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American and British Superannuation Systems.

THE fifteenth annual report of the president and of the treasurer of the Carnegie Foundation for the Advancement of Teaching provides some interesting reading, particularly with regard to the pension system in operation in the universities and colleges of the United States. The work of the Foundation falls into three parts: (1) the completion and liquidation of the old system of full-paid pensions; (2) the development of the contractual forms of insurance and of old-age annuities through the policies of the Teachers' Insurance and Annuity Association; and (3) the prosecution of significant studies and reports through the Division of Educational Inquiry. The last-named constitutes an important and active branch of the Foundation, with an income derived from the investment of a capital of one and a quarter million dollars. Its most recent inquiries relate to the subjects of legal education and the training of teachers. As a result, "A Study of the Training of Teachers for the Public Schools" has recently been published, and there is promised in the immediate future the first section of a "Study of Legal Education." Without doubt, such inquiries form an increasingly valuable feature of the work of the Foundation.

On the other hand, it is to be noted that the trustees administer a total sum of almost twenty-five million dollars, the income from which is at present mainly devoted to superannuation purposes. For the year ending June 30, 1920, the sum of 875,514 dollars was granted in retiring allowances to administrative officers and teachers or their widows in certain of the colleges and universities in America. As is well known, the gift was intended primarily to establish retiring allowances for teachers in the higher institutions of learning in the United States, Canada, and Newfoundland. The income was, however, quite insufficient to provide for all these, and at present the pension obligations of the Foundation are confined to some five or six thousand teachers and administrative officers who were in the service of institutions associated with the Carnegie Foundation on November 17, 1915. As the income is released, it will be devoted to the advancement of teaching in American colleges and universities.

With regard to the officers and teachers who do not participate in these pensions—the large majority—the trustees have promoted a contractual plan of old-age annuities, and some fifty pages of the report give an account of its progress and development. In brief, it is a contributory system of deferred annuities which will gradually supersede the previous non-contributory pension scheme. It is intended that the teacher should contribute 5 per cent. of his salary, and the institutions a like sum, the combined premium to be paid to the Teachers' Insurance and Annuity Association and to become the property of the association. In exchange the teacher will receive an annuity policy—a contract which guarantees that in case he dies before the stated age a sum equal to the premiums with interest will be paid to his dependents, and that in case he lives to the stated age a selected annuity of equivalent value will be paid. It will be observed that insurance is considered a responsibility of the teacher alone. The success of the scheme so far may be measured by the fact that the association, which began the issuing of contracts in March, 1919, had, by July, 1920, issued policies representing more than two and a half million dollars insurance, and also annuities representing the payment at maturity of nearly half a million dollars annually.

It is instructive to compare this scheme with the Federated Superannuation System of British universities. In the first place, some five or six thousand American teachers who were in service in the associated institutions before November 17, 1915, are well provided for by the Foundation by means of a non-contributory scheme for which there is no parallel in the British scheme. The nearest approach to this splendid provision is the recent Government grant of 500,000*l.*—a sum, however, which is less than half what is required to put the pensions of the senior members of the university staffs upon a satisfactory footing. In addition, the Carnegie Foundation will continue to provide retiring allowances on the same non-contributory basis to a certain number of old and distinguished teachers. Next, in the British system there is no specific provision for widows or orphans, nor is there provision for disability such as has been instituted by the Carnegie Foundation "for the teacher who, despite his own foresight and self-denial, finds himself and his family the victims of disease or of accident." The reserve accumulated to meet such claims is now 220,000 dollars.

Further, the American scheme is administered from within, as opposed to the Federated System, which is worked through insurance companies. In consequence, there is economy in administrative and other expenses. Insurance companies are not philanthropic institutions. Mr. Fisher, President of the Board of Education, on the second reading of the School Teachers (Superannuation) Bill, 1918, was aware of this when he stated that if the Act were worked through insurance companies there would be the objection that public money was going in dividends to the shareholders of these companies. This is precisely what is happening in the Federated Superannuation System to-day. The Teachers' Insurance and Annuity Association furnishes policies better suited to the teacher's needs, and at lower cost, than companies operating on a commercial basis.

The report contains a mass of interesting matter relating to pensions and pension schemes, including arguments, by no means convincing, in favour of contributory schemes as opposed to non-contributory.

Lord Rayleigh's Scientific Papers.

Scientific Papers. By Prof. John William Strutt. Vol. vi., 1911–19. Pp. xvi+718. (Cambridge: At the University Press, 1920.) 50*s.* net.

THE sixth[1] volume of Lord Rayleigh's collected works, just issued by the Cambridge University Press, contains his papers, nearly one hundred in number, published between 1911 and his death in 1919. In fact, the last two papers, Nos. 445 and 446, of the whole series were left ready for publication, but had not appeared when he died, while the concluding paragraphs of No. 444, on "The Travelling Cyclone," were dictated by him only five days before his death on June 30. He was happy in being able to continue his work until so near the end, and in his fifty years of active scientific life to achieve so much.

The papers in the volume range over a wide list of subjects, and while none of them have the importance of some of those appearing in earlier volumes—*e.g.* the series on the fundamental units of electrical measurements, or the publications describing his work on gases and the discovery of argon—they are marked, as ever, by his power of clear thinking, his grasp of first principles, and his ability to appreciate the essentials of any problem which appealed to him. Some three or four of the articles were contributed to the discussions of the Advisory Committee for Aeronautics, over which he presided for ten years. Among these may be specially mentioned No. 389, the note on the formula for the gradient wind, in which the formula connecting the velocity of the wind, the barometric pressure, the latitude, and the rotation of the earth, which had been employed by Gold and other meteorologists, is derived, assuming the motion in two dimensions, from hydrodynamical principles. The paper No. 444, already mentioned, on "The Travelling Cyclone," though not formally communicated to the Committee, arose out of its discussions.

There are also some notes and reviews communicated to NATURE, but most of the other articles appeared in the *Philosophical Magazine*. Hydrodynamics, optics, and acoustics form the subject-matter of many—problems of vibrations in the solution of which the methods developed in the theory of sound or in some of his earlier optical work are employed with success. Of recent years he returned to a number of optical problems which in earlier days had interested him, and advanced our knowledge by his work. Among these papers may be mentioned several on the scattering of light by small particles. The problem was discussed in the well-known paper on "The Blue of the Sky," published in 1871, and in 1918 Lord Rayleigh gave the complete solution for a sphere in which the structure is symmetrical, but periodically variable, along the radius, while a further paper—*Phil. Mag.*, vol. xxxv.—discussed the case of the scattering of light by a cloud of similar small particles of any shape oriented at random. He was led to investigate the question by the results of his eldest son's experiments on light scattered by carefully filtered gases.

[1] A notice of vol. v. appeared in NATURE for October 28, 1913. The other volumes were reviewed at an earlier date.

One of the papers communicated to the Advisory Committee for Aeronautics deals with the analogy between the conduction of heat from a surface and the transfer of momentum in a viscous fluid flowing over the surface. Lord Rayleigh shows that the analogy, which holds so long as the motion is laminar, breaks down when it becomes turbulent. A letter to Prof. Nernst, dated October, 1911, is of rather special interest, though there is nothing in the later pages of the volume to indicate whether or not Lord Rayleigh continued to hold the same opinion to the end. He is discussing some of the difficulties which attend the kinetic theory of gases, and writes:—

"Perhaps this failure might be invoked in support of the views of Planck and his school that the laws of dynamics (as hitherto understood) cannot be applied to the smallest parts of bodies. But I must confess that I do not like this solution of the puzzle. Of course, I have nothing to say against following out the consequences of the [quantum] theory of energy—a procedure which has already, in the hands of able men, led to some interesting conclusions. But I have a difficulty in accepting it as a picture of what actually takes place."

A paper in the *Philosophical Magazine* for 1919 of somewhat greater length than the majority of those in the present volume deals with the optical character of some brilliant animal colours. The question whether the colours displayed by various birds, by butterflies, and by beetles are structure colours more or less like those of thin plates or are due to surface or quasi-metallic reflection is discussed, and the conclusion reached by Lord Rayleigh is thus stated:—

"The impression left on my mind is that the phenomena cannot plausibly be explained as due to surface colour, which in my experience is always less saturated than the transmission colour, and that, on the other hand, the interference theory presents no particular difficulty unless it be that of finding sufficient room within the thickness of the cuticle."

In the paper a reference is made to the drawings and conclusions of the Hon. H. Onslow, some of which have since been published.

It is not necessary to add more, or to attempt to give a full account of the contents of the volume under review; there is interest to be found in every page, and throughout it is marked by the characteristics of Lord Rayleigh's writings. He is to be commemorated by a tablet and inscription in the Abbey; the six volumes of his collected works form his true memorial, built by himself, to live so long as there are students of physical science to read and learn the truths which they contain.

The volume has been edited by his son, the present Lord Rayleigh, with the help of Mr. W. F. Sedgwick. It is published by the Cambridge University Press in its usual admirable style, and concludes with a classified table of contents of the whole of the six volumes. The list, occupying some forty pages, shows in a remarkable way the extent of ground covered by Lord Rayleigh's contributions to physical science.

Studies of British Mammals.

Habits and Characters of British Wild Animals. By H. Mortimer Batten. Pp. 346. (London and Edinburgh: W. and R. Chambers, Ltd., 1920.) 21*s.* net.

THERE are several trustworthy and readily available books on British mammals, such as Lydekker's and Sir H. H. Johnston's, not to speak of the expensive volumes of Millais and others, but there is a distinctiveness in Mr. Mortimer Batten's studies which makes them welcome. They have a broad basis of personal observation, they give prominence to habits, and they try to get at the character of the creatures. The book is written in excellent style; it smacks of the open country, and it is packed with interesting information without being overloaded. The very artistic illustrations by Mr. Warwick Reynolds appeal to us as revealing the temperament of the animals portrayed and also as pictures, *e.g.* the charming coloured frontispiece of roe-deer jumping up at rowan berries.

Mr. Mortimer Batten deals with red deer, roe-deer, fox, weasel, stoat, otter, pine-marten, badger, polecat, brown hare, mountain hare, rabbit, hedgehog, squirrel, brown rat, water-vole, and wild cat. Without rigidly adhering to any scheme, he discusses range, feeding habits, breeding, struggle for existence, interrelations, general characteristics, size, weight, and last, not least, the disposition or character. We wish that, when he was at it, he had completed his survey of British mammals so that his excellent book might have been a comprehensive unity. A second edition should remedy this. We do not mean that there need be any treatment of the Orkney vole and that sort of thing, but we miss the little gentleman in the velvet coat; we should like to have seen the book representative of all the short list of British mammals. We must protest, of course, against the usage which calls this a book on British wild *animals*.

We have found Mr. Mortimer Batten's studies full of interest, and we have a lively appreciation of their originality and independence. Sometimes, we confess, his theoretical interpretations make us pause, *e.g.* the suggestion (after rejecting all others known to the author) that the biological significance of the stag's antlers is to divert the attention of enemies from the hinds. Sometimes we wish the author had been a little more bookish, for his remarks on the correlation between antlers and reproductive organs are far from being up to date. We are sorry that he has no contribution to make to our knowledge of the method of the ermine's assumption of its white dress, the precise mode of which seems still uncertain. Was Prof. MacGillivray right or Mr. Aplin, or were both right? Sometimes the author's generalisations pull us up with a start: "There is no logic in the ways of Nature." But we thought that Darwin proved there was! The fact is that Mr. Mortimer Batten is stronger on the side of natural history than on the side of biology. He rather scoffs at the protective value of the whiteness of the mountain hare in winter, but he does not mention the other utilitarian interpretation—in relation to body-temperature. He says of the common hare: "Wherein lies the secret of the hare's survival? In its fecundity, and there alone." Yet the preceding pages make it perfectly clear that this is not the case. Again, to take a more concrete point, it is surely in a metaphorical sense only that we can speak of the hedgehog's fat serving "as sustenance during the foodless days of sleep." It is interesting to notice that the author occupies a Lamarckian position as regards the mental endowment of the subjects of his studies:—"All these things the water-voles of to-day do not, probably, reason out for themselves; the knowledge of them has been inherited from countless generations of forefathers who, atom by atom, grain by grain, have profited by their experience, and, acting accordingly, have handed their lessons on to their children, thus establishing such life habits and customs of the species that we have to-day a water-vole that can hold its own." But we are afraid there is no plane-sailing for this theory.

