SATURDAY, OCTOBER 15, 1927.

CONTENTS.

Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

Imperial Agricultural Research.

It is distinctly unfortunate that the first seven plenary sessions of the Imperial Agricultural Research Conference were held during the week in which two political parties held their annual conferences. The subject matter under discussion at the research conference is of the greatest significance to an Empire in which the foremost industry is agriculture and the future of which depends wholly upon the progressive realisation of the vast potential resources of the lands which it embraces. Nothing has been left undone by the Empire Marketing Board and the Ministry of Agriculture to emphasise these two points. The reports, memoranda, and pamphlets which they have prepared and distributed to the delegates present for their information and guidance in discussing the various items on the agenda are calculated to interest a wide public, and would undoubtedly have been extensively used by the Press for this purpose had the meetings to which they refer been held a week earlier. It can scarcely be expected, however, that the Press will give undue prominence to a conference dealing with such impersonal and serious questions as those relating to the influence of scientific research upon our economic position, unless they are dealt with in a brilliantly illuminating and arresting manner and by speakers who have attained a position in popular esteem which rivals that held by the leaders of the Conservative Party and the Labour Party respectively.

The items on the agenda were so arranged that the plenary sessions during the opening week were devoted to the consideration of administrative questions. The task of considering the agricultural problems confronting the various parts of the Empire, for the solution of which the aid of science must be invoked, has been delegated to groups of specialists. Now it cannot be suggested seriously that any of the so-called technical questions which have been delegated for the consideration and report of specialist commissions, questions affecting veterinary science, soils and fertilisers, plant pathology, the preservation and transport of food and raw materials, animal and plant genetics, agricultural economics and dairying, are without interest for any of the delegates present at the Conference. Time spent on the discussion of the problems related to these various branches of agricultural research would have been exceedingly well spent. The delegates would have been able to grasp the magnitude of the responsibilities of the agricultural services, they would have been able to envisage their problems as a whole and the inter-relations of the work already being carried out in various constituent parts of the Empire, and to survey the possibilities of co-operation in connexion with the researches already in progress and those others which the Conference might decide were imperatively needed.

However, it was pre-ordained that the Conference should give first consideration to administrative questions relating to staffs and institutions. The discussions which arose out of them at the plenary sessions are certainly illuminating. In connexion with man-power, it was alleged that there is a serious shortage of suitable candidates for most branches of scientific services supported by Governments, a shortage which is being accentuated by the growing demand for specialist officers made by the non-self-governing dependencies. The Research Sub-Committee of the Imperial Conference attributed this shortage to the wholly inadequate appreciation of the importance and value of scientific research on the part of the public, of the Press, and even of Governments themselves: to the uncertainty in the minds of students embarking on a university course as to the career offered by agricultural research: to the increasing demand by private employers for men with a university training in science: and to the lack of knowledge shown by educational institutions and parents of the careers available overseas in the various branches of science and their special attractions. The shortage of candidates is particularly acute in the services—other than medical—for which a training in the biological sciences is a requirement.

The only satisfactory and permanent remedy for this state of affairs, suggested Lord Lovat, Parliamentary Secretary of State for the Dominions, is to make the Agricultural Research Services in pay, status, career, and rewards the equal of other Government services carrying equal duties and responsibilities. It is folly to expect that the best men from the universities will be attracted to agricultural science while there are so few definite and certain prizes at the top. High initial pay is an insufficient inducement. Practically every subsequent speaker endorsed these views, which will obviously commend themselves to every scientific worker in the Empire.

These are the views which have been advanced from time to time in our columns. Generally speaking, the flow of entrants to a career is regulated by its attractiveness, and not the least attractive aspect of a career is its estimation in the public esteem. This esteem must be more than a recognition of the money value of those officers who enter specialist services; it should include a proper understanding of their creative outlook. Nothing has done more harm to scientific workers than the popular acceptance of the theory that those who have achieved eminence in a particular field of science have become so specialised in their interests and so biased as to render them unfit for positions of administrative responsibility. Too early specialisation in a student's career would, it is true, tend to produce an undesirable narrowing of outlook, but provided specialisation is left to the post-graduate stage of a student's educational career, there could be no better preliminary training for future administrators than that provided by a liberal and general course in science. This fact has been recognised by certain provincial governments in India. They have been recruiting their Indian administrative staffs from the scientific institutions, particularly the colleges of agriculture in their provinces, and have found this method thoroughly satisfactory.

It is imperative that any general science course in the schools should include general biology as a subject and should not be confined, as it is in most schools in Great Britain, to physical and chemical science. The interest which is stimulated in a subject at school has a direct bearing upon the course of study undertaken at a university. Moreover, as Sir Daniel Hall rightly observed, biology should be taught in the schools not only because the Empire will have to make greater and greater demands for trained investigators in the field of biology, but also because no man can properly be regarded as well-educated who does not fundamentally understand how a plant grows and how an animal lives and has its being. If, moreover, as Sir John Farmer pointed out, an interest in biology were stimulated in the schools, it would not be taken up as a 'soft-option' at the universities mainly by those students who were conscious of their deficiencies in physics and chemistry.

The suggestion that the shortage of biological students at the universities is due to the lack of endowments for biological study was discounted by Major Walter Elliott. He emphasised the fact that there is no shortage of candidates for the medical schools, for the obvious reason that parents are satisfied that medicine provides a satisfactory career for their sons and daughters. To the proposition that scholarships should be provided for public and other secondary schoolboys to enable them to take up agricultural science at the university under the condition that they afterwards entered the agricultural service, he was resolutely opposed. This inducement, like the provision of pensions under the Civil Service scheme for the retention of officers in the service, he regarded as coming within Sir James Currie's definition of "attracting candidates by means of well-baited but otherwise poor booby-traps."

Various other means of stimulating recruitment to the overseas services were discussed. It was pointed out that various post-graduate scholarship schemes in existence have been successful in this regard. Those scholarships provided by the Government, tenable at the Imperial College of Agriculture at Trinidad, have already provided a number of officers for the colonial agricultural services in the Tropics. The scheme of the Empire Cotton Corporation has also been successful in obtaining men for cotton research in various territories. On the other hand, no success has so far attended the efforts of the Australian Commonwealth Government to obtain recruits for certain biological services by the grant of similar scholarships. The Commonwealth offered post-graduate scholarships to the value of £300 a year for two years, with £150 travelling allowance, in addition to the payment of all special fees in connexion with study. Some of these scholarships were offered to enable students to specialise in mycology and genetics. On the completion of their course, they were to be guaranteed at least three years employment under government at a minimum salary of £400 for the first year, £450 for the second, and £500 for the third. No applications were received for these scholarships. This was attributed to the past neglect of the agricultural services by the Australian Government and the failure of the people of Australia to appreciate the need for agricultural research.

Generally speaking, the discussion on training and recruitment was disappointing. It is true that much that needs saying has been said several times already in the past twelve months at gatherings of Imperial delegates, so that it was difficult to escape the platitudinous. But since every representative of the Home Government present subscribed to the view that the Imperial Agricultural Research Service must provide an attractive career for first-class men, if it is adequately to fulfil its prescribed functions, it is reasonable to expect that they should have defined its attractiveness in specific terms, and stated what further financial provision the Government is prepared to make, and what financial support has been promised or is expected from the Dominions and non-self-governing Dependencies, for the effective carrying out of the schemes submitted to the delegates for their consideration. It is to be hoped that some definite statement of this character will be made before the break-up of the Conference.

Cambridge under the New Statutes.

THE Vice-Chancellor, in his recent address at the commencement of the academic year at Cambridge, referred to the heavy strain which has fallen during the past year upon the administrative officers of the University—the Registrary, the Secretary of the General Board, the Treasurer, and, we may add, the Vice-Chancellor himself—and upon the members of various boards and committees. When 1000 pages of ordinances have to be recast to meet the requirements of new statutes, the labour involved must necessarily be extremely heavy. It may not be without interest to inquire after a year's working how far the results obtained justify not only last year's work, but also the heavy work involved over a period of years by the labours of the Royal Commission and the subsequent Statutory Commission.

What are the gains of the new scheme? The first one that strikes the eye at once is the feeling of security that the younger married 'don' has gained through the existence of a pension scheme of the same type as holds in the other universities of Great Britain. This means a comparative freedom from serious financial anxiety, and it makes easier the free interchange of teachers between Cambridge and other universities. Coupled with this is the advantage to the University which must accrue from a scheme which ensures the retirement of the teaching staff on reaching an age limit. Opinion will vary as to the proper age for retirement and the benefit that comes from a rigorous compulsory scheme, but it is clear that the scheme is, on the whole, a definite improvement on the old order of things.

Financially, many teachers in the University also benefit by the increased stipends which the annual grant to the University secured by the Commission has made possible. University stipends still lag behind the corresponding figures for professional careers outside, but the disgrace of the charity pittance awarded in the past to distinguished teachers has been stopped. It is for the University to watch that fresh developments are not marred by inadequate financial arrangements. This may check some of the valuable growths which in the past have come from poor beginnings; an enlightened policy should see to it that such growth should be encouraged, but with a start on a better basis.

The real gain of the Commission is that the University has now secured control of the development of its educational policy to an extent that was impossible before. The General Board of the Faculties, with its control over the finances of the purely teaching side of the University, has become the most important body in the University. The faculties, acting through their appointment committees, have control of the appointment of new teachers and are not so dependent as before on the chance appointment by the colleges of members of college staffs. It is significant of the change how many of the vacancies of the past year in lectureships have been filled by candidates from outside Cambridge. This widening of the field must be a pure gain to the University.

This would not be the case if the chances of promotion of the best sons of Cambridge to office in the University were blocked by the new scheme. It may be that the process of co-operation between faculties and colleges in making their staff appointments has not yet been fully explored. The ideal scheme by which the University and the college should each take its share in supporting the man who divides his time between the two of them may take some time to hammer out, but the new statutes make such a scheme possible and practicable. Goodwill and organisation will do the rest.

Among other gains requiring mention are the opening of most University prizes, scholarships, studentships, and teaching posts to women, the improved financial position of the University Library, the easing of University taxation on the smaller colleges—here it must be admitted at the expense of the larger and richer foundations—and the official recognition of research as part of the University's duty.

There are necessarily difficulties, and here and there doubts and regrets. It is incumbent on those responsible not to let organisation become dominant and not to press the professors with too much departmental administrative work. The Vice-Chancellor, we believe rightly, attributed the comparative lack of discussion of recent changes in the ordinances to "a disposition to settle down to work and to put the new Statutes of the University and the Colleges to the test of practice." The University may well spend a year or two in rounding off the fruitful work of the Commission and making quietly the further changes which experience shows to be desirable and necessary.

Catalysis.

(1) *Die Katalyse in der organischen Chemie.* Von Paul Sabatier. Nach der zweiten französischen Auflage, übersetzt von Dr. Berthold Finkelstein. Mit einem Literaturnachweis für die Jahre 1920 bis 1926, bearbeitet von Dr. Hans Häuber. Pp. xi + 466. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1927.) 24 gold marks.

(2) *Catalysis in Theory and Practice.* By Eric K. Rideal and Prof. Hugh S. Taylor. Second edition. Pp. xv + 516. (London: Macmillan and Co., Ltd., 1926.) 20*s*. net.

CATALYSIS is a subject which has always excited the interest of chemists—sometimes, indeed, their prejudices and passions. There is one point, however, on which they are probably all agreed, namely, that the association between the catalyst and the substances the reactions of which it catalyses is of so specific a nature that it is proper to apply the term 'chemical.' On the other hand, to understand the mechanism of the large class of chemical reactions which take place in contact with solid catalysts, it is necessary to inquire into the physical nature of the interfacial region where the surface catalysis takes place, and this introduces all the phenomena of 'adsorption.' For some purposes it is more important to know about the adsorption equilibria than about the nature of the forces which hold the adsorbed molecules to the surface; and there has occasionally arisen a quite unnecessary distinction between 'chemical' and 'physical' theories of catalysis. In recent years, however, Langmuir has done much to dispel the idea of any such antithesis.

The truth about catalysis has many aspects, one or other of which becomes of predominating importance according to the problem under consideration.

There are two great objects: one is to arrive at an understanding of the nature of chemical change in general, and the other is to be able to control specific reactions for particular ends, possibly industrial. The two books under review are quite different in scope and method. That of Rideal and Taylor is of a quite general character, and deals with both the chemical and physical aspects of catalysis and with its industrial applications; that of Sabatier is written entirely from the specific chemical point of view.

(1) "La Catalyse en chimie organique" is already well known to most chemists either in the French edition or in the English translation by Prof. Reid. It is an inexhaustible source of

information about the multitudinous organic reactions which can be catalytically controlled. These reactions must be regarded as forming almost a separate branch of chemistry, and one which is becoming yearly more important. It is only necessary to think of the convenient catalytic process for the dehydration of alcohol to ethylene, compared with the traditional procedure, to understand what industry owes to catalytic chemistry.

It is often possible to make at least a shrewd guess at the kind of catalyst which will be most effective in provoking some desired reaction. Although most of the information about catalytic organic chemistry is purely empirical, nevertheless the vague outlines of general laws are in places dimly discernible. Definite rules, which would enable catalytic influences to be predicted *a priori*, cannot of course be formulated, but Sabatier succeeds in bringing many hundreds of reactions into a degree of co-ordination which is surprising. The picture he presents is not more chaotic than that, say, of inorganic chemistry fifty years ago. The analysis and arrangement of the material is masterly, and admiration is increased by the reflection that a very large portion is derived from Sabatier's own researches.

It is interesting to read the statement that Sabatier's own work on catalysis has been guided by the hypothesis that unstable intermediate compounds between the reacting substances and the catalyst are always formed. In the introductory part of the book, which occupies about fifty pages, he develops a general theory based upon this idea, and shows convincingly the fundamental part played by specific chemical interaction. This aspect is a very important one, indeed all-important, since Sabatier is concerned solely with the nature of reaction products, and not at all with the kinetic problems connected with the mechanism of reactions, or with the relation between reaction rate and concentration. To deal with these, however, it would have been necessary to take into account the physical chemistry of the processes in a manner similar to that of Langmuir and others.

For the purposes of his treatment, then, Sabatier has quite rightly laid all the stress on the specific chemical influences; but it must be remarked that for the physical chemist in search of examples on which to test his theories, this book provides the best storehouse of raw material that could be imagined.

After three introductory chapters of a general nature, there follows a classified survey of different types of reaction, beginning with isomerisations, polymerisations, and condensations. The following chapters deal in order with reductions, hydrations, hydrogenations, various decompositions, dehydrogenations, dehydrations, the decompositions of acids and esters, the splitting off of halogen hydrides, the decomposition of hydrocarbons, and the hydrogenation of fats.

The translation of the French text appears to be accurate, if here and there very slightly on the side of freedom, and the German edition possesses an index, the absence of which was an almost intolerable disadvantage of the original. This disadvantage is specially felt in what is in some respects a work of reference. The translation contains 83 pages of additions, covering the years 1920–1924, and a synopsis, not very complete, of papers which have appeared since 1924. In the theoretical part of this appendix are two scanty references to 'Longmuir.'

(2) Since the original edition of "Catalysis in Theory and Practice" was published, considerable advances in the theoretical aspects of the subject have been made, and industrial applications have developed and multiplied. The theoretical parts have been completely re-written for the new edition, and much additional matter relating to modern developments on the practical side has been put in.

Two introductory chapters deal with the early history of catalysis, and 'criteria of catalysis.' Then general theories about the nature of chemical change are discussed under the headings 'Homogeneous Reactions,' and 'The Theory of Heterogeneous Catalytic Reactions,' homogeneous reactions providing a standard with which catalytic reactions may be compared and contrasted. The subjects of promoter action and catalyst poisons are then dealt with, after which various chapters deal with the applications of catalysts to processes of oxidation, hydrogenation, and so on.

To the reviewer the most interesting parts of the book are, perhaps, those dealing with technical processes. There is, for example, an excellent discussion of the general problem of the reduction of the oxides of carbon, with an account of the modern methods of producing methyl alcohol from water gas. In this, and other similar examples, the authors have shown the application of the theoretical principles to practical problems in an illuminating way.

Information is to be found in different parts of the book on such varied matters as the cracking of oils, the production of synthetic rubber, the hydrogenation of fats, and the production of aniline black.

It is always a difficult problem, in a book which aims at completeness, to decide how far the author should merely quote the work and views of others, and how far he should criticise and re-interpret. On the whole, Rideal and Taylor have compromised well between the possible extremes.

No book dealing with a rapidly developing subject could be written every page of which would compel unqualified assent. On p. 82, for example, it is stated that to account for proportionality of reaction rate to a fractional power of the pressure in a heterogeneous reaction, it is necessary to assume that each molecule of one of the reacting gases occupies some definite integral number of elementary spaces on the lattice of the solid. There is a much simpler explanation. When the degree of adsorption of a gas like stibine is large, the rate of its chemical change is independent of the pressure; when the adsorption is small, the rate is directly proportional to the first power of the pressure. For intermediate degrees of adsorption, therefore, the rate of reaction must vary as some fractional power, which, in point of fact, is never quite constant.

The production of the book is very good indeed. It is perhaps a pity that more care was not taken over proper names; it was, for example, 'Knietsch,' and not 'Kneitsch,' who did pioneer work on the contact process, and 'McC. Lewis' is rather colloquial. These minor blemishes should be removed when possible from a book which will be of importance to all chemists for some time to come.

The Calculus of Tensors.

The Absolute Differential Calculus (*Calculus of Tensors*). By Prof. Tullio Levi-Civitò. Edited by Dr. Enrico Persico. Authorised translation by Miss M. Long. Pp. xvi + 450. (London and Glasgow: Blackie and Son, Ltd., 1927.) 21*s*. net.

THE "Lezioni di calcolo differenziale assoluto" by Prof. Levi-Civitò were published in Italian in 1925. This account of the foundations of the absolute differential calculus has now been translated into English. Miss Long has thus conferred a benefit upon British mathematicians for which they will be very grateful. The subject is of fundamental importance in the applications of mathematical methods to modern theoretical physics; the treatment is as masterly as can be expected, coming as it does from the lecture notes of one of the outstanding exponents of the subject and one of the outstanding contributors to its development; the translation is excellent, combining, as Prof. Levi-Civitò says in the preface, "scrupulous respect for the text with its effective adaptation to the spirit of the English language."

It is more than a mere translation, however, that we have before us now. More than 150 pages are devoted to two new chapters, written specially by Prof. Levi-Civitò, dealing with the fundamental principles of Einstein's general theory of relativity, including as a limiting case the special theory, as an application of the absolute calculus. More than one-third of the book is therefore new, and it is a privilege to British mathematicians to have this addition to the original contents published in the English language. This treatment of the theory of relativity possesses distinctive features, which give it added value. The present writer has for a long time thought that the study of relativistic mechanics should be presented on the basis of the classical Newtonian mechanics. This would have obvious advantages, the most important being that the essentials in the transition from the conceptions in the classical dynamics to the conceptions in the relativistic dynamics could be presented clearly and effectively, instead of being lost in a maze of optics and electromagnetics. Further, it is surely reasonable to claim that the study of the space-time manifold is fundamentally a kinematic exercise, although the causes which have led to the modern view of space-time are derived from astronomical, optical, and electromagnetic experiences.

Prof. Levi-Civitò has adopted this viewpoint. He traces the relativistic evolution of mechanics, including geometrical optics, which in the theory of relativity is based upon the conception of a light ray as a special case of the path of a massless particle. He also adds another distinctive characteristic in the fact that he does not lay down the postulates of relativistic mechanics in abstract form, as so many new laws introduced arbitrarily, but proceeds inductively from the classical mechanics to discover modifications which are forced upon us if we take account of the principle of relativity.

Starting off with Hamilton's principle for the motion of a free particle, Prof. Levi-Civitò first shows that it is possible to apply the same treatment to the time co-ordinate as to the three space co-ordinates of the particle, with reference to the variational equation $\delta\int L dt = 0$. Introducing the form $L/c^2 = 1 - \sqrt{1 - \frac{v^2}{c^2} - \frac{2U}{c^2}}$, which for a very large value of c

is approximately the same as $L = \frac{1}{2}v^2 + U$, the classical form of the Lagranian function, the equation $\delta\int ds = 0$ is obtained, where ds^2 can be expressed in terms of any four co-ordinates as a general quadratic form. The results of the special theory of relativity follow at once by putting U zero, and the author deduces the Lorentz transformation and all its familiar consequences. Further, the extension to space-time manifolds differing from the pseudo-Euclidean space-time in the special theory is a comparatively simple conception, the world lines of a free particle being the geodesics in its space-time continuum. Particular attention is devoted to geodesics of zero length, or light rays, where s cannot be used as the independent variable. The equations of motion of a continuous system are obtained in the same inductive manner and the introduction of the energy tensor justified.

Having defined the Einstein tensor and the gravitational tensor in the older form, with divergence zero, Prof. Levi-Cività writes down Einstein's equations of the gravitational field (without the cosmological term). He at once proceeds to deal with the statical problem, thus separating the time-like from the space-like terms, and shows how to a first approximation the Newtonian field is obtained. After the 'crucial phenomena' the author attacks the problem of fields having spherical symmetry, dealing with the Schwarzschild, the Einstein, and the de Sitter solutions, and introducing the cosmological term. No reference is made to Einstein's new form of the equations of the gravitational field, which does not affect the field in empty space, but introduces modifications into the field inside matter.

Of the large number of books that have appeared in the English language on the theory of relativity, very few have had anything very original to contribute. Prof. Levi-Cività's book in its English translation is a notable addition to the literature of relativity. S. Brodetsky.

Two Vienna Biologists Abroad.

Im Lande der aufgehenden Sonne. Von Prof. Dr. Hans Molisch. Pp. xi + 421. (Wien und Berlin: Julius Springer, 1926.) 24 gold marks.

Amerikafahrt: Eindrücke, Beobachtungen und Studien eines Naturforschers auf einer Reise nach Nordamerika und Westindien. Von Prof. Othenio Abel. Pp. ix + 462. (Jena: Gustav Fischer, 1926.) 24 gold marks.

BOTH these books are by Viennese biologists, who describe their observations during tours of one to Japan and of the other to America. Prof. Molisch was from 1922 until 1925 on the staff of the Botanical Section of the Biological Institute of the Sendai University in Japan. He has already, in his "Pflanzenbiologie in Japan," recorded his special observations, and in this book writes of his journeys to and fro and in Japan, as he puts it, as a "globe trotter." He is, however, a highly trained, skilled observer, and he writes an interesting account of his voyages out and home, and of the various phases of Japanese life. He describes, amongst other topics, life and sports at the Japanese universities and schools, the theatre, the magic mirror, fishing by cormorant, the hot springs, the ascent of Fujiyama, the aboriginal race—the hairy Ainu, the earthquake of 1923, and Japanese horticulture, fruits, and vegetables.

