the resulting "London School of Hygiene and Tropical Medicine", affiliated with the University of London, was incorporated by Royal Charter, a union which serves to emphasise the fact that the fundamental needs of hygiene are the same throughout all climates.

Now that the School is about to take possession of its new premises, it is possible to gauge the magnitude of the task which has been entrusted to the director, Dr. Andrew Balfour. The School consists of six divisions: Public health; epidemiology and vital statistics; bacteriology and immunology; biochemistry (including chemistry as applied to hygiene); medical zoology (including protozoology, helminthology, and entomology); and tropical medicine and hygiene. These divisions will collaborate in providing courses of instruction for the diplomas of hygiene and of tropical medicine and hygiene; independently they will provide advanced teaching in their special subjects; and they will afford ample facilities for research. It has been the constant aim of those concerned with the organisation of the School to secure a nice balance between these several activities, and much of the space available in the building has been so allotted that it may be used for teaching or research as occasion may demand. It

Photo.] [Walshams, Ltd.

FIG. 2.

is most desirable that men on furlough from the tropics should have somewhere to go where they can finish off any research work that they may have on hand. The services of the library to the man in the tropics, as well as to the worker in Great Britain, will be no less valuable. For, with the collaboration of the Bureau of Hygiene and Tropical Diseases which will be housed in the building, it is hoped to develop something approaching an international information bureau in all subjects within the purview of the school. The museum also, which will be open to the public, will play an important part, both educational and propagandist. It consists of three parts: sanitary engineering, general hygiene, and tropical medicine. Many of the exhibits have been prepared and presented, and will be kept thoroughly up-to-date by large commercial interests concerned in public health activities of various kinds.

The building which is to subserve this varied array of functions is a massive block in Portland stone lying just north of the British Museum (Fig. 1). The successful design was submitted by Mr. P. Morley Horder, and Mr. Verner O. Rees, in association with Mr. Horder, has carried through the execution of the design so submitted; and despite the economy in external ornament, dictated by the practical needs of the building, the architects have succeeded in making a very pleasing contribution to the architecture of Bloomsbury. The building consists of four main stories with a recessed floor above these, and finally a small top floor composed mainly of animal houses. The walls and foundations have been so constructed that they will support another story should this eventually become necessary.

The general plan of the building is that of a letter H, with the long sides on Gower Street and Malet Street, a cross-bar uniting the two and separating the north and south courts, and with the foot of the H closed by the main front which faces south on to Keppel Street. The severity of the Keppel Street elevation is relieved by a wide frieze composed of wreaths and of the names of some of the pioneers in hygiene and tropical medicine; and a lively series of gilded designs, representing some of the animals which concern the hygienist most closely, are set in the metal balustrades below the first floor windows. These ornaments are continued some way along Gower Street and Malet Street, but beyond this the side elevations are relieved only by the prominent entrances. The main entrance, in Keppel Street, is surmounted by a large panel engraved with the handsome seal of the School.

Probably the most striking feature about the interior of the building is the abundant supply of light and air. The passages are considerably wider than is usually the case in a building of this type, and this reflects the intention of the architects to ensure that the School should in no way fall short of those principles which it will be its main function to inculcate. With the exception of the main lecture theatre, ventilation is secured throughout by natural means; the large open courts help to make this possible. The working departments occupy the sides and cross-bar of the H, and the planning of these departments has varied with their respective functions. The base of the H, the Keppel Street front, contains those sections which are of more immediate concern to the outside public; and in this part, naturally, more concession has been made to architectural effect.

Immediately beyond the entrance hall and occupying the south court is the main lecture theatre. It is the easiest part of the building to find; a most convenient arrangement, for this theatre will frequently be used for 'outside' lectures. On the first floor, the entire frontage is occupied by the library, a wide, imposing room, unbroken by pillars, panelled throughout with oak (Fig. 2). Immediately behind the library, access is provided to the flat roof of the lecture theatre, which will be laid out as a garden court. The second and third floors comprise the museum; the lower devoted to hygiene, the upper to tropical medicine, both splendidly illuminated by large windows in the north and south walls and by three open wells admitting light from above.

The opening ceremony was performed by H.R.H. the Prince of Wales on July 18, almost exactly three years after the foundation stone was laid by Mr. Neville Chamberlain as Minister of Health. The Prince of Wales was received by Lord Melchett, chairman of the Board of Management, who read an address of welcome which outlined the history and functions of the School. In his reply, the Prince of Wales stressed the importance of this great benefaction as a sign of Anglo-American friendship, and expressed his belief that the opening of this School would inaugurate a new era in preventive medicine. When Sir Holburt Waring, chairman of the Court of Governors, had returned thanks to the Prince of Wales for his attendance, and had been supported by Sir Gregory Foster, Vice-Chancellor of the University, His Royal Highness visited the various departments of the building. The assembled company was entertained to luncheon as the guests of Lord Melchett, the building was thrown open for general inspection, and a series of kinematograph displays showing some aspects of preventive medicine were exhibited in the lecture theatre. The School achieved a very gay and successful debut, and, given adequate financial support, there is every reason to expect that it has before it a long and prosperous career "in the Service of Mankind".

History of Science Exhibition at Florence.