We have often thought that great benefit might result to science if a field-naturalist like Mr. Mortimer Batten were to test biological theories in the light of the everyday life of the creatures he knows. If, however, this is to be of avail, the field-naturalist must first sit at the feet of the biologists, and he will not do this because they do not know a badger's track. Thus the possibilities of a mutually profitable partnership are lost. We must not forget, however, that this book was meant, not for biologists, but for ordinary folk interested in the country, especially for those who can understand and sympathise with the author's plea for the pine-marten. To such the book is strongly to be recommended. It is first-hand material, vividly presented, abounding in picturesque and essential detail, and making a resolute attempt to see each of these wild mammals as an individuality with a character and temperament of its own.

Forestry in France.

Studies in French Forestry. By T. S. Woolsey, jun. With two chapters by W. B. Greeley. Pp. xxvi+550. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) 36*s*. net.

MR. T. S. WOOLSEY, who is well known as an expert in and an authoritative writer on forestry, has given to American and British foresters in his "Studies in French Forestry" a means of gaining a deep insight into the theory and practice of forestry in France. The material for the present book was collected largely in 1912, but administrative work at home and service with the U.S. Corps of Engineers during the war prevented earlier publication. That is, we think, a fortunate thing, because the author has been able to include much information regarding the wonderful organisation of the French Forestry Service and the Allied Forestry Corps in maintaining an adequate supply of timber. Many forests had to be clear-felled, and others were so depleted of growing stock that "normal" production cannot be secured for a century or more. There are more than a million acres of French soil to be restored to productivity, and the rehabilitation of innumerable forests—300,000 acres—the growing stocks of which have been cleared or seriously depleted, must be brought about by the strictest economy at a time when the economic demands for wood products will be at least double the normal consumption.

The attitude of public opinion in France in regard to the *rôle* of the forest in national economics is reflected in the extremely stringent regulations contained in the National Forest Code. The common law alone is regarded as inadequate for the protection of forests in France; therefore the special forest code provides not only against wilful damage, but also against damage due to carelessness or ignorance in dealing with forests and forest lands. Still, it is not by these means that France has established her State, communal, and privately owned forests. She has in actual practice relied more on methods of example and co-operation in building up and establishing for all time her excellent forest reserves and systems of management.

The influence of the forest or its indirect value is a matter of great importance from national, economic, and æsthetic points of view, yet this phase of forest utility is only too often ignored. In a short but interesting chapter the author has succeeded in summarising the main facts and focussing them in an admirably lucid manner.

In the succeeding chapter the forest regions of France and the important tree species are described. An interesting review is given of the area, topography, and prevailing climatic conditions of France, and striking illustrations are given of the recent wonderful development of the natural resources of the country in hydraulic power. Further on are presented the forest statistical data, which bring out many points of absorbing interest. One striking fact is that the number of small forest owners is incredibly large. The small owner of less than 25 acres of forest is greatly in the majority, but the proportion of sawn timber to fuel wood in State-owned or technically managed forests is much more advantageous than in those privately owned.

The natural and artificial regeneration of forests, as practised in France, is well worth the close attention of students of sylviculture. An excellent account is also given of the control by afforestation of mountain torrents and lowland floods, which in the past have caused privation and ruin to thousands of the population, and untold loss to the nation.

The author also gives a most interesting account—historical, statistical, and technical—of the wonderful forests of the Landes. The almost magical transformation of a barren, fever-stricken waste of something like two million acres into a healthy and prosperous revenue-yielding territory, to the enormous advantage of France and every individual Frenchman, was a marvellous achievement. The State, as the author puts it, "blazed the trail," the good lead was followed by the "communes," and private effort did the rest. Much useful information is given concerning French Government regulations and working plans, the features of French national forest administration, and private forestry in France.

An interesting account is given of the activities of the Forest Engineers in France. The vital importance of timber in modern warfare is shown in many ways, and it is safe to conclude that without the well-planned forests and timber resources of France "the war might have been a draw or a defeat instead of a victory."

A number of interesting appendices are added which deal with specific forestry subjects, including an exhaustive list of French forestry literature, and there is a good index. The book is well illustrated with photographs and diagrams.

Our Bookshelf.

Official Statistics. By Prof. A. L. Bowley. (The World of To-day.) Pp. 63. (London: Humphrey Milford: Oxford University Press, 1921.) 2s. 6d.

A LITTLE book on statistics by so well-known an authority as Prof. Bowley is sure of a welcome from the educated public. In these times, when copious reports are issued by many Government departments, it is not only interesting, but also necessary, to appreciate fully the significance and limitations of official statistics. This is admittedly difficult, and it is with the view of steering the uninitiated through the mass of detail which necessarily obscures the real value of statistical information that Prof. Bowley has written this little book. A brief account is given of the more important reports and papers published officially in recent years containing statistics of general interest. The use of reports is illustrated by collecting details scattered throughout such a volume as the Report on Pauperism and retabulating them so as to show how the various tables are connected. In all cases exact references have been given to the original documents. The scope of the volume is well indicated by the chapter headings, four in number: population; industry, trade, and prices; income and wages; and social conditions.

A Laboratory Manual of Organic Chemistry for Medical Students. By Prof. M. Steel. Second edition. Pp. xi+284. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) 9s. 6d. net.

A CHAPTER on colloids which contains some interesting experiments forms the principal addition to this edition. Many careless expressions have been overlooked: "fused" copper sulphate and "fused" calcium oxide are not common reagents, and "hydroscopic" (p. 32) appears instead of "hygroscopic." Moreover, some of the directions for experiments do not seem to be based on trials, *e.g.* the preparation of acetylene would be dangerous if carried out as described on pp. 19–20, for air could not be displaced from the apparatus under the conditions named; also the directions given for the preparation of colloidal platinum on p. 220 do not seem correct—it would be difficult to pass a current of 10 amperes through distilled water by applying only 40 volts.

Ammonia and the Nitrides: With Special Reference to their Synthesis. By Dr. E. B. Maxted. Pp. viii+116. (London: J. and A. Churchill, 1921.) 7s. 6d. net.

THIS small volume contains an account of laboratory investigations of the nitrides of the elements. No mention is, however, made of the very important industrial applications of the results except in the case of the Serpek process, which is not in use in the form described by the author. "Deville," on p. 37, should be "Regnault."

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Co-operative Indexing of Periodical Literature.

THE following remarks refer to the periodical literature of science alone. The present lack of system in indexing this leads, we all know, to a huge waste of energy. If this could be saved by intelligent co-operation it might be set free for more profitable work. The leading article in NATURE of June 9 may help towards this both by the information that it gives and by that which it may elicit. For example, it recognises that a necessary preliminary is a survey of the periodicals in the libraries, and it states that for the United Kingdom such a survey was prepared in 1914-15 and is in MS. at the British Museum. This can scarcely have been within the knowledge of the Conjoint Board of Scientific Societies when it issued a recent appeal for this information to the scientific libraries of London, nor can it have been known to the Zoological Record Committee of the Zoological Society when it still more recently instructed its editor to make a similar survey for its own purposes. If NATURE can help forward the publication of a complete survey it will do good service.

The next step, so far as this country is concerned, will be to fill up gaps and to render all the periodical literature of any consequence accessible to the indexers. Your article does not touch on this, but it is surely more important for us that a paper should be accessible than that an index-slip for it should be sent from Bulgaria or Bolivia.

You consider the publication of abstracts before that of the index to be indefensible. This is not clear. It is possible to publish an abstract at the same time as (or even before) the original paper; the abstract is complete in itself, and, since it is in the nature of news, the sooner it is distributed the better. The index-slips can also be issued at the same time; but they have little meaning until arranged in an index, and the more complete the index is, and the larger (within limits) the period it covers, the better. Consequently, the index volume falls to be published later than the abstracts. The index material is of no use to the abstractor, and the indexer should not work from an abstract. Index and abstract are different in aim, in substance, and in mode of preparation. Their sole connection is that they deal with the same material, and both demand that material to be accessible. We return then to the primary need of completing our libraries as the best way of helping both parties.

This conclusion is opposed to your other suggestion, that the best way, so far as science is concerned, is to get index-slips from the Central Bureau of the International Catalogue of Scientific Literature. If this means a return to the attempt at furnishing slips through a number of national bureaux, it may be dismissed as discredited and now less workable than ever. If it means that the Central Bureau is to embark on all the work of collecting the literature, analysing it, and preparing the slips, may one ask if the proposer has considered whence the staff, offices, and funds are to be obtained?

Finally, what is the use of a *general* conference to determine the requirements of *special* branches of knowledge? Let each branch of science look after its own abstracts and indexes. Probably this would best be done by the leading societies, as for some sciences it already is. Any society taking the lead in its own branch should receive ungrudging aid from the others who are not so ready to shoulder the burden. Let general international help be concentrated on supplying the first essential, namely, the publications that are to be indexed. And so we are back where we started—at the foundation that has to be laid firmly and broadly. F. A. BATHER.

June 11.

IN considering the future of indexing, must not the method of indexing and abstracting depend on the purpose and future utility of abstracts? Do we want the means of manufacturing footnotes by unlimited references, or a guide in research? If for research, does a worker wish—or have time—to look up every reference, or does he want to get the sense of what has been done that will affect him? Can all classes of subjects be treated usefully on a uniform system, or is there any reason for doing so? Can a discrimination be expressed between papers that advance a subject, by new facts or new arrangements, and those that are inconclusive? Should an abstractor be entirely mechanical, or should any criticism be allowed?

A small experience in one department, of abstracting the produce of some twenty foreign periodicals (special and general) with a view to future utility, has led me to adopt the following standard:—

(1) State briefly every new fact and argument that leads to a definite result.

(2) Add references to any confirmatory or contradictory facts that have been omitted.

(3) Suggest if the paper is essential.

Such abstracts should be indexed at suitable intervals.

Some such standard seems likely to be the most useful for present reading and future research, in some subjects. How far would such a standard be desirable or applicable to different subjects? How far can individuals be found to make themselves responsible for dealing with their own special branch?

Too often, after struggling through thorn-brakes of German, or seas of Italian diffuseness, one emerges at the same point again, and finds that the whole is a rhetorical exercise. Should not workers be protected from such writing? Think of the future, with another century of accumulated writing, even at the present rate. W. M. FLINDERS PETRIE.

I AM in entire sympathy with the leading article in NATURE of June 9 on the subject of the co-operative indexing of scientific communications to periodicals. If, however, any scheme is to be carried out efficiently competent workers must be employed, and they must be adequately paid, which is no easy matter in these days.

I cannot, however, subscribe on the scientific side to the assumption that there is any considerable amount of periodical literature consisting of "water-tight compartments containing homogeneous material" presenting "no special difficulties" in indexing. The different sciences are becoming more and more interdependent. For example, geological investigators are continually in need of results obtained in other spheres of work, such as chemistry, physics, astronomy, geodetics, botany, and zoology. Numerous facts important to geologists also occur scattered through technical mining publications. It is important that all these fields should be gleaned in the interests of geology, as well as the common land of general periodical literature. The index of advances in physics required by a geologist will differ materially from that which meets the needs of a physicist.

JOHN W. EVANS.

Imperial College, South Kensington, June 12.