Prof. O. Abel's account of his visit to the United States and some of the West Indian islands in 1925, at the invitation of the International Education Board, contains more original matter. He is professor of palæobiology and visited many localities famous for their evidence on geological ecology, and he expresses on their problems a competent, independent judgment. He visited the American museums rich in fossil vertebrates, he examined the quarries in Connecticut famous for their Triassic footprints; his visit to the mangrove belts in Florida and the West Indies leads to the conclusion that the Flysch of the Alpine belt, which has been regarded as the deposit of mud volcanoes or of deep seas, is the mud of ancient mangrove swamps, deposited when Central Europe consisted of a group of islands and had a tropical climate; in Florida he examined the beds at Vero which have yielded remains of fossil man, and concludes that the man was not as old as the associated fossils; he discusses the West Indian fauna and explains the various continental visitors to the islands not by land bridges but by mangrove bridges, and his interesting chapter on this problem illustrates the extent to which biologists, whose conclusions depend so largely on negative evidence, overlook the direct tectonic evidence. In Western America, Prof. Abel visited the Grand Canyon and the Brea deposit at Los Angeles which has yielded such a rich Pleistocene mammal fauna, and also the fossil quarries of Nebraska; there he also examined Dæmonelix, an obscure fossil which has been regarded either as due to a burrowing animal or to plant roots; and he advocates the latter

Both books are richly illustrated by excellent photographs, and many of these by Prof. Abel are of the specimens he collected. He gives many references to the literature, so that the book is a useful guide to recent contributions to many problems in American geology. In his account of the bone beds of Nebraska he explains their origin by the crowding of the animals on to hill-tops at times of flood; and in reference to the opposite explanation, that they were bogged beside drying pools in time of drought, he quotes a sentence which he attributes to W. K. Gregory instead of to the present writer. J. W. G.

Our Bookshelf.

Æolus: or The Future of the Flying Machine. By Oliver Stewart. (To-day and To-morrow Series.) Pp. 96. (London: Kegan Paul and Co., Ltd.; New York: E. P. Dutton and Co., n.d.) 2*s*. 6*d*. net.

THE "To-day and To-morrow" series has a reputation of brilliance and provocativeness. Mr. Oliver Stewart's account of the future of the flying machine amply maintains this reputation. The writing is clever, the argumentation is fearless, and the prophecy is unhampered by any hesitation to speculate on the barest foundations. In civil aviation, Mr. Stewart foresees a severe struggle between the present-day type of fixed-wing aeroplane and the moving-wing flying machine of which the autogyro is a forerunner. He concludes that the moving-wing type will prevail for short-distance flight, while the fixed-wing machine, in the form of monster flying boats weighing a thousand or more tons, will prevail for long-distance and trans-oceanic flight. An amusing forecast of the relationships between the police and sporting aviation is followed by a fantastic and gruesome account of the future battle in the air round and over London. Why has nobody yet written on the renewed sense of dignity and privilege that the provincial will acquire as the result of the concentration of aerial warfare round the large centres of population?

Mr. Stewart seems to have considerable objection to statesmen and financiers. It may be of interest to scientific workers to discover that the author objects to them too: ". . . scientists have demonstrated that the world is flat, that it is round, and that it is oblong. In the future they will demonstrate that it is rectangular." This is pretty nonsense, and the author bases much of his interesting prophecy on the results of scientific investigation. Mr. Stewart does not believe in the future of the airship. S. B.

Theory of Vibrating Systems and Sound. By Dr. Irving B. Crandall. Pp. x+272. (London: Macmillan and Co., Ltd., 1927.) 20*s*. net.

THE reader of Rayleigh's classical treatise on the theory of sound cannot but feel that the subject is more of theoretical than of practical interest. It is true that the theoretical results have many illustrations in certain of their musical and technical aspects; but one does not feel that the theory has had much influence on the design work of the constructional engineer. In recent years, however, great progress has been made in applied acoustics, more especially in connexion with the problems of telegraphy, telephony, sound transmission and reproduction, and certain parts of the classical theory have been extensively employed to analyse and explain the problems and results that presented themselves in the technical developments of these subjects.

In the book before us, the late Dr. Crandall, who was a member of the technical staff of the Bell Telephone Laboratories in New York, has presented an account of those parts of the theory which have proved of service to the constructional designer. The theoretical side of the subject is treated thoroughly—on the lines of Rayleigh's treatise—without, however, too great insistence on mathematical detail, but also without that slovenliness and circumlocution so familiar in technical works dealing with mathematical subjects. The best parts of an altogether good book are those essential connecting links in the mathematical argument where the physical assumptions underlying the theory are examined from the point of view of their practical possibility and where the limitations and usefulness of the mathematical results are discussed in their physical and technical bearing. To a theorist these parts make very satisfying reading and to the practical man they more than justify the application of somewhat complex mathematical analysis to the technical problems of the subject.

The book is well written and can be strongly recommended as an up-to-date text-book of the subjects with which it deals. It is replete with bibliographical references even of the most recent developments of the subject, and is produced in a style worthy of the publishers' name that it bears. G. H. L.

Crashing Thunder: the Autobiography of an American Indian. Edited by Paul Radin. Pp. xxvi+203. (New York and London: D. Appleton and Co., 1926.) 10*s*. 6*d*. net.

THIS autobiography of one of the Winnebago Indians living on the Nebraska side of the Missouri River, is a remarkable document. It may be regarded either as a piece of anthropological evidence or as material for psychological study. Its engaging frankness and entire absence of a moral viewpoint are illuminating. At the same time it must be admitted that from neither point of view do the conditions which this record reveals seem such as are conducive to the welfare and preservation of the Indian, if they can be regarded as typical. It is perhaps significant that in seventeen years a Presbyterian mission had in 1909 converted one family only. This suggests a conservatism which adds to the value of the autobiography as a record of tribal custom and tradition. Anthropologists who have worked in the field are well aware of the difficulty of getting at the subjective side of the information they seek. In this document custom, ritual, and belief take their proper place as integral elements in proper perspective in the everyday life of the individual.

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.*]

Radioactive Haloes. Possible Identification of 'Hibernium.'

Some years ago, Prof. Joly (*Proc. Roy. Soc.*, A, **102**, 682; 1923) discovered radioactive haloes which could not be ascribed to any known radioactive product. One class, not unlike thorium haloes, he called X-haloes; a second class, of radii less than those of other haloes, he called 'hibernium' haloes, hibernium being the suggested name for the new radioelement causing the halo. Recently, S. Iimori and J. Yoshimura (*Sci. Papers Inst. Phys. Chem. Res. Tokyo*, **5**, 11; 1926) have found a class of haloes not unlike X-haloes which they call Z-haloes. They suggest that the X-haloes and possibly the haloes ascribed by Prof. Joly to radon are identical with these, and that they are due to products of the actinium series. Z-Haloes have sometimes two inner rings smaller in radius than any caused by a known radioactive product, and these they ascribe to two uranium isotopes at the head of the actinium series with half-value periods of the orders of 10^{12} and 10^{23} years. They also state that their work on Z-haloes definitely establishes that the actinium series originates independently of the uranium series.

The Japanese workers are, I think, probably right in their ascription of the Z-haloes to actinium products, but in identifying radon haloes with actinium haloes, and in ascribing the two very small rings to isotopes of uranium, they have missed an important point. The actinium series cannot be regarded as originating independently of the uranium series in view of the strong experimental evidence to the contrary. Moreover, if the actinium series has uranium isotopes, as they suggest it has, how did these get separated from uranium itself to form a halo unmasked by that due to uranium and its products? They have evidently not considered this. The only answer I can suggest is that the uranium isotopes which originate the actinium series giving the Z-haloes are end-products of elements of atomic number greater than 92 and so have not necessarily mixed with ordinary uranium.

I think the explanation of the unexplained rings and haloes is probably simple and involves two things: isolation of radioactive products from known minerals by chemical agencies, and the possession of feeble radioactivity by some of the so-called end-products.

It is known (W. Marckwald and Russell) that uranium minerals may be so altered by agencies like percolating water that, while the presence of the equilibrium amount of ionium testifies to their great age, they are anomalous in possessing no lead, a fraction only of their equilibrium amount of radium and, as unpublished work of mine shows, a fraction only of their protoactinium. Let us consider what is likely to occur if each of the different elements present in a primary uranium mineral were isolated by chemical agencies and afterwards formed a halo in the mica with the particles they emit. Isolation of element 91 would isolate protoactinium and lead to the formation of the halo characteristic of the actinium series; isolation of elements 90 and 88 would lead to uranium haloes in different stages of development; isolation of element 89 would lead to actinium haloes minus the ring due to protoactinium; isolation of element 86 would lead to the characteristic radon halo discovered by Prof. Joly; isolation of elements 84 and 83 would lead to a single ring characteristic of polonium; isolation of element 82 would perhaps lead to the polonium ring and to any rings due to possible α-particle activities from the end-products; no halo is to be expected from the isolation of the quick-changing products of element 81. Thorium minerals may be similarly considered.

Now it is not unlikely that some of the end-products of atomic number 82 may be found to be feebly radioactive. For theoretical reasons too lengthy to be given here I find that possible end-products of atomic masses 204, 205, 206, and 207 are unlikely to possess any radioactivity, while those of masses 210, 209, and 208 may be feebly radioactive, and that, of these three, actinium-Ω, of mass 209 (Nature, Sept. 17, p. 402), is likely to be more unstable than the two others. Now, for a given half-value period, an 'α-rayer' of the actinium series has a larger range than an 'α-rayer' of the thorium or uranium series. The α-particle from the product of mass 209 might therefore be expected to have a longer range than those from the two other products, but shorter than the α-particles from uranium or thorium.

The identification by S. Iimori and J. Yoshimura of Z-haloes with X-haloes was made, not by a comparison with their own of Prof. Joly's published measurements, but from observations of his photographs. (The published measurements of both sets of haloes do not, in fact, agree well.) For a reason I know not, the radii of the rings of uranium and thorium haloes measured by the Japanese agree closely with those to be expected theoretically, while those of Prof. Joly are generally smaller, the deviation from theory being the greater the shorter the range of the α-particle. A straight-line relation appears to connect the theoretical with his observed radii of the rings, and, using it, I have calculated the radii of the rings of Prof. Joly's unexplained haloes to compare them with the other measurements. The smallest ring observed has then a radius of 7, 5·4, and 6·3 μ in hibernium-, Z_1-, and Z_2-haloes respectively, and the second smallest ring has a radius of 11·0, 10·5, 10·8, and 10·7 μ in two different sets of X-haloes, in a Z_1-halo and in an unnamed halo respectively. Each of these rings is too small in radius to be ascribed to any active radioelement. The larger of these I ascribe to actinium-Ω (mass 209), and the smaller to both radium-Ω′ (mass 210) and to thorium-Ω (mass 208).

On this view, if lead alone were isolated from a uranium mineral, a single ring, the larger of the two small rings, would be observed, since the concentration of radium-Ω′ relative to that of actinium-Ω is very small. This would explain Prof. Joly's unnamed halo, the single ring of which has a radius of about 10 μ. Similarly, if lead alone were isolated from a thorium mineral, the smaller of the two rings would be formed. This would explain the hibernium ring. If protoactinium were isolated, the resulting haloes would have rings characteristic of protoactinium and its products without either of the smaller rings. This would explain the majority of Z_1- and Z_2-haloes. If lead and protoactinium were simultaneously isolated from uranium minerals, the resulting haloes would show the rings of protoactinium and its products and the larger of the two small rings. This would explain the X-haloes. If, finally, the uranium minerals contained thorium, as many of them do, there would be, in addition to the actinium rings, the smaller of the two small rings. This might explain the remainder of the Z_1-haloes.

I do not stress these identifications at the moment, but I submit that the two points stated above afford a solution of these unidentified rings more probable than the ascription of Z-haloes to undiscovered and unlikely radioactive products and, as S. Rosseland (Nature, **109**, 711; 1922) suggested, of hibernium to an element of atomic number approximately 40.

If these views are correct, the disintegration series are partly extended to the element mercury; hibernium is identified as thorium-Ω (or one of the two thorium-Ω's); the half-value period of actinium-Ω calculated from Geiger and Nuttall's relation is of the order of 10^{16} years.

A. S. Russell.

Christ Church, Oxford,
Sept. 16.

Changes in Herring Shoals.

After the War, extended herring investigations were commenced at Cullercoats, and since 1919 there has been a continued series of observations as to the size, age, sexual development, and growth of the fish from some of the most important shoals in British waters. It is possible to point to three well-defined changes in the shoals, and the evidence from growth data indicates that these have been brought about by migration. There is a possibility that these migrations have been due to hydrographic conditions.

Towards the end of 1920 there was a movement of some of the North Sea herrings to or towards oceanic conditions. This movement was continued in 1921, in which year the whole of the east coast fishery was a failure (*Reports, Dove Marine Laboratory*). The years 1920–21 were marked by an abnormal invasion of Atlantic water into the North Sea. In 1923 the migrants of 1920–21 returned as spring spawners to the grounds off the north of Scotland and about the Shetlands; some few made their way so far south as the Berwickshire coast. Their scales showed a North Sea growth for the first three years and an oceanic growth for 1921–22. In the same year old fish, six winter rings and more, practically disappeared from the shoals of the north of Scotland, Shetlands, East Anglia, and north-west Ireland; the scales of fish from Howth, the Smalls, and St. Ives indicated extended migrations (*ibid.*). The white fishery was poor on practically all our fishing grounds.

Johansen directs attention to an abnormally strong inflow from the Skager Rack to the Kattegat in the spring of 1923 (*Jour. Con. Per. Inter. Explor. de la Mer*, vol. 1, No. 2) and to increased catches of mackerel from Danish waters (*Medd. Komm. Havund.*, Fisk., Bd. 7, No. 8). Watkins, in his report on Cardigan Bay shoals, quotes Lloyd as to the invasion of Cardigan Bay by oceanic forms in the summer of 1923.

In January 1926, extraordinary numbers of young fish (1924 year-class) appeared off north-west Ireland, and trade papers reported the invasion of the lochs of western Scotland by shoals of small size and poor quality. About the north of Scotland, the 1920 year-class and younger fish failed to appear in sufficient numbers to make anything but a poor spring fishery, and the same applies to the Berwickshire coast (*Repts., Dove Mar. Lab.*). In August there was an exceptionally good fishery off the Northumberland coast. Following this we have to note a marked difference between the shoals of north-western Ireland and northern Scotland in the early months of 1927. Previously the relative values of the different year-classes were the same for these grounds, but now the 1923 year-class is predominant about northern Scotland and that of 1924 about north-western Ireland. In Shetland waters the year-classes which had been good previously are now poor, and the poor year-classes are good. This is illustrated by the age composition of two samples given below.

Winter Rings (Percentages).

Date.	3.	4.	5.	6.	7.	8.	9.	10.	10+	Total.
Feb. 27, 1926 . .	12	2	4	35	7	36	3	–	1	178
Mar. 5, 1927 . .	+	36	7	17	8	21	8	–	1	190

The Northumberland shoals have been marked this year by abnormally high percentages of fish with 2 winter rings. They are a year younger than usual. Reports from friends in the herring trade state that from Wick to below Scarborough the fish have been small. It will be of interest to see if the East Anglian fishery is marked by large numbers of young fish in October and different relative values of the older year groups later in the season.

It is evident that the herrings have been swimming differently and the large catches of salmon off the Tyne 1926–27, and the taking in August off the Tyne of cod more than 40 lb. when gutted, suggest that other fish have been doing the same.

The *Dana* in August 1926 took 297 larval eels from the southern part of the Faroe-Shetland channel, and Schmidt (*Jour. Con. Per. Inter. Explor. de la Mer*, vol. 2, No. 1) gives these an age of 2¼ to 2½ years. The International Ice Patrol reported for 1924 an absence of ice and fog, warmer water than usual—5° to 6° F. above normal in March—over the Grand Bank Region, and for the first time a complete cessation of the flow of Arctic water southward along the east side of the Bank during the ice season. The *Annual Report*, Department of Marine and Fisheries, Newfoundland, 1924, states that Labrador cod were on the grounds before the fishermen were ready, and that whilst the southern Labrador cod fishery was poor, that of northern Labrador was excellent. Huntsman ("The Ocean around Newfoundland") records exceptionally warm water over the Grand Bank early in the season of 1924, cod farther in than usual on the banks off Nova Scotia, large quantities of haddock close inshore off Nova Scotia and New Brunswick, the failure of the cod fishery of the Belle Isle region, and the capelin farther north on the Labrador coast than ever before. Jensen ("On the Fishery of the Greenlanders") records for 1924 the presence of great quantities of large cod in Davis Strait in June, great shoals of small cod off western Greenland at the end of summer, and for the first time in seventeen years the presence of *Gadus virens* in Greenland waters. From the statistics of the cod fishery given by Jensen, it would appear that in 1924 the cod population of western Greenland split, one half going north, the other south.

There is evidence that in 1924 the fish of the north-western Atlantic were swimming differently and that their movements were influenced probably by hydrographic conditions. The connexion between the happenings on the other side of the Atlantic in 1924 and changes in British waters, indicated by the herring shoals as beginning early in 1926, is perhaps worthy of consideration.

At present the chain of events would appear to be as follows: An abnormal activity of oceanic waters in 1920–21 probably due to lunar influence; a cumulative effect or a rebound from the Arctic accounting for the happenings of 1923; the production of a mild Arctic winter, 1923–24; a diminution of cold currents entering the north-west Atlantic in the spring of 1924, followed by changes in the north Atlantic warm currents which influenced British waters and fisheries early in 1926. B. Storrow.

Dove Marine Laboratory,
Cullercoats, Sept. 24.

The Crystalline Nature of the Chief Constituent of Ordinary Coal.

THE examination of thin sections of coal with the petrological microscope (see NATURE, Dec. 25, 1926, p. 913) has been extended to Tertiary coals from Baluchistan, the Punjab Salt Range, and Assam. The observations previously made on Palæozoic coals have been confirmed by the later investigations, except for the pleochroism, which is deceptive and probably not actual.

In every section which has been studied in ordinary transmitted light, practically all the bright coal and much of the dull coal layers seem to have the structure of polished wood and to consist of a madder-red coloured, translucent substance. If the section is thick or the illumination feeble, this substance is darker coloured or almost black. In very thin sections or with strong sunlight, this substance has a distinct golden yellow colour. Examined in plane polarised light, all sections show an exceedingly faint waxing and waning in the illumination of the coal substance throughout the movement of rotating the section. There is no definite darkening or lightening as a whole at certain positions, and thus pleochroism is evidently absent.

Sections of bright coal cut parallel to the plane of lamination and examined between crossed Nicols show the coal substance to be isotropic. The section, although dark, is not absolutely dark between crossed Nicols. Close attention, while rotating the section in this position, shows that every part of the substance goes absolutely dark at some point, but it lets a little light through in other positions. The total light coming through is, however, small, and the darkened section seems to be uniformly darkened even during the rotation of the slide. There is of course the same very faint continuous waxing and waning during the rotational movement, as was noticed for the illuminated section in plane polarised light.

All sections cut perpendicular to the planes of lamination and examined between crossed Nicols show the coal substance to have the crystalline character of a uniaxial mineral. The whole of the coal substance seen in the field of the microscope is in optical continuity as if parts of a single crystal. It has, on rotation of the section, a definite extinction, very distinct with really strong illumination, parallel to the lines of the laminæ. The extinction is not absolute at its darkest point, nor is the section very bright when the Nicols are at 45° to the laminæ. However, there is no doubt whatsoever about the extinction phenomena being quite clear in all the sections cut perpendicular to the coal laminæ.

The coal substance is seen to be somewhat granular under higher powers of the microscope. In some portions of the slides there is evidence of a cellular or woody structure. The presence of recognisable structure in the coal substance does not affect the optical phenomena at all. If a honey-comb was filled with opaline silica and a section made, the general appearance of the slice under the microscope would probably be similar. Stopes and Wheeler ("The Constitution of Coal," Department of Scientific and Industrial Research, 1918, pp. 20-21) have recorded an observation of this nature in the case of a piece of fossil-wood examined by them. The siliceous matter had permeated and filled the wood cells without destroying or replacing the tissues separating the cells of the original wood.

In addition to the main or chief constituent of coal, the section reveals the presence of three types of minor constituents: (1) Resinous bodies, (2) amorphous 'mineral charcoal,' and (3) inorganic matter. Any one or more of these three minor constituents may be present in abundance and impart a distinctive character to the coal, *e.g.* dull waxy or spore coal (bog head), dull silky coal, and coal shale being types respectively. Each of these minor constituents offers an attractive field for research. Their study is far more complex than the simple names suggest.

The discovery that the chief substance or constituent in ordinary coal was probably liquid or a fluid jelly which has afterwards hardened affects the existing nomenclature of coal constituents. No terms based on lithological characters (*e.g.* vitrain, clarain, and durain) or on a botanical origin (*e.g.* anthraxylon and attritus) can have more than a descriptive significance. Such names may be convenient if restricted to the appearance or structure, respectively, of the coal, and not extended to the nature of the coal substance. The older, well-known terms, bright coal, dull coal, and mineral charcoal, with perhaps the introduction of such adjectives as silky, glossy, matte, waxy or resinous, and shaley, can be made just as explicit as any of the above terms for descriptive purposes. (See descriptions by Fermor, *Memoirs, Geological Survey of India*, vol. 41, pt. 2, 1914, pp. 180-181.)

A note of warning must, however, be sounded in regard to the naming of the chief constituent of coal. It is as certain as can be that this constituent permeates the coal and has crystalline properties suggestive of a definite substance. We are under no delusion that analyses of the purest forms of brown coal, bituminous coal, and anthracite clearly indicate a loss of carbon dioxide and methane from a composition, say, of *dopplerite*. There is little doubt that with loss of volatile matter the coal substance has not merely hardened, become denser and changed in appearance (lustre), but that there is an evident change in composition. Therefore in giving a name to this chief constituent we must remember this change of chemical composition. It would be simplest for the present, perhaps, to use the word *coal substance*, in a strict scientific sense, for the chief constituent of coal, using the general word 'coal' as it has always been used.

CYRIL S. FOX.

Geological Survey of India,
Calcutta, Sept. 7.

Origin of the Rio Tinto Ore Bodies.

AFTER a year's intensive study of the surface and underground conditions at the Rio Tinto Mines in the Province of Huelva, Spain, I have been led to a theory as to the origin of the great ore bodies in this region. As this theory or working hypothesis has already borne fruit, inasmuch as it has led directly to the finding of several new ore masses, it is deemed worthy of brief mention here in advance of the full discussion which will appear later.

In the vicinity of the mines there are two masses of quartz porphyry. The southern mass is a sill which has been injected along the cleavage of the slate. To the north of this sill, and separated by slate, there is another porphyry intrusion which maps as a dyke. On its southern flank it either undercuts or reverses the dip of the slates. On its northern flank it has a conformable intrusive contact with slates, that is, the strike and dip of the porphyry-slate contact are the same as the strike and dip of the slaty cleavage. Within the porphyry area there are numerous isolated bands of slate. The North Lode group is entirely surrounded by porphyry. On the other hand, San Dionisio, Eduardo, and South Lode are on the south contact between porphyry and slate.