THE first National Exhibition of the History of Science is being held from May to October of this year at Florence. It is of great interest to those concerned with the story of the development of scientific thought, although this development is somewhat obscured by the grouping of the exhibits according to their local origin rather than in logical or chronological order.

Of the various sections of the Exhibition, perhaps the most important are those in the rooms illustrating the discoveries of Leonardo da Vinci and Galileo Galilei. Here are interesting models of flying machines constructed in accordance with the descriptions in Leonardo's "Codice del Volo degli Uccelli". Among them is a machine to be fitted to the shoulders, and another of a canvas wing, the formation of which, similar to that of a Venetian blind, was imitated from the wing of a bird. Other designs show Leonardo's final device for the motion of the wings, his "macchina volante con piano portante", representing the final perfection of the type. There is also Leonardo's parachute and his instrument devised for the solution of the problem of the Arabian mathematician, Alhazen.

A number of models illustrate the experiments and discoveries of Galileo. There is the inclined plane for testing the rate of descent of bodies, the semiparabola illustrating the path traversed by objects horizontally projected, and the apparatus that illustrates the action of the pendulum. Here, too, are the 'Compasso di proporzione' or 'military compass', invented by Galileo in 1596, and a photograph of the first lens constructed by him in 1610, with a diameter of 4 centimetres. There are also various astronomical and other instruments of the sixteenth and seventeenth centuries. Thus we have an apparatus for the discharge of projectiles, with pistol and quadrant attached to it, which belonged in 1597 to Robert Dudley, Duke of Northumberland, and a lens of 1690 used by Averani and Targioni for experiments on the action of solar rays on precious stones, and by Donati for the observation of stellar spectra.

The Exhibition contains many first editions and manuscripts of famous scientific works. Among these are Galileo's "Compasso geometrico" printed at Padua in 1606, the MS. of his first draught of the "Sidereus Nuncius", his "Il saggiatore" (Rome 1623), and his "Delle cose che stanno in su l' acqua" (Florence 1612). There is also Galileo's autograph letter in defence of his "Tractate" on the motion of the earth, from the Biblioteca Roncionana di Prato. Among other early editions of famous works is a copy, printed at Florence in 1611, of Kepler's "Narratio de observatis a se quatuor Iovis satellitibus erronibus".

More modern scientific developments are also represented in the Exhibition. There is a case of manuscripts of Galvani (1737–1798), among which is the holograph copy of his "De viribus electricitatis in motu muscolari". The telescope, microscope, and other instruments used by G. B. Amici are shown, with a copy of the famous electromagnetic machine of Antonio Pacinotti and a case of his manuscripts.

The Turin and Milan rooms are mainly devoted to the development of modern engineering. Here is exhibited the Sommeiller perforator, used in the construction of the Mont Cénis tunnel, the first F.I.A.T. automobile of 1899 and material relating to the making of the first Italian railways. There is a case of autograph letters by Galileo Ferraris, the physicist (1847–97), and the original apparatus constructed by him for the study of the rotating magnetic field. The first instruments used by Marconi, including condenser, receiver, transformer, etc., are to be seen. There is also a case of early printed pamphlets relating to aeronautics, among which is Blancard's "Relation du 15me voyage aérien fait à Francfort A.M. le 3 d'octobre 1785".

It is impossible to close an account of this Exhibition without mentioning the very interesting exhibits of the Reale Academia Nazionale dei Lincei. Among these is a series of manuscript volumes of the proceedings of this famous Italian predecessor of the Royal Society. The first volume is dated 1603, the year of the foundation of the Academy by Prince Federigo Cesi. This case contains also the first editions of some notable works by the early Lincei, including the "De nova stella disputatio" by Johan Eck (Rome 1605), the "De aereis transmutationibus", by Giovanni Battista Porta (Rome 1614) and Galileo's "Il saggiatore" (Rome 1623). In another case are the MS. volumes of the proceedings of the Academia del Cimento, dated 1666 and subsequent years.

The Official Guide and Catalogue to the Exhibition can be obtained on application to the Direzione, Prima Esposizione Nazionale di Storia della Scienza, Piazza Cavour, Firenze. S. D. WINGATE.

Long Delayed Radio Echoes.

PRINCIPAL PEDERSEN, of the Technical College, Copenhagen, has communicated a paper in English on "Wireless Echoes of Long Delay" to the physical section of the Danish Royal Society, which shows that scientific workers hold very different opinions on this subject.

Störmer, Pedersen, and Wagner think that the echoes are caused by radio waves being reflected from swarms of electrons out in space, whilst others, van der Pol, Appleton, and Ardenne, assume that the long delay is due to special conditions in the Heaviside-Kennelly layer. To account for the long delay which sometimes occurs before the arrival of the echo, Ardenne assumes that the waves travel round the earth some hundreds of times. Owing, however, to the necessary attenuation, this assumption presents great difficulties.

Principal Pedersen gives a mathematical proof that the long delayed echoes cannot arise either by the propagation of radio waves within the earth's atmosphere or by the waves travelling outside the latter in a medium so strongly ionised that the group velocity of the electrons approaches zero. In his opinion they are due to the fact that the waves have travelled very great distances outside the earth's atmosphere and have then been reflected by swarms or bands of electrons in space, as described by C. Störmer in NATURE (Vol. 122, p. 681, 1928). The assumption is made that all waves shorter than about 8 metres will penetrate into space with very little attenuation. At noon, all waves longer than about 40 m. are completely reflected or refracted back to the earth. At midnight the waves must be longer than 70 m. to be reflected back. The lengths vary appreciably with the ionisation of the upper atmosphere.