IN the very interesting and important leader of your issue of June 9, dealing with the co-operative indexing of periodical literature, attention is mainly confined to the natural sciences, but whatever is said as to the necessity for some new co-operative effort there in order to render more accessible the contributions in what you call the non-homogeneous class of periodicals, the need is even greater in another field of knowledge. May I venture to point out that in the field of one of the political sciences, if history and its allied subjects can be included in such a term, co-operation is even more urgently needed, and may be profitably undertaken along similar lines and in close concert? In very few fields of historical investigation do workers possess the advantages that are afforded by comprehensive bibliographies of recent publications, and practically nowhere are there to be found abstracts such as are familiar to their colleagues in chemistry, physics, and other natural sciences. The "Lists of Writings on American History" that have been published since 1902 under the auspices of the American Historical Association, and the bibliography of "Publications relating to the History of Canada," published at Toronto, show that it is entirely practicable to undertake such work with success. At the approaching conference of Anglo-American Historians, to be held in the University of London on July 11–16, various schemes for co-operative effort are to be considered, and among them may possibly be projects for co-operative lists of periodical publications. It is hoped by many of those who are taking part in the conference that some concrete results will arise from these discussions. May I, therefore, suggest that when any steps are taken to summon a conference such as you propose for the extension of the bibliographical equipment of the sciences opportunities should be afforded to the historians to take part? It would be an inestimable boon if the principle of co-operative and co-ordinated action on common lines could be extended as widely as possible in the fields where the scientific method can be profitably employed.

ARTHUR PERCIVAL NEWTON.

University of London, King's College, June 18.

I HAVE read with great interest the leading article on "Co-operative Indexing of Periodical Literature" in NATURE of June 9.

I have never been concerned with any work involving indexing of scientific periodicals, and those which have been my business, dealing with the classics, Oriental subjects, and bibliography, are essentially of the "watertight" character which present a much less serious problem to the student.

I think, however, there is one class of publication to which I should direct attention in connection with the subject of indexing for the use of present and future students, namely, official publications (Parliamentary papers, Stationery Office publications, reports of committees, etc.), which contain a great quantity of material which must necessarily be of value to investigators in various lines of research, and the lack of a clue to them is serious, especially as they are, from their quasi-anonymous nature, difficult to discover in the ordinary library catalogue.

If any conference such as that suggested in your article were called, I hope it would consider the indexing of these as well as of periodicals in the strict sense of the word. I do not think that any endowment will be forthcoming from public funds, but librarians in Government Departments and other Civil Servants with bibliographical interests would probably be willing to help in the work of compilation. I should certainly be prepared to make myself responsible for slips analysing the papers laid before Parliament by the Foreign Office.

June 11. STEPHEN GASELEE.

W. Warde Fowler: A Personal Appreciation.

ALL who know his "Tales of the Birds" will deplore the loss of this gifted observer and writer. My review—three and a half pages long!—of his charming booklet, "An Oxford Correspondence of 1903," under the title "Oxford on the Up Grade," in NATURE, June 16, 1904, was the beginning of an all too infrequent correspondence. He was good enough to write that I had entered into the spirit of his views more than any other critic. They certainly appealed to me at the time; and to-day, when mere memorising and over-examination—including psycho-analysis—are becoming more and more of a curse and subversive of all mental progress, they merit the most careful consideration. Warde Fowler had cast off the blinkers worn usually by the literary man and could see widely. He could console his pupil's father for the son's failure in the I.C.S. examination by saying, "Never mind; he will do good work in life as soon as he recovers from the effects of his education."

In a postscript to his last letter to Jim Holmes, his young correspondent, he remarks:—

> I agree with what you said in your last letter about Greats. We had better grow our own plants instead of introducing exotics; but we must take care that our own plants get a real chance of coming to perfection.

Here the Oxford position is stated in a sentence; but the newer Universities are still more open to the implied criticism—as in all of them far too many things are attempted and the plants consequently are of stunted growth. In the interval, there has been advance at Oxford but not on an even grade; and the beer-point of enthusiasm (see my review) is not yet reached. So ineffective is the influence of its environment, that a professor, who over a long period had shut up the instruments of research in glass cases, into whose lap a great fortune had been dropped, could die recently without benefit to the University.

Take, too, his interesting quotation from Roger Ascham's "Scholemaster":—

> "All soch Authors as be fullest of good matter and right judgement in doctrine be likewise always most proper in wordes, most apte in sentence, *most plain and pure in uttering the same.*"

On this he makes the comment:—

> If I am not mistaken, this would have delighted Darwin.

This is not only a just recognition of Darwin's literary gift but should serve to confound Sir A. Quiller Couch and all those who presume to scoff at the literary shortcomings of scientific workers—without recognising how few literary men can be plain or pure in their utterance and how few either have matter to write about—rarely anything novel—or can produce doctrine worth consideration. Usually they are but dealers in hashed mutton; they may spice it pleasantly but it is still hash. "It is astonishing what nonsense able men will sometimes write, just because they don't know even the elementary laws of scientific investigation," said Warde Fowler.

I have a letter of his before me, from Kingham, Chipping Norton, dated July, 1913, acknowledging a pamphlet on Nature Study which I had sent to him :—

> I must confess (he writes) to an innate aversion from "Nature Study" in inverted commas and capital letters, *i.e.* as practised in too many schools, because I know that the teachers are quite ready to "teach" what they don't understand a bit and that the only person who can really help the children in these things is one who is learning himself all the time and learning not only from books but using them just as a help. I am very glad to see that you have the same kind of feeling.

Then he speaks of his work in the village school :—

> This week, for example, I have given away two copies of my recent book on this village (which is sought after in the village) as prizes for accounts of the growth of corn (which is growing all around us in different stages) from the seed to the fruit, with specimens. Two girls won the prizes and there were some dozen good answers. The boys seemed more interested in the processes of agriculture than in the growth of the plant and the boys are fewer in number than the girls. I myself have learnt much that I did not know before and so has the schoolmaster. They were all silent or in difficulties about the bloom of the corn and no wonder. What a number of beautiful and interesting things there are to be learnt about it. To-day I have been learning something about the corn smut and turned out a book about diseases of cereals which I had hardly opened since I wrote my "Roman Festivals" and wanted to know something about the robigo, for the Festival of Mildew (Robigalia). One wants a microscope, however, to interest children in such things as that.
>
> I feel as if I should like to go on talking to you but I must be content with thanking you for your reminiscence of my young friend Jim Holmes, for whom I still have a sneaking fondness, as the only (or almost the only) creature of my brain.

In the "Roman Festivals," a work of marvellous erudition and research, he devotes quite a long section to the discussion of the Robigalia and remarks that "the red mildew was at times so terrible a scourge that the Robigalia (April 25) must in early Rome, when the population lived on corn grown near the city, have been a festival of very real meaning. A red dog was sacrificed to Robigus, the spirit who works in mildew. Nowadays nothing that happens in agriculture is marked by sacrifice."

Whether we think of Warde Fowler as literary man or naturalist, however, for the man who could write :—

> I will tell you that the joy of discovering something that you did not know before is in my experience very great and that the joy of finding that so far as your knowledge goes no one ever found it out before is far greater,

we shall long keep a place in our memory. Oxford will best serve his memory by increasing the number who can have that joy, as to-day, it may be feared, we are farther off than we ever were from that "general and vehement spirit of search in the air," which Lord Morley long ago proclaimed to be our prime need: not a few schools, too, are aiming at a classical revival; the meaning of science is not yet with them generally.

H. E. A.

Ionisation Potential and the Size of the Atom.

It is known that there is for different elements a relation between the ionising potential and atomic volume, the one increasing as the other diminishes. Hughes in his book on "Photo-electricity" (p. 51) indicates that the work in removing an electron wholly from an atom might be expected to vary inversely as the radius. In other words, the ionising potential might be inversely proportional to the cube-root of the atomic volume.

Now W. L. Bragg, in the *Philosophical Magazine* (August, 1920), has given the diameters of atoms in Ångstrom units (10^{-8}cm.), on the assumption of close packing in crystal structure. The diameter which he determines is more strictly the distance from centre to centre of contiguous atoms of the same kind. The dimensions which he thus found are far smaller than those deduced from calculations by kinetic theory.

It appears desirable to make a comparison of the ionisation potentials (1) with the diameters as given by W. L. Bragg, and (2) with the cube-root of the atomic volume.

In the subjoined table the name of the element, the ionisation potential, and Bragg's diameter ($\times 10^8$), are set forth in the first three columns. The product of the diameter and ionising potential appear in the fourth column. The cube-root of the atomic volume is stated in the fifth column, and its product with the ionisation potential in the sixth column.

I. Element	II. Ionisation potential	III. Diameter $\times 10^8$	IV. II.×III.	V. Cube root of atomic volume	VI. II.×V.
Group I.					
Na	5·11	3·55	18·1	2·87	14·7
K	4·32	4·15	17·9	3·57	15·4
Rb	4·16	4·50	18·7	3·81	15·9
Cs	3·88	4·75	18·4	4·12	16·0
		Mean	18·3	Mean	15·5
		Range	0·8	Range	1·3
Group II.					
Mg	7·61	2·85	21·7	2·40	18·3
Ca	6·09	3·40	20·8	2·96	18·0
Sr	5·67	3·90	22·2	3·25	18·4
Ba	5·19	4·20	21·8	3·31	17·2
		Mean	21·6	Mean	18·0
		Range	1·4	Range	1·2
Group II.B.					
Zn	9·35	2·65	24·8	2·09	19·5
Cd	8·95	3·20	28·6	2·35	21·0
Hg	10·38			2·45	25·4
Group III.B.					
Tl	7·3	4·50	32·8	2·58	18·8
Group IV.B.					
Pb	7·93	3·80	30·1	2·63	20·8

		Group V.A.			
As	11·5	2·52	29·0	2·36	27·2
				or 2·52	or 29·0
P	13·3			2·37	31·5
				or 2·57	or 34·2
		Group VI.			
S	8·30	2·05	17·0	2·50	20·8
	or 12·2	2·05	or 25·0	2·50	or 30·4
		Group VII.A.			
I	10·1	2·80	28·3	2·95	29·8
	or 8·0	2·80	or 22·4	2·95	or 23·6
		Inert Gases.			
He	25·4			2·86	73·0
Ne	16	1·30	20·8	2·67	42·8
A	12	2·05	24·6	3·03	36·4

In the first group of the periodic table the products shown in each of the fourth and sixth columns of the above table are fairly concordant, so that we may conclude that the work done in the removal of an exterior electron is nearly proportional inversely as the radius.

The same remark applies to four elements of the second group, while the members of sub-group B diverge considerably from the values for the A group. According to Urbach (*Phys. Zeit.*, February, 1921, p. 116), the elements of the B sub-group have a double ring of electrons in the outer zone, while those of the A sub-group have a single ring. In the case of the inert gases, neon and argon, the diameters estimated by Bragg give products in the fourth column in far better accord with theory than those found from the cube-root of the atomic volume set forth in the sixth column.

The values for certain elements in groups iii.–vii. are given in the table for comparison, but our knowledge of ionising potentials is as yet too fragmentary to permit of any definite conclusions.

The ultimate solution of this problem may involve calculations of the character given by Sir J. J. Thomson in his recent paper in the *Philosophical Magazine* (March, 1921, p. 526).

I am indebted to Prof. A. Ll. Hughes for his assistance in endeavouring to collect the most trustworthy values for the ionising potentials.

A. S. EVE.

Macdonald Physics Building,
McGill University, Montreal, June 6.

A Novel Magneto-Optical Effect.

THE interesting observation recorded by Prof. Elihu Thomson in NATURE of June 23, p. 520, seems likely to have a bearing on the old Reichenbach experiments, which were for the most part disbelieved by orthodox science, but on which Sir William Barrett and others made some careful observations, to ascertain what truth there might be in them. The effects could not be denied, but they were capricious; and in view of Prof. Elihu Thomson's discovery, it seems possible that the luminosity may have been visible to sensitive percipients when there was a trace of magnetic dust in the room and when other light was not excluded. The obvious precaution of excluding other light may have been the condition which militated against the examination of the phenomenon, which it was then thought was presumably of a subjective character.

OLIVER LODGE.

June 25.

Helicopters.

ONE often sees published statements to the effect that a helicopter has been invented and that wonderful things are expected of it. If the design gets as far as an actual trial a few alterations are found to be required, and then nothing more is heard of the matter.