Planes is at the eastern nose of the dyke with mineral between its slate roof and the porphyry.

The porphyry, which is near a mineral mass, is fractured and also sheared. The shearing appears as an approximation to a rough irregular cleavage. The fracturing gives a coarse cross pattern and the fractures are now filled with pyrites, chalcopyrite, and gangue. The ensemble of these veinlets is called a stockwork.

The stockwork is always found below or to the side of the mineral, and extends both horizontally and vertically for considerable observable distances from the masses.

I believe that *the masses were fed from depth by the solutions traversing these channel-ways.*

In regard to the shearing and fracturing, it would appear that forces other than those usually termed orogenic, that is, large scale tangential compressive forces, must be called in to explain their origin. The reason is that any forces of sufficient magnitude to shear and fracture the porphyry would have pulverised the slates to a degree not seen in the areas around the dyke. It follows that one should look for the cause within the porphyry mass itself. Where stockwork is strongest there is less shearing and vice versa. Furthermore, the strike and dip of the shearing approximately parallels the contact of the porphyry and slate. These facts seem to indicate (*a*) that the shearing is the result of injectional pressure, and (*b*) that the shattering took place following the crystallisation of the magma when torsional forces were brought into play by slight upward or downward movements of the semi-liquid magma beneath its chilled roof. Where a shear structure existed, the movement was taken up along the already existing lines of weakness, but where the magma had crystallised normally the result was a shattering. The pattern of the shattering on any plane resembles closely that which was produced by Daubree in his classical experiment on the torsional effects on a glass plate ("Etudes synthetiques de Géologie Experimentale." Paris, 1879.)

As the magma cooled, pressures were brought to bear on the interior of the porphyry mass and the mineral bearing solutions were caused to circulate upwards through the fractured zone. *These solutions replaced the softened and comminuted slate*, which had suffered alteration by the intrusion of the porphyry, and to a certain extent the porphyry itself. It may be asked why all the slate at the slate-porphyry contact is not thus altered and therefore in a state favourable for replacement. The answer is that *where the porphyry has cut across the slaty cleavage or where the porphyry has included keel-shaped masses of slate, it has had the opportunity of altering the slates.* Where the porphyry has simply slid up along the slaty cleavage there has been little alteration, because the slate is almost impermeable to solutions in a direction normal to a cleavage plane.

G. Vibert Douglas.
Geological Department,
Rio Tinto Mines, Spain, Sept. 1927.

The Electric Arc in High Vacuum.

Whatever the mechanism of the electric arc, we can scarcely expect an arc to strike and to persist under pressures so low as to render difficult the passage of a high voltage discharge. However, in the course of some experiments on the discharge of electricity through gases, it was observed that under certain conditions an electric arc carrying many amperes can be maintained in a vacuum as high as 0·001 mm.

The electrodes *A*, *B*, and *C* (Fig. 1) are placed under a large bell-jar of 12 litres capacity. Electrode *A* is a heavy rod or block of metal enclosed in *B*, an electrode in the shape of a box made of heavy metal gauze or perforated plate. Electrode *C* is composed of a circular plate and an insulated platinum strip stretched across an opening in the plate ; it may be used either as a cold electrode or as a Wehnelt cathode. Electrodes *A* and *B* can be connected to the 230 volt line, and electrode *C* to a source of high potential. When a vacuum is produced under the bell-jar and a high voltage discharge passed between *C* and *B*, an arc strikes between *A* and *B* and keeps going after the auxiliary discharge is stopped. The higher the vacuum, the easier the arc starts. At 0·001 mm. pressure, a p.d. of 60 volts across *A* and *B* is sufficient to start the arc, at 0·05 mm. 120 volts is necessary, while at 1 mm. pressure a p.d. of 230 volts is not sufficient. During the passage of the arc the pressure under the bell-jar naturally increases, but if the electrodes *A*, *B*, and *C* are previously freed from the occluded gases by a prolonged discharge

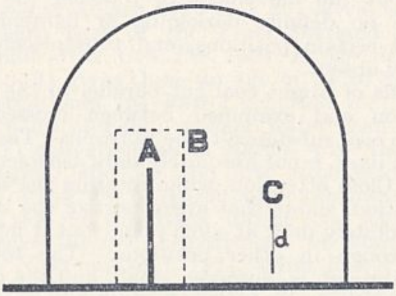

Fig. 1.

and the moisture in the vessel removed by phosphorus pentoxide, this increase becomes very small. In one experiment, for example, an arc carrying 3 amperes for 10 seconds raised the pressure to only 0·002 mm., and at this pressure, after the arc had been interrupted, the high voltage discharge from electrode *C* still passed with difficulty, showing the characteristic green fluorescence on the walls of the bell-jar. The fact that with small potential differences practically unlimited currents can pass between electrodes *A* and *B*, while the low pressure makes it almost impossible for the discharge to pass from the electrode *C* in spite of the high potential applied, is very surprising, and indicates that the mechanism of the electric arc is radically different from that of an ordinary discharge.

The arc has been produced with copper, brass, iron, and aluminium electrodes. It shows the usual current-voltage characteristic, the p.d. across the electrodes dropping to about 20 volts when the current is increased to 30 amperes. When the arc strikes, a brilliant spot appears on the surface of the cathode and continuously changes its position as in the case of a mercury arc.

An interesting feature of the arc is the unilateral relationship which the polarity of the arc must bear to the polarity of the auxiliary discharge between *C* and *B*. If *C* is an anode, the arc strikes independently of the direction of the field between its electrodes *A* and *B*, but when *C* is used as a cathode the arc strikes only when *A* is the anode in the arc circuit. This property of the arc has been successfully employed in some experiments in rectifying alternating current.

S. Ratner.
Physics Laboratories,
Columbia University,
New York, Aug. 30.

Coherence of the Reflected X-Rays from Crystals.

ON Jauncey's theory (*Phys. Rev.*, 25, 314; 1925) of the unmodified line in the Compton effect, an unmodified X-ray is scattered when the energy of the impulse imparted to an electron is insufficient to eject the electron from the parent atom. In this case the impulse is presumably imparted to the atom itself. The change of wave-length of the unmodified ray should thus be of the order of [(mass of the electron)/(mass of the atom)] × (change of wave-length of the modified line). It is generally assumed that no coherence occurs for modified scattering on account of the change of wave-length. In the case of unmodified scattering, however, it is assumed that coherence does occur, as, for example, in regular crystal reflection (see papers by Williams, *Phil. Mag.*, 2, 657; 1926; and Jauncey, *Phys. Rev.*, 29, 757; 1927). But how can coherence occur in unmodified scattering if there is a change of wave-length, however small? Perhaps there is no change of wave-length at all in unmodified scattering.

Following the idea underlying Jauncey's interpretation of the unmodified line, the atom should not by itself receive the impulse of the scattered quantum unless the energy acquired from this impulse is sufficient to give at least one quantum of vibrational heat energy to the atom. According to Einstein's theory of specific heats, this energy is $h\nu$, where ν is a frequency of the order of that of the *reststrahlen* from the substance in question. The wave-lengths of two bands of these *reststrahlen* from rock-salt are 47μ and 54μ (Wood, "Physical Optics," p. 412), or, let us say, of the order of 50μ. A quantum of this wave-length has an energy of 0·024 electron. If we consider the K_a line of molybdenum reflected from the (100) planes of rock-salt in the n^{th} order, the energy of recoil given to a sodium atom by the impulse imparted by the reflected quantum is $0{\cdot}0252 \sin^2\theta$ volt-electrons (see Compton, "X-Rays and Electrons," p. 267). Replacing $\sin\theta$ by $n\lambda/2d$, the energy of recoil is $4{\cdot}02 \times 10^{-4} \times n^2$ volt-electrons. Hence the ratio of the energy of recoil for each order to the energy of a quantum of *reststrahlen* is as follows:

n	1	2	3	4	5	6	7
ratio	0·017	0·067	0·15	0·27	0·42	0·60	0·82

The highest possible order of reflection according to Bragg's law is the seventh. The fact that the ratio is always less than unity indicates that the energy of recoil is always less than that of a quantum of thermal agitation, and this implies that the thermal agitation will not be excited. Presumably, therefore, the impulse is imparted to the crystal as a whole. There is thus no reason to anticipate an absence of coherence in the reflected rays.

This point of view leads naturally to the quantum interpretation of crystal diffraction as suggested by Duane.

G. E. M. JAUNCEY.
Washington University, St. Louis.
A. H. COMPTON.
University of Chicago, Sept. 1.

Spectrum of Ionised Krypton.

THE lines of the spectrum of krypton which appear under the influence of condensed discharge, were first carefully measured by Baly (*Phil. Trans.*, vol. 202, p. 183; 1903). Messrs. L. and E. Bloch and Dejardin (*Ann. de Phys.*, vol. 2, 1924) have recently studied the spectra of krypton developed with electrodeless discharges, and re-arranged most of the lines given by Baly, and also many new lines measured by themselves, into groups of spectra appearing with varying excitations. Following the analogy with ionised neon, the spectrum of which was analysed by me some time ago, I have observed that the spark lines of krypton which appear at the lowest excitation show a considerable number of regularities. I give below three groups of terms, *A*, *B*, and *C*; such that *A* combine with *B*, and *B* with *C*, and account for a large percentage of lines. The values given are purely arbitrary, the deepest level so far discovered corresponding to 0.

A.

0	4774·4
2263·6	5645·7

B.

21094·9	25550·4	28891·5
21457·7	26272·7	29164·5
22952·1	27288·0	29532·4
23240·1	27306·1	

C.

44247·5	48970·1	50526·3
45053·8	49045·7	51607·5
48577·4	49227·2	52245·5
48620·0	49734·2	52310·1

I have not yet succeeded in identifying the natures of these terms unambiguously: Zeeman splitting of some of the lines holds out the best promise of success in this direction.

P. K. KICHLU.
Physics Dept., Science College,
Patna, India, Sept. 14.

The Diminution in Number of the Nodes in the Bivalents of Lilium.

THE species of Lilium examined have twelve pairs of long chromosomes. The numbers of nodes in the bivalents of *Lilium longiflorum* (and *Lilium regale*) were counted at different stages, from the earliest prophase, immediately after the diplotene stage, to the diaphase; and also at the metaphase itself. These counts were usually made after pressing cytoplasm and chromosomes from the cell. Such counts showed that the average number of nodes for the group of twelve chromosome pairs was 22·1 for the diaphase and metaphase, while in the earliest prophase it was found to be 39. Thus nearly half the nodes (43 per cent.) disappeared between the diplotene stage and the diaphase. In *L. longiflorum*, pollen mother-cells observed at stages between the earliest prophase and the diaphase showed different degrees of diminution in the number of nodes. In the four largest chromosomes of *Hosta cœrulea*, a similar reduction was observed, from 9 to 5 nodes. From the drawings of Newton (*Linn. Soc. Jour.* (*Bot.*); 1927) it can be estimated that there was a loss of nodes between the earliest prophase and the diaphase of somewhat less than one-half the number in Tulipa.

The nodes at the diaphase and first metaphase can be proved, in all or nearly all cases, to be chiasmas. This can be shown in *L. candidum* by pressing the metaphase bivalents flat, when the X-chiasmas are clearly visible. The question is, then, what is the nature of the nearly fifty per cent. of the nodes which disappear before diaphase? The writer considers that the majority of these are not half twists; as has, perhaps somewhat hastily, been concluded by the early cytologists.

JOHN BELLING.
Department of Genetics,
Carnegie Institution of Washington,
Cold Spring Harbor,
Long Island, N.Y., Aug. 23.

Invention as a Link in Scientific and Economic Progress.[1]

By Sir James B. Henderson.

INVENTION and discovery are so closely allied that they are often confused. In our common speech the two terms are frequently used as synonymous, and if one seeks an exact line of demarcation between them one finds it difficult, if not impossible, to distinguish one from the other in any but the most general terms. Both involve an increase in knowledge which may be great or slight, and may have an immediate effect or may take a lifetime or more to consolidate. Both involve scientific imagination. Each may be only a happy idea, the inspiration of a moment or in some cases an accident, but the testing of the idea and its final enunciation as a physical truth or as a finished invention may occupy many years. Newton is reputed to have discovered the theory of gravitation on seeing an apple fall from a tree, but assuming that to have been the birth of the idea, we know that the completion of his discovery and the proof of the universal law of gravitation took the best part of his lifetime and involved the invention of new branches of mathematics to complete the proofs.

The dividing line between discovery and invention is, in very general terms, the same as between theory and practice, between the abstract and the concrete. Discovery is essentially an increase in man's knowledge of Nature and its complexities, and is therefore intangible. It may be a discovery of a new principle, a new element, a new and hitherto unknown quality or characteristic of a known substance, and so on, but the discovery, *per se*, has no regard to any particular practical application of the new knowledge. Invention, on the other hand, has its sphere in the practical application of knowledge, and the knowledge used may be new or may be as old as the hills. It may be, and it is often the case, that invention involves other discoveries which may be complementary to the original discovery and form its completion, or may be entirely unrelated to it and form the nucleus of a new branch of study. It is possibly this fact, that the difficulties encountered in developing an invention often lead to new discoveries, which makes it so difficult to separate discovery from invention. I think, however, that this distinction in general terms is sound, that discovery is mental while invention is material, and while it is true that in the large majority of cases an invention is in its origin a mental conception, it is a conception of something material and practical, while a discovery begins and ends in the realm of the mind.

When one seeks to study the history of some of the great inventions, one begins to realise how exceedingly complex they are, despite their outward appearance of simplicity. As an example, take wireless telegraphy and telephony. No single person deserves the credit for its discovery and invention. Maxwell, Hertz, Lodge, Crookes, Branly, Marconi, Jackson, Fleming, de Forest, Fessenden, and many others have contributed their share to its development, but the basis of wireless communication did not necessarily begin with Maxwell.

Hertz was the first to produce apparatus for transmitting and receiving wireless waves, and this apparatus was improved by Branly, Lodge, and many others, but for further progress finance was needed. The firsts steps to make a wireless telegraphic installation were taken in Italy by Marconi and in Great Britain by the Admiralty experiments carried out by Admiral Sir Henry Jackson, who was then a captain. In this kind of competition money counts for much, and in the development of an invention having a commercial as well as a service aspect, a commercial firm with good financial backing will always have a great advantage over a Government department with a strictly limited budget allowance for research. It says much, therefore, for the scientific direction of the Admiralty of that time, that the Admiralty is to-day numbered among the pioneers of this great invention.

Wireless has been taken as a typical illustration. To the man in the street it represents simply an invention, a single invention and an apparently simple one represented by a small wooden box with a knob to turn. But to the scientific historian who tries to decipher all that the little box represents in human thought and effort, it presents an appearance of amazing complexity in which the discoveries and inventions of some of the finest brains of two centuries are inextricably blended.

Invention as a Historical Science.

The science of invention is a curious blend of the exact sciences, like mathematics, physics, and chemistry, with a historical science. It is in many respects similar to the science of war, the war being against the complexity of Nature, man's ignorance of that complexity and the inefficiency and insufficiency of the human intellect itself.

Yet if we compare this contest with the wars of man with his fellow-man, what a difference we find. Napoleon said he learned the art of war from a study of the lives of the 'great captains,' but in the greater war with Nature, if we consult the books that have been written round the lives of its 'great captains,' we find only human documents in which the searcher after knowledge, to help him to carry the fight a little further, finds little help beyond an example of high courage. The technical difficulties are seldom recorded, and the new searcher has generally to start afresh and reconnoitre his way across the old battle-ground of centuries. The fault sometimes lies with the chronicler, but too often with the lack of records which the 'captain' might have left but

[1] From the presidential address delivered to Section G (Engineering) of the British Association at Leeds on Sept. 1.

failed to leave. In fact, here we have a startling lesson from the science of war, for is it not drummed into every budding soldier until it becomes second nature when he attains command, that one of his first duties in the field which must never be neglected is to maintain communication and pass on all information that may come his way, whether it be useful to him or not? The lesson has two sides. The soldier knows that he may become a casualty at any moment and the information which he gleans may be of vital importance to enable some one else to carry on in his stead; also, that information which may appear unimportant to him may prove to be the key to the movements of the enemy elsewhere of which he is in entire ignorance.

Of the hundreds of inventions which have been abandoned as failures, or of possibly revolutionary inventions left incomplete simply from lack of capital or lack of courage, no record is available to those who come after and might carry them on to success. Has every inventor for all time to start from scratch? The same difficulties crop up time after time in the development of inventions, yet every new inventor has to tackle the difficulties *de novo*, and fortunes are wasted in the process.

Development of an invention is always costly, even when guided by all the experience obtainable from allied inventions; how much more costly it is when not so guided, the history of the failures would most surely show. In most inventions there comes a time when the inevitable question arises, 'Shall we cut our loss or risk further expenditure?' If the decision is to cut the loss, the invention, which is possibly a sound one and of great value, is pronounced to be a failure, and the result may be the loss of an industry to the country or a delay in its introduction for many years. Science will prevail in the long run, but the cost of the trials both in time and money could probably be greatly curtailed if records of similar ventures in the past were available. Inventors would gain much if they could be trained in, and benefit by, the experience of their predecessors in the same field, while masters of industry, with records of that experience before them, would be better able to appreciate the difficulties of the inventor and to co-operate fully with him.

In every industry one finds that the experience gained in developing the inventions of the industry is often guarded as a most valuable secret. The result is that this knowledge is not recorded and often dies with the individuals who possess it. Future workers even in the same industry have to pass through the same or similar experience to regain the lost knowledge and the whole condition is economically unsound. The expense to the nation which it entails must be enormous. It retards progress, it adds greatly to the time and expense of developing other inventions, and it brings invention into disrepute because so many firms have lost money in trying to develop inventions which have had to be abandoned simply through inexperience.

Invention and Industry.

The history of the twentieth century shows clearly that invention is the heart of industry, the root of new developments, and the source of improved methods of production which have led to cheaper costs and a wider scope in every industry. It has also been the cause of some of the greatest social upheavals and strife. Innumerable strikes have arisen from it, and if there is one lesson in political science more potent than another to be learned from the history of such movements, it is that science is always victorious in the end. Progress may be delayed or an industry may be lost to a country temporarily or permanently by such strife, but the steady advance of the world's progress through the science of invention is certain. One country may lose, but the world will gain in the end. It is only a question of time, and if the leaders of industry, both masters and men, would only recognise this fundamental truth, how much faster progress would be.

It must not be imagined, however, that every invention can or, from the commercial point of view, should be introduced into an industry the moment it is made. Quite apart from the time necessarily spent in developing and perfecting the invention, for which purpose many industries have now instituted research departments of incalculable value, it is sometimes found that the occasion is inappropriate or that the time is not ripe for the change involved. The introduction of a new invention or of a new design may involve many complicated questions of policy or finance, because the change may have to be accompanied by heavy sacrifice in other directions, possibly affecting other industries or the public at large. There may have to be heavy scrapping of spare parts, tools and plant. There may also be considerable loss to the customers of the industry through depreciation of the products of the industry already in use, for nothing depreciates a firm's production more rapidly than the introduction of a new and superior model.

Manufacturers have therefore, on some occasions, to collect and husband their inventions and improvements after testing their merits and keep them in reserve for a more opportune occasion. The opportunity may occur very suddenly. It may arise through a sudden whimsical change in fashion which no one can explain, or from some other cause which it has been impossible to anticipate, and if a manufacturer has no policy of improvement all worked out and ready to apply, he is faced with the awkward alternative of falling behind the times by making no change at all, or of risking his market by adopting some new model which he has not had sufficient time to test thoroughly. The former policy is almost always disastrous and the latter is often worse. Numerous illustrations of both these courses and their results could be cited from any industry. There inevitably comes to every industry a time when radical change is demanded, and the firm which is best prepared for the change reaps the reward of its foresight.

Industry when viewed in its international aspect determines the lives of nations. The nation which organises its industry most efficiently, which hampers it least and stimulates it most by legislation, or absence of legislation, and by its scientific foresight, is the nation which will prosper most. Since invention is the heart of industry, the inquirer naturally asks: Is this country doing its best to stimulate invention as a means to foster industry? Are the leaders of industry fully alive to the position which invention plays in industrial progress? Have our legislators ever paused to think that their functions are only called for because of the progress which has been made by scientific invention, and that without such progress they would be unnecessary; also that, in the past, legislation has done much to retard progress? A study of the fundamental scientific causes of progress would form a useful addition to the education of legislators.

Invention as a Link between Exact Sciences.

It is sometimes stated that the physics of to-day becomes the engineering of to-morrow. This is a natural development, since the engineer is more concerned than the physicist with the practical application of physical discoveries. But the converse is frequently true, for many physical discoveries and inventions arise from difficulties encountered by the engineer. The science of practical hydrodynamics is a case in point. The mathematical science of hydrodynamics has been of little service to the engineer in the practical problems of the propulsion of ships, in the complex phenomena of vortex motion associated with the flow of water and steam through turbines, or in problems of aerodynamics, with the result that the engineer has had to develop an empirical science of hydrodynamics to supply his immediate needs. A huge mass of experimental results in screw propulsion, in aerodynamics and in hydraulics has thus been accumulated and is now awaiting some discovery or discoveries in mathematics or physics to correlate it all. If vortices could only be dealt with like potatoes or any other form of merchandise, each a complicated physical system in itself but capable of being considered as a unit differing only in mass or in its energy contents, a forward step might be made. The Lanchester-Prandtl theory of lift and drift of aeroplanes is a first step in a particular case of the general problem. Such a discovery, when made, will be bound to lead to further advances and improvements on the engineering side of the subject.

Most discoveries in physics arise from some experimental fact discovered more or less accidentally. The discovery of Röntgen rays was accidental, and the enormous strides which have been made in our knowledge of the atom by J. J. Thomson, Rutherford, Bragg, Bohr, and many other physicists during the last thirty years have resulted from Röntgen's discovery combined with another great discovery in pure thermodynamics, Planck's quantum theory, which also arose from an accidental discovery made in the course of experiment. The Reichsanstalt in Berlin had published a family of curves representing the distribution of energy in the spectrum of a hot black body. Prof. Wien by trial and error obtained an equation to the family, and the form of this equation was suggestive. Planck, in trying to develop this equation from the laws of thermodynamics, found that he could only do so by assuming that energy is not indefinitely divisible, and he coined the term 'quantum' to represent the fundamental unit.

These two discoveries of Röntgen and Planck form the starting-point of that most important branch of modern physics which has increased our knowledge of the constitution of matter, a science which is just beginning to find its field of application in engineering practice, as in the thermionic valve and the modern power transformers on the same lines. From these and other applications great advances are still to be expected.