It is concluded by Principal Pedersen that echoes occurring after 10 seconds cannot be due to the propagation of waves within the earth's atmosphere. Echoes occurring after intervals of time up to 30 seconds are probably due to propagation along or reflection from Störmer bands. Occasionally echoes do not occur until several minutes have elapsed. In these cases the bands of ions must be outside the space in which the magnetic field of the earth exerts any appreciable direct influence.

University and Educational Intelligence.

ABERDEEN.—The degree of Doctor of Science has been awarded to Dr. A. N. Campbell, for a thesis entitled "The Existence of Liquid Racemates"; Sophia L. M. Connal (*née* Summers), for a thesis entitled "A Particular Study of 55 Species of Mosquitoes met with in Nigeria"; Mr. G. Redington, for a thesis entitled "The Effect of Light on Plant Growth".

CAMBRIDGE.—The Wrenbury Scholarship has been awarded to L. J. V. Shepherd, of St. John's College. Miss A. S. Dale, of Newnham College, has been re-elected to the Michael Foster Research Studentship in physiology. At Clare College the Denman Baynes Studentship has been divided equally between E. C. Bullard and R. M. Margoei.

EDINBURGH.—The Cameron Prize in practical therapeutics has been awarded to Sir Leonard Rogers, in recognition of the discoveries he has made in the treatment of several tropical diseases, and in particular in the treatment of cholera, amœbic dysentery, and leprosy. This prize is "awarded annually to a person who, in the course of the five years immediately preceding, has made any highly important and valuable addition to practical therapeutics".

LEEDS.—Dr. Ll. Lloyd has been appointed reader in entomology and protozoology.

LONDON.—Prof. H. H. Woollard has been appointed as from Sept. 1 to the University chair of anatomy tenable at St. Bartholomew's Hospital Medical College.

Prof. Woollard was educated at the University of Melbourne and at University College, London. From 1919 until 1923 he was senior demonstrator, and from 1923 until 1927 assistant professor of anatomy at University College, London. Since 1927 he has been professor of anatomy in the University of Adelaide. His publications include "Recent Advances in Anatomy" (Churchill, 1927) and "Scientific Basis of Anatomy" (translated from the German; Bale, Son and Danielsson, 1927).

Mr. L. C. Robbins has been appointed as from Aug. 1 to the University chair of economics tenable at the London School of Economics. Mr. Robbins entered the London School of Economics in 1920 and on graduation was appointed research assistant to Sir William Beveridge, and later lecturer in economics. His published work includes numerous papers on the theory of population, the theory of value, and other problems of economic theory.

The following doctorates have been conferred: D.Sc. in Chemistry on Mr. J. E. G. Harris (University College), for a thesis entitled "The Soledon Reaction"; Mr. A. J. Turner, for a thesis entitled "The Relation between Atmospheric Humidity and the Breaking Strengths and Extensibilities of Textile Fabrics before and after Weathering", and other papers; D.Sc. (Engineering) on Mr. Arthur Winstanley, for a thesis entitled "Roof Control when working Coal Seams by Longwall".

The University Studentship in Physiology for 1929–30, of the value of £100 and tenable for one year in a physiological laboratory of the University or of a school of the University, has been awarded to Miss Margaret Hill.

The Chadwick Trustees have made a grant of £500 towards the cost of equipping the new laboratory of the Department of Municipal Engineering at University College, and also a grant of £200 a year for three years to the Department.

APPLICATIONS are invited by the Association of Surgeons of Great Britain, 17 Wimpole Street, W.1, for a surgical scholarship of the value of £350. The object of the scholarship is to enable the holder to pursue a definite line of research or to study surgery in specified clinics, either at home or abroad, and candidates in their applications should state the line of research or study that they propose to pursue. The latest date for the receipt of applications is Sept. 20.

THE Ramsay Memorial Fellowship Trustees have made the following awards of new fellowships for the session 1929–30 at the centres named: British Fellowship, tenable for two years, to Mr. O. H. Wansborough-Jones (University of Cambridge); British Fellowship, tenable for one year only, to Mr. R. J. Phelps (University of Oxford); Canadian Fellowship to Dr. L. M. Pidgeon (University of Oxford); Japanese Fellowship to Prof. Y. Nagai (University College, London); Spanish Fellowship to Don Andres Leon y Maroto (University College, London); Swedish Fellowship to Mr. E. K. Troell (Rothamsted Experimental Station, Harpenden). The Trustees have renewed the following fellowships for the session 1929–30: Dr. H. Bienfait (Netherland Fellowship at the Imperial College of Science and Technology, London), and Dr. P. Maitland (Glasgow Fellowship at the University of Cambridge). Sir Robert Waley Cohen has been appointed vice-chairman of the Trust in succession to Sir John Brunner, deceased, and the Hon. Henry Mond has been appointed a Trustee.

Calendar of Patent Records.