To make a machine which without an extravagant expenditure of power will raise itself vertically and remain poised in the air is possible and most desirable, and the many failures in the attempt to do this are all attributable (omitting mistakes in mechanical design) to the same cause, namely, that of giving an insufficient area to the lifting surface.

The sort of area required may be gathered from the following illustration. Let two aeroplanes facing in opposite directions be connected by a few hundred yards of light line joining their wing-tips. The machines so connected could rise and circle round each other without much difficulty. When in the air the line might be hauled in until the wing-tips were almost in contact, and in this condition the combined machines would form a helicopter. There would be no banking, as the connecting line would take the centrifugal force, but more power would be required than when the machines were flying independently on account of the lower speed and efficiency of the inner pair of wings.

The function of a screw or lifting surface is to generate a downward current of air, the reaction of which on the surface shall be equal to the weight supported. If L^2 is the cross-section area of this current (dependent on, though not identical with, the area of the lifting surface), V its velocity, and W the weight, $L^2V^2 \times$(constant somewhat greater than half the density of air)$=$W. Hence LV is a constant, and V is inversely proportional to L.

The power required to maintain the current is WV, and can therefore be reduced by making L/V large.

For instance, if W can be sustained on a current of area L^2 by P horse-power, only half this power would be required if the current area were $4L^2$.

A. MALLOCK.

A Physical Interpretation of the Energy Quantum.

THE work of Bohr (*Phil. Mag.*, 1913–15) indicates that we may assume stability only for *some* electronic orbits, *i.e.* amplitude changes occur discontinuously. We arrive at a similar conclusion in the case of the vibrating atoms of solids if we accept the quantum explanation of the change in their specific heats with temperature.

It is here suggested that the amplitude of a periodic disturbance in the æther can alter only by definite amounts which depend on its frequency, so that as soon as any part of a wave-front meets with something that is capable of inducing a decrease in amplitude, such as a suitably situated electron, that part suffers a definite decrease of amplitude, which extends back into the wave-train (uniformly in all directions in an isotropic medium) to the extent of one quantum. The æther is relieved of its energy of strain, not continuously, but in quanta.

With the modification suggested above the wave theory renders understandable, on one hand, phenomena such as interference, and, on the other, phenomena such as the photo-electric effect, a detailed discussion of which is here impossible owing to lack of space.

More light might be thrown on this subject by a mathematical treatment.

IAN AUCKEN.

The County School, Long Eaton,
June 13.

University Statistics of the United Kingdom, 1919–20.[1]

UP to the year 1913–14 the Board of Education presented Annual Reports relating to university institutions in England and Wales in receipt of grants from the Board, but during the war this publication was discontinued. The volume now issued by the University Grants Committee marks the end of this five-years statistical holiday and the starting-point of a series of returns which, including, as they do, Scottish and Irish institutions in receipt of annual grants, and, as they presumably will, the Universities of Oxford and Cambridge and Trinity College, Dublin, will be far more comprehensive and significant than the pre-war returns published by the Board of Education. In eight comparative tables the public is provided with an abundant, but compact, store of information regarding university students of both sexes—whence they came, at what ages they were admitted, where they resided while pursuing their studies, the directions and durations of the courses they followed, the degrees and diplomas they gained—as well as complete statements of the grants made from the Treasury in each of the years 1913–14 to 1919–20. These are followed by notes and statistics and accounts concerning each institution separately. The notes are arranged under such heads as "Faculties and Subjects," "Extension Work," "Cost of Living and Hostel Facilities," "Local Support." To the accounts of income and expenditure are appended expenditure schedules showing, separately for each department, the salaries of departmental heads, number and salaries of other teachers, cost of departmental and laboratory maintenance, etc. In future years income and expenditure are to be tabulated in comparative statements, and the cost per student of each institution is to be exhibited.

In the following paragraphs an attempt is made to indicate the more salient features of the information given in the collated statistics, and as these do not, as yet, include the students of Oxford, Cambridge, Trinity College, Dublin, the colleges at Durham, Guy's Hospital Medical School and some other schools of the University of London, and University College, Exeter, supplementary figures have been quoted from the 1921 edition of "The Yearbook of the Universities of the British Empire."

The *number of full-time students,* as given in the tables, was 37,081, of whom 27 per cent. were women. The total for England alone, 20,486, may be analysed topographically as follows, using round numbers: London institutions, 8000; North Midland group of universities—Birmingham, Leeds, Liverpool, Manchester, and Sheffield—with the Manchester College of Technology and Nottingham University College, 9300; Bristol University, with the Merchant Venturers' Technical College and the University Colleges of Southampton and Reading, 2000; Armstrong College and the College of Medicine, Newcastle-upon-Tyne, 1200. The totals for Wales, Scotland, and Ireland are 2473, 10,992, and 3130 respectively. Compared with the returns for 1913–14, the numbers show increases of 83, 101, 31, and 76 per cent. in England, Wales, Scotland, and Ireland.

The results obtained by adding to the above figures statistics from the "Yearbook" may be stated thus: Oxford and Cambridge (including 1100 women), 11,800; London, 10,100; North Midlands, 9300; the rest of England, 3400; Scotland and Wales, as above; Ireland, 4500; grand total of full-time students, 52,600.

In any estimate of the significance of these statistics it is important to bear in mind that a very large number of persons engaged in studies of university grade are not accounted for either in the Grants Committee's tables—because they are not students of grant-receiving institutions—or in the "Universities' Yearbook"—because they do not belong to any university or university college. The institutions in the United Kingdom in which professional education of university grade is provided, although they are not organically connected with any university—theological colleges, training colleges, agricultural colleges, schools of mines, etc.—are numerous and important. Moreover, there are many students reading privately for the external degrees of the University of London, for the Bar, etc. On the other hand, it must be remembered, as pointed out in the Grants Committee's introduction to its returns, that there were in 1919–20 nearly 17,000 full-time ex-Service students in attendance at university institutions in the United Kingdom (including 11,500 attending institutions in receipt of Treasury grants), and that when this special source of supply comes to an end there may be a substantial fall in the numbers.

Again, in any attempt to compare the number of university students in the United Kingdom with the corresponding number in, for example, the United States of America, where, in 1918, there were 224,000 men and 151,000 women in 672 universities, colleges, and professional schools, it would be necessary to allow for several important differences in the conditions of higher education between the countries compared. For example, the work of the higher forms of many of our secondary schools corresponds with the earlier stages of the work done in many of the American colleges and collegiate departments of universities, and in many of the American institutions the enrolment of part-time students constitutes a very large proportion of the total number. In France the number of students in 1913–14 in the University of Paris (17,500) and the fifteen provincial universities amounted to 39,000, but special branches of knowledge, tech-

[1] Returns from Universities and University Colleges in Receipt of Treasury Grant, 1919-20. Presented to Parliament by the University Grants Committee, April, 1921. (Cmd. 1263.) 3*s.* 6*d.*

nology, and research were cultivated in numerous institutes and schools outside the universities.

A new and interesting feature of the returns is the classification of full-time students according to *locality of home residence*. The homes of approximately 60 per cent. were within 30 miles of the university, of 35 per cent. in other parts of the United Kingdom, of 4 per cent. (1390) within the British Empire overseas, of 2 per cent. (646) in foreign countries. The following institutions drew a noticeably high percentage of their students from beyond the 30-mile radius: University of Glasgow (50 per cent.), London Medical Schools (52), King's College Household and Social Science Department (58), Westfield College (61), University Colleges of Galway (62), Dublin (71), Reading (72), Aberystwyth (78). Those most frequented by students from outside the United Kingdom are shown in the following list, wherein the first figure (A) represents the total number of such students, and the second (B) the number from *foreign countries*:

	A	B
University of Edinburgh	494	58
,, ,, Glasgow	202	100
,, ,, Aberdeen	52	7
,, ,, Birmingham	139	48
,, ,, Liverpool	56	9
Armstrong College	49	41
Royal Technical College, Glasgow ...	41	24
College of Technology, Manchester ...	51	29
Imperial College of Science and Technology	90	42
London Medical Schools	338	60
London School of Economics ...	88	75
University and King's Colleges, London	176	54

It will be noticed that a large proportion of the students from overseas in schools of technology and the London School of Economics were foreigners.

As regards Oxford and Cambridge and the other university institutions which find no place in these tables, the "Yearbook" does not indicate the sources from which their students are supplied, but the Universities Bureau of the British Empire a few months ago collected lists of students from other countries, both British and foreign, studying in the universities and university colleges of the United Kingdom, and it has permitted the publication of the following totals, taken from these lists, of students from (*a*) the British Empire overseas, (*b*) foreign countries: Oxford (*a*) 307, (*b*) 308; Cambridge (*a*) 290, (*b*) 126; Dublin (*a*) 91, (*b*) 2; Guy's Hospital Medical School (*a*) 195, (*b*) 26. The Oxford figures reflect the influence of the Rhodes Scholarships, which provide for the continuous residence at Oxford of 186 scholars drawn from the United States of America (two from each State), as well as from Canada and Newfoundland, Australasia, South Africa, the West Indies, and Malta. Apart from this, however, Oxford exerts on American students a powerful attraction, as is shown by an analysis of the (*b*) figures given above. Separating students from the United States of America (*c*) from other foreign students (*d*), the totals for Oxford are (*c*) 217, (*d*) 91; for Cambridge, (*c*) 34, (*d*) 92. Nearly all the students from overseas at Trinity College, Dublin, came from South Africa.

From the same source the following statistics have been compiled: Students from Asia, 1228; Africa, 1046; Europe, 703; America and the West Indies, 676; the Pacific (Australasia), 282. The countries contributing most largely to these totals are listed below with the distribution of the students to London (*a*), Oxford and Cambridge (*b*), Edinburgh (*c*), and Glasgow (*d*):—

	Total	(*a*)	(*b*)	(*c*)	(*d*)
India, Burma, and Ceylon	974	418	200	157	58
South Africa	781	267	155	178	30
U.S.A.	362	72	251	25	4
Australia and New Zealand	279	50	151	57	4
Egypt	223	78	13	28	4
Canada and Newfoundland ...	164	33	105	18	1
China	112	36	14	22	10
Japan	54	34	7	2	3
Russia	113	70	25	4	5
Serbs, Croats, and Slovenes	75	7	18	11	9
Rumania	68	32	3	2	4
France	66	21	15	2	3
Norway	62	20	8	3	12
Greece	50	17	18	1	3

Of the students from South Africa, 229 were at the London Medical Schools, and 32 at Aberdeen. Of those from Egypt, 51 were at the London Medical Schools, 41 at Manchester and Liverpool, and 39 (24 medical) at Birmingham.

In future years the Grants Committee will present a comparative statement showing the number of new entrants who had previously attended a secondary school for three years or more, and the number who commenced their education in a public elementary school. In a few cases this information is given for 1919–20 in the separate chapters devoted to the several institutions; thus the College of Technology, Manchester, reports that of 286 full-time students 137 began their education in a public elementary school.

"The increasing demand for *Halls of Residence* and for more facilities for corporate life," says the Committee in its introduction, "makes it important to show the extent to which provision of the kind is made." Accordingly, Table 1 classifies students with reference to university residence. Half of them, it appears, lived at home, 37 per cent. in lodgings (22 per cent. of the women and 42 per cent. of the men), and 11 per cent. (4025) in halls of residence, these constituting 26 per cent. of the women and only 5 per cent. of the men. These proportions would, of course, be very different if the figures included the students of Oxford, Cambridge, and Trinity College, Dublin. In Wales, Scotland, and Ireland the proportion of students in lodgings is much higher—of those living at home, lower—than in England. There are good grounds for believing that future returns will show a substantial increase in the proportion of students living in halls of residence. Meanwhile, it may be noted that accommodation of this kind has already been provided for 80 per cent. of its students by Reading University College, for 47 per cent. of their students by the London Women's Colleges, for 36 per cent. by Dublin University College, for 30 per cent. by the University Colleges of Southampton, Aberystwyth, and Bangor, and for 23 per cent. by the University of Bristol.