In reviewing the discoveries in physics which have had most effect in developing new industries and thus calling forth new inventions, one is struck by the great results in this respect which have arisen from application of the second law of thermodynamics, first stated by Carnot in 1824. Carnot described his ideal heat engine and showed that the efficiency of this engine is independent of the working substance used. Looking back upon the history of the science of thermodynamics of the last century, it is unfortunate that no one seems to have employed this statement of Carnot's as a general text, and developed it to find what information could be derived from it by using different working substances and mixtures in order to discover something about all the substances used. Had any one done so, progress might have been greatly accelerated.

James Thomson was the first to use this second law to determine the lowering of the freezing-point of water due to pressure. His brother, Lord Kelvin, followed with the application to the change from liquid to vapour. Helmholtz used the voltaic cell as the working substance and determined the temperature coefficient of its electromotive force. Then followed at long intervals the applications to chemical changes which have resulted in the modern science of thermodynamic chemistry with which the names of Helmholtz, Ostwald, Nernst, Van 't Hoff, and Gibbs are so closely associated, and upon which the modern industry of chemical engineering is based.

It is a wonderful development to be able to prophesy that under certain conditions a certain chemical reaction will take place, say, that the nitrogen and oxygen of the air will combine at certain temperatures and pressures in a definite proportion, and that the resultant oxide can be recovered and converted to nitrate and used as fertiliser to replace the imported article at an economic price. The applications of thermodynamic chemistry to explosives enable us to calculate the maximum pressure to be obtained by detonating an explosive, or to calculate the temperatures and pressures throughout the explosion of cordite in a gun from the chemical constituents of the cordite. This possibility has gone far to raise internal ballistics from an empirical science to a branch of natural philosophy.

The advances which have taken place in the commercial development of chemical processes based upon this important new science of thermochemistry, although already considerable, are only in their infancy, but the men with the experience gained in practical development are very few; and as the experiments are generally very lengthy and expensive, the development of the industry is necessarily slow. The resultant saving to the country, however, will far outweigh the cost.

(To be continued.)

Indian Agricultural Practice and Research.

During the past century of British rule, many attempts have been made to improve Indian agriculture; but wave after wave of effort has broken, with little result, on the firm foundations of the indigenous practice of the country. Until within quite recent years, only in the fundamental matters of irrigation and reduction of famine has any notable advance been made. It is well, then, to look back and try to form a picture of the nature and origin of this indigenous agricultural practice.

When we do so, we are at once struck by the commanding position of the industry in former times, and the enthusiasm with which it was carried on. It is generally agreed that the Aryans, an agricultural people, entered the north-western part of India some 4000 years ago; and the view is also held, although more conjecturally, that the Dravidians, also noted agriculturists, had then already intrenched themselves in the south. Of the latter we have little knowledge. But there is detailed evidence in the ancient writings of the delight with which the Aryans regarded cultivation—witness the following extracts from a pastoral hymn on ploughing in the Rig Veda (period 2000 to 1400 B.C.): "Let the god of rains moisten the earth with sweet rains . . . may the crops be sweet to us . . . turn the sod merrily, let the oxen work merrily, let the plough move on merrily, fasten the yoke merrily, apply the goad merrily."[1] Allowing for a certain poetic exaltation, this was a bright beginning; and was undoubtedly followed by a great development of agricultural knowledge and practice in north India. There appears to have been steady progress at any rate until the early part of the Buddhist period (500 B.C. to A.D. 500); and western knowledge of Indian agriculture dates from this period, in that it was carefully studied by the Greeks, shortly after Alexander the Great entered the country in 326 B.C.

In ancient India, soils were classified according to colour, taste, productivity, and suitability to particular crops; alkalinity was known and feared; irrigation was widely spread, by dams, tanks, and wells; methods of dry farming were practised; deep ploughing was universal; manuring with animal residues and with oil cakes was practised, and green manuring was known and valued; paddy was sown in nurseries and transplanted into puddled fields; most of the crops now grown were cultivated; the seasons and rains were well understood and allowed for, and agricultural practice seems to have reached a high level.[2] But after the peak was reached, there would appear to have set in a steady decline both in the enthusiasm for agriculture and in the importance attached to it. Most of the details have, however, been handed down by example and oral tradition to the present day. But an Indian writer, after discussing these ancient glories and the progress being made elsewhere, allows himself to describe the Indian cultivator as "an ignorant, custom-bound creature, forced to content himself with his lot." Naturally, the inquiring western student will not altogether agree with this; rather is he struck by the wealth of detail, the rare economy, and the surprising adaptation to environment; and he soon discovers in that environment the main reason why Indian agricultural practice appears to be a mass of contradictions, when first viewed by those trained in western scientific methods.

Putting it briefly, the work of the Indian cultivator is often excellent, considering the limits of his conditions and resources. The first business of any one desiring to improve matters must be a study of this environment. The important benefit conferred by British rule in the development of irrigation has been already referred to; the next great advance was made when, in the early years of the present century, the Government at last recognised the necessity of founding an adequate agricultural department and allocating funds for its permanence. This was done on a generous scale by Lord Curzon, and during the past quarter of a century this department has been expanding and 'digging itself in'; in place of some half-dozen agricultural officers, nearly 200 superior posts have been created, and the number is daily increasing.

Defining research as the detailed study of any subject by a scientifically trained mind, the first difficulty of these officers was to bring their training into alignment with Indian conditions. Any attempt at betterment was of necessity dependent on a knowledge of the local climate, soils, stock, implements, crops, and the resources of the people. Amelioration or alteration was obviously needed, but a series of interlocking factors made this very difficult. Irrigation and dry farming had been practised from ancient times, but are always susceptible of improvement. There is plenty of good soil in India, but much of it has, by continual cropping without due return, reached the verge of 'permanent infertility.' There is a marked deficiency of pasture land, and what there is, is often very inferior; the cattle, therefore, although

[1] "Ancient India," R. C. Dutt, 1896.

[2] G. Jogi Raju, *Journal Madras Agricultural Students' Union*, 8, 2-4, 1920.

numerous, are generally small and weak. As a consequence of this, agricultural implements have to be designed with an eye to the strength of the animals rather than the needs of the soil. Lack of humus and nitrogen content are characteristic of cultivated land in the tropics; and cattle manure is easily the most suitable material for remedying this. But most of this manure is, in India, of inferior quality and the bulk is used as fuel; while the rich nitrogenous residue from oil pressing is largely sent out of the country. Pure seed is practically unknown, a field of any crop being usually a mass of unselected varieties. Taking all these things together, the cultivator gets little out of the soil; it is not to be wondered at that he is poor, and anything like the accumulation of agricultural capital is out of the question. Without this capital it is difficult to see the way to any permanent improvement.

The principle of co-operation was early invoked, and some of the first agricultural successes were largely dependent on its application. Agricultural co-operation has been an enormous success, and has spread through all the provinces, and it was long ago taken out of the hands of agricultural officers, with a department of its own. For a century efforts have been made to improve the character of the crops grown, largely by introducing strains grown elsewhere; and one of the first lessons learnt in the new department was that this method was unlikely to succeed to any great extent, but that in the *mixtures* grown many forms were worth selecting and purifying. Work in this direction has been a great success in almost every crop studied, and some seven or eight million acres are now under selected strains of wheat, cotton, jute, and rice; while hybrid canes have been evolved which are rapidly replacing the former inferior kinds.

These two lines of work, co-operation and seed selection, are readily appreciated by the cultivators, and obviously place him in a better financial position. They may thus be regarded as laying the foundation for improvements in other directions. Meantime, a great deal of study was devoted to the pests and diseases of the crops grown, and means for their control worked out. Alterations in agricultural practice, because of its time-honoured nature, are much more difficult. It was soon seen that the importation of the costly and powerful implements of the West would be unsuitable in the circumstances; and as with the crops, a careful study was made of the local village equipment, costing a few shillings, on the chance of increasing its efficiency. Cheap models of improved ploughs, harrows, cultivators, etc., have been evolved; and some 30,000 of these are sold every year. But it must be confessed that a great deal more remains to be done.

There are some 150 million cattle in India, and this very number is one of the chief bars to their improvement in quality. Yet cattle may be said to represent the key factor influencing soil fertility and agricultural practice in India; and far too little research has been devoted to this difficult problem. An excellent Veterinary Department has existed for years, but it is only quite lately that a proper liaison has been effected between it and the Agricultural Department. One of the most encouraging features of the present-day research is the increasing attention being paid to cattle questions.

Agricultural research in India has, in the past, lagged considerably behind that in Great Britain, for the simple reason that the number of trained men employed was so absurdly inadequate for the work. The total area of the Indian Empire is given as some 1100 million acres. Of this, British India covers a little more than half, the rest being under native rulers; about two-thirds of British India is classed as cultivable. Such figures are impressive; but no one can appreciate the situation as regards research on the agriculture of the country, who has not spent the best years of his life in odd corners endeavouring to better things, continually making long train journeys over territory as yet untouched. This must be constantly borne in mind when reading of the successes of which the Agricultural Department is so justifiably proud. It is probable that not one hundredth part of the country has as yet been materially affected.

Taking the broad view, we may regard the efforts of the past quarter of a century as so much preparatory spade work; in almost every direction we know a great deal more about the crops and their environment, and can now form an opinion as to where progress may be reasonably expected. Encouraged by incidental successes along the path, the officers of the Agricultural Department are busy applying the most recent advances obtained elsewhere to the solution of their most pressing problems. It is only possible to refer here to one aspect of this development, namely, a fundamental study of the nutrition of man and beast under Indian conditions.[3] This study embraces the whole of agriculture, as well as veterinary science and certain aspects of medicine. In each case the soil is the basis; with cattle, its mineral constitution and the effect of this on the pasture and vegetable food generally; and with man, the inherent nutritional value of the staple foods of the different nations, and the effect of soil treatment on the nutritive value of the different cereals eaten. The two studies are interlocking. For example, it has been found that the nutritive value of cereals is distinctly higher when the crop has been treated with cattle manure than when artificial manures were used. It is obvious that a great many years of work will be needed before either of these projects can yield its full results. But a promising start has been made. Some of the analyses have shown a surprising difference in the proportions of the more important vitamins in the different cereals; and experimental feeding of animals has thrown suggestive light on the known variation in virility and disease resistance of the different nations inhabiting India—work which will awake interest far beyond the limits of the Indian Empire. C. A. B.

[3] "Royal Commission on Agriculture in India," vol. 1, part 2, 1927.

Obituary.

Prof. W. Burnside, F.R.S.

By the death of William Burnside, England has lost a mathematician of rare ability and lasting achievement; and his science can now inscribe another name on her bead-roll of memorable men.

Burnside was born on July 2, 1852, the son of William Burnside, a merchant, of 7 Howley Place, London. On the paternal side, the ancestry was Scottish: his great-grandfather had been minister of St. Michael's in Dumfries. His grandfather went to London and, in the earlier half of the last century, was a partner in the bookselling and publishing firm of Seeley and Burnside.

Left an orphan at the age of six, Burnside was educated at Christ's Hospital, where he was a Grecian—a privileged dignity which, by those who know it not, may be pictured from Lamb's essay on that ancient foundation. At the school, Burnside attained pre-eminence in mathematics as well as in grammar.

He was elected [1] to an entrance scholarship at St. John's College, Cambridge, being the first man of his year—in the old phrase; and he went into residence in October 1871. Late in his second year (May 1873) he migrated to Pembroke College in the same University. He graduated in the Mathematical Tripos of 1875 as second wrangler, being bracketed with Chrystal, who afterwards was professor at Edinburgh; and in the subsequent Smith's Prize examination, Burnside was first, Chrystal second.

A fellowship at Pembroke followed, in his Tripos year: he continued a fellow until 1886. He was at once appointed to lecture in his college: and he lectured also at Emmanuel in 1876, and at King's in 1877. College teaching included selections from the normal course for the Tripos; and Burnside also gave lectures, in one advanced set open to the University, on hydrodynamics. The subject was coming into vogue again at Cambridge: attention, regularly paid to the previous work of Stokes, was stimulated by the then new work of Greenhill and of Lamb. Burnside examined for the Tripos from time to time; and occasionally he did some private coaching.

In one respect, however, Burnside maintained a special undergraduate interest: indeed, a vigorous youthfulness of bearing and appearance was a characteristic through life. At St. John's, even as a freshman, he had rowed in the Lady Margaret First Boat which, with the famous Goldie as stroke, went head of the river in 1872—a success not repeated until 1926. Rather light in weight when an undergraduate, always spare and enduring, he kept his rowing form for many years. He rowed in the Pembroke boat so long as he remained in residence after his graduation: a splendid '7,' he had a full share in its steady rise on the river. For some years after he left Cambridge, his reputation as an oar was a tradition in college circles.

[1] For several of the personal records, the writer is indebted to the present Master of St. John's College, Sir Robert F. Scott, who was fourth wrangler in Burnside's year.

After going out of residence, such opportunities for rowing were no longer open. But Burnside had acquired a zest for fishing, and had often gone to Scotland: he continued to go there, many a summer, to pursue what grew to be his favourite sport. He became an expert fisherman. There were no half-measures with Burnside in any occupation: whatever he undertook, he did thoroughly.

In 1885, at the instance of Mr. (afterwards Sir) William Niven, the Director of Naval Instruction—himself an old Cambridge man, devoted to natural philosophy, as it was styled—Burnside was appointed professor of mathematics in the Royal Naval College at Greenwich. The rest of his teaching life was spent there. There was a current belief that his old college, Pembroke, had invited him to return to important office. But he remained at Greenwich: his work was to his liking: and the multifarious detail, incident to the duties of a college office or of the presidency of a scientific society, such as the London Mathematical, was almost inexpressibly irksome to him through all the years.

At Greenwich, Burnside's work was concerned with the training of naval officers. It consisted of three ranges. There was a junior section for gunnery and torpedo officers, the chief subject being the principles of ballistics. There was a senior section for engineer officers, the chief subjects being strength of materials, dynamics, and the like. The advanced section—perhaps that in which he exercised the greatest influence on his students—was for the class of naval constructors: there, his special mastery of kinetics and of hydrodynamics proved invaluable. He was a fine teacher, stimulating, patient with students—though, elsewhere, occasionally his manner might have a note of abruptness: he certainly earned their gratitude, as appeared from their spontaneous token of tribute to him when he left in 1919, in an address treasured by him and his family.

Burnside had married Alexandrina Urquhart in 1886, soon after going to Greenwich: she survives him, with their family of two sons and three daughters. After his work at the Naval College had ended, they retired to West Wickham in Kent; he enjoyed a leisure spent among his continued researches, his books, and in fishing holidays up in the north. The last year of his life was marked by failing health: and the proximate cause of his death was a recurrence of cerebral hæmorrhage. He died on Aug. 21 last: and he is buried in West Wickham churchyard.

Valuable as was his teaching, important as was his influence alike as an examiner in the highest ranges of mathematics and as a strong referee upon contributions submitted to learned societies, it is by his own contributions to the mathematics he loved that Burnside's name will be held in remembrance.

Throughout Burnside's residence at Cambridge, the University had been in the finest flower of her activity in applied mathematics. Stokes, Cayley, and Adams were the long-established professors: Maxwell's appointment had been more recent. Physical astronomy, dynamics, light, sound, heat, were the staple subjects of the best students. The range of electricity and magnetism, except for an infusion of some of the work of Sir William Thomson (afterwards Lord Kelvin), was rather academic: Maxwell's presentation had still to make its place in the Cambridge course, men scarcely even dreaming of the revolution it was to accomplish. Pure mathematics (save for the exceptional appearance of a Clifford or a Glaisher) was left to the unfrequented domain of Cayley. Much of the original thought of her mathematicians in those years found its expression in Tripos problems, a veritable mine of isolated results propounded as Senate House conundrums. Even so, the worship of the mathematical spirit at the shrine of natural philosophy was maintained in a distinctly conservative range. At the beginning of his work, Burnside could scarcely fail to conform to the Cambridge use: indeed, as regards activity in applied mathematics, he largely remained in the older round to the end.

Burnside's earliest lectures were devoted to hydrodynamics, as has been stated already. But the old-fashioned methods for conjugate functions, stream-lines, velocity potential, were being analytically transformed through the introduction of functions of the complex variable. For many a day Cambridge had preserved an almost invincible repulsion to the then objectionable $\sqrt{-1}$, cumbrous devices being adopted to avoid its occurrence. But some teachers could show that, in two-dimensional fluid motion, simplicity and new results were easily attainable by its means; and its formal Cambridge debut was made in Lamb's book. To Burnside's intellect, the new calculus appealed: and, as a matter of record, his first published paper is concerned with elliptic functions, not with hydrodynamics. That paper, modest in size, finished (' elegant ' was a favourite epithet) in quality, was published in 1883; and thereafter there flowed a swelling current of papers, embodying the thought of his active brain.

It is not difficult to note various stages in the progress of Burnside's knowledge. From time to time there is an occasional return to his earlier preferences. Thus he had produced hydrodynamical papers in the early 'eighties: he returned to the discussion of waves in 1914. The 'potential,' as used by Green, by Stokes, by Thomson and Tait, was all-important in the Cambridge of the 'seventies: Burnside wrote a paper on that topic in 1894, but the work was now beginning to be affected by function-theory. It soon appeared that he had wandered far from his ancient fold. He had made a profound study of the newer (Weierstrass) elliptic functions, proved in the quality of a few scattered papers. He had delved into differential geometry, a subject which was ignored in Cambridge except for some rarely read selections in Salmon's "Geometry of Three Dimensions." His study of elliptic functions had compelled him to range—he always ranged to purpose—in the field of the general theory of functions.

Burnside's matured development flashed out in his two papers on automorphic functions, written in 1891 and 1892. The subject belonged to a new section of knowledge, largely inaugurated by Henri Poincaré, whose exposition was contained in a succession of memoirs, now classical, in the initial volumes of *Acta Mathematica*. The underlying idea is simple. Trigonometrical functions are singly periodic: that is, they repeat [2] their analytical form and values, when the argument suffers an increment or a decrement which is any integer multiple of a single quantity. Elliptic functions are doubly periodic: that is, the repetition of form and values occurs, when the argument is similarly changed by integer multiples of two distinct quantities whose ratio must not be real. Jacobi had proved, long ago, that triply periodic uniform functions of a single argument do not exist. But the question remained (though even the existence of such a question had not been obvious, until it was propounded): What is the most general type of periodicity for a function of one variable? And then, naturally, there followed the question: What are the functions with that type of periodicity? Isolated results were known, though of unrealised significance, indicating a general theory, such as Jacobi's elliptic modular functions, and Klein's icosahedral functions. But it was Poincaré who presented the first systematic consideration of the questions.

Into this work of Poincaré, Burnside plunged; in it he revelled; and his fundamental results are to be found in the two papers already mentioned. They have the finished character usual in his work: terse, free from digression ("No flowers" might have been his motto), moving swiftly in their advance to new results, they reveal the power and the knowledge of a master. In particular, Poincaré had overstated an exclusive result: Burnside detected the overstatement and the cause: and he devised a new class of such functions, simpler than any of the classes due to Poincaré. This investigation led to both simplication and to advance. The full theory has yet to be completed: it awaits the construction of a central function or functions which, while palpably automorphic, shall submit to the customary analytical manipulations, as do the corresponding theta-functions of purely incremental periodicity. When the history of the theory comes to be written, Burnside's name will hold an honourable place in the record.

The consideration of the very foundation of these automorphic functions led Burnside further afield, into a region where he explored with ample result. For every such function, the argument is subject to a number of operations, which are independent of one another, are capable of unlimited repetition, and admit all possible combina-

[2] The writer remembers one day when Sir William Thomson surprised his hostess at lunch by asking her whether she had noticed that "all the carpets of Christendom are strictly periodic."

tions and repetitions in unrestricted sequence. The aggregate of all the operations, which thus emerge, is termed a group; so that a function is automorphic under a group of transformations. But just as the properties of the integers, which occur in the arithmetic of any calculation, merge into the general theory of number without regard to any specific application, so the properties of a group of transformations of an automorphic function are but a part of a more comprehensive calculus. That calculus deals with the composition, the construction, and the resolution, and the essential properties of a group, regarded as an abstract entity subject to mathematical laws, and without any consideration of the regions of its use, whether they are algebraic equations, or analytic functions, or differential equations, or rotations of a solid body, or the divisions of space, to mention only some instances. The first expression of the general notion was due to Galois: later, it found a fine exponent in Camille Jordan. By the late 'sixties it had secured increasing attention in the continental Schools, where soon it divided into two co-ordinate theories, continuous groups and discontinuous groups. The former theory became a grand body of growing knowledge under the inspired researches of Sophus Lie.

It was to the theory of discontinuous groups that Burnside devoted himself in the main, though he attained a stage in the discussion of their invariants where some processes of the theory of continuous groups may yet be drafted into service. Paper after paper appeared from him, on a variety of issues, in ordered development, ever adding fresh contributions to the theory, and marked, all of them, by imaginative vision and compelling power. They found their first culmination in his book on the "Theory of Groups," published in 1897, a systematic and continuous exposition of the subject as it then stood, embodying researches of continental workers (always with ample references) as well as his own. His production of papers, on the theory of groups, continued unhastingly and unrestingly; and the range of the second edition of the book, in 1909, was considerably greater than that of the original volume. Even so, his activity in the subject still continued, though with a gradually decreasing production. All this work, original from himself and copious in extent, is a splendid contribution, emanating from one mind, and sufficient to secure the remembrance of his name.

With the coming of the War, there was comparative cessation in Burnside's work. His frame was almost as lithe as ever and apparently as full of easy spring, seeming to belie the passage of years: but his constructive activity in published mathematics slackened, some of it passing silently into the service of his country, in certain naval matters. In those years he undoubtedly continued to produce papers; but the main body of his creative work might be regarded as verging towards its termination.

There stands, however, in the list of Burnside's memoirs, one brief paper (dated 1918) dealing with a topic in probability; among its fellows, it seems strangely isolated. It now appears that his thought had been settling towards that subject for some time. He has left a draft, which could have been developed into a treatise, on probability: though only consisting of the initial chapters, it is complete within its range; it will make a small volume which can proceed to publication exactly as it was written.

In recognition of his eminence as a mathematician, not a few academic honours came to Burnside in life. He received honorary degrees, Sc.D. from Dublin, LL.D. from Edinburgh. He was elected a fellow of the Royal Society in 1893, served on the Council of that body in 1901 and 1902, and was awarded one of the two Royal Medals in 1904. He was a member of the Council of the London Mathematical Society for the long continuous period from 1899 to 1917, where he was a tower of strength in advice; he was awarded the De Morgan medal in 1899: and in 1906–7–8 he served as president (he had accepted the office with grave and characteristic reluctance). The honour which he esteemed perhaps most of all, was conferred on him in 1900: he was then elected an honorary fellow of his old college, Pembroke, of which he had become the senior among the honorary fellows at the time of his death. Yet even in the few remarks of thanks which he made at the College dinner welcoming, by courteous custom, the newly elected honorary members of the foundation, he urged that the happy and successful pursuit of research was its own reward; and the sincerity of his plea was appreciated not least by those who had done their part in recognition of his labours.