July 28, 1758.—The production of zinc on a commercial scale was first undertaken by William and John Champion, who erected works at Bristol about 1740. John Champion's patent for extracting zinc from blende, a method of manufacture which did not become general until the middle of the nineteenth century, was granted on July 28, 1758. The Bristol works were later transferred to Swansea, which became the centre of the British trade.

July 30, 1571.—Richard Mathew was the first Englishman to make fine cutlery, an art which he had learnt while travelling abroad. On July 30, 1571, he was granted a patent for the "making of certen haftes called Turkye haftes for knyves, weapons, and other things by hym lately devised in our realme to be made of dyvers peces of horne of one or of sundry coloures mixed and garnished betwene those peces with yellow or white plate", but the patent was successfully contested by the Cutlers' Company before the Privy Council on the ground "that it hath been and will be the overthrow of the cutlers within the city".

July 31, 1781.—One of the early competitors for the prize offered by the Paris Academy of Sciences in 1775 for a practicable process of manufacturing artificial soda was Bryan Higgins, whose invention was patented on July 31, 1781. The process did not overcome the difficulty, but this and other early attempts paved the way for Leblanc's successful solution of the problem a few years later.

July 31, 1846.—Lord Armstrong's invention of the hydraulic crane, which was the pioneer in the application of hydraulic power for lifting purposes, and from which evolved the hydraulic elevator, was patented on July 31, 1846. It was first introduced for lifting the stone in a Yorkshire quarry and was rapidly adopted.

August 2, 1695.—On Aug. 2, 1695, there was granted to Daniel Quare, a noted London clockmaker and the inventor of the repeater watch, a patent for "a portable weather glasse or barometer which may be removed or carried to any place though turned upside down without spilling one drop of the quicksilver or letting any aire into the tube". The Clockmakers' Company took exception to the patent and informed its members that anyone who was proceeded against on account of the patent would be defended, but the quarrel must have been of short duration, for Quare became Warden of the Company in 1705 and Master in 1708.

August 2, 1800.—The rifling-machine for guns dates from the patent of Thomas Gill, gunmaker of Birmingham, whose patent is dated Aug. 2, 1800. The barrel is fixed on a reciprocating frame, and the cutters of the required width are attached to a long bar which passes through the barrel and is rotated in centres at each end by means of a rack and pinion mechanism. No record of a machine having been made is, however, known.

On the same day, Aug. 2, 1800, there was granted to Mathias Koops a patent for his newly invented method of manufacturing paper from straw, etc. The patent was voided by the non-enrolment of a specification, but the process is described in a specification enrolled on a second patent formally granted the following year, though Koops petitioned that a specification might be dispensed with. In 1800, Koops published "An historical account of the substances which have been used to describe events and convey ideas", which was printed on paper made from straw and had an appendix on paper made from wood.

Societies and Academies.

LONDON.

Geological Society, June 26.—**R. O. Roberts**: The geology of the district around Abbey-Cwmhir (Radnorshire). This paper deals with an area of about 30 square miles in north-western Radnorshire. The rocks belong to the Bala, Valentian, and Wenlock Series. Only the lowest beds of the Birkhill Stage are exposed, and they are overstepped by the Tarannon Stage, which, over most of the area, rests directly on folded Bala rocks. The Bala rocks are exposed along the north-eastern extension of the Towy anticline; but, in this district, the anticlinal axis is partly replaced by an important strike-fault, which hades westwards. Subsidiary folds may be recognised within the Bala rocks. The axes of these folds are parallel to the general strike of the strata, although there is a change in the direction of pitch around Nantmel. The Bala rocks were folded in pre-Tarannon times, but broad shallow folds in the Tarannon and Wenlock rocks indicate that there has been a repetition of folding along the same lines at different periods.—**C. A. Matley** and **A. Heard**: The geology of the country around Bodfean (south-western Carnarvonshire). The area includes the prominent hill of Garn Bodfean (918 feet above O.D.) and a lesser hill, Moel y Penmaen. Most of the remaining ground is covered by drift. The country can be divided into two belts with reference to the dominant east-north-easterly strike. In the southern belt there is a volcanic series of submarine lavas and tuffs interbedded with ashy and argillaceous sediments. Fossils found at several horizons indicate a Lower Bala age. Garn Bodfean, in the northern belt, consists of a great mass of 'felted' and granular keratophyres and some quartz-keratophyres. It seems possible that the whole hill is a transported mass carried over the Nevin Shales by earth-movements. All the igneous rocks of the area are considered to be extrusive, with the possible exception of a basalt, which may be a sill. A detailed account of the petrography and tectonics of the area is given.—**G. H. Mitchell**: The petrography of the Borrowdale volcanic series of the Kentmere Area (Westmorland). The volcanic rocks are composed of both lava-flows and tuffs of intermediate composition, varying from basic andesites to rhyolites. The rocks are greatly altered, and this has led to difficulty in distinguishing between lava-flows and tuff-deposits, particularly when the former are brecciated owing to flow. The alteration of the rocks, as shown by the changes in mineral composition, together with the materials filling the vesicles, is considered. Much of the alteration may be referred to a variety of propylitisation.

PARIS.