The total number of full-time students admitted in 1919–20 for the first time for degree and diploma courses is given in Table 2 as 17,381, of whom rather more than one-fifth were women. They represent half and 38 per cent. respectively of the full-time men and women students in the institutions in question. The *ages at admission* of two-thirds of the men and one-half of the women were nineteen and over; of four-fifths of the men and five-sixths of the women, eighteen and over; while only 352 men and 53 women were under seventeen. Of these last-mentioned juvenile entrants Glasgow is responsible for 71, Birmingham for 51, and East London College for 26.

Table 3 gives particulars of *part-time students* taking courses of university standard. The total number, 15,234, of whom 23 per cent. were women, includes (*a*) 10,524 occasional, (*b*) 2389 diploma, (*c*) 890 degree, (*d*) 576 research, and (*e*) 1055 other post-graduate students. The chief contributors to these totals were:—

	(*a*)	(*b*)	(*c*), (*d*), (*e*)
Royal Technical College, Glasgow	2787	255	—
London School of Economics	1934	28	228
University and King's Colleges, London ...	1493	391	796
University of Leeds ...	661	33	39
University of Sheffield ...	416	663	34

Tutorial classes are organised in co-operation with the Workers' Educational Association by all the universities of England and by those of Wales, Aberdeen, Edinburgh, and Belfast. Particulars given in the several returns show that upwards of 5000 students attended these classes.

Research students were at work in all the institutions figuring in the returns except a few medical schools. Their total number was 1009, including 533 full-time students. Women researchers numbered 339. London institutions had 586 research students, Manchester 133, Liverpool 126, Birmingham 43. Post-graduate students other than those engaged in research numbered 1592, including 1055 part-time students. London alone accounts for 869 of these (765 part-time). Such data as are available for estimating the number of research and other post-graduate students at work in the university institutions excluded from these tables point to a total of about 1200.

The classification of full-time students *by faculties* gives the first place to medicine, including dentistry, with 12,657, including 2949 women. In the faculties of arts, theology, law, music, commerce, economics, and education were 11,745, including 5309 women; in pure science, 6571 (1538 women); in engineering, applied chemistry, etc., 6114 (145 women). Medical and dental students were most numerous in London (3347), Glasgow (1838), Edinburgh (1739), Liverpool (741), and Aberdeen (704). They outnumbered all other students put together in Belfast and the colleges of the National University of Ireland (in University College, Dublin, they were in a majority of almost 2 to 1), and were above 40 per cent. of the total in Glasgow, Aberdeen, and Edinburgh. Corresponding figures for Oxford, Cambridge, and Trinity College, Dublin, are not available. The statistics of degrees and diplomas gained so soon after the war present, of course, abnormal features. The total numbers of recipients were: Of degrees, 4054, including 1275 women; diplomas, 2062 (599 women); degrees according to faculties: arts, theology, law, music, commerce, economics, and education, 1666; pure science, 1074; medicine, 1008; engineering, applied chemistry, etc., 306.

Tables 7 and 8 exhibit the Treasury grants, annual and special, made to university institutions for 1913–14, when they amounted to 442,147*l.*, and each later year to 1919–20. The annual grants show but few important variations up to 1918–19, but in the following year they were increased, on the whole, by 70 per cent., and amounted to 786,500*l.* Of this, 198,000*l.* went to London institutions, 260,000*l.* to others in England, 52,500*l.* to Wales, 165,000*l.* to Scotland, and 111,000*l.* to Ireland. The special grants amounted to 104,000*l.* in 1915–16, 12,000*l.* in 1918–19, and 304,000*l.* in 1919–20, in which year special emergency grants pending the reports of the Royal Commissions inquiring into their financial resources were received by Oxford (30,000*l.*), Cambridge (30,000*l.*), and Trinity College, Dublin (12,000*l.*). The Civil Service Estimates of March last show 1,000,000*l.* for grants in 1920–21, and 1,500,000*l.* for grants in 1921–22. A further sum of 500,000*l.* is provided for grants in 1921–22 to the Federated Superannuation Funds for Universities. The principles upon which it is proposed to allocate grants in future are discussed in a report presented by the University Grants Committee on February 3, 1921, a paper which is likely to exercise a far-reaching influence on the further development of our universities and their relations with the State.

Protective Measures against X-rays and Radium.

A COMMITTEE was recently formed in London to see whether some general precautionary measures could be outlined which would be of service to those employed in the use of X-rays or radium for medical, scientific, or industrial purposes. The members of the committee are as follows: Sir Humphry Rolleston (chairman), Sir Archibald Reid, Dr. Robert Knox, Dr. G. Harrison Orton, Dr. S. Gilbert Scott, Dr. J. C. Mottram, Dr. G. W. C. Kaye, and Mr. Cuthbert Andrews. Dr. Stanley Melville and Prof. S. Russ are acting as honorary secretaries to the committee. The need for a statement on this subject has been felt for some time. During the war the Röntgen Society issued a printed card pointing out the dangers of exposing parts of the body to X-rays unduly, but the uses of these forms of radiation are becoming so numerous in medicine and the arts that it was felt that the ground should be gone over in more detail, and general recommendations drawn up as to the conditions under which work of this character should be carried out.

The preliminary report of the committee has just been issued. It is a carefully thought-out statement of present knowledge in regard to the equipment, ventilation, and working conditions of X-ray and radium departments. We are glad to see from the introduction to the report that the committee holds the view that the dangers which may attend the use of these radiations can be avoided entirely by the provision of efficient protection and suitable working conditions.

The damage which people have suffered in the past falls into two categories:—

(1) Visible injuries to the superficial tissues which may result in permanent damage.

(2) Derangements of internal organs and changes in the blood. These are especially important, as their early manifestation is often unrecognised.

The protective measures to be employed naturally vary with the work in hand, and the report contains details of the measures which the committee thinks appropriate to (1) X-rays for diagnostic purposes, (2) X-rays for superficial therapy, (3) X-rays for deep therapy, (4) X-rays for industrial and research purposes, (5) electrical precautions in X-ray departments, (6) ventilation of X-ray departments, and (7) radium therapy.

The report concludes with a statement bearing upon several aspects of the subject, and we accordingly reproduce it in full:

"The governing bodies of many institutions where radiological work is carried on may wish to have further guarantees of the general safety of the conditions under which their *personnel* work.

"(1) Although the committee believe that an adequate degree of safety would result if the recommendations now put forward were acted upon, they would point out that this is entirely dependent upon the loyal co-operation of the *personnel* in following the precautionary measures outlined for their benefit.

"(2) The committee would also point out that the National Physical Laboratory, Teddington, is prepared to carry out exact measurements upon X-ray protective materials, and to arrange for periodic inspection of existing installations on the lines of the present recommendations.

"(3) Further, in view of the varying susceptibilities of workers to radiation, the committee recommend that wherever possible periodic tests —*e.g.* every three months—be made upon the blood of the *personnel,* so that any changes which occur may be recognised at an early stage. In the present state of our knowledge it is difficult to decide when small variations from the normal blood-count become significant."

It is satisfactory to learn that the committee intends to continue to meet and to consider the advisability of directing some researches which arise out of the considerations involved in the memorandum in question.

Suggestions and offers of personal or other assistance are invited; they should be forwarded to the honorary secretaries of the X-ray and Radium Protection Committee, from whom copies of the preliminary report may be obtained, c/o Royal Society of Medicine, Wimpole Street, W.1.

Cosmogony and Stellar Evolution.[1]

By J. H. JEANS, SEC.R.S.

I.—*The Evolution of Gaseous Masses.*

THE progress of observational astronomy has made it abundantly clear that astronomical formations fall into well-defined classes; they are almost "manufactured articles" in the sense in which Clerk Maxwell applied the phrase to atoms. Just as atoms of hydrogen or calcium are believed to be of similar structure no matter where they are found, so star-clusters, spiral nebulæ, binary stars are seen to be similar, although in a less degree, no matter in what part of the sky they appear. The problem of cosmogony is to investigate the origins of these comparatively uniform formations and the process of transition from one class to another.

In attacking this problem the cosmogonist of to-day stands upon the shoulders not only of previous cosmogonists, but also, what is of even greater importance, upon the shoulders of the brilliant and industrious astronomical observers of the past century. We shall find it convenient

[1] Lectures delivered at King's College on May 3 and 10.

to take as our starting point the most famous theory of cosmogony ever propounded—the nebular hypothesis of Laplace—and we shall examine to what extent it remains tenable in the light of modern observational and theoretical research.

Laplace's hypothesis referred primarily to the genesis of the solar system, which he believed to have originated out of a hot nebulous mass that shrank as it cooled. The nebula was supposed to be in rotation, so that the principle of conservation of angular momentum required that as the mass cooled its speed of rotation should increase. It is well known that a mass either of gas or of liquid in rotation cannot rest in equilibrium in the spherical shape which would be assumed in the absence of rotation. If the rotation is very slow the equilibrium shape will be an oblate spheroid of small eccentricity. As the rotation increases, the ellipticity will increase, but it is found that the spheroidal shape is soon departed from. Laplace believed, as a matter of conjecture rather than of reasoned proof, that with continually increasing rotation a mass of gas would in time reach a stage at which it could no longer exist as a single continuous mass. When this stage was reached he believed that a ring of particles would be discharged from the equator through the centrifugal force of rotation outweighing the centripetal force of gravitation. The mathematical researches of Roche (1873) provided some support for this general conjecture, and more recent investigations put its general accuracy beyond doubt.

It is found that the changes of shape which accompany increase of rotation are, in their general features, the same for all masses, whether gaseous or fluid, provided only that there is sufficient central condensation of mass. When the rotation becomes so great that the spheroidal figure is departed from, the equator of the mass is found to pull out into a pronounced edge which ultimately becomes perfectly sharp (see Fig. 1). The mass has now assumed a lenticular shape, and any further increase of rotation results in matter being discharged from this sharp edge. The lenticular shape is retained from now on, the sharp edge acting like a safety valve and emitting just so much matter as is necessary to carry off the excess of angular momentum beyond the maximum which can be carried by the central mass. Fig. 1 shows the configurations of the lenticular figures for masses of gas in adiabatic equilibrium, in which γ (ratio of specific heats) has the extreme values 1·2 and 2·2 respectively. Other calculated lenticular figures show generally similar shapes. With a further increase of rotation beyond that for which these curves are drawn, the figures would remain unaltered save for the addition of a distribution of matter in the equatorial plane—the matter already thrown off from the sharp edge of the lens.

If gaseous stars assume these forms our telescopes refuse to reveal them. Even in the most powerful telescopes the stars remain infinitesimal points of light; the only bodies which show any observable shape are the nebulæ. It is highly significant that a number of these exhibit precisely the lenticular shape just described. This is in most cases accompanied by a distribution of matter in the plane through the sharp edge of the lens. A number of such nebulæ have been found by direct spectroscopic observation to be in rotation about an axis perpendicular to this plane. Thus there is very strong justification for supposing that these nebulæ are masses of gas or other matter with high central condensation behaving precisely as imagined by Laplace—rotating and throwing off their excess of angular momentum as they cool by the ejection of matter in their equatorial planes.

There is, however, almost incontrovertible evidence that the nebulæ which have just been described are nothing but ordinary spiral nebulæ seen edgewise, for observation discloses a continuous sequence of nebulæ the shapes of which bridge completely the gap between the lenticular nebulæ, in which we are looking at right angles to the axis of rotation, and the familiar spiral nebula in which we look approximately along this axis. The characteristic nebula shows a nucleus which we can now identify with the lenticular

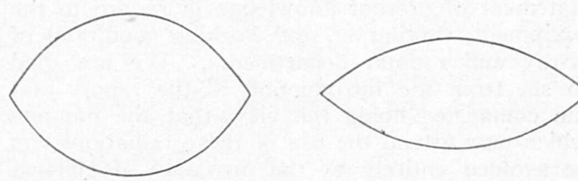

FIG. 1.—Figures of equilibrium for rotating masses of gas.

figure demanded by theory, having two arms emerging symmetrically from opposite points of the nucleus. If our identification is correct these arms must be formed out of the matter already discharged from the nucleus. It has in point of fact been found by van Maanen and Kostinsky that the matter in the arms appears to be in motion approximately along the arms and in the outward direction.