Significant and merited as were the academic honours conferred upon him in life, to William Burnside, as to men of like mark in their generations, the most enduring monument is the work that his genius contributed to the progress of his science.

A. R. F.

MR. C. M. WOODFORD, C.M.G.

WE regret to record the death at Steyning, Sussex, on Oct. 4, of Mr. Charles Morris Woodford, for eighteen years administrator of the Solomon Islands. Mr. Woodford was born at Gravesend in 1852, and educated at Tonbridge School. On leaving in 1871, he went to the western Pacific as a naturalist and collector for the Rothschild Museum at Tring. For ten years he explored Melanesia, visiting the Solomons three times between 1886 and 1888. These islands then had few European inhabitants. Most of them were British, and they lived in constant danger from the native inhabitants, whose habits then fully accorded with the popular idea of a savage, as they were bloodthirsty cannibals, and assiduous in head-hunting. Woodford, however, succeeded in acquiring a considerable knowledge of their habits and characteristics, which he was afterwards to turn to good use.

In 1895, Mr. Woodford became acting Consul and Deputy Commissioner in Samoa, and in the following year he was appointed first resident

Commissioner in the Solomon Islands by Sir J. B. Thurston, Governor of Fiji. In 1900 he proclaimed the Solomons a British Protectorate and hoisted the flag. In 1912 he was made a C.M.G. and in 1915 he retired. During his term of office he succeeded in impressing his strong personality on the natives. He induced them to abandon their head-hunting and cannibalistic habits, and put down the murder of white traders and missionaries. Under his influence the natives provided the labour for the extensive coconut plantations established in the comparatively settled conditions which he set up, even though sporadic outrages, such as that reported within a day or two of his death, still occurred.

Mr. Woodford's profound knowledge of the natives was mainly turned to profit in the practical affairs of administration; but such contributions as he made to anthropological literature were marked by their powers of close observation and careful and accurate record.

We regret to announce the following deaths:

Prof. Max von Gruber, president of the Bavarian Academy of Sciences, known for his work on social hygiene, on Sept. 17, aged seventy-four years.

Lord Iveagh, K.P., G.C.V.O., F.R.S., Chancellor of the University of Dublin, who, among numerous public benefactions, gave £250,000 to the Lister Institute of Preventive Medicine for the endowment of bacteriological research, and was elected in 1906 to the Royal Society under Rule 12, which provides for the election by the Council of "persons who, in their opinion, . . . have rendered conspicuous service to the cause of science," on Oct. 7, aged seventy-nine years.

Prof. Emil Zettnow, director of the department of photomicrography at the Robert Koch Institute in Berlin, on Sept. 7, aged eighty-five years.

News and Views.

In an article in last week's issue of Nature, the main characteristics of several types of metallurgical photomicrographic apparatus at present on the market were discussed, and it was suggested that British manufacturers must pay more attention to details of mechanical construction and design of this type of apparatus if they are to compete successfully with Continental manufacturers. That such competition is making itself felt is shown by the fact that twenty-two institutions and firms in Great Britain, and also sixteen in the United States, have recently installed Reichert metallurgical photomicrographic equipments of the type referred to in the article. From the point of view of British industry, it is unsatisfactory that so many British purchasers should have to place their orders with a foreign firm for an apparatus of such importance in industry and in scientific investigations. In 1920 the Faraday Society, under the presidency of Sir Robert Hadfield, in conjunction with the Royal Microscopical Society, the Optical Society, and the Photomicrographic Society, held a symposium on "The Microscope: Its Design, Construction, and Applications." A valuable discussion took place, in which microscope users stated their requirements and manufacturers presented their proposals to meet these requirements. The meetings aroused a considerable amount of enthusiasm on the part of manufacturers and resulted in the production of several types of microscopes of such a quality and in such quantity as to meet fully the requirements and the demands of the users. It would seem, however, that in regard to photomicrographic apparatus for metallurgy, the manufacturers have not kept pace with the demands of the metallurgists.

Messrs. Hadfield's, Ltd., desire to purchase an up-to-date metallurgical photomicrographic outfit. In order to avoid the necessity of placing the order abroad, Sir Robert Hadfield informs us that he or his firm is prepared to pay to any manufacturer who will supply a British-made equipment similar to the Reichert large photomicrographic apparatus, or one which fulfils the requirements of the metallurgist at least as fully as does the Reichert, a premium of £50 in addition to the price at which the Reichert equipment is now obtainable. For photomicrographic work, the adjustment of the intensity of illumination requires a system of auxiliary lenses and light filters. These must be held in definite relation to the microscope itself, as must also the camera. For metallurgical purposes, the camera must be capable of being used also for macrophotographic work. This involves the production of an elaborate and delicate piece of apparatus, but it is certainly not beyond the resources of British microscope manufacturers. They have the advantage of a Scientific Instrument Research Association which is rendering valuable service to the industry. There is also a chair of instrument design at the Imperial College of Science and Technology, where the scientific principles of design are taught. The technical knowledge and skill of the British optician and mechanician are of a high standard, as is evidenced by several other types of instrument at present on the market. Since attention has now been directed to mechanical details in British photomicrographic apparatus in which improvement might be effected, it may be confidently anticipated that Sir Robert Hadfield's offer will meet with a ready response. Its acceptance and the successful completion of the order would undoubtedly result in increased sales of British-made apparatus of this type.

On Oct. 10, Prof. W. C. McIntosh, of St. Andrews, the Nestor of marine biology in Great Britain, entered upon his ninetieth year. Prof. E. E. Prince, Dominion Commissioner of Fisheries for Canada, who is visiting England, has sent us an appreciation of Prof. McIntosh's work, from which we are glad to print the following extracts. Born in St. Andrews in 1838, Prof. McIntosh passed through his arts course in the University of St. Andrews and his medical course at the University of Edinburgh. On graduating M.D. he was awarded the University gold medal, for a thesis on some peculiar features in the shore crab. Though burdened with heavy official duties when appointed to the Perth Mental Hospital in the late 'fifties, he decided to devote himself as a scientific investigator to the marine annelids. The great "Monograph of British Annelids," the last of the long succession of superbly illustrated parts of which was issued only in 1923, is a monumental work. It will ensure lasting fame for its venerable author, and rank him as one of the very great zoologists of our time. The Nemerteans, so rich in the rock-pools of St. Andrews, first claimed his attention. At Perth, in sea-water tanks far from the sea, he skilfully carried on his studies on the living forms, and with marvellous artistic skill portrayed the gorgeously tinted creatures. In 1884 was published the famous Report to the Royal Commission on Trawling, embodying work done on many cruises and including the discovery that the sole and other fish produced floating eggs. Prof. McIntosh is the pioneer in Great Britain of sea-fishery investigations, and it is a matter for congratulation that he continues active in the pursuit of zoological science and is as zealous as in his earlier years.

At the opening of the thirty-sixth session of the School of Pharmacy of the Pharmaceutical Society on Oct. 5, the Hanbury Memorial Medal for "high excellence in the prosecution or promotion of original research in the chemistry and natural history of drugs" was presented to Dr. T. A. Henry, Director of the Wellcome Chemical Research Laboratories. Dr. Henry, in an address on receiving the medal, stressed the importance of maintaining a close relationship between pharmacology and organic chemistry. Although the position of Great Britain as a producer of new synthetic drugs has improved since 1914, yet it is only too notorious that many of the additions to the physician's armamentarium come from abroad, especially in the case of drugs used in the treatment of tropical diseases. This is not a creditable state of things for a great Empire: in part it is no doubt due to the fact that, as a nation, we are more interested in the preventive than in the curative side of medicine: on the other hand, the lack of facilities for pharmacological testing has also militated against research. For this reason, Dr. Henry welcomed the opening of a pharmacological laboratory by the Society. New compounds are always being synthesised, the pharmacological properties of which ought to be tested, especially when it is remembered that it is only one out of many examined, which will finally find its place in practical therapeutics. For scientific research, therefore, adequate facilities for pharmacological testing are essential, in order to direct the chemical work as it develops and to assist it as required. Moreover, quite apart from the production of new synthetic drugs, pharmacological assay of therapeutic substances of unknown chemical constitution, such as insulin, require the assistance of trained pharmacologists. In both these directions Dr. Henry considers that the new laboratory will prove itself of great value.

The presentation of the Hanbury gold medal of the Pharmaceutical Society of Great Britain to Dr. T. A. Henry, affords an opportunity for recalling the work of the man whose name is commemorated in the name of the medal. Daniel Hanbury was the son of Daniel Bell Hanbury, a president of the Pharmaceutical Society and one of the founders of the historic business which still bears his name. The son, born in 1825, early impressed his contemporaries by the beauty of his handwriting and his skill at water-colour painting, talents which he later developed in his characteristically painstaking and detailed descriptive work. His writings included a series of papers on Chinese materia medica; numerous contributions to the *Transactions of the Linnean Society*, and the "Pharmacographia" published in conjunction with Prof. Flückiger, of Strasbourg, which was completed in 1874. Shortly after his death in 1875, a fund was raised for the purpose of giving from time to time a gold medal to perpetuate his memory. The medal is awarded for high excellence in the prosecution or promotion of original research in the chemistry and natural history of drugs, the award being made by a committee composed of the presidents for the time being of the Chemical, Linnean, and Pharmaceutical Societies, the chairman of the British Pharmaceutical Conference, and one pharmaceutical chemist. Twenty-one awards have been made since 1881, when the first medal was presented to Hanbury's co-worker, Flückiger. Englishmen naturally head the list of recipients, but Germany, France, Switzerland, Russia, and the United States are also represented. The last award was made in 1922 to Prof. Emile Perrot, of the University of Paris, and in the list of earlier recipients occur the names of Dragendorff, De Vrij, Ladenburg, Tschirch, and F. B. Power. Dr. Henry's work has been mainly upon problems connected with the chemistry rather than the natural history of drugs, but his reputation in that field of research and the wide range of subjects covered in his published papers both in Great Britain and abroad, indicates the appropriateness of the award of the medal to him this year.

Controversy still rages over Glozel, and Dr. Morlet continues to champion the genuine character and the high antiquity of the alleged implements and inscriptions on the clay tablets found there in the *Mercure de France* and numerous separately issued pamphlets. In the meantime, according to a dispatch from Paris which appeared in the *Times* of Oct. 6, the site at Glozel has been declared a national historical monument, and M. Heriot, acting in his capacity of Minister of Education, has informed Dr. Morlet in a letter that it has been placed under the control of M. Peyrony, the eminent archæologist and member of the Historical Commission. M. Peyrony will be assisted by M. Champion, head of the technical department of the National Museum. All future discoveries will therefore be officially scheduled. M. Peyrony's profound and intimate acquaintance with the palæolithic sites of France and their antiquities should provide an acid test of the genuineness of any future find as Glozel. At the same time, it must be admitted that the camp of the pro-Glozelists is by no means negligible, including as it does Dr. S. Reinach, Dr. Van Gennep, M. de Laborde, Senor Leite de Vasconcellos, and Prof.

Mendes-Correa. They are, however, by no means united in their views. While Dr. Morlet regards the site as a link between palæolithic and neolithic, others, accepting the antiquity of the specimens, assign them to the various periods from the Magdalenian to the neolithic, but are hard put to it to explain the simultaneous occurrence of remains of all these periods on one site. Some, again, assign the site to so late a period as the Gallo-Roman. Against these views must be set the weighty authority of the Abbé Breuil and others, to which we have referred from time to time in these columns. Their great experience in handling the relics of early man renders their verdict of forgery one which it is difficult not to accept.

A Science Exhibition held at Hastings in the White Rock Pavilion on Oct. 5–8 shows what it is possible to do in popularising science among the inhabitants of a residential town. The promoters were local scientific and professional men, with the Mayor as chairman and the master of the Grammar School as honorary secretary and treasurer; in fact, it was quite a co-operative effort. The aim was to attract the ordinary man as well as the serious student by exhibits showing the advances in modern scientific knowledge, but the merely amusing was excluded. This involved much thought in planning, but the actual getting together of models and apparatus did not present serious difficulty for, as the catalogue shows, they were obtained on loan from public institutions, firms, and private individuals. The exhibits were divided into sections: engineering, electrical; radio and signalling; chemical and physical; and applications of science to the arts and to music. Since science objects, unlike art exhibits, cannot be appreciated merely through the eye, but call for exposition, care was taken to have stewards at hand to give explanations, while short talks and demonstrations followed one another from 3 P.M. until 9 P.M. each day; there was also a lantern lecture each day by a well-known man. The exhibition, which was well advertised by a specially designed poster and folder, was a great success, and may well serve to induce other local authorities to arrange exhibitions of a like character.

The courses of lectures at the Royal Institution during November and December will commence on Tuesday, Nov. 1, at 5.15 P.M., with the annual course of three Tyndall Lectures, which will be delivered by Sir John Herbert Parsons on the subject of light and sight. These will be followed on Nov. 22 by four lectures by Sir William Bragg on a year's work in X-ray crystal analysis. On Thursday afternoons, beginning on Nov. 3, there will be two lectures by Mr. H. Clifford Smith on the furniture and equipment of the medieval house; three by Dr. R. E. Mortimer Wheeler on London before the Norman conquest; and two by Mr. James Kewley on petroleum natural gases and their derivatives. The Saturday lectures will be given at three o'clock, starting on Nov. 5, when Mr. Emile Cammaerts will give two lectures on the main features of modern English literature, to be followed by three musically illustrated lectures by Mr. Gustav Holst on Samuel Wesley and Robert Pearsall, and two lectures by Mr. F. J. M. Stratton on recent developments in astrophysics. The 102nd course of Christmas Lectures for Juveniles will be delivered by Prof. E. N. da C. Andrade on "Engines," commencing on Thursday, Dec. 29, at three o'clock. The subjects of the lectures will be (1) The rules which all engines must obey; (2) learning about steam; (3) engines which work to and fro; (4) engines which work round and round; (5) putting the furnace in the cylinder; (6) heat engines which produce cold.

Referring to the letter by Messrs. Rosenheim and Webster in Nature of Sept. 24, p. 440, Mr. C. A. Hill, of the British Drug Houses, Ltd., writes informing us that, immediately after the publication of Rosenheim and Webster's work on ergosterol in February last, his firm placed irradiated ergosterol at the disposal of medical men. Since then, the British Drug Houses, Ltd., has achieved the large-scale production of ergosterol and of the irradiated product, so that the latter is now available commercially. It is already on the market in a popular form for the public use; it is available for manufacturers of margarine to bring their product up to the standard of summer butter, which they can do at a fractional increase in cost; and chocolate manufacturers are already experimenting with it.

On Sept. 10 the second Pan-Union Archæological Conference was opened at Sevastopol. It lasted until Sept. 15 and was followed by an excursion, in the course of which the delegates were conducted to the principal archæological sites in the Crimea by Prof. C. E. Grinevich. The Congress coincided with the hundredth anniversary of archæological excavation in the Chersonese, for, as stated in a historical survey by Prof. Grinevich, it was in 1827 that Admiral A. S. Greig, who was of Scottish descent, ordered Lieutenant Crusoe to begin excavations in the Tauric Chersonese. Work was carried on intermittently until 1885, when systematic excavation of this Dorian colony was begun and pursued continuously until 1915. It was renewed after the War in 1925, and at the same time the rich collections were reclassified and housed in the former monastery buildings. Representatives of the Academy of Sciences and the principal archæological museums and institutions of the Soviet Republics were present at the Congress, and a number of communications, some twenty in all, were presented in two sections, one covering Chersonese archæology, the other general archæology. Among these, G. A. Bonch-Osmolovsky described excavations in Kukrek and the Siuren Caves of sites belonging to the Stone and Bronze Ages, from which had been obtained bones of mammoth, rhinoceros, cave bear, and the skeleton of a dog. Considerable discussion was aroused by Prof. Grinevich's communication on the oldest defence wall of Chersonese, delivered from the wall itself, which seriously modified pre-existing ideas of the topography of the town.

The Imperial Department of Agriculture in India has commenced the issue of a new quarterly agricultural journal, of which Part 2 (July 1927) has been received. The *Journal of the Central Bureau for Animal Husbandry and Dairying in India*, as it is named, will deal with cattle breeding, dairying, cultivation and storage of fodder crops, animal nutrition, and other aspects of animal husbandry, and the present number contains five articles on various aspects of Indian cattle and dairying, one on poultry feeding, and part 2 of a veterinary entomology for India. The journal is illustrated and the subscription price is Rs. 2-8 per annum.

The annual Report for 1926 of the International Health Board, Rockefeller Foundation, has been issued. Public health work has been assisted in eighty-eight States and countries. Governments have been assisted in surveys relating to yellow fever, hookworm, malaria, and other diseases; in campaigns for the control of yellow fever and hookworm disease; in field studies in malaria and hookworm disease and in demonstrations of malaria control; in county and district health work; and in the development of public health services, such as epidemiology and vital statistics, sanitary engineering, public-health laboratories, and nursing. Contributions have been made to schools of hygiene for education, including the London School of Hygiene and Tropical Medicine. Fellowships in public health were provided for 253 men and women of thirty-one countries. The Board also co-operated with the Health Section of the League of Nations. The expenditure for the year amounted to 3,260,524 dollars. The report gives a summary of the Board's activities and contains many maps, charts, and diagrams, and illustrations.

An air survey of the western part of Northern Rhodesia is to be undertaken by the Government of that country. The *Times* reports that the area to be surveyed covers the valley of the Upper Zambezi for about four hundred miles above Livingstone and includes the two tributary rivers, the Lungwebungu and the Kabompo. This region is almost entirely unmapped and undeveloped, but is believed to have considerable mineral wealth. Major Cochran-Patrick will be in charge of the survey and the aeroplane will be supplied by the Aircraft Operating Company. The machine to be used is at present working on survey near N'Changa, and will be flown to Livingstone to be fitted with floats. The aeroplane will fly at a height of 10,000 feet along the course of the river, and a series of vertical overlapping photographs will be taken. Larger scale photographs will be taken of rapids. Ground control is being provided by the company's surveyors, who will fix points by observation, using radio time signals.

One of the whalers at work in the waters around Graham Land is reported in the *Geographical Journal* for September to have made a voyage through Bransfield Strait and to have reached Peter I. Island, which has not been visited since its discovery by Bellingshausen in 1821. The whaler, *Odd I.*, circumnavigated the island seeking in vain for a safe harbour; heavy weather prevented a landing. The island is 8 miles long and 5 miles broad. Most of it is covered by snow or ice, and only on the western side is there much bare rock. It rises to about four thousand feet, and the absence of an ice foot on the coast suggests, but does not prove, that it is clear of solid pack throughout the year. The same whaler reports in lat. 60° 30′ S., long. 52° W., that is, west of the South Orkneys, an iceberg which was estimated to be about a hundred miles in length and 100 to 130 feet above the water line. Other enormous tabular bergs were sighted in the vicinity. It seems not improbable that these bergs represent the broken Stancomb Wills ice tongue of Coats Land or fragments of the Wilhelm Barrier farther south. The currents of the Weddell Sea would carry ice from that direction to the north-western corner of the sea.

The experiments being made with short radio waves all over the world are giving most astonishing results. In the October number of *Experimental Wireless*, the Radio Research Board refers to results obtained by E. Quäck, published in two German technical papers. Oscillographic records have been obtained at Geltow, near Berlin, of signals sent from Rio de Janeiro. Each signal is accompanied by an 'echo' signal, caused most probably by waves which have travelled round the earth in the opposite direction to the direct signal. This is most curious, because the beam transmitter is not only directional but also works with a reflector. Further experiments carried out recently show that several signals are received at definite equal intervals after the first signal. As the interval of time between the first direct signal and these additional signals is always a multiple of 0·137 of a second, it looks as if the waves, after causing the first signal, travelled completely round the world several times, recording signals as they passed the receiver. For waves lying between 14 and 34 metres, double signals have been observed. It has also been noticed that double signals occur most commonly when the great circle on which the receiver and transmitter lie is in twilight. On the other hand, the 'echo' signals caused by waves travelling round the world in the opposite direction to the direct signal are often noticed in the day-time. The attenuation of the signals after encircling the earth several times is not great, and it is concluded that many more encirclings occur before the waves subside. In practical work, methods have to be devised to eliminate the disturbances caused by these multiple signals, but their systematic study should be a great help in elucidating the phenomena of short wave propagation.

Dr. W. G. Savage, Medical Officer of Health, Somerset, will deliver the second annual Malcolm Morris Memorial Lecture under the auspices of the Chadwick Trust on Oct. 17, taking as his subject "Food Poisoning." The lecture will be given in the Hastings Hall of the British Medical Association.

The Council of The Institution of Civil Engineers has made the following awards: The Howard Quinquennial Prize to Prof. W. E. Dalby, in recognition of his researches on the strength and structure of iron and steel; The Indian Premium to Mr. A. W. Stonebridge. For selected engineering papers published during session 1926–27: A Telford Gold Medal to Sir E. Owen Williams (London), Telford Premiums to Dr. E. H. Salmon (London), Mr. R. S. Cole (India), Dr. H. Mawson (Liverpool), and Mr. A. H. Douglas (London); and a Crampton Prize to Mr. D. M'Lellan (Glasgow).

Applications are invited for the following appointments, on or before the dates mentioned: Three examiners (men or women) in the Industrial and Commercial Property Registration Office of the Ministry of Industry and Commerce, Dublin, for the examination of applications for patents for mechanical engineering, electrical engineering, and chemical inventions—The Secretary, Civil Service Commission, 33 St. Stephen's Green, Dublin (Oct. 19). An assistant lecturer in agriculture, book-keeping, and farm costs at the South-Eastern Agricultural College, Wye—The Secretary, South-Eastern Agricultural College, Wye, Kent (Oct. 21). A fishing mate and a chief engineer in the fishery research vessel of the Ministry of Agriculture and Fisheries at Lowestoft—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (Oct. 22). An assistant naturalist in the Laboratory of the Marine Biological Association of the United Kingdom—The Director, Marine Biological Laboratory, Plymouth (Oct. 23). A scientific officer under the Air Ministry, primarily for duty at the Royal Aircraft Establishment for design and research work in connexion with high speed supercharged internal combustion engines and with special reference to research on blowers—The Chief Superintendent, Royal Aircraft Establishment, South Farnborough, Hants, quoting A.220 (Oct. 24). A research assistant for blast furnace reactions research at the Imperial College of Science and Technology — The National Federation of Iron and Steel Manufacturers, Caxton House (East), Tothill Street, S.W.1 (Oct. 25). A demonstrator in inorganic chemistry in the University of Leeds — The Registrar, The University, Leeds (Oct. 26). An Inspector under the Alkali, etc., Works Regulation Act, 1906 — The Director of Establishments, Ministry of Health, Whitehall, S.W.1 (Oct. 29). An assistant lecturer in economics and political science in the University College of South Wales and Monmouthshire—The Registrar, University College, Cardiff (Oct. 29). A lecturer in hygiene in the department of education of the University of Bristol —The Registrar, The University, Bristol (Nov. 12). An assistant research physicist at the Gramophone Company, Ltd.—The Gramophone Company, Ltd., Hayes, Middlesex (quoting Z14).