Academy of Sciences, June 17.—The president announced the deaths of Henri Andoyer, Charles Moureu, and Léon Lindet.—**Charles Moureu, Charles Dufraisse**, and **Joseph Robin**: Researches on rubrene. Study of the mechanism of its formation: description of an intermediate chlorine derivative. In the preparation of rubrene an intermediate compound of the composition $C_{42}H_{29}Cl$ has been obtained by modifying the conditions of the reaction; that this is really an intermediate stage in the formation of rubrene is shown by the fact that it is readily transformed into rubrene without by-products.—**P. A. Dangeard** and **Mme. Mara Lechtova Trnka**: The phenomena of symbiosis in *Myrica Gale*. The tubercles frequently found on this plant are due to a bacterium, for which the name *Rhizobacterium Myricæ* is proposed. Its relations with the cells of the *Myrica* closely resemble those in the tubercles of the Leguminosæ.—**de Possel**: The characteristic invariants of varieties in two dimensions with infinite connexion and the homeomorphy of discontinuous closed ensembles.—**J. Delsarte**: The group of conformal geometry in space of functions of summable square.—**G. Kolossoff**: The extension of a theorem of Maurice Lévy.—**A. Martinot-Lagarde**: An arrangement of an aerodynamic tunnel for the study of flow in two dimensions.—**I. Tamm**: The new theory of A. Einstein and the theory of quanta.—**G. Bruhat**: The notations of thermodynamics.—**E. Sevin**: The introduction of an electric charge vector. Application to the synthesis of the theories of electromagnetism, of light, and of gravitation.—**Pierre Daure**: The photometric study of the Raman effect.—**J. Gilles**: The ultra-violet bands of sulphur.—**Traján D. Gheorghiu**: A method of photoelectric photometry with a variable source of radiation. The method described avoids the necessity of using two exactly similar photoelectric cells or absorbent standards, and an ordinary Heraëus mercury lamp can be used as the source of light.—**M. Mathieu**: Crystal constants of the compound $K_2(PtBr_6)$.—**E. Larroque**: The discovery of a Strombus horizon in the island of Djerba (Tunis).—**A. Demay**: The general structure of the Hercynian subdivision.—**Louis Dangeard**: The Bacteriaceæ of the Oolitic iron minerals. The facts observed, while not excluding the possibility of chemical action, confirm the hypothesis that the ferruginous bacteria play an important part in the formation of these iron minerals.—**P. Choux**: The Dideraceæ, Madagascan xerophytes.—**A. Guilliermond**: The development of a *Saprolegnia* in media containing vital colouring matters and the coloration of the vacuome during growth. A comparison of various colouring matters showed that neutral red is very slightly toxic for *Saprolegnia*: this develops nearly normally in the presence of small quantities of this dye which it accumulates in its vacuome.—**E. Chemin**: The variations of iodine in *Trailliella intricata*.—**Jules Amar**: The origin and destination of the cellular fats.—**Paul Dutoit** and **Christian Zbinden**: The spectrographic analysis of the ashes of the blood and of organs. Arc spectra from the ashes of the blood indicate the presence of thirteen elements, including silver, copper, manganese, titanium, and zinc. Examination of the ashes of various organs show a selective action of the pancreas on nickel, cobalt, and lead. The suprarenal capsules appear to retain tin, while zinc is abundant in the liver and kidney. Copper and silver disappear in tumours.—**L. Margaillan**: The regularity of the variations of the characters of oils extracted from a given animal as a function of the point of withdrawal. The fats extracted from tissues taken from various points of *Delphinus tursio* show marked differences in composition. These variations are not irregular, the iodine absorption figure, for example, increasing from the nose to the tail.—**R. Fosse, A. Brunel**, and **P. de Graeve**: The application to urine of the biochemical determination of allantoin.—**E. Doumer**: Osmotic drainage.

CAPE TOWN.

Royal Society of South Africa, May 15.—**A. L. du Toit**: The volcanic belt of the Lebombo—a region of tension. The belt of the Lebombo follows the thirty-second meridian for six degrees and is composed of Karroo Beds disposed in the form of a monocline sinking eastwards beneath the Cretaceous and younger deposits of the littoral. The volcanic rocks of which it is mainly composed consist of a lower group of basalts (and in the north of limburgites and alkaline basalts), a middle one of rhyolites and an upper one of basalts, to a maximum thickness of about 9000 metres. Originating out of crustal tension is a swarm of dolerite dykes, and in the lower group of dykes of felsite and larger linear bodies of dolerite, gabbro and granophyre with north-south trend, regarded as the consolidated feeders of the lavas. Judging from the tilting of these dykes, the growth of the monocline took place during the middle of the eruptive period, seemingly during the Liassic. The crest of the range marks a surface of planation developed during the late Mesozoic and early Cainozoic.

LENINGRAD.