Any external gravitational field, whether of the universe as a whole or of neighbouring stars or nebulæ, would produce a tidal field similar to that produced by the sun and moon on the surface of our earth, a field specified mathematically by a second harmonic. This field, no matter how small in amount, would suffice to destroy the exact circular shape of the "equator" of the nucleus and so would concentrate the emission of matter at two opposite points on this equator. Thus it is easy to understand why the nebulæ, as a rule, exhibit two symmetrical arms emerging from antipodal points. It is very much less easy to understand why these arms should be of the universal spiral form—the absence of any explanation of this form must be regarded as a serious drawback to our interpretation of the spiral nebulæ. It is readily proved that the ejected filaments of matter, whatever the shape they assume, could not remain of uniform line-density.

Such a distribution of density would be unstable, and it can be proved that nuclei would form at approximately equal distances, around which the matter of the arms would condense. In this way it is possible to explain the nuclei and condensations which are observed in the arms of the spiral nebulæ. It is also found possible to calculate the amount of matter which will condense around each nucleus; the mass of each is found to be of the order of magnitude of the known masses of the stars.

In this way I have been led to conjecture that the spiral nebulæ are whirling masses of gas which, owing to their rapidity of rotation, throw off gaseous stars much as a "Catherine-wheel" firework throws off sparks. If so, the condensations in the arms of these nebulæ are stars in the process of birth. Dynamically the mechanism is almost identical with that imagined by Laplace as resulting in the birth of systems of planets and satellites, but on a far more stupendous scale. The final product of the chain of events we have been considering must be some type of star-cluster—perhaps a globular star-cluster, or possibly an "island-universe" similar to our galactic system. The difficulties in the way of an exact mathematical investigation into the history of the ejected gas as the filaments condense around nuclei and as these form stars and begin to move as detached bodies are enormous. On the other hand, the determination of the final steady states possible for a system of stars created in this way is quite simple. There is found to be only one type of final steady state possible for a system of stars created out of a rotating mass of gas, and this shows exactly the features presented by the system of stars of which our sun is a member. The system of stars will be of a flattened shape, symmetrical about the plane of greatest cross-section (the galactic plane in our system); the velocities in any small region of space will not be distributed at random, but will show a preference for two opposite directions ("star-streaming"); these directions will be parallel to the plane of symmetry and perpendicular to the radius to the centre of the system. This last direction is that given by Charlier for the direction of "star-streaming" in our system. Our system passes all tests for having been born out of a spiral nebula the plane of which was what is now the plane of the Milky Way; indeed, Easton and others have claimed to find traces of the two spiral arms still surviving in the distribution of stars in this plane, as though the final steady state had not yet been reached.

Let us now turn to a study of the lives of individual stars. To the naked eye the stars appear as mere points of light of varying brightness. The telescope adds little except possibly differences of colour. The spectroscope appears at first to add a wealth of new information, but a detailed study of stellar spectra discloses the unexpected fact that all stellar spectra, apart from a few exceptions, fall into one single linear series. Photographs of the spectra of all stars, in which varying exposures have been made to compensate for varying brightnesses, can be arranged uniquely in a consecutive order in which each spectrum differs only imperceptibly from its neighbour. All the complicated diversities of stellar spectra appear to be determined, in the main, by one single variable. This is believed, with good reason, to be the temperature of the star's surface.

Positions on this linear series are specified by reference to six selected points denoted by the letters B, A, F, G, K, M in this order. The order given is that of decreasing surface temperature. Stars having B-spectra are of bluish colour with a surface temperature of 10,000° C. or more. Stars of type M are red with a surface temperature of only 3000° C. Our sun is of type G, with a surface temperature of about 6000° C.

We might also arrange the stars in order of brightness. The distances of many stars are known, and for these we can calculate the "absolute brightness" or "luminosity"—*i.e.* the amount of light emitted as compared with our sun. Since the masses of the stars are all approximately the same, it might be expected that the order of "luminosity" would prove to be substantially the same as that of surface temperature, but this does not prove to be the case. Eight years ago it was found by Hertzsprung and H. N. Russell that the red M-stars fell into two widely different classes, one class having abnormally high luminosity, and the other abnormally low. The ratio of luminosities in the two classes is of the order of 10,000 to 1, and since the surface temperatures are the same, this ratio must imply a corresponding ratio in the areas of the radiating surfaces. Thus the two classes of M-stars must have volumes in a ratio of about 1,000,000 to one, for which sufficient reason they have been designated "giants" and "dwarfs." From a comprehensive discussion by Russell, recently confirmed by Adams and Joy, it is clear that the demarcation between "giants" and "dwarfs" extends, although with diminished intensity, through the types K, G, and F, while at types A and B the classes coalesce.

Lately Shapley, by determining the distances of the globular clusters, has greatly increased our knowledge of stellar luminosities, and has calculated the individual luminosities of 1152 giant stars in clusters. If we plot the logarithms of the luminosity (or the absolute magnitude) against spectral type as in Fig. 2, the vast majority of Shapley's 1152 stars are found to lie within the belt marked "giants," while of the stars previously discussed by Russell and by Adams and Joy, nearly all lie either within this belt or within that marked "dwarfs." In this diagram a few typical stars have been marked. The stars α Orionis and our near neighbour Lalande 21.185 are examples of giant and dwarf red stars. The diameter of the former has recently been found by direct measurement to be about 300 times that of our sun, corresponding to a density of the order of at most one-thousandth of that of atmospheric air; the latter has a luminosity only 0.009 times that of the sun, and probably a mean density comparable with that of the earth. Our sun and our nearest stellar neighbour, α Centauri, are marked as typical dwarfs of type G, and Sirius is a representative A-type star.

From the known luminosity and surface temperature of any star it is easy to calculate its surface and so its density. Giants of types G and K are found to have densities of the order of 0·004 and 0·0005 respectively, agreeing with the known densities of binary stars of these types. Sirius, with a luminosity of forty-eight times, and a surface temperature about one and a half times, those of our sun, must have a surface nine times as great. Its mass is 3·4 times the solar mass, so that its density must be about 0·2. In general it is found that all giant stars must be gaseous, of

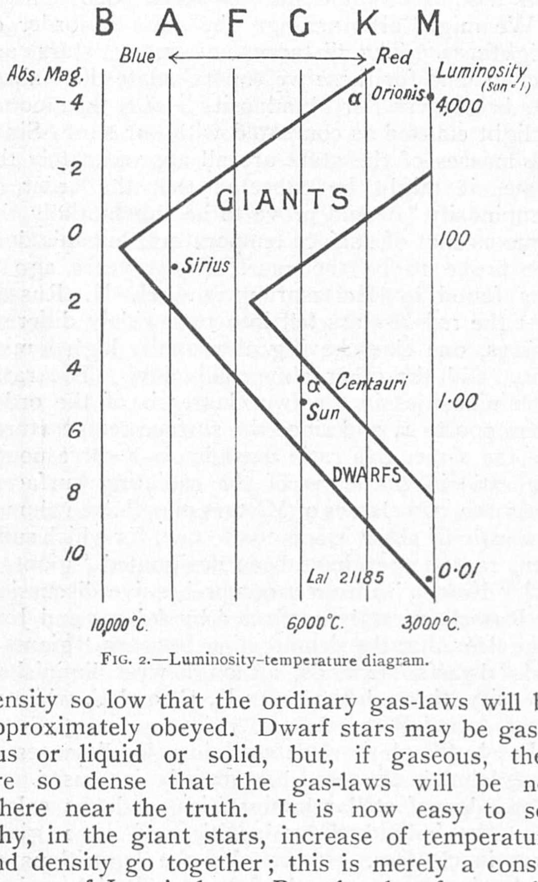

FIG. 2.—Luminosity-temperature diagram.

density so low that the ordinary gas-laws will be approximately obeyed. Dwarf stars may be gaseous or liquid or solid, but, if gaseous, they are so dense that the gas-laws will be nowhere near the truth. It is now easy to see why, in the giant stars, increase of temperature and density go together; this is merely a consequence of Lane's law. But the dwarfs may be thought of as approximating rather to masses of fixed dimensions, and for these the luminosity falls off as the temperature decreases.

Our sun radiates light at a rate of about 2 ergs per second per gram of its mass. Gravitational contraction, as Lord Kelvin showed, could provide energy at this rate for only about 20,000,000 years, and radio-active and chemical energy could only slightly lengthen this period. For a giant star, radiating at 1000 times the rate of the sun, the maximum period would be only a few thousand years. This period is far too short, and it is now generally accepted that, so far from gravitation and known sources of energy providing the whole of a star's radiation, they can provide only an insignificant fraction. Energy of adequate amount can originate only from sub-atomic sources, as, for instance, from internal rearrangements in the positive nuclei of the atoms or from the transformation of a small fraction of the star's mass into energy. It is a matter of simple calculation to show that all other stores of energy in a star can constitute only an insignificant reservoir of energy which, unless continually replenished from sub-atomic sources, would be exhausted in, astronomically, a moment. Thus the rates of radiation and of generation of sub-atomic energy must be practically equal, and the luminosity of a star will be determined by the latter rate at any instant.

We may now think of the evolution of the stars as represented by the march of a vast army through our diagram (Fig. 2), the individuals keeping, for the most part, within the marked belt. Each individual takes his marching orders from the supply of sub-atomic energy, and so long as we remain in ignorance of the exact source and nature of this we cannot be certain whether the motion of the army is up or down, or even that it is all in the same direction. But if we are right in conjecturing that the stars were born out of a nebula of very low density, the order of march will be from low density to high; our army will be marching downwards in the diagram. Its tail, except for a few stragglers, is about at absolute magnitude −4, its head is lost in darkness. In the next lecture we must study the incidents which may occur during the march of this army of stars.

(To be continued.)

Obituary.

DR. A. M. KELLAS.

BY the death of Dr. A. M. Kellas we have lost one of the best authorities on the effect of high altitudes on the human system. No one else had so great a practical knowledge, or worked scientifically at the subject with more persistence than he.

Born in Aberdeen, he was educated there, and afterwards went to Edinburgh, London, and Heidelberg. For some time he was assistant to Sir William Ramsay, and afterwards lecturer on chemistry at Middlesex Hospital.

As a teacher he was most successful, taking endless trouble in helping backward students. In pure chemistry he did little research, his chief contribution being a long and careful investigation on "The Determination of the Molecular Complexity of Liquid Sulphur," published in 1918. But during the last ten years he gave up most of his spare time to study the physiological and physical difficulties connected with the ascents of high mountains.

This subject he was particularly fitted to investigate, for he had probably climbed to heights above 20,000 ft. more often than anyone else. For instance, in 1910, in the Sikkim Himalaya, he was nine times above 20,000 ft., the highest altitudes being the first and only ascents of Pawhunri, 23,180 ft., and Chumiomo, 22,430 ft.

He also visited other parts of the Himalaya, the Nanga Parbat district, north of Kashmir, and Garwhal, where last summer he reached 23,600 ft. on Kamet. It was, however, in Sikkim that he did most of his mountaineering.

From time to time he published papers and reports in the Journal of the Royal Geographical Society and in the *Alpine Club Journal.* But as he was of a retiring disposition, there are few accounts of his extraordinary mountaineering record. Perhaps his most important paper was on "A Consideration of the Possibility of Ascending the Loftier Himalaya" (Journal of the Royal Geographical Society, 1917), in which he discussed all the factors conditioning acclimatisation to high altitudes, and the question whether it was possible to climb Mount Everest. His conclusion was: "A man in first-rate training, acclimatised to maximum altitude, could make the ascent of Mount Everest, without adventitious aids (*i.e.* oxygen), provided that the physical difficulties above 25,000 ft. are not prohibitive."

Dr. Kellas had a unique knowledge of the Sikkim Himalaya, and his death has deprived the Mount Everest expedition of one of its most valuable members, for he had studied the geography of the country round Mount Everest more deeply than anyone else.