Our Astronomical Column.

Detection of Schaumasse's Comet.—This periodic comet, which was discovered by M. Schaumasse at Nice in 1911, and seen again on its return in 1919, has now been detected by Prof. G. van Biesbroeck at the Yerkes Observatory on Oct. 4^{d} 10^{h} $22{\cdot}8^{m}$ U.T., in R.A. 11^{h} 6^{m} $2{\cdot}5^{s}$, N. Decl. 12° 57′ 59″, magnitude 12. The position is in excellent accord with that derived from the elements given by Dr. G. Merton in *Mon. Not. Roy. Ast. Soc.* for May last, the time of perihelion passage being Oct. 1·43 as compared with the predicted value Oct. 1·54. The comet is very badly placed, being low in the east at dawn, but it will be even worse placed at its next return in 1935, so it is fortunate that it has been found, as if missed for several returns it would have been difficult to find it again. This is the second comet this year for which Dr. Merton has predicted the perihelion passage within a tenth of a day; the other was comet Grigg-Skjellerup. In the present case, the forecast by the Nice astronomers was Nov. 19, seven weeks too late, so that the comet would not have been found if this had not been corrected.

The Total Solar Eclipse of June 29.—*Forschungen und Fortschritte* for Sept. 20 contains an article by Dr. H. Kienle, of the Observatory of the University of Göttingen, describing the expedition from that observatory to Gällivare, Swedish Lapland, to observe the eclipse. The height of the sun was 27° and the duration of totality 42 seconds, these being practically the greatest values obtainable at any land station; in consequence it was selected by ten different expeditions from Germany, Holland, Sweden, Esthonia, Russia.

The programme of the Göttingen party included flash spectra with a slit spectroscope, measures of radiation with a photo-electric cell, and photometry of the corona. The radiation measures began an hour before first contact, and continued until an hour after last contact. The sky was clear except for two bands of clouds that were near the sun during totality. These interfered with the observation of the second flash and with the later corona photographs, but the rest of the programme was carried out successfully. Totality is described as "Eine besonders helle und schöne Erscheinung, die nur leider viel zu kurz andauerte"; but details of the results are reserved for a future paper.

Observations of the Variable Star Z Herculis. —*Bull. Internat. de l'Acad. Polonaise des Sciences* contains a series of observations of this star made by M. Jean Gadomski of the Observatory of Cracow at the mountain station on Mt. Lysina (3000 feet high). The period of light-variation falls short of 4 days by only ten minutes; in consequence it is difficult to follow all the phases of the star at a single station. However, by making 141 observations on 38 nights in 1923, the author succeeded in determining the whole of the variable part of the light curve. The eclipses last altogether 9·6 hours, just a tenth of the period: the curve seems to be quite symmetrical about minimum, implying that the orbit is appreciably circular. The light is stationary for 2·2 hours at minimum, which shows that the eclipse is total or annular for that period; the rise and fall are rapid for 2·4 hours before and after minimum, and slow for the rest of the eclipse. The magnitude is 7·19 at maximum, 8·01 at minimum.

The study of variable stars is one of the special lines of work undertaken by Poland; also the computation and publication of ephemerides of many of them. Observations of eclipsing variables, when combined with spectroscopic observations of radial velocities, give valuable information on the diameters and surface brightness of the stars.

Research Items.

SCOTTISH BROCHS.—In *Antiquity* for September, Mr. Alexander O. Curle discusses the origin and structure of the broch—the characteristic defensive structure of the north and west of Scotland, consisting of a circular tower surrounding an open court, built of dry masonry without mortar or other binding material, and of which the height originally in some cases must have been as much as 60 feet. The walls at the base are usually 15 feet thick and contain series of superimposed galleries. A puzzling feature, a ledge projecting about 12 inches from the interior of the wall, is now explained in the light of excavations at Dun Troddan, as the resting place for beams extending to posts circling the interior and forming the roof of a closed colonnade around a central hearth open to the sky. The brochs have no relation to the Nurhagi of Sardinia, which differ from them essentially in structure and purpose. Their closest analogies are to be found in the galleried duns or promontory forts and the so-called 'semi-brochs' of the west of Scotland. The distribution of the broch points to its origin in the north and west of Scotland, those found outside this area being due to an extension of tribal influence from the north. In date they are to be regarded as not earlier than the Iron Age, while the occurrence of Samian ware, Roman coins, and other objects, indicates that they were occupied at the time of the Roman invasion and in the second century A.D., though probably they date back some hundreds of years before that time. They probably were occupied for some time later, but from the absence of wheel-made pottery and Viking relics, it cannot be asserted that they survived to the eighth century.

THE BIRDS OF ANCIENT EGYPT.—In the *Nineteenth Century* for October, Prof. R. E. Moreau publishes a study of the birds depicted on the monuments of ancient Egypt. Bird forms appear with great frequency in reliefs and paintings on tomb walls. Yet a closer examination of this great mass of material reveals that there is much repetition and continuous copying. The earliest work is the best. Three different kinds of geese at Medum were painted with great faithfulness. Nothing equals them in later Egyptian history or in the western world until fifty years ago. The uncoloured reliefs of Sakkara of the fifth dynasty come next to the paintings at Medum. The earliest bird relic is an exquisite ivory figure of a nightjar of predynastic age, before 3400 B.C. at the latest. This bird does not appear in Egyptian art again. In the marsh scenes of the Tomb of Ti a large number of birds are shown, ibises, gallinules, herons, spoonbills, cormorants, and spur-wing plovers. Genet cats crawl through the papyrus raiding the nests. An exquisite scene of a kingfisher fluttering round a cat's head while its mate hurtles down in defence of the half-fledged young was copied repeatedly in all its details in later times. In the paintings a number of traps are set for the ornithologists in the restrictions imposed upon the colourist by his palette. Thus gray is represented by a strong bluish green. Mummied birds make only a late appearance in the twentieth dynasty. Nearly thirty species of raptorial birds have been identified at Kom Ombo. Apparently the practice was intended in honour of the hawk-headed god Thoth. Mummied ibises come from Sakkara. They honour Isis and apparently are connected with the idea of fruitfulness. Some birds identifiable have now disappeared from Egypt—the red-breasted goose, the chanting goshawk, and the sacred ibis. In numbers there must be great impoverishment.

CAPTIVE CRICKETS.—Under the title of "Insect Musicians and Cricket Champions of China," Mr. Berthold Laufer, of the Field Museum of Natural History, Chicago, has recently issued an interesting brochure on the ancient Chinese custom of keeping crickets in captivity. It appears that in A.D. 618–906 they began to keep them in cages in order to enjoy their song, while in A.D. 960–1298 they developed the sport of cricket fights. The cult of cricket-keeping, and the vessels and instruments employed, are admirably discussed and figured in this pamphlet, which should be read by any one interested in the subject.

POPULATION DENSITY AND DURATION OF LIFE IN DROSOPHILA.—The influence of the density of population on the duration of life of *Drosophila melanogaster* has been investigated experimentally and the results analysed statistically by Prof. Raymond Pearl and his collaborators (R. Pearl, J. R. Milner, and Sylvia L. Parker, *American Naturalist*, **61**, p. 289; 1927). The general method of experiment was to introduce the young flies in varying numbers—from 2 to 200—into one-ounce bottles containing 8 c.c. of a banana-agar, or other standard food mixture. The total number of flies was 13,000, distributed in 530 bottles, and equal numbers of males and females. The longest duration of life was found to be when the flies numbered 35-55 per bottle, and with larger numbers the mean duration of life declines steadily with advancing density. A wholly unexpected result was that minimal population densities are not optimal for duration of life. The deleterious effect of crowding is most pronounced during the first few days of life, and is exerted even upon those flies that do not immediately die as a result of it.

SILK PRODUCTION IN THE SILKWORM.—In the *Journal of the College of Agriculture of the Imperial University, Tokyo* (vol. 9, 1927, pp. 119-138), Mr. Jiro Machida discusses the secretion of the silk-forming substance in the silkworm. It is well known that two chief silk substances are produced, fibroin and sericin, but opinions differ with regard to their origin. By some it is maintained that the fibroin is first secreted and a part of it becomes oxidised later into sericin. By others the two substances are considered to be distinct from the beginning. Mr. Machida's methods of study were primarily histological and, after suitable fixation, the silk glands were dissected from the body of the caterpillar and cut into sections. By means of a mixture of equal volumes of 1 per cent. aqueous solution of acid fuchsin, 2 per cent. aqueous solution of methyl green, and an aqueous saturated solution of picric acid, good staining was obtained, the fibroin appearing blue and the sericin purple. From an examination of material treated in this manner, he concludes that fibroin and sericin are secreted as different substances in different parts of the glands, sericin being produced along the whole length of the middle division and the fibroin at the posterior division of each gland.

MITOCHONDRIA AND CELL INJURY.—The September issue of the *Journal of the Royal Microscopical Society* contains a pictographic review by G. M. Findlay of the changes which occur in mitochondria as the result of injury to the cell. Whether these changes are due to direct action on the mitochondria or to changes produced in the cytoplasm is unknown. The most common qualitative change is in shape—a transformation of rods into granules which occurs in many pathological conditions. It is noted that though qualitative changes can readily be produced by pathological conditions in gland-cells, there is no evidence of corresponding change in the cells of the central nervous system in such conditions as fatigue, poliomyelitis, and botulism. The quantitative variations which occur under different physiological conditions make extremely difficult any estimate of quantitative change under pathological conditions. Changes of position of mitochondria within the cell are by no means rare; *e.g.*, in tissue culture individual mitochondria pass from the nuclear region to the periphery of the cell and back again, but the reasons for these movements are unknown. Observations on mitochondria in pathological conditions throw little or no light on their function. As first suggested by Regaud (1909), the surfaces of the mitochondria may be the loci of synthesis in the cell. Joyet-Lavergne (1927) has found that mitochondria are coloured by sodium nitroprusside, and it is therefore possible that they represent the cell areas in which the auto-oxidisable substance glutathione is concentrated. The review is illustrated by 24 plates, and a list of references is appended.

Crustacea of the North Sea and Baltic.—Recent additions to the Crustacea in "Die Tierwelt der Nord- und Ostsee" (Leipzig: Akademische Verlagsgesellschaft, 1927, Lieferung 8) are the non-parasitic copepods (*Copepoda non parasitica*, by O. Pesta, Teil X. e 1), the Cirripedes (*Cirripedia*, by P. Krüger, Teil X. d), and the *Leptostracea*, by Johannes Thiele, in Lieferung 7 (Teil X. g 1). With such a large group as the free-living copepods, much space must necessarily be occupied by the systematic survey, which is here particularly useful, giving keys to the genera of the three groups—Calanoidea, Cyclopoida, and Harpacticoida. The harpacticids being so much less known than the other two, the notes on these are specially welcome. In the biological part the author gives a summary of his own previous work on the relations between the build of the copepod and the method of movement in marine forms, in which he designates three types: floaters, swimmers, and creepers, calanoids being typical of the first, harpacticids of the last, and amongst the swimmers are members of all the groups.

Production of Plankton.—Observations were made by Prof. H. H. Gran on the spring production of diatoms in Norwegian coastal waters off Bergen in 1922 (*Report on Norwegian Marine and Fishery Investigations*, vol. 3, No. 8, 1927). The outburst was of its usual short duration, reaching a maximum on Mar. 23, after which date there was a rapid decrease. The predominant species were *Thalassiosira Nordenskiöldii* and *Skeletonema costatum*, which each attained a density of more than 200,000 cells per litre. It is suggested that this plankton and the requisite supply of nutrient salts came in the Baltic stream which issues from the Skager Rack, where a similar plankton occurs about a month earlier. Working on Mohn's figures for the average velocity of the Baltic stream, 0·4 sea mile per hour, it would take just a month for water from the Skager Rack coast of Sweden to reach Bergen. Collections taken in the Hardanger Fjord showed a different diatom population, with *Leptocylindrus minimus* the most abundant form (up to 2½ millions per litre). On the basis of the increase of oxygen, shown in the coastal waters to run parallel with the diatom maximum, the production down to a depth of 10 metres was estimated as being 1·4 gm. glucose per cubic metre for the minimum value for three weeks. It must be realised that during this period much oxygen was probably being lost to the atmosphere from the supersaturated surface waters, and results from culture experiments gave considerably higher values. By this means the production was estimated as 5·2 gm. glucose per cubic metre in 20 days, or an average of 0·26 gm. glucose per 24 hours per cubic metre.

Indian Forest Plants.—In a recent number of the *Indian Forest Records* (vol. 13, pt. i., 1927) Mr. R. N. Parker, Forest Botanist at the Research Institute at Dehra Dun, commences a series of "Illustrations of Indian Forest Plants." The author gives as his reason for undertaking this work that much useful information not generally known is available in the form of specimens accumulated in the Dehra Dun Herbarium, which, it may be mentioned, contains specimens collected by Wallich and Roxburgh. He quotes Sir D. Prain ("Bengal Plants," p. 263) as writing, "It is not a matter for congratulation that we know less about trees so important as the Garjans than was known by English residents in Bengal 90 years ago." Mr. Parker says he hopes to show that this is no longer true, and opens his series with an account of the Dipterocarps of Gaertner and Roxburgh. A further example is given of the necessity and usefulness of the present work. In the "Flora of British India" two species of Anisoptera are mentioned, namely, *A. oblonga* Dyer, described in 1874, and *A. glabra* Kurz, described in 1873. In the "Flore générale de l'Indo-Chine," published in 1910, these two Indian species are mentioned as "espèces incomplètement connues." The Anisopteras, like the Dipterocarps, are forest trees of the largest size, and it is highly desirable that they should not remain obscure; as if they extend into neighbouring regions such as Siam, Indo-China, and Malaya they will inevitably be renamed, if this has not already been done, thus causing a useless multiplication of names. Much of the material which Mr. Parker has had to work on, especially that from Burma, has been collected from marked and numbered trees which have been visited periodically by the forest staff in order to collect leaves, twigs, flowers, and fruits when available on the tree. The successful collection of specimens from big trees is not an easy matter when we picture the dimensions of one instanced—110 feet high, 7 feet girth, and 62 feet to the first branch! In the Part I. of Mr. Parker's series here dealt with he describes five species of *Dipterocarpus* (*costatus* Gaertn., *turbinatus* Gaertn, *pilosus* Roxb., *tuberculatus* Roxb., and *alatus* Roxb.). The series will be of undoubted value to the botanist, but it will be equally welcomed by the forest officer; for those who have worked in the Chittagong, Arrakan, Burma, and Andamans forests are well aware of the confusion which has reigned in the correct identification of these species of a fine genus of timber trees.

The Genera of Magnolieæ.—In the *Kew Bulletin* (No. 7, 1927), J. E. Dandy gives the results of a much-needed critical study of the Magnoliaceæ, in so far as it concerns the tribe Magnolieæ. For a long time much of the confusion which has existed in the group has been due to the various interpretations of the limits of the genera. The author has now been able to assemble at Kew for the first time the type specimens of nearly all the species of the tribe. By relegating the very distinct genus Liriodendron to a tribe of its own, he finds that the remainder of the family, the true Magnolieæ, form an extremely natural group, about the number of constituent genera of which there has never been any uniformity of opinion. Baillon arranged the genera under five sections of the one genus Magnolia. The present study suggests that taxonomically Baillon's unigeneric view is untenable, and nine genera, four of them new, are recognised, namely, Talauma, Manglietia, Magnolia, Alcimandra, Aromadendron, Pachylarnax, Elmerrillia, Michelia, and Kmeria. Of the new genera, Alcimandra is a split-off from Michelia, on account of the terminal instead of axillary flowers; Pachylarnax is based on a species hitherto undescribed, and unique in the family on account of its capsular fruit; Elmerrillia resembles some species of Michelia in general appearance and in the axillary flowers, but differs in the sessile gynæcium and introrsely dehiscent anthers; Kmeria (formerly *Magnolia Duperreana*) has unisexual flowers and a mode of dehiscence quite unknown in the rest of the family.

VARIATION OF RADIOACTIVITY OF HOT-SPRINGS.—In the *Science Reports of the Tohoku Imperial University*, vol. 16, No. 5, K. Shiratori gives detailed results of the investigation of the radioactivity of hot-springs in the west of Honsyu, carried out in the summer of 1925, and compares his figures with those obtained by Ishizu, made in 1913–14. In the interval, the radioactivity of six springs has increased, whilst that of four springs has decreased. An earthquake intervened in the interval.

SOUNDPROOF HOUSES.—Two recent papers of the Bureau of Standards (*Scientific Paper* 552 and *Technologic Paper* 337), by Mr. V. L. Chrisler, deal with the building construction problem of preventing sound from passing from one room to another in a tenement house. Each wall of a room acts as a diaphragm fixed at its edges, but capable of being moved backwards and forwards at its centre by sound waves which impinge on it. The stiffer and heavier it is the less its motion and the less the sound it transmits to the room on the other side. With a compound wall having an air space, the intervening air acts as an ineffective connexion between the two surfaces, so that little sound is propagated through the wall. If, however, the two surfaces are connected by studs, struts, or cross ties, the transmission is greatly increased, and this is found to be true to some extent of many of the fillers which are at present introduced into the air space as sound insulators. It is recommended that the two surfaces of the wall should not be tied together in any way, and that the weight of each should be carried by felt pads.

CONDUCTION THROUGH METALS.—In a communication from the Physikalisch-Technischen Reichsanstalt, published in the *Zeitschrift für Physik* (vol. 44, p. 615), E. Grüneisen and E. Goens have described some attempts to systematise the data on thermal conduction through metals of simple crystalline form, making use very largely of new values obtained by them for the conductivities between 0° C. and - 252° C. They have found that there is a linear relation between the reciprocal isothermal conductivities for heat and for electricity with different specimens of a substance, and suggest that the thermal conductivity is partly 'metallic' and partly 'non-metallic.' The former component satisfies the Wiedemann-Franz relation, and gives a value for Drude's constant which is close to that predicted from the theory of electrons, whilst the second component depends only on the temperature. The total resistance can be expressed in terms of the characteristic functions introduced into the theory of specific heats by Prof. Debye. Although many of their measurements were made both with single crystals and with ordinary test-pieces, it is still uncertain if the size of the individual grains in the latter is of any consequence.

THE ANNEALING OF COLD-ROLLED STEEL.—Edwards and Kuwada have studied the annealing of a mild steel subjected to varying degrees of reduction by cold-rolling. Their results are stated in a paper read at the Glasgow meeting of the Iron and Steel Institute. The temperature at which the hardness begins to be removed falls as the degree of cold work is increased and the rapidity of the removal increases at the same time. Around 500° C., just before softening sets in, there is a distinct tendency for the hardness to rise somewhat. The most effective range of temperature for softening the steel lies between 550° and 650° C. The curious fact was observed that on annealing at 650°-750° C. specimens which had been subjected to an intermediate amount of cold work, 11·6-19·5 per cent. reduction, become softer than either the original material or that which has been either more or less severely deformed.

SILICA GEL AS A MEDIUM FOR DRYING BLAST.—Whether dry blast in iron smelting is, or is not, economically useful may perhaps be still a matter of opinion. A paper dealing with the application of silica gel for this purpose, read at the Glasgow meeting of the Iron and Steel Institute, however, appears to carry the subject a good deal further from the purely technical point of view. The main features of the use of the material from the blast-furnace point of view are that at room temperatures it can adsorb up to at least 20 per cent. of its weight of water with almost perfect efficiency, and that by raising the temperature to about 600° F., this water can be driven off, leaving the re-activated gel ready for another cycle. It is not advisable to reduce the water content below about 5 per cent. and about 2 lb. of gel per cub. ft. of air to be treated a minute is required. A plant to deal with 35,000 cub. ft. of air a minute has been erected and run satisfactorily for the past year. It consists of six units, of which five are in operation, while the sixth is being re-activated, the normal period for this being about $1\frac{1}{2}$ hours. By reducing the moisture in the blast to about $1\frac{1}{2}$ grains per cub. ft., the output of the furnace has been considerably increased, with a distinct saving of fuel. The labour required is almost negligible, the power needed about 20 h.p., while the life of the gel appears to be long. Blast-furnace gas is used to supply the heat for the treatment of the gel, which, like the air needed for the combustion, is filtered before use. The dehydration of the blast can be carried much below the present figure if it be desired, and the figure of 0·1 grain of moisture a cub. ft. is mentioned.

THE CONSTITUTION OF GENTISIN.—The constitution of gentisin, first isolated from gentian root in 1821, has been definitely settled by the synthesis of the only possible alternative substance, which was found to have different properties from gentisin. Gentisin is the monomethyl ether of gentisein, which in turn is 1 : 3 : 7-trihydroxyxanthone. The work, by Shinoda, is described in the August number of the *Journal of the Chemical Society*.

SYNTHESIS OF TAURINE.—Taurine, 2-amino-ethylsulphonic acid, occurs in the tissues of various lower animals and in secretions of higher animals, where it is probably formed from the amino-acid, cystine. It has been synthesised by several methods, first by Kolbe in 1862, but these are unsatisfactory. Marvel, Bailey, and Sparberg, in the July number of the *Journal of the American Chemical Society*, show that a modification of a method proposed by Köhler in 1898 gives fairly satisfactory yields. It consists in treating 2-bromo-ethylsulphonic acid or its sodium salt with aqueous ammonia to give a mixture of taurine and sodium bromide, from which pure taurine is easily obtained by crystallisation from alcohol. Full experimental details are given in the paper.

Leipzig Meeting of the International Commission for the Exploration of the Upper Air.

DURING the week Aug. 28–Sept. 3, the ancient city of Leipzig was the scene of an exceptionally well-attended meeting of the International Commission for the Exploration of the Upper Air. Of the European countries, members of the Commission were present from Norway, Sweden, Denmark, Russia, Poland, Hungary, Austria, Germany, Holland, Great Britain, France, Spain, Italy, and Greece. Extra-European countries were represented by Dr. H. H. Kimball, of the Weather Bureau of the United States of America, and by Dr. Ooishi, the Director of the Aerological Observatory of Tateno, Japan. Sir Gilbert Walker, though no longer holding an official position, may perhaps be regarded as having established contact with India. Letters expressing regret for unavoidable absence were read at the opening meeting from various other members from over-seas.