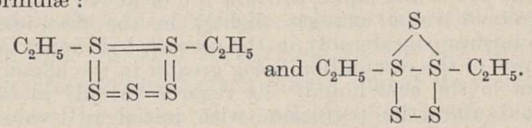
Academy of Sciences (*Comptes rendus*, No. 5).—**P. P. Lazarev** and **S. Lioznianskaia**: The structure of annealed glass. A description of physical properties including the polarisation phenomena.—**V. I. Vlodavec**: Results of the investigations on the apatite deposits in the Khibin tundras in 1928. The deposits are characterised by the presence of rare earth, particularly of strontium, as well as of phosphorus, fluorine and titanium. Preliminary estimations of phosphorus show that its quantity must be sufficient for an extensive development of a superphosphate industry.—**E. F. Miram**: Contributions to the knowledge of Palæarctic Orthoptera. Descriptions of *Pœcilimon bifenestratus*, sp. n. from W. Caucasus and *Paradrymadusa kiritshenkoi*, sp. n. from Mongolia; the latter species belongs to a genus hitherto known only from Mediterranean countries.—**N. Annenkova**: A new polychæte worm, *Oridia rivularis*, sp. n. from brackish water in the Shantar Islands, in the Okhotsk Sea. Four other known species of the genus occur on sea-shores.—**N. Annenkova**: Corrections and additions to the fauna of Ponto-Caspian Polychæta. Notes on distribution and morphology of a number of species.—**G. Y. Vereščagin** and **I. P. Sidorytchev**: Some observations on the biology of Comephoridæ. *Comephorus dybovskii* Kor. and *C. baicalensis* Pal., two endemic fishes of Lake Baikal, are not typical deep-water fishes as was supposed previously. The reproductive seasons differ, that of *C. dybovskii* being in February–March, and of *C. baicalensis* in July–August. The food of *Comephorus* was found to consist of an endemic gammarid crustacean, *Macrochetopus branickii* Dyb.

MELBOURNE.

Royal Society, May 9.—**W. J. Harris** and **R. A. Keble**: A collection of graptolites from the Federal Territory. This is the first collection of graptolites from the Federal Territory. The forms recognised are *Dicellograptus* cf. *gravis*, K. and H.; *D.* cf. *gurleyi* Lapw.; *Dicranograptus furcatus* cf. var. *minima* Lapw.; *Diplograptus calcaratus* var. *vulgata*, Lapw.; *D. ingens* T. S. Hall; *Olimacograptus tubuliferus* Lapw. Substantially the same sub-zone has been recognised at Mt. Easton in Victoria. The British equivalent is the *Dicranograptus clingani*, sub-zone 12, in Elles and Wood's Zonal Distribution (Pal. Soc.).

ROME.

Royal National Academy of the Lincei, May 5.—**U. Cisotti**: Christoffel's second triple tensor and the intrinsic derivation.—**G. A. Maggi**: The potential function of a double layer. (Extract from a letter to T. Levi-Civita.)—**S. Pincherle**: Linear functional operations and developments of the zero.—**A. Bemporad** and **L. Genovese**: Investigations on the systematic errors of the Draper Catalogue. The errors in this catalogue which can be investigated according to (1) the spectral type and (2) the stellar magnitude are considered, and a table is given for the simultaneous correction of the two errors. Further calculations are being made for a more general treatment of the question, which is of fundamental interest for the photometric reduction of the twenty zones into which the Astrographic Catalogue is subdivided.—**M. La Rosa**: The interpretation of the behaviour of Algol, and the variability of the velocity of light. A further point remaining obscure in the author's ballistic theory of variable stars is examined, namely, the divergence between the theoretical predictions and the behaviour exhibited by Algol and analogous stars, this divergence having been pointed out by Bernheimer and by Salet and used by them as the basis of their denial of the applicability of the ballistic principle to the propagation of light. It is shown that the phenomena presented by such stars actually furnish a striking confirmation of the author's theory.—**U. Bordoni**: Measurement of the thermal conductivity of specimens of irregular shape.—**G. Rovereto**: The tectonic indications of a new railway tunnel of the Ligurian coast.—**L. Petri**: Alterations produced in the stem of papyrus by protozoa. Papyrus growing in Syracuse is subject to various parasitic diseases; one of these, which causes rotting of the portion of the stem immersed in the water, being caused by a flagellated protozoon. The nutriment of this organism consists of the protoplasm and starch granules of the peripheral parenchymatous cells, which it invades by perforating the pecto-cellulosic wall.—**S. Minetti**: Ratio of convergence of Taylorian development.—**S. Cherubino**: Definite or semi-definite polynomes.—**A. Tonolo**: Classification of the surfaces of Hilbertian space, the 2-tangent space of which is of four dimensions (2).—**G. Bacchi**: Decomposition of vectorial hyperhomographs.—**A. M. Bedarida**: The prime ideals of a quadratic body.—**L. Onofri**: The series of powers which assume the circumference of convergence as a singular line.—**L. S. Da Rios**: Curved tubing and wings.—**E. Gugino**: Extension of the theorem of maximum kineto-dynamic effect to the motion of systems with unilateral linkings.—**G. Viola**: Light curve and period of W Ursae majoris.—**U. Barbieri**: Radiotelegraphic determination of longitude, and local attraction in the first order peak Monte Colma di Mombarone.—**R. Brunetti**: Theory of paramagnetism for ions subject to intense molecular action.—**Marya Kahanowicz**: A new series in the spectrum of iron, produced by highly condensed discharges.—**S. L. Straneo**: The functional resolution of the linear problems of the propagation of heat.—**G. R. Levi** and **A. Baroni**: Diethyl pentasulphides. Two isomeric diethyl pentasulphides are obtainable, their constitutions being probably represented by the formulæ:



The former is probably the isomeride boiling at 119° under 26 mm. pressure and formed by the condensation of sulphur trichloride with mercaptan, and the latter the one having the boiling point 130° and produced by the direct action of sulphur on ethyl disulphide.—**E. Pace**: Condensation of piperonaldehyde with certain pinacolines. The condensation products of piperonaldehyde with the three pinacolines, methyl tert. butyl ketone, ethyl tert. amyl ketone, and propyl tert. hexyl ketone, are described.—**A. Ferrari**, **A. Celeri**, and **F. Giorgi**: The importance of crystalline form in the formation of solid solutions (5). Thermal and X-ray analyses of the anhydrous systems, $CoCl_2 - FeCl_2$ and $MnCl_2 - FeCl_2$. The melting points of these anhydrous chlorides, based on those of sodium and potassium chlorides as 803° and 774° respectively, are $722° \pm 1°$ for cobalt chloride, $674° \pm 1°$ for ferrous chloride, and $650° \pm 1°$ for manganous chloride. Ferrous chloride is miscible in all proportions with each of the other chlorides, and the melting points of the mixtures are intermediate to those of the components, the intervals of crystallisation being so small as to be inappreciable. For the $CoCl_2 - FeCl_2$ mixtures, the angle of the rhombohedron remains unchanged at 60° and the magnitude of the side a varies from 7·05 A. for $CoCl_2$ to 7·155 A. for $FeCl_2$. With the $FeCl_2 - MnCl_2$ mixtures, the angle of the rhombohedron varies from 60° to 61° 25′, the value of a from 7·155 to 7·20, and the ratio $c : a$ from 2·45 to 2·37 in passing from $FeCl_2$ to $MnCl_2$.—**T. G. Levi**: A new class of organic sulphur bases. When an alcoholic solution of aniline is added to a 20 per cent aqueous alcoholic formaldehyde solution into which hydrogen sulphide has previously been passed, heat is generated and 3:5-diphenyl-1:3:5-dihydrothiazine is formed. Other aromatic amines form similar compounds, and analogous selenium derivatives are obtainable if hydrogen selenide is used in place of hydrogen sulphide.—**Aldo Spirito**: Observations on the regulative processes in relation to the development of the cerebral hemispheres in embryos of Anura (2).—**C. Forti**: Further investigations on the action of certain alkaloids on leucocytes isolated from the organism. Before causing the death of the cell, the hydrochlorides of cocaine, novocaine, and tutocaine give rise to an arrest of its activity, that is, to a suspension of the cellular functions from which recovery is possible. The ease with which these compounds are eliminated or destroyed by the cellular protoplasm varies in degree with the different alkaloids. —**U. Cassinis and L. Bracaloni**: Normal alcoholemia during physical exercise. Experiments on eight individuals fail to furnish evidence that alcohol, even in minimal amount, is formed in the blood as a result of muscular work.—**A. Galamini**: The food value of legumes studied with albino rats. When rats are fed solely on raw beans, their urine becomes first neutral and then alkaline, the animals losing weight and dying more rapidly than when fasting. If the beans are cooked, the rats withstand the diet far better, although they lose in weight.—**S. Goldberger**: The action of pH on striated muscle. Experiments made on the lines of Trendelenburg's perfusion method with frog's muscle show that variation in the pH of the liquid (Ringer's) is not accompanied by modification of the latent time. With change of the pH from 5·8 to 9·0, the threshold value, the optimum stimulus, and the magnitude of the muscle contraction alter very little, any slight variations being only gradual. If the pH of the liquid is below 5·8 or above 9·0, the threshold value changes slightly in the first, and diminishes considerably in the second, half-hour, the degree of the diminution being greater in the alkaline than in the acid liquid. As regards the pH in the liquid after the perfusion, with initial pH values between 3·2 and 10·8, the muscle exhibits perfect equilibrating power, the Ringer's liquid having the pH 6·7 after perfusion, even when the experiment is continued for twenty-four hours. With higher or lower pH values, the liquid remains the same after as before the perfusion.—**R. Margaria**: The alkaline reserve of sea-water. Experiments on the capacity of sea-water to fix carbon dioxide indicate that, although the reaction of the water is markedly alkaline, this is displaced, in the perfusion of surviving organs, towards the acid side solely by the presence of the carbon dioxide produced by the tissues and that, considering the pressure of the dioxide existing in the tissues, such displacement might be sufficient to make the pH value less than that of organic liquids. It cannot, however, be assumed that this phenomenon would actually occur, since the tissues have sufficient regulating power to enable them to confer their characteristic reaction on the perfusion liquids.

Official Publications Received.

BRITISH.

Commonwealth of Australia: Council for Scientific and Industrial Research. Pamphlet No. 12: The Cattle Tick Pest and Methods for its Eradication. Pp. 23. (Melbourne: H. J. Green.)

Indian Journal of Physics, Vol. 3, Part 4, and Proceedings of the Indian Association for the Cultivation of Science, Vol. 12, Part 4. Conducted by Sir C. V. Raman. Pp. 451-536+plates 22-24. (Calcutta.) 3 rupees; 4s.

Flora of the Upper Gangetic Plain, and of the Adjacent Siwalik and Sub-Himalayan Tracts. Vol. 3, Part 3: Palmæ to Cyperaceæ. Pp. ii+285-371. (Calcutta: Government of India Central Publication Branch.) 12 annas; 1s. 3d.