WE regret to report the death, on June 26, of MR. WILLIAM SHACKLETON, at the age of fifty. Mr. Shackleton received his early training at the Keighley Institute, and after completing a three years' course at the Royal College of Science, became an assistant to the late Sir Norman Lockyer. By his skill and enthusiasm he contributed largely to the success of the early work at South Kensington on the photography of stellar spectra. In 1893, in company with Mr. Albert Taylor, he observed the total eclipse of the sun in Brazil, and was one of the first to obtain photographs with a prismatic camera of adequate power. In 1896, with Dr. E. J. Stone, he took part in the expedition which was conveyed to Novaya Zemlya by Sir George Baden-Powell in his yacht *Otaria.* Favoured by a brief interruption in a snowstorm, he then achieved a notable success in photographing for the first time the complete "flash" spectrum, with perfect definition, notwithstanding that an accident to the yacht had left but little time for preparation. On this occasion some admirable photographs of the corona were also obtained under his supervision. This expedition was further memorable for a meeting with Nansen at Hammerfest on his return from the polar regions.

For some years Mr. Shackleton was occupied with the late Dr. Common in the design of rangefinders and other optical instruments, and a special interest in optics was added to that in astronomy during the remainder of his life. In 1905 he took up an appointment at the India Stores Depôt as Inspector of Scientific Supplies, and scientific workers in India have profited much from his extensive technical knowledge and careful supervision of their requirements. Mr. Shackleton was elected a fellow of the Royal Astronomical Society in 1893, and of the Optical Society in 1913. He was secretary of the Optical Society from 1916 to 1920, and rendered valuable services to the society in that capacity, besides contributing papers of practical importance; he was a vice-president of the society at the time of his death. Mr. Shackleton's health had not been good for several years, but his death came unexpectedly, and will cause deep regret to his many friends in scientific and technical circles.

Notes.

A CHEMICAL laboratory of a new type was opened at the Imperial College of Science and Technology by Mr. A. J. Balfour on June 24. The laboratory is fitted with apparatus of a size which will render it necessary for chemical processes to be carried out under conditions closely resembling those which are present on the large scale. Just as the ordinary scientific laboratory contains specimens of all types of apparatus necessary for small-scale work, the new laboratory contains appliances which will enable the student to carry through the corresponding large-scale operations in a manner which will render it possible for him to study the influence of those factors, such as heat exchange, etc., which are not of vital importance in ordinary laboratory work. Students, and especially research students, whether they intend to follow an academic or an industrial career, will thus obtain a knowledge of large-scale conditions which it has hitherto been possible to acquire only by actual works experience. Moreover, the means for preparing initial material in large quantities will be of the greatest value for the research workers in the chemistry department of the college. It is hoped that a full description of the new laboratory, with illustrations, will appear in a forthcoming number. The equipment was provided by Mr. W. G. Whiffen, an old student of the college.

WE learn from the *Times* of June 24 that the West London Hospital is in possession of electrical plant capable of delivering current at 200,000 volts for X-ray purposes. The X-rays are of a penetrating character, and are being used for the treatment of patients suffering from malignant disease, on the lines laid down by the Bavarian doctors Seitz and Wintz. The use of more and more penetrating X-rays in medical work has been a gradual growth, and, quite apart from any marked differential action which the short wave-length radiation may have on cancer cells as compared with the longer wave-lengths, the employment of the more penetrating rays has technical advantages when dealing with deep-seated tumours. One sees in their use a natural development which depends very largely upon the electro-technician. It is greatly to be deplored that statements as to how this development may improve the results of cancer treatment are based, not upon facts, but upon the hopes of those engaged in this work. The use of X-rays and of radium in the treatment of cancer has been justified by results, and these results continue to improve, but we think that the public may be expecting more than is warranted when it is told that "a conservative estimate of the possibilities of the new treatment is to put the number of cures in the future at double that ever known in the past."

On June 27 the president of the Royal Society of Arts, the Duke of Connaught, presented the Albert medal of the society to Dr. J. A. Fleming "in recognition of his many valuable contributions to electrical science and its applications, and specially of his original invention of the thermionic valve, now so largely employed in wireless telegraphy and for other purposes." It may be of interest to recall the important part that Dr. Fleming played in the development of the thermionic valve and its applications to wireless telegraphy and telephony. The first form of valve was made in 1904, and led to revolutionary developments in that and other branches of electrotechnics. It is perhaps less generally realised that he gave scientific assistance in the early developments of "wireless" so far back as 1899, and directed some of the constructional work in connection with the first long-distance station at Poldhu. Dr. Fleming was also actively connected with the early progress of electric lighting in this country. In 1882, and for twelve years after, he held an advisory position with the Edison Electric Light Co., of London, and later with the Edison and Swan Co. He carried out the installation on board one of the first ships of the Royal Navy to adopt the new illuminant when it was introduced in 1882, and during succeeding years assisted several of the London companies and provincial corporations in electric lighting matters. Still older is his connection with telephony, for so far back as 1879 he was scientific adviser to the Edison Telephone Co., formed to begin telephone-exchange working in London. Other scientific work which Dr. Fleming has accomplished includes an important research into the electric and magnetic properties of matter at very low temperatures carried out in conjunction with Sir James Dewar.

On June 22 a portrait of Sir Napier Shaw, painted by W. W. Russell, was presented to him by the staff of the Meteorological Office, South Kensington, for preservation in the office. A copy of the portrait was presented to Lady Shaw.

An International Hydrographic Bureau has been established at Monaco, with the following directors: Vice-Admiral Sir John Parry (Great Britain), Capt. Phaff (Netherlands), and Capt. Muller (Norway). The secretary is Capt. Spicer-Simson (Great Britain).

It is announced in the *British Medical Journal* for June 25 that the International Labour Office has decided to appoint a committee of experts to deal with the question of industrial hygiene. Accordingly letters have been dispatched to the Governments of Great Britain, France, Belgium, Germany, Holland, Italy, Spain, Sweden, Switzerland, and Japan, inviting each of them to nominate one of its health inspectors or factory inspectors as a member of the advisory committee. The committee will meet from time to time, preferably on the occasion of the International Labour Conference, and its members will keep in touch with the International Labour Office and its industrial hygiene section by correspondence.

The twelfth annual meeting of the Oxford Ophthalmological Congress will be held on July 7–9, when the following communications will be made:—Discussion on "The Causes of Infection after Extraction of Senile Cataract," Dr. V. Morax and others; "Stereoskopometry," R. J. E. Hanson; Petrosal sinus sepsis, A. Greene; The Doyne memorial lecture on "Heterophoria," E. E. Maddox; An instrument which is set in motion by the eye, *i.e.* by vision, or by proximity of the human body, *e.g.* the hands, Dr. C. Russ; Experiences of 606 and its substitutes in eye diseases, J. Hern; The trench operation for chronic glaucoma, with account of cases, N. C. Ridley; A plea for early diagnosis and operation in chronic glaucoma, with some remarks upon the treatment of acute glaucoma, Dr. T. H. Butler; A modified operation for chronic glaucoma, P. H. Adams; Some points in the performance of the Lagrange operation for chronic glaucoma, B. Cridland; Loss of vitreous during cataract extraction, Dr. T. H. Butler; Sight-testing with coloured test types, P. J. Hay; Some points of interest in the work of a school oculist, Dr. H. McIlroy.

An exhibition, free of charge, of Egyptian antiquities from Tell-el-Amarna will be held in the rooms of the Society of Antiquaries on July 5–13, from 10 a.m. to 5 p.m. A lecture on "The Season's Work at Tell-el-Amarna" will be delivered by Prof. T. E. Peet on July 7, at 8.30, in the Royal Society's rooms.

The seventy-third annual meeting of the Somersetshire Archæological and Natural History Society will be held at Crewkerne on July 19–21, under the presidency of Sir C. Hercules Read, who will deliver his presidential address, "Somerset Archæology—a Suggestion," at 11.20 a.m. on the opening day.

The first exhibition of prehistoric art, organised by the Society of Friends of Art under the superintendence of the well-known archæologist, Don Elias Tormo, is now being held at Madrid. The object of the exhibition is to display reproductions of the remarkable series of rock paintings from the Spanish caves, the first discovery being that of the Altamira cave-paintings by the small daughter of the archæologist Sautuola in 1879. Since that date discoveries, encouraged by the Prince of Monaco and others, have been made in great numbers. The present exhibition includes what are supposed to be examples of early Iberian script, figures of suns, fishes, horseshoes, women weaving short skirts, drawings of the chase, tiny and most artistic stags from the eastern regions of the Peninsula, and splendid life-size wild boars and bisons from Altamira in the north-west. These figures, in drawing and colouring, are splendid examples of prehistoric art.

BARON EDMOND DE ROTHSCHILD has intimated to the Paris Academy of Sciences his intention to place at the disposal of the Academy the sum of 10,000,000 francs for the purpose of creating a fund for the development of physico-chemical research in France. According to the *Morning Post*, the revenue from the capital sum will be used first for assisting young students who devote themselves to pure science; secondly, to furnish investigators with the means to carry out their work; thirdly, to help inventors who have made discoveries as a result of being assisted by the new foundation to take out patents protecting their discoveries; and, fourthly, to create later on, if it should be deemed necessary, an institute with laboratories to be named after the founder.

AT the annual general meeting of the Röntgen Society, held on June 16, the following officers and council were elected:—*President:* Prof. J. W. Nicholson. *Vice-Presidents:* Dr. G. H. Rodman, Sir Ernest Rutherford, and Sir William Bragg. *Hon. Treasurer:* Mr. G. Pearce. *Hon. Secretaries:* Dr. E. A. Owen and Dr. J. R. Reynolds. *Hon. Editor:* Dr. G. W. C. Kaye. *Council:* C. Andrews, Dr. H. Black, A. E. Dean, Major Kenelm Edgcumbe, N. S. Finzi, Dr. F. L. Hopwood, Dr. F. H. Johnson, Dr. R. Morton, C. E. S. Phillips, Prof. A. W. Porter, Prof. A. O. Rankine, and Sir Archibald D. Reid.

THE seventy-fourth annual meeting of the Palæontographical Society was held in the rooms of the Geological Society, Burlington House, on Friday, June 17, Mr. E. T. Newton, vice-president, in the chair. The report referred to the completion of Dr. Reed's monograph of Bellerophontacea, and the early publication of a new monograph of carboniferous insects by Mr. Herbert Bolton. It also announced further instalments of the monographs of Pliocene Mollusca, Palæozoic Asterozoa, and Pleistocene Mammalia (Hippopotamus). The size of the annual volume had unfortunately to be reduced owing to the higher cost of production and to the difficulty of increasing the membership of the society. Dr. J. S. Flett, Mrs. Longstaff, Mr. A. W. Oke, and Dr. C. T. Trechmann were elected new members of council. Dr. Henry Woodward was re-elected president, Prof. E. J. Garwood was elected new vice-president, and Mr. Robert S. Herries and Dr. A. Smith Woodward were re-elected treasurer and secretary respectively.

THE council of the Society of Chemical Industry has nominated Prof. R. F. Ruttan, of Montreal, as president for the session 1921–22. The council, in view of the fact that the current annual meeting will be held in Montreal, requested the Canadian sections to suggest one of their members for nomination for the office of president, and Prof. Ruttan's name was proposed.

EARLY last year, as announced in NATURE, the Medical Research Council, by the courtesy of the Governing Body of the Lister Institute, made arrangements to maintain a national collection of type cultures at the institute. The scheme is under the general direction of Prof. J. C. G. Ledingham, with Dr. R. St. John Brooks and Miss M. Rhodes as curator and assistant curator respectively. It now appears that mycologists feel the need of a similar collection. Since the formation of such a collection is not at present contemplated by any institution it is considered that the scope of the national collection should be extended. The British Mycological Society has appointed a fully representative standing committee to consider the ways in which the collection can be made most valuable, and to advise and assist in all questions appertaining to fungi. It is proposed to collect and maintain cultures of fungi of importance in phytopathology, medicine, veterinary science, technology and soil biology, types useful for teaching purposes, and any rare or interesting species. At present it is not possible to cope with the innumerable strains of common fungi, and room can be found only for those forms with some published distinguishing name or symbol. The co-operation of bacteriologists and mycologists is earnestly invited, and in return every effort will be made to supply the needs of applicants for cultures. All communications respecting the collection should be addressed to the Curator, National Collection of Type Cultures, Lister Institute, Chelsea Gardens, S.W.1.