The main business before the meeting was the consideration of a specimen volume containing the observations in the free atmosphere made on the international days of the year 1923 which the bureau of the Commission had been charged to prepare. The question of reviving the arrangements for publishing in collective form the data referring to the international days has been before meteorologists ever since the termination of the War, which had brought the old arrangement to an abrupt conclusion. It was discussed in detail at a meeting of the Commission held in Bergen in 1921, but it was found impossible to evolve a practical scheme or even to formulate the basis on which international contributions to the cost should be asked for. The matter dragged on until 1924, when it came before the Meteorological Section of the International Union of Geodesy and Geophysics. That body came forward with the suggestion that the preparation of a specimen volume containing one year's observations would afford the best means of furthering the enterprise on the principle *c'est le premier pas qui coûte*, and allocated from the funds at its disposal a sum of £500 for the purpose. That sum was afterwards increased by contributions from other sources and it became possible to take the work in hand. The general lines which the publication should follow were agreed upon at a meeting of the Commission held in London in April 1925, and the task of preparing it was entrusted to the president, Sir Napier Shaw, and secretaries.

The volume submitted at Leipzig represents the result of their labours. It is in four parts. Part 1 (p. 28), the introduction, sets out the *Règlement* approved by the Commission in London for the guidance of the editors. It enjoins the use of systematic units and the specification of geopotentials in place of the more usual geometric heights. This has rendered necessary conversion tables and some further explanation of the methods of applying the *règlement* adopted by the editor. The Introduction ends with a list of stations co-operating in the international investigation of the upper air during 1923 and 1924, with their co-ordinates and geopotentials, and also the local time corresponding with G.M.T.

Part 2 (p. 40) consists of an index of the data available for each international day, and a collection of synoptic charts showing for each of the days the distribution of pressure over the whole world. This is probably the first occasion on which charts have been published showing the distribution over both hemispheres. The information has in general been compiled from the daily weather reports of the various countries. For the northern hemisphere, thanks to the daily maps of the Pacific Ocean published in Japan, and the corresponding information available in the Meteorological Office for the Atlantic, representation by means of isobars has been possible over the greater part of the area. For the southern hemisphere, much of the information has been supplied specially. Representation by isobars is confined to the land areas; for the oceans it has only been possible to give individual readings representative of observations on islands or ships. The inclusion of world maps in a volume devoted to observations of the upper air is eloquent testimony that the study of the upper air has become truly international and world-wide in its scope. The maps form a standing challenge, on one hand to meteorologists in the regions remote from the areas directly controlled by the larger meteorological services to contribute their share to the common stock, and, on the other hand, to those working in the meteorologically more favoured regions to think in terms of world meteorology.

Part 3 (p. 148) sets out the data in tabular form. The British reader will note with satisfaction that in addition to the observations from British and Canadian stations, the Empire is represented by pilot balloon observations from Australia, Ceylon, South Africa, Samoa, and Hong Kong. The labour of presenting the very heterogeneous material submitted by the individual co-operators in the homogeneous form enjoined by the Commission's *règlement* has been very great, but the task once achieved, the volume forms an invitation to all to adopt the standard form in the primary tabulation of their meteorograms, whereby the task devolving on future editors would be much reduced. It is indeed a case of the first step being the most expensive, but it must of course be borne in mind that, as the years go by, the number of co-operators and the amount of material they will supply is bound to increase.

Part 4 (p. 20) consists of a collection of tephigrams, or entropy-temperature diagrams for the ascents of registering balloons.

Such was the specimen volume [1] submitted to the Commission. Its printing has been entrusted to the Cambridge University Press, which fact may be taken as a guarantee that the selection of types and printing leaves nothing to be desired. A considerable part of the time of the meeting was taken up in exploring the possibilities of making provision for the publication of similar volumes for future years. Such volumes might be regarded as complementary to the annual volumes of the *Réseau Mondial* published by the Meteorological Office, which gives a monthly résumé of surface conditions for the whole world. Ultimately it was decided that an appeal, signed by the past and present presidents of the Commission, Sir Napier Shaw, Prof. V. Bjerknes, and Dr. Hergesell, and by the president of the International Meteorological Committee, Dr. E. van Everdingen, should be circulated to all Meteorological Offices asking for annual contributions to the cost of the publication.

Considerable discussion arose on the question of the use of geopotential in preference to the more usual geometric height as the vertical co-ordinate. From the point of view of organisation, the question is one of considerable importance, for on it depends whether

[1] Copies may be obtained from the Secretary of the International Commission for the Exploration of the Upper Air, c/o The Royal Meteorological Society, 49 Cromwell Road, S.W.7. Price, £2.

observers, when tabulating the traces of their meteorographs, should evaluate the pressures, temperatures, etc., corresponding with specified geopotentials, or whether they should be asked to give corresponding values for specified heights. It is scarcely practical politics to call on them to undertake the labour of tabulating in both forms or to print both sets of results *in extenso*. The *règlement* approved in London in 1925 specified the meteorological values corresponding to the geopotentials 1000, 2000, 3000 . . . dynamic metres, but the editors of the specimen volume found themselves unable to comply with that instruction, as the data for 1923 had been submitted by the co-operators before the date of the London meeting and had been computed for steps of 1000 (geometric) metres. The corresponding evaluation for steps of 1000 dynamic metres can only be satisfactorily performed by reference to the original records, and the editors had perforce to give the data "aux hauteurs kilométriques définitives au lieu des niveaux géodynamiques." The Leipzig meeting reaffirmed the decision taken in London two years earlier, and it thus remains an instruction to the editors of future volumes to publish the values for specified geopotentials as soon as the material shall be available in that form, and an invitation to co-operating observers to reduce their observations in that manner. At the same time, there was a strong feeling that geometric height should not be entirely eliminated from the publication, and a small sub-commission was appointed to consider what modifications of detail could be made in the tables in order to give heights as well as geopotentials.

Among other matters of organisation which came before the Commission was the selection of the days for combined international ascents for future years. In this matter the Commission followed the programme drawn up at Bergen in 1921, but, in deference to a suggestion by Prof. Exner that the international ascents should be used so far as possible for the investigation of specified meteorological conditions, it was agreed that the president and the regional vice-presidents should not be expected to restrict to the 'international month' their choice of days on which special ascents are made in response to notice circulated by telegram or broadcast. October was specified as the international month for 1927 and March that for 1928.

Attention was also devoted to organising the arrangements for preparing and publishing the observations of pilot balloons for the twelve months commencing July 1, 1917, from the very close network of observing stations that existed during the War. This proposal had been remitted to the Commission by the International Meteorological Committee at its meeting in Vienna in 1926.

Though the greater part of the time of the meeting was taken up with the discussion of questions of organisation, time was found at the afternoon meetings to bring forward a number of purely scientific questions and to receive reports of progress in various branches of upper air work. Summaries of these will be published in due course as appendices to the official report of the meeting.

At the penultimate meeting, the Commission was called upon to make choice of a new president, as Sir Napier Shaw had intimated his firm intention of vacating the arduous post which he has filled with such distinction for so many years. Upon the motion of M. Wehrlé, of the Office Nationale de France, Dr. Hergesell, the Director of the Lindenberg Observatory, was unanimously elected president. In proposing Dr. Hergesell, M. Wehrlé referred in a few well-chosen words to the eminent services which he had rendered to the study of the upper atmosphere during his tenure of the office of president during the years prior to the War. Sir Napier Shaw was invited to accept the position of honorary president. Dr. C. W. B. Normand, Director-General of Indian Observatories, was elected vice-president of Region D (India and Philippines) in succession to Mr. J. H. Field. Dr. Marvin remains vice-president of Region A (North America), and Dr. Th. Hesselberg (Oslo) and Mr. R. G. K. Lempfert will continue to act as secretaries of the Commission.

This account of the meeting would be incomplete without some reference to the cordial welcome extended to the Commission by the Saxon Government, the University and the Municipality of Leipzig, and by the authorities of the *Leipziger Messe*. The Minister for *Volkswirtschaft*, the Rektor of the University, and the Mayor of Leipzig attended the opening meeting to welcome the members of the Commission, at which Dr. Hergesell also spoke a few words of welcome on behalf of the authorities of the *Reich*. The Minister afterwards took the chair at an official dinner. The authorities of the *Messe* not only put their organisation for providing lodging ungrudgingly at the service of the Commission, but also invited the members to pay an official visit to the technical section of the Fair. The Municipality entertained the members at a special performance at the Opera. Last, but not least, all who attended the meeting will feel that they owe a special debt of gratitude to Prof. L. Weickmann, the Director of the Geophysical Institute of the University, in which building the meetings were held, for the excellent arrangements made for their comfort. Nothing could have exceeded the care with which Dr. Weickmann and his staff had thought out in advance all details which could contribute to the success of the meeting.

R. G. K. L.

Grouse Disease in Norway.[1]

We have recently received a memoir by Prof. August Brinkmann on coccidiosis in the willow grouse (*Lagopus lagopus*) which forms communication No. 16 of the comprehensive investigation on the biology of this bird undertaken by the Bergen Shooting and Fishing Society. The object of this investigation, which is on similar lines to that of the British Grouse Commission, is to inquire into the causes of the fluctuation in the stock of willow grouse.

Prof. Brinkmann found that the development in the willow grouse of *Eimeria avium*, the causal organism of coccidiosis, agrees in general with the account given by Prof. Fantham of its development in grouse. It differs from the *Eimeria avium* of domestic fowls and turkeys in that the large sub-epithelial cysts with their numerous merozoites found in these birds are not present in the willow grouse. Oocysts from the willow grouse are on the average larger than those from the fowl, and they are shorter but broader than those from the grouse; their size and shape, though their variations overlap those from other birds, stamp them nevertheless as a particular type, supporting Vervey's view that *Eimeria avium* is to be found in various birds as phenotypes more or less different in form.

Examination of the willow grouse shows that the jejunum was most generally infected and that the duodenum was also frequently infected. In both these parts of the intestine the whole life-cycle of

[1] *Bergens Museums Aarbok*, 1926, Naturv. raekke, No. 9 (1927).

Eimeria takes place; the duodenum does not appear to be, as in the grouse, the special site of schizogony. The cæcum may be full of oocysts, but its epithelium is always free from the intracellular stages.

In the willow grouse coccidiosis is especially a disease of young birds—75 per cent. of those examined were infected. It is also common in the adult birds, 49 per cent. being found infected, but the infection is much more severe in the young birds. The number of parasites present in severe cases has been estimated to be several millions.

The course of the infection is similar to that in grouse; if the young bird survives the acute stage, the disease passes into a chronic stage, during which oocysts are produced, though in meagre numbers, for a protracted period. Severely infected birds fly little if at all when they are flushed, nor do they try to hide themselves, but remain sitting in quite open ground and can easily be taken with the hand.

In a concluding chapter, Prof. Brinkmann points out that investigations in Norway during the last ten to fifteen years show that neither migrations, meteorological conditions, nor the toll taken by beasts of prey and by man can be considered as having had any decisive influence on the increase or decrease of the stock, but that the decrease must be due to the epizootics by which the stock has been ravaged from time to time. The only known epizootics of the willow grouse are those due to coccidiosis, for hitherto the presence of *Trichostrongylus pergracilis*, the nematode worm which causes great mortality among adult grouse, has not been proved. Moreover, the known facts indicate that it is the disease in the young willow grouse which decimates the stock, and that improvement in the stock is correlated with a decrease in the disease.

In the fluctuations in the stock of willow grouse until the 'nineties, the intervals between the good years were of fairly short duration—a few years only —but the last bad period has extended from the year 1912–13 to the year 1925–26, which suggests that some new factor is exerting an influence. Prof. Brinkmann considers this new factor to be the heavy toll which has been taken of the Norwegian birds of prey. He regards as proved that birds of prey have a favourable effect on the stock of birds, as they take more of the sick than of the healthy birds. One result of the decimation of birds of prey was an enormous increase in the stock of willow grouse which culminated in 1911. But as no attempt was made to preserve the stock by having gamekeepers to collect sick and dead game and to cleanse infected areas by burning the heather—which would have been impossible under Norwegian conditions—the result was a complete collapse of the stock. This was due to a violent epizootic (coccidiosis) which, because the coveys lay very close together in the summer, had exceptionally favourable conditions for development. The epizootic has continued year after year, and it was not checked until the stock had become much reduced. The coveys then lay so far apart during the breeding season that the risk of infection was considerably diminished.

Coccidiosis appears to be endemic almost wherever grouse are found; Prof. Brinkmann states that he has proved its occurrence in Iceland and Spitsbergen. Vervey's view that coccidiosis in different kinds of birds is due to a series of phenotypes of the same parasite, *Eimeria avium*, which can be transferred from one species of bird to another, is in accord with the Norwegian observations that there was coccidiosis simultaneously among willow grouse, ptarmigan, black game, and capercailzie, and that at the time when the epizootic was at its height the small birds also disappeared in various places. On these grounds, Prof. Brinkmann concludes that it would be impossible to exterminate *Eimeria avium*. He recommends less destruction of the birds of prey so as to endeavour to return to the conditions before the 'nineties, when, though there were fluctuations in the stock of willow grouse as great as they are now, the bad periods were of shorter duration.

Sex-change in the Oyster.

A LONG and fully documented paper by Dr. J. H. Orton (*Jour. Marine Biol. Assoc.*, **14**, 4, May 1927, pp. 967-1045) forms Part I. of an account of the observations and experiments which he has been carrying out for some years past on sex-change in *Ostrea edulis*; it deals with the change from female to male. The sex-physiology of the oyster well merits elaborate study, and Dr. Orton has been successful in clearing up many debatable points and giving a coherent account of the curious phenomena involved.

The material examined by Dr. Orton has been extensive; more than 1000 female-functioning oysters at about the time of spawning and at intervals thereafter have been closely examined for the purposes of this part of the work. While a number of undoubted hermaphrodites exist, and some curious inter-sexual types, Dr. Orton confirms the view of Hoek and Möbius that the oyster is bisexual. But alternation of sex is the rule. The data clearly show that, except for a small percentage of abnormal individuals, all female oysters normally change their sex immediately after spawning and develop ripe sperm before their larvæ are set free in the water. Functional maleness continues as a rule for one or two months, when the gonad becomes quiescent; after this period a proportion revert to the female condition and produce eggs. There is reason to suppose that a regular, probably annual, alternation of sex occurs normally.

As to the cause of this swift change over from female to male, Dr. Orton suggests that it is due to a metabolic rhythm characteristic of the species, whereby the type of metabolism—perhaps predominantly a protein metabolism—associated with femaleness changes over to the type associated with maleness—perhaps a carbohydrate metabolism. The hypothesis is advanced that the accumulation of unusable products of the one kind of metabolism is the stimulus for the change over to the other.

Dr. Orton's observations on sex-change in the oyster have led him to discuss in a short but suggestive paper (*loc. cit.*, pp. 1047-55) the fundamentals of a theory of sex-determination. The sex-chromosome theory clearly breaks down in cases of regular alternation of sex, and Orton proposes in its stead a metabolic theory of sex. He suggests that the X- and Y-chromosomes when present have the function of superimposing upon the general metabolism of the species a metabolism of a particular type to which the gonad responds by producing eggs or sperm. But the same sex-modification of metabolism may be brought about by other means than the sex-chromosomes, as by some fundamental change in the rhythm of metabolism related to the conditions of life.

The attempt at a physiological interpretation of sex and of the action of the sex-chromosomes is of course not new, but there is little doubt that such attempts are in the right direction. Dr. Orton's contribution, both of fact and of interpretation, to this difficult problem merits close attention.

Competition and Economic Equilibrium.

PROF. J. SCHUMPETER, a distinguished German economist of the University of Bonn, contributed an interesting paper on "The Instability of our Economic System" to the proceedings of Section F (Economic Science and Statistics) of the British Association at the recent meeting in Leeds. Propounding the question "In what sense can the present economic system of capitalist production and distribution be said to contain possible causes of instability?" Prof. Schumpeter said that by the phrase 'capitalistic system' he understood an economic order characterised by: (1) Private property and private initiative; (2) division of labour or production for the market; and (3) credit creation by banks, which latter he considered an essential element of that system. Neglecting disturbances which might arise from without the economic sphere and would react on economic life, for example, reactions of a policy of deflation in certain circumstances, he showed that the capitalistic system is in itself economically stable, and would not show any tendency to outgrow the elements of which it consists, and would therefore last indefinitely if left to itself.

Prof. Schumpeter pointed out that, as has been demonstrated by the economic analysis of which the late Dr. Marshall is the greatest exponent, there is to be found under competitive conditions a stable equilibrium of the economic process, to which in given circumstances real life tends to conform. This theorem, it has to be admitted, is not accepted by the 'man in the street,' who, on the contrary, is in the habit of attributing all sorts of instability to competition, though this he usually does under misapprehension. But though competitive conditions prevailed during the nineteenth century with sufficient approximation to theoretical hypotheses, Prof. Schumpeter pointed out that they certainly do not prevail at the present time, and it is therefore necessary to prove a similar proposition in the case where monopoly is the rule among various industries. This is not so easy a task, and there are many economic authorities who do not admit that a stable equilibrium of economic life can exist in this case. Nevertheless, such equilibrium can be shown to exist. It can also be proved that the increase of population is never by itself a cause of economic instability.

Prof. Schumpeter next went on to explain that there remains the fact that the business cycle destroys the state of equilibrium, which may have established itself. The business cycle cannot be accounted for by outside impulses such as harvests, wars, and so on, but is, on the contrary, the necessary form which economic evolution takes under capitalistic conditions. But although every boom destroys an equilibrium, every depression tends to establish a new one, and there is nothing in these recurring waves of prosperity and depression to affect the capitalistic system as such, nor are extensions and contractions of banking credit causes of instability.

Economic stability, however, Prof. Schumpeter stated, does not imply or guarantee political or social stability, and a position of stable economic equilibrium may be socially or politically unstable. For a variety of reasons the political and social circumstances of our time are in fact unstable in the highest degree. By its own working the capitalistic system evolves a mentality and a way of arranging life and looking at life which is bound to undermine what are regarded as indispensable psychological bases of capitalistic society.

Our modern attitude towards taxation, inheritance, home life, etc., which attitude is not dependant on economic necessities, are illustrations of the development of this psychological process. The capitalistic system provokes discussion, and discussion is the beginning of all revolutions. When psychological reactions have proceeded far enough they may exert a destructive effect on the system itself by removing the motives which have been the mainsprings of that system. People may get into a mental attitude in which they would do away with the economic system without any economic pressure and even against economic interests. If the capitalist system passed away in that fashion many other things would necessarily die, including even, as a possibility, family life as we now know it.

University and Educational Intelligence.

ST. ANDREWS.—At the autumn graduation ceremony on Friday, Oct. 7, the Vice-Chancellor, Sir James Irvine, announced that the donor of the gift of £100,000 to the University was Dr. E. S. Harkness, of New York, well known on both sides of the Atlantic for his generosity in the cause of education. More than one-fourth of the gift was allocated by the donor towards the cost of building a new residential hall for men students. The intention is to restore the old collegiate system which was a feature of university life until a century ago. The honorary degree of LL.D. was conferred upon Prof. John Burnet, who has just retired from the Chair of Greek in the University; Sir Richard Gregory; Dr. Knud Rasmussen, Copenhagen, the Arctic explorer; and Mr. Benjamin Thomson, Rector of Forfar Academy.

CO-OPERATION between universities and industrial and commercial firms is increasingly close and effective in the United States and is being systematically fostered by the American Council on Education. Remarkable progress has been made in developing ways and means of securing for educational institutions suitable kinds of trustworthy occupational information. Large industrial organisations have co-operated in the task of formulating detailed specifications of the work required to be done by the various classes of persons employed by them, and these 'job specifications,' as they are called, have been proved to be of great value both to schools and colleges and to the employers. The following description of methods of co-operation between the Yale University Bureau of Appointments and the industrial organisations with which it is in touch is based on an article published in the April number of *The Educational Record*. The Bureau is in touch through its bulletins with about 1200 firms, and almost daily from early in March until late in May, representatives of one or more firms, frequently one of the chief executives, attend at the Bureau to interview undergraduates in their final year. Even where the interviews do not lead directly to appointments they are useful to the undergraduates, for in most cases the firm's representatives are glad to give general vocational advice and talk freely and helpfully even with candidates who are not so much interested in the particular company represented as in obtaining specific occupational data, which is, in fact, regarded by many as the most valuable advantage of the scheme. When applying for interview dates—and many more apply than can be accommodated—the firms furnish an outline of the positions to be filled, salaries offered, nature of work, etc., which enables the undergraduates to judge which representatives they wish to see.

Calendar of Discovery and Invention.

October 16, 1759.—The building of Smeaton's Eddystone lighthouse occupied the summers of 1756–1759, and the light was first exhibited on Oct. 16, 1759. The lighting apparatus consisted of 24 candles held in a bronze frame.

October 16, 1843.—The name of Hamilton is now chiefly associated with the memorable invention of the calculus of quaternions, of which Hamilton wrote in 1858 to the Rev. J. W. Stubbs: "To-morrow will be the fifteenth birthday of the Quaternions. They started into life full-grown on the 16th October 1843, as I was walking with Lady Hamilton to Dublin, and came up to Brougham Bridge—which my boys have since called Quaternion Bridge. I pulled out a pocket-book which still exists, and made entry, on which at the very moment I felt that it might be worth my while to expend the labour of at least ten or fifteen years to come." In another letter, written some years afterwards, Hamilton said: "Nor could I resist the impulse—unphilosophical as it may have been—to cut with a knife on a stone of Brougham Bridge, as we passed it, the fundamental formula which contains the Solution of the Problem."

October 17, 1741.—On this day Linnæus, who had himself travelled in Lapland, Denmark, Germany, Holland, France, and England, pronounced before the University of Upsala his "Oratio de Peregrinationum intra Patriam necessitate." He displayed the usefulness of such excursions, by pointing out to the students that vast field of objects which their country held out to their cultivation; whether in geography, physics, mineralogy, botany, zoology, or economics; showing the benefit that must accrue to themselves and their country as rewards of their diligence.

October 18, 1892.—In the development of long distance telephony in America, Theodore Vail played a leading part. He first connected Boston with Salem, then Boston with New York, and on Oct. 18, 1892, New York was connected with Chicago, Graham Bell being the first to speak over the new line.

October 20, 1868.—Sir Norman Lockyer's notable spectroscopic discoveries were made known to the Royal Society in a letter dated Oct. 20, 1868, in which he stated: "I have this morning perfectly succeeded in obtaining and observing part of the spectrum of a solar prominence. As a result I have established the existence of three bright lines in the following positions:—(i) Absolutely coincident with C. (ii) Nearly coincident with F. (iii) near D."

October 20, 1880.—The first public lighting of a hall in Great Britain by means of the incandescent electric lamp was carried out by Swan on Oct. 20, 1880, in the rooms of the Literary and Philosophical Society of Newcastle.

October 21, 1824.—The home of the portland cement industry was Leeds, where Joseph Aspdin, a stonemason, discovered that by mixing finely pulverised lime with clay in certain proportions, burning it at a high temperature, and then grinding the product to powder, he obtained a new building material which, with the addition of water, when set, produced a block resembling Portland stone. He took out a patent for his invention of 'Portland cement' on Oct. 21, 1824. A century later a memorial to him was placed in Leeds Town Hall, when it was stated that the annual production of portland cement was 50,000,000 tons.