Indian Central Cotton Committee: Technological Laboratory. Technological Bulletin, Series A, No. 13: Technological Report on Samples of Punjab-American and Mollisoni (desi) Cottons grown in different Parts of the Punjab in the Season 1928-29. By A. James Turner. Pp. 10. (Bombay.) 6 annas.

Astrographic Catalogue 1900·0. Sydney Section, Dec. −51° to −65°, from Photographs taken at the Sydney Observatory, New South Wales, Australia. Vol. 5: R.A. 0^h to 6^h, Dec. −52° to −54°, Plate Centres Dec. −53°. By J. Nangle. Pp. ii+25. Vol. 6: R.A. 6^h to 12^h, Dec. −52° to −54°, Plate Centres Dec. −53°. By J. Nangle. Pp. ii+92. (Sydney: Alfred James Kent.)

County Borough of Halifax. Third Annual Report of the Corporation Museums for the Year 1927-8. Pp. 18. (Halifax.)

FOREIGN.

Proceedings of the United States National Museum. Vol. 76, Art. 3: Descriptions of New Species of Foraminifera of the Genus Discocyclina from the Eocene of Mexico. By Thomas Wayland Vaughan. (No. 2800.) Pp. 18+7 plates. Vol. 75, Art. 12: A New Liver Fluke from a Monkey and New Parasitic Roundworms from various African Animals. By J. H. Sandground. (No. 2783.) Pp. 11+2 plates. Vol. 75, Art. 13: Bugs of the Family Miridae of the District of Columbia and Vicinity. By H. H. Knight and W. L. McAtee. (No. 2784.) Pp. 27. Vol. 75, Art. 21: A New Species of Trematode Worms belonging to the Genus Hasstilesia from Rabbits in Texas. By Asa C. Chandler. (No. 2792.) Pp. 5. Vol. 75, Art. 23: A New Species of Mosquito from Montana with Annotated List of the Species known from the State. By Harrison G. Dyar. Pp. 8. (No. 2794.) Vol. 76, Art. 2: A Revision of the Two-winged Flies of the Genus Procecidochares in North America with an Allied New Genus. By J. M. Aldrich. (No. 2799.) Pp. 13. Vol. 75, Art. 26: Two New Species of Polychaetous Annelids from the Argentine Coast. By A. L. Treadwell. (No. 2797.) Pp. 5. Vol. 75, Art. 20: Tapeworms of the Genera Rhabdometra and Paraiterina found in the Quail and Yellow-billed Cuckoo. By Myrna F. Jones. (No. 2791.) Pp. 8+1 plate. Vol. 75, Art. 22: Pagecrinus, a New Crinoid Genus from the American Devonian. By Edwin Kirk. (No. 2793.) Pp. 4+1 plate. (Washington, D.C.: Government Printing Office.)

CATALOGUES.

Bulletin of Development covering the Thirty Months ending December 31st, 1928. Pp. 67. (London: Adam Hilger, Ltd.)

Apparatus for Radiology: High Tension Transformer Units. (Publication No. A/29.) Pp. 16. (London: Newton and Wright, Ltd.)

Heat Treatment Bulletin. No. 42: The Heat Treatment of High Tensile Aluminium Alloys. By A. R. Page. Pp. 8. (London: Wild-Barfield Electric Furnaces, Ltd.)

Diary of Societies.

PUBLIC LECTURE.

FRIDAY, JULY 26.

BRITISH INSTITUTE OF PHILOSOPHICAL STUDIES (Annual General Meeting) (at Royal Society of Arts), at 5.30.—Sir Oliver Lodge: Beyond Physics.

CONGRESSES.

JULY 26 AND 27.

WOMEN'S ENGINEERING SOCIETY (Annual Conference of Women Engineers) (at Bedford College for Women).

Friday, July 26, at 8.—Lady Moir: Presidential Address.

Saturday, July 27, at 2.30.—Miss D. D. Buchanan: Some Modern Bridges: A Brief Description of their Construction (Lantern Lecture).

AUGUST 4 TO 9.

GENEVA INSTITUTE OF INTERNATIONAL RELATIONS.

Monday, Aug. 5, at 10 A.M.—K. Zilliacus: The Structure and Working of the League of Nations.

At 8.30.—E. J. Phelan: The Future of the International Labour Organisation.

Tuesday, Aug. 6, at 10 A.M.—Norman Angell: The Economic Causes of War.

At 8.30.—Henri Rolin: The Peaceful Settlement of all Disputes.

Wednesday, Aug. 7, at 10 A.M.—Prof. J. L. Brierly: The Contribution of Law to Peace.

At 5.30.—H. S. Grimshaw: The Problems of Native Labour.

At 8.30.—The Unreadiness of Public Opinion.

Thursday, Aug. 8, at 10 A.M.—Arnold Forster: The Freedom of the Seas and the Outlawry of War.

At 3.—W. T. Layton: Reparations and Debts.

At 5.30.—G. A. Johnston: Industrial Relations.

Friday, Aug. 9, at 10 A.M.—A. E. Zimmern: The Preparation of Public Opinion.

At 3.—Prof. S. de Madariaga: The Monroe Doctrine and the League of Nations.

At 5.30.—Prof. C. K. Webster: The Far East.