October 22, 1797.—The use of the parachute as a means of descending from balloons was due to the French aeronaut, Garnerin, who made his first descent with one on Oct. 22, 1797.

E. C. S.

Societies and Academies.

CAPE TOWN.

Royal Society of South Africa, Aug. 17.—**A. J. Hesse**: Some new species of Curculionidæ from South Africa and South-West Africa. The total number of Hipporrhinus species has been increased from 146 to 152. The genus Solenorrhinus, which up to now was composed of only 1 species, has been enriched by 2 other new species, one of which is found on the Silver-leaf trees on Signal Hill. Two of the Curculionidæ described are found in such widely separated areas as Zululand and South-West Africa and Transvaal and South-West Africa.—**P. R. v. d. R. Copeman**: Studies in the growth of grapes, Part 4: The initial changes in acidity. During the initial stages of growth of the berry, the changes in acidity of the juice are autocatalytic.—**F. Dixey**: The Dinosaur Beds of Lake Nyasa. A series of sediments occurring along the north-western shores of Lake Nyasa have yielded a number of interesting Dinosaur remains which are allied to the better-known deposits of Tendaguru. The beds consist principally of a great thickness of friable sandstones, sandy marls, and clays. They lie unconformably on older rocks which are affected by post-Karroo faults; and are themselves faulted and overlain by more recent deposits of the Nyasa trough.—**S. H. Haughton**: On some reptilian remains from the Dinosaur Beds of Lake Nyasa. It has been possible to identify two forms specifically; and many other bones can definitely be assigned to the Sauropoda. The forms named are *Platycheloides nyasæ* gen. et. sp. n., the first recorded African Mesozoic testudinate, and *Gigantosaurus dixeyi* sp. n., a sauropod allied to a form described from Tendaguru.—**D. Thoday** and **M. A. Pocock**: On a Myosurus from South Africa, with some notes on *Marsilia macrocarpa*. The discovery is recorded of a species of Myosurus, a genus new to South Africa. It is identified provisionally, in the absence of material with ripe achenes, as *Myosurus Minimus*.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, Vol. 13, No. 8, August).—**Carl H. Eigenmann** and **George S. Myers**: A new genus of Brazilian characin fishes allied to Bivibranchia.—**E. F. B. Fries**: Nervous control of xanthophore changes in Fundulus. The killifish changes in colour to correspond with its background by means of the expansion and contraction of melanophores and xanthophores. Control of the latter is mainly through a discriminating pigment-motor centre in the central nervous system.—**Selig Hecht**: A quantitative basis for the relation between visual acuity and illumination. Koenig found that visual acuity increases nearly as the logarithm of the intensity of illumination; hence the number of rods and cones in the retina can be varied functionally. This can be accounted for quantitatively by assuming that the sensibilities of the individual rods and cones vary about a mean in a manner similar to that in which a population varies. At the lowest intensities, vision is by the rods; then the cones begin to function, and since they come into action ten times as fast as the rods, visual acuity becomes a function of the foveal cones and increases to a maximum. Observations on colour-blindness can also be explained.—**David White**: The flora of the Hermit Shale in the Grand Canyon, Arizona. This shale constitutes the upper 300 ft. of the red beds in the Grand Canyon and is of Lower Permian age. The flora includes European conifers and pteridosperms and many Uralo-Asiatic forms; it indicates a dry climate possibly not much more humid that that of northern New Mexico at the present day.—William H. Gates: Linkage of short ear and density in the house mouse. Linkage appears to be complete.—Willard J. Fisher: Note on corrections to H. A. Newton's "1850 dates" of meteor showers.—Carl Barus: Reciprocating acoustic vibration on opposite sides of the pinhole, in long quill tubes.—Walter A. MacNair and A. Ellett: Explanation of the incomplete polarisation of mercury resonance radiation.—E. C. Watson: The space-distribution of the photo-electrons ejected by X-rays. Using unpolarised X-rays, the distribution of electrons about the direction of the X-ray beam has a maximum a little forward of perpendicular to the X-ray beam and falls to zero at about 90° on each side of the maximum; it is asymmetrical, particularly with high frequency X-rays. Using polarised X-rays, the distribution has a maximum in the direction of the electric vector and does not fall to zero at 90° from this direction; it is symmetrical, but the maximum is less than in the former case. The theory of nuclear scattering explains these effects.—Earl E. Libman: Surface tension of molten metals. (1) Copper. The method used is to measure the depression of surface caused by a vertical plate and a vertical tube which are not wetted by the liquid. Copper is melted in a high vacuum molybdenum wound furnace in a crucible with lid combining a plate and a tube. An X-ray photograph is taken through the entire furnace and the levels of the liquid measured on the photograph. The 'capillary constant' (2 × surface tension/density × g) for copper in contact with its vapour varies from $0{\cdot}308 \pm 0{\cdot}0017$ at 1083° to $0{\cdot}297 \pm 0{\cdot}0017$ at 1318°. The effect of impurities increases with rise of temperature.—A. Keith Brewer: The relation between temperature and work function in thermionic emission. Gas molecules approaching a surface are dissociated into ions by forces regarded as composed of an electrostatic image force, which has the same effect on both ions, and an intrinsic force, which holds one ion more firmly than the other. These forces are opposed by the kinetic energy of agitation. Hence as the temperature rises, the more lightly held ion escapes first. For pure metal surfaces, positive ions escape first; for oxidised surfaces, the negative ions are released first.—F. A. Saunders: On the spectrum of argon in the extreme ultra-violet.—P. R. Heyl: A redetermination of the Newtonian constant of gravitation (see NATURE, Oct. 8, p. 529).—Jesse Douglas: Contact transformations of three-space which convert a system of paths into a system of paths.—M. S. Knebelman: Motion and collineations in general space.—G. A. Miller: Felix Klein and the history of modern mathematics.—S. Lefschetz: The residual set of a complex on a manifold and related questions.—Gilbert N. Lewis and Joseph F. Mayer: A disproof of the radiation theory of chemical activation. Pinene was passed at very low pressure through a quartz tube heated by platinum spirals to about 1000° K. At the pressure used there was negligible screening of one molecule by another and a negligible number of collisions because the mean free path was longer than the gas stream. Under these conditions, energy sufficient for about 10 per cent. racemisation is available but no racemisation was detected.—James H. Hibben: Radiation and collision in gaseous chemical reactions. Nitrous oxide and ozone were submitted to infra-red radiation at different pressures; no increase of reaction velocity was observed. The bimolecular decomposition of nitrous oxide at low pressure is entirely heterogeneous. There is no change in the reaction rate of the unimolecular decomposition of nitrogen pentoxide at pressures of $0{\cdot}2$–$0{\cdot}002$ mm. of mercury.—H. L. Shapiro: Note on a correction formula for artificially deformed crania.

Official Publications Received.

BRITISH.

Publications of the Dominion Astrophysical Observatory, Victoria. Vol. 3, No. 18: The Orbits of Two Spectroscopic Binaries. By S. N. Hill. Pp. 349-363. Vol. 4, No. 1: Three Peculiar Spectra. By J. S. Plaskett. Pp. 26+3 plates. Vol. 4, No. 2: Three Long-Period Spectroscopic Binary Stars. By Reynold K. Young. Pp. 27-38. (Ottawa: F. A. Acland.)

Report of the Government Chemist upon the Work of the Government Laboratory for the Year ending 31st March 1927. Pp. 42. (London: H.M. Stationery Office.) 1*s.* 3*d.* net.

Journal of the Manchester Egyptian and Oriental Society. No. 13. Pp. 67. (Manchester: At the University Press; London: Longmans, Green and Co., Ltd.) 7*s.* 6*d.*

Journal of the Chemical Society: containing Papers communicated to the Society. September. Pp. x+vi+2023-2388. (London: Gurney and Jackson.)

Animal Breeding Research Department, The University, Edinburgh. Report of the Director for the Year April 1st 1926 to March 31st 1927 (being the 7th Annual Report). Pp. 40. (Edinburgh.)

The Half-Yearly Journal of the Mysore University. Vol. 1, No. 2, July. Pp. 93-196. (Bangalore: Bangalore Press.) 2 rupees.

Transactions of the Royal Society of Edinburgh. Vol. 55, Part 2, No. 18: Jurassic and Eocene Echinoidea from Somaliland. By Dr. Ethel D. Currie. Pp. 411-441+1 plate. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 4*s.*

Agricultural Research Institute, Pusa. Bulletin No. 166: Sampling for Rice Yield in Bihar and Orissa. By J. A. Hubback. Pp. 23. 7 annas; 8*d.* Bulletin No. 167: A Scheme of Classification of the Varieties of Rice found in Burma. By R. A. Beale. Pp. 14+4 plates. 6 annas; 8*d.* (Calcutta: Government of India Central Publication Branch.)

Gramophone Records of the Languages and Dialects of the Madras Presidency: Text of Passages. Pp. vi+124. (Madras: Government Press.) 1.4 rupees.

The Edinburgh and East of Scotland College of Agriculture. Calendar for 1927–1928. Pp. 96. (Edinburgh.)

Union of South Africa. Department of Mines and Industries: Geological Survey. The Geology of the North-Eastern Part of the Springbok Flats and surrounding Country. An Explanation of Sheet 17 (Springbok Flats). By Dr. Percy A. Wagner. Pp. 104. 2*s.* 6*d.* Sheet 17: Springbok Flats. 2*s.* 6*d.* (Pretoria: Government Printing and Stationery Office.)

FOREIGN.

Department of the Interior: U.S. Geological Survey. Bulletin 792-A: Mineral Industry of Alaska in 1925 and Administrative Report. By Fred H. Moffit. (Mineral Resources of Alaska, 1925-A.) Pp. ii+49+xiii. Bulletin 792-B: Geology of the Knik-Matanuska District, Alaska. By Kenneth K. Landes. (Mineral Resources of Alaska, 1925-B.) Pp. ii+51-72+1 plate. Bulletin 795-A: Manganese-bearing Deposits near Lake Crescent and Humptulips, Washington. By J. T. Pardee. (Contributions to Economic Geology, 1927, Part 1.) Pp. ii+24+2 plates. 10 cents. Bulletin 795-B: Potash Brines in the Great Salt Lake Desert, Utah. By Thomas B. Nolan. (Contributions to Economic Geology, 1927, Part 1.) Pp. ii+25-44+1 plate. 10 cents. Bulletin 795-C: Organic Precipitation of Metallic Copper. By T. S. Lovering. (Contributions to Economic Geology, 1927, Part 1.) Pp. ii+45-52. 5 cents. (Washington, D.C.: Government Printing Office.)

Department of the Interior: U.S. Geological Survey. Professional Paper 148: Geology and Ore Deposits of the Leadville Mining District, Colorado. By S. F. Emmons, J. D. Irving and G. F. Loughlin. Pp. xvi+368+70 plates. (Washington, D.C.: Government Printing Office.) 2.50 dollars.

Smithsonian Institution: United States National Museum. Bulletin 140: Bird Parasites of the Nematode Suborders Strongylata, Ascaridata and Spirurata. By Eloise B. Cram. Pp. xvii+465. (Washington, D.C.: Government Printing Office.) 85 cents.

Smithsonian Miscellaneous Collections. Vol. 80, No. 3: Fossil Footprints from the Grand Canyon. By Charles M. Gilmore. Second Contribution. (Publication 2917.) Pp. ii+78+21 plates. (Washington, D.C.: Smithsonian Institution.)

Mededeelingen van het Geologisch Instituut der Landbouwhoogeschool, Wageningen (Holland). No. 10: Bijdrage tot de kennis van Pseudo-Gaylussiet. Door Prof. J. van Baren. Pp. 25+8 afb. (Wageningen: H. Veenman en Zonen.)

Reprint and Circular Series of the National Research Council. No. 78: Fifth Report of the Committee on Contact Catalysis. By E. Emmet Reid, in collaboration with other Members of the Committee. Pp. 31. 50 cents. No. 79: Third Census of Graduate Research Students in Chemistry. By Clarence J. West and Callie Hull. Pp. 3. (Washington, D.C.: National Academy of Sciences.)

Diary of Societies.

SATURDAY, OCTOBER 15.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Newcastle-upon-Tyne), at 2.30.—M. Ford: Presidential Inaugural Address.—H. T. Foster: Notes on an Inrush of Water at the Montagu Colliery, Scotswood, Northumberland, on March 30th, 1925.—The following paper will be open for further discussion:—The Dry Cleaning of Coal, by J. S. Carson.

PHYSIOLOGICAL SOCIETY (in Physiological Laboratory, Guy's Hospital Medical School), at 3.30.—L. F. Hewitt and H. Florey: Effect of Drugs on Protein Content of Cerebro-Spinal Fluid of Rabbits.—H. Florey and H. M. Marvin: The Blood Pressure Reflexes of the Rabbit under Urethane Anæsthesia.—R. S. Aitken and A. E. Clark-Kennedy: The Concentration of CO_2 in Successive Portions of an Expired Breath.—Dr. J. H. Burn and H. W. Ling: The Effect of Pituitary Extract, Adrenalin, and Insulin on the Ketonuria produced in Rats by a Fat Diet.—W. Marshall: The Preparation of Oxyhæmoglobin Crystals.—N. E. Pitt: The Influence of Ether Anæsthesia upon the Gaseous Composition of the Blood.—E. T. Conybeare, H. B. A. R. Densham, M. Maizels, and M. S. Pembrey: Observations upon the Respiratory Exchange, Temperature, and Sugar in the Blood of Anæsthetised Animals.—A. C. Hampson and M. Maizels: The Permeability of Red Cells.—R. A. Collier, H. B. A. R. Densham, and H. M. Wells: The Reaction of the Skin Vessels in Man during Over-Ventilation.—Prof. J. Mellanby: Petroleum Emulsion in the Small Intestine.—Demonstrations:—Dr. W. Cramer: The Adrenals of a Mouse with Exophthalmic Goitre.—Prof. J. Barcroft: Some Observations on the Denervated Spleen.

MONDAY, OCTOBER 17.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Prof. P. Bruynoghe: The Twort-d'Herelle Phenomenon, and some New Research on Relapsing Fever (Harben Lectures). Also on October 18 and 20.

RAILWAY CLUB (25 Tothill Street, S.W.), at 7.30.—R. G. de Bray: Outdoor Interlocking Apparatus.

INSTITUTION OF THE RUBBER INDUSTRY (Sales Section) (at Engineers' Club, Coventry Street, W.1).—H. Hadley: What Advertising-Salesmanship can do for the Rubber Industry.

TUESDAY, OCTOBER 18.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 4.—Sir William Hale-White: Harveian Oration.

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

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Secretary: Report on the Additions to the Society's Menagerie during the months of June, July, August, and September 1927.—C. H. Donald: Some Indian Birds of Prey.—Dr. H. H. Scott: Double Malignant Tumour of Thyroid and Parathyroid in an Otter (*Lutra lutra*).—R. Essex: Studies in Reptilian Degeneration.—J. W. Low: Contributions to the Development of the Pelvic Girdle. II. The Pelvic Girdle in the Batrachian *Hynobius nebulosus* s. *Ellipsoglossa nebulosa* Dum et Bibr.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—F. F. Renwick: Presidential Address.

INSTITUTION OF AUTOMOBILE ENGINEERS (Wolverhampton Centre) (at Engineering and Scientific Club, Wolverhampton), at 7.30.—Major E. G. Beaumont: The Influence of the Automobile User upon the Automobile Engineer (Presidential Address).

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.—A. J. T. Taylor: The Industrial Engineer.—W. S. Murphy: British Engineering Export Problems.

ROYAL SOCIETY OF MEDICINE (Pathology Section), at 8.30.—J. McIntosh: The Histology of Some Virus Infections of the Central Nervous System.—Dr. R. J. Ludford: The Repair of Superficial Skin Lesions in the Mouse.—Dr. W. Cramer: Stomach Lesions in Rats kept on a Diet Deficient in Vitamin A.

WEDNESDAY, OCTOBER 19.

SOCIETY OF GLASS TECHNOLOGY (in Applied Science Department, University, Sheffield), at 2.30.—W. Butterworth, sen.: Presidential Introductory Address.—J. F. Hyslop: Opal Glass—Crystal Growth and Impact Brittleness. (A Communication from the Research Laboratories of the General Electric Co., Ltd., Wembley.)—F. Buckley: The Birmingham Glass Trade 1740–1833.—E. J. C. Bowmaker and J. D. Cauwood: The Detection of Selenium in Decolourised Bottle Glasses.

ELECTRICAL ASSOCIATION FOR WOMEN (at E.L.M.A. Lighting Service Bureau, 15 Savoy Street), at 3.—R. Borlase Matthews: Electricity and the Small Holding (Lecture).

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Prof. L. Cummins: Tuberculosis as a Social Disease.

EUGENICS SOCIETY (at Royal Society), at 5.30.—Dr. R. A. Fisher: Multiple Births in Man.

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (in Demonstration Room, Ground Floor, of Science Museum), at 5.30.—E. W. Anderson: The Development of the Organ.

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (jointly with the Chemical Engineering Group) (at Ca'doro Restaurant, Glasgow), at 7.—C. Scott Garrett and G. W. Riley: The Desiccation (De Vecchis) Process of Beet Sugar Manufacture.

ELECTRICAL ASSOCIATION FOR WOMEN (at E.L.M.A. Lighting Service Bureau, 15 Savoy Street), at 7.—Mrs. L. Hollis and others: Discussion on A Demonstrator's Experience of Electric Cooking.

MERSEYSIDE AQUARIUM SOCIETY (at 1 Falkland Road, Egremont), at 7.30.—Annual General Meeting.

INSTITUTE OF CHEMISTRY, at 8.—S. M. Gluckstein: Chemists and Dividends.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

ROYAL MICROSCOPICAL SOCIETY, at 8.—C. Beck: Note on Diatom Structure and Resolution.—Prof. H. G. Cannon and Dr. A. J. Grove: Aerating and Circulating Apparatus for Aquaria and General Use.—Dr. A. J. Grove: A Simply Made Hot Plate for Flattening Paraffin Sections.—Dr. O. Heimstadt: Stereoscopic Vision with the Microscope.—Prof. P. Vonwiller: Microscopy with Incident Light and its Application to Living Objects.—D. P. Wilson: Note on a Method of obtaining Long Working Distances wth Low Power Objectives.

THURSDAY, OCTOBER 20.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—A. Page: Presidential Inaugural Address.

THE INSTITUTE OF METALS (Birmingham Local Section) (Birmingham Metallurgical Society and Staffordshire Iron and Steel Institute) (at Engineers' Club, Birmingham), at 7.—Dr. F. W. Aston: Isotopes.

INSTITUTION OF MECHANICAL ENGINEERS (North-Western Branch) (at Engineers' Club, Manchester), at 7.15.—R. E. Bailey: The Mechanical Testing of Materials.

CHEMICAL SOCIETY, at 8.—Prof. T. M. Lowry and G. F. Smith: Studies of Dynamic Isomerism. Part XXIV. Neutral Salt Action in Mutarotation.—Prof. T. M. Lowry: Studies of Dynamic Isomerism. Part XXV. The Mechanism of Catalysis by Acids and Bases.—Prof. C. S. Gibson and J. D. A. Johnson: 10-Chloro-5:10-dihydrophenarsazine and its Derivatives. Part V. The General Method of Synthesis and Determination of Constitution.—E. J. B. Willey: On Active Nitrogen. Part IV. The Independence of the Afterglow and Chemical Properties of Active Nitrogen.

C.B.C. SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall, Strand), at 8.—Prof. J. S. Huxley: The Population Conference at Geneva (Lecture).

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, W.1), at 8.15.—Prof. J. W. W. Stephens: The Functions of the Spleen (Presidential Inaugural Address).

FRIDAY, OCTOBER 21.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration of Rheumatic and other Changes in Joints.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Sir Henry Fowler: Presidential Address.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Informal Meeting of Pictorial Group), at 7.—Discussion on Some Reasons for the Limited Appeal of Pictorial Photography.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—M. McCarthy: Piling in General with Special Reference to the Vibro Concrete Piling System.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Sir Henry Gauvain: Electro-Therapeutics and the Future of Medicine (Presidential Address); and short papers by Prof. Iselin, Dr. Dunham, and Dr. Gravesen.

INSTITUTE OF CHEMISTRY (Manchester and District Section and Manchester Section of Society of Dyers and Colourists) (at Manchester).—Prof. E. C. C. Baly: Light and Life (Lecture).

SATURDAY, OCTOBER 22.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Yorkshire District Meeting) (at the Mansion House, Doncaster), at 11 A.M.

PUBLIC LECTURES.

SATURDAY, OCTOBER 15.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Egyptian Temples.

MONDAY, OCTOBER 17.

BRITISH MEDICAL ASSOCIATION (Hastings Hall), Tavistock Square, at 5.15.—Dr. W. G. Savage: Food Poisoning (Malcolm Morris Memorial Lecture).

TUESDAY, OCTOBER 18.

UNIVERSITY COLLEGE, at 5.—A. J. Hall: The Static Reflexes of Magnus: How Animals get right-way-up and keep so.

WEDNESDAY, OCTOBER 19.

KING'S COLLEGE, at 5.30.—Dr. F. H. Spencer: The Public Elementary School.

LONDON SCHOOL OF ECONOMICS, at 6.—V. N. Guinness: Office Machinery: The Mignon Typograph and Cheque Protector.

SATURDAY, OCTOBER 22.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Mrs. H. M. Dunn: The Peoples of India.

CONGRESSES.

OCTOBER 14 AND 15.

PUBLIC CONFERENCE ON FAMILY ALLOWANCES (at London School of Economics).

Friday, October 14, at 8.—Sir William Beveridge: The Case for Family Allowances.—Dr. R. A. Fisher: Effects of Family Allowances on Population.

Saturday, October 15, at 2.30.—Prof. V. H. Mottram: The Physiological Basis of the Minimum Wage.

At 3.30.—J. L. Cohen: Family Income Insurance.

At 5.30.—H. N. Brailsford: The State and Family Allowances.

At 8.—Principal J. Murray: Family Allowances in Industry.

OCTOBER 16 TO 22.

CONGRESS OF INDUSTRIAL CHEMISTRY (at Paris).

OCTOBER 18 TO 23.

JORNADAS MÉDICAS DE MADRID (at Madrid).

OCTOBER 22 TO 24.

CONGRESS OF THE ITALIAN SOCIETY OF LARYNGOLOGY, RHINOLOGY, AND OTOLOGY (at Parma).

OCTOBER 23 TO 26.

ITALIAN CONGRESS FOR COMBATING TUBERCULOSIS (at Milan).

OCTOBER 24 TO 26.

ITALIAN CONGRESS OF INDUSTRIAL MEDICINE (at Parma, Modena, and Carpi).