THERE was an interesting demonstration of new wireless telegraph apparatus by the R. M. Radio Co. on Thursday last. This company has developed and shown in operation a Morse printing wireless receiver, which, in addition to the ordinary detector and amplifier valves, is provided with another valve, to rectify the currents that would normally go into the receiving telephone circuit, so that a relay can be made to work. The relay is of a sensitive Post Office pattern, and is actuated by upsetting the balance of a Wheatstone bridge arrangement, in one arm of which the valve is connected. The relay controls an ordinary Morse inker, so that a permanent record of the messages is produced. This apparatus is due to Mr. F. H. Haynes, of the R. M. Radio Co., and Mr. V. Ramage, of the Central News, Ltd., and can easily take down messages from Paris, Moscow, etc., as well as from ship installations up to a considerable distance. Capt. H. de A. Donnisthorpe also showed a new form of thermionic valve known as the R.M.R. triode. In this, improved efficiency is obtained by the use of a hemispherical anode which avoids the fringing effect produced by the more usual cylindrical electrodes, and thus utilises the electron stream more completely. In a further development of this apparatus a "soft" tube of this kind is surrounded by a current-carrying coil, which produces a magnetic field having the effect of concentrating the ions where they are wanted, so that an increased flow of electrons is produced, giving a steeper characteristic curve and improving the sensibility by something like a further 50 per cent. The increased anode current when the field was applied was seen by means of an ammeter, and in another experiment the effect of a powerful electromagnet in controlling the position of the glow in a softer tube was demonstrated. It was pointed out that this action is similar to that taking place in the aurora borealis, according to the theory that in the layers of reduced pressure of the upper atmosphere the earth's field concentrates the ions and thus locates the glow produced by the bombardment of electrons shot off from sun-spots. This apparatus, which Capt. Donnisthorpe calls the "Thermagnion," can also be used to produce continuous oscillations with an equal gain in efficiency.

THE tercentenary of the death of Thomas Harriot, the mathematician and astronomer, occurs on July 2. Not only was he the most celebrated English algebraist of his time, but he was also one of the first astronomers in England to use a telescope, and, like Galileo, Fabricius, and Scheiner, was one of the early observers of the spots on the sun. Born at Oxford in 1560, he was a year older than Henry Briggs. He graduated from St. Mary's Hall, and became an ardent student of mathematics forty years before the inauguration of the first university chair of mathematics. At the age of twenty-five he entered the service of Sir Walter Ralegh, by whom he was employed in the survey of the newly founded colony of Virginia. The greater part of Harriot's life, however, was passed in the neighbourhood of London, where he came under the patronage of Henry Percy, Earl of Northumberland, who gave him a pension and assigned him rooms at Sion House, which stands on the banks of the Thames opposite Kew. When the earl was confined to the Tower through the complicity of some of his family in the Gunpowder Plot, Harriot and two other mathematical worthies, Thomas Hughes and Walter Warner, often bore him company. They were known as "the three magi." Harriot appears to have passed an uneventful life, and at his death was buried in St. Christopher's Church, on the site of which now stands the Bank of England. A monument erected to his memory was destroyed in the Great Fire of 1666. As an algebraist Harriot is a connecting link between Vieta and Descartes. His "Artis Analyticæ Praxis" was not published until ten years after his death. The revival of his fame as an astronomer was due to von Zach, who, while on a visit to the Earl of Egremont in 1784, discovered some of Harriot's writings beneath a pile of old stable accounts at Petworth Castle; while the reduction of Harriot's observations of the comet of 1607 formed one of the first tasks of Bessel's astronomical career. Some of Harriot's manuscripts are in the British Museum.

AT the annual meeting of the British Pharmaceutical Conference at Scarborough on June 14, Mr. E. Saville Peck, in his presidential address on "British Pharmacy and its Possibilities," said he looked forward to the time when pharmacy in this country shall have established itself as a separate professional entity. It could not be raised to this status without the combined efforts of its members, and would have to move forward with the advance of general education and of applied science. In his opinion every student before registration should be required to pass one of the school leaving certificate examinations which the Board of Education has recognised as equivalent to matriculation. While not advocating any serious extension of the syllabus for the qualifying examination, Mr. Peck favoured the addition of commercial science. In the major examination, which should be renamed the fellowship examination, practical physiological chemistry and bacteriology (with clinical microscopy) should be included among the compulsory subjects, and steps should be taken to establish a degree in science with pharmaceutics as one of the subjects in the final examination. If pharmacy is to take its position with other professional bodies it must bring its final qualification up to university standard. He looked forward to the ultimate evolution of a real profession of pharmacy.

MRS. SCORESBY ROUTLEDGE has made another important contribution to our knowledge of the ethnology of Easter Island in her account of a series of carved rocks and stone houses, published in the Journal of the Royal Anthropological Institute (vol. l., part ii.). The houses built of slabs of stone procured from an adjoining quarry are remarkable. The soil is excavated on a sloping site; the foundations are made of large rough cubes of rock, on which slabs are laid on edge, and the roof is formed of similar slabs. The house is entered by a rectangular tunnel. A series of excellent photographs enables us to understand the methods of construction, and the accommodation provided for the occupants.

IN *Ancient Egypt*, 1921, part ii., Prof. Flinders Petrie explains that the work of the British School has been moving southward, in the course of a systematic clearing of the western bank of the Nile valley. The excavation of the cemetery of Herakleopolis, which had been wrecked in ancient times, provided some important results. In particular, a number of well-dated skeletons gave an opportunity to compare them with those of other sites on either side—Medum, Tarkhan, and Deshashe. This showed important differences between the types of the Second, Sixth, and Ninth Dynasties, but the question whether the interments were those of nobles or of plebeians may to some extent confuse the results.

IN the April issue of the *Entomologist's Monthly Magazine* Dr. R. C. L. Perkins writes on the variation exhibited by the British species of parasitic bumble-bees of the genus Psithyrus. It is evident from the many colour forms which are recorded in this article that variation in these bees has been very inadequately studied. The subject is an interesting one, and species of Psithyrus need to be much more extensively collected before we shall be able to learn the distribution of their varietal forms. Dr. Perkins also refers to the very rare bumble-bee *Bombus pomorum*, Panz. A few examples of this insect were captured by the late F. Smith in Devon in 1857, but since that time the species has been lost sight of in this country. Owing to the resemblance which the male bears to a variety of the same sex in *Psithyrus rupestris*, F., and the similarity of the female to more common Bombi, Dr. Perkins is of opinion that *Bombus pomorum* may have been overlooked, and possibly may be re-discovered by some enterprising entomologist.

PAMPHLET No. 12 (1921) of the Economic Series issued by the British Museum (Natural History) is written by Mr. F. Laing, and deals with the ubiquitous cockroach. In addition to the common species (*Blatta orientalis*, L.), three other kinds of cockroach have established themselves in sufficient numbers in this country to be occasionally troublesome. The general reader is far more interested in their control than in their biology, and Mr. Laing finds that a powder consisting of three parts of sodium fluoride to one part of pyrethrum is a successful remedy. The mixture should be scattered about the haunts of the cockroaches in the evening, and the dead ones removed the next morning. The powder is harmless to any domestic pets and is cheaply and easily prepared.

THE inhabitants of Buckinghamshire and Hertfordshire will be grateful to Mr. W. Whitaker for his memoir on the water-supply of the two counties, recently published by the Geological Survey. In both counties chalk is the principal water-bearing rock, but supplies are also obtained from overlying gravels, sands, etc., Tertiary beds, and the Greensand and Jurassic rocks. The deepest bores recorded are 1000 ft., and from some of the wells more than 1,000,000 gallons a day are being obtained. Numerous analyses of the water are given, and the details are of considerable interest to all concerned in the well-being of the community. The geological student will be particularly interested in the full description of the swallow holes in which surface-water disappears, and which are numerous in Herts. Probably the best known are those in North Mymms, which can easily be seen at Water End; here the drainage of some 20 square miles of the county is lost. Swallow holes are found in two sets of conditions: along the junction of the Tertiary beds and chalk, and in the chalk itself, where the saturation level is below the bottom of the valley. The former are active at all seasons, the latter may not be. Directions are given for finding good examples. There is also an interesting discussion on the effect of pumping on the adjacent wells.

A PAPER by Mr. S. H. Warren on "A Natural 'Eolith' Factory beneath the Thanet Sand" (Quart. Journ. Geol. Soc., London, vol. lxxvi., p. 238, 1921), has already raised considerable discussion. It is clear that many persons would have accepted Mr. Warren's naturally flaked specimens as eoliths had their early Eocene age and their mode of origin not been demonstrable. The specialists in eoliths, on the other hand, maintain that the natural product, due to interaction under earth-tremors, is inartistic compared with an eolith for which human origin can reasonably be claimed. Mr. Warren's "natural factory" occurs at Grays in Essex.

IN a short paper of four pages, reprinted from the Proceedings of the U.S. National Academy of Sciences for June, 1920, Prof. A. G. Webster, of Clark University, directs attention to a necessary connection between the equation of state of a gas and the specific heats of the gas at constant pressure and at constant volume which does not take the simple form given to it by some authorities. In particular, he shows that a characteristic equation of the form $T=pf(v)$ does not indicate that the two specific heats are independent of the pressure; on the contrary, neither of them is a constant or independent of the pressure, nor is their difference constant, although it is independent of the pressure. Such a gas has no cohesion pressure, although it may have a finite Joule-Kelvin effect. In the same way a gas having a characteristic equation of the form $T=vF(p)$, although it has a zero Joule-Kelvin effect, has specific heats which are neither constant nor independent of the pressure. In conclusion, Prof. Webster expresses the opinion that the present method of teaching thermodynamics by means of the equations of the ideal gas or of the van der Waals equation "is by no means conducive to clearness."

WE have received from the Decimal Association a pamphlet entitled "The High-Value Penny," in which a proposal is put forward to increase the token value of the penny and employ the existing penny, half-penny, and farthing coins to represent values 20 per cent. higher than at present, thus dividing the shilling into ten pence instead of twelve, while leaving the values of the shilling and the £ sterling unaffected. All the existing notes and silver coins would be retained at their present values, and the sixpenny and threepenny coins employed as half-shilling and quarter-shilling pieces exchangeable into 5 and 2½ high-value pence instead of 6 and 3 low-value pence respectively. At convenience the unpopular silver threepenny piece could be withdrawn from circulation and a more useful nickel twopenny piece issued. It is claimed that by the adoption of this proposal the purchasing power of the penny would be brought into closer harmony with modern needs. Owing to the absence of a coin intermediate in value between 1*d*. and 1½*d*., the price of articles sold at 1*d*. before the war has been increased earlier than necessary to 1½*d*., and will be retained longer than necessary at this figure when prices are falling. The chief defects of the recent decimal coinage proposals would be avoided by continuing to reckon in pence instead of in mils, and no new coins or knowledge of decimal arithmetic would be required.

IN the *Meteorological Magazine* for May Dr. C. Chree gives a brief account of "Recent Work on Aurora." The subject was suggested to him by the installation of an observatory in Shetland, one of its objects being auroral observations. Due acknowledgment is made of the work done by Norwegian physicists. Arcs and curtains are said to be the most frequent forms of aurora portrayed, and many, if not all, are built up of rays. Illustrations are given both from drawings and from a photograph, the preference being given somewhat to the former method, although reference is made to the method devised by Prof. Störmer of measuring auroral heights by taking photographs simultaneously from the two ends of a base, the inclusion of stars determining the position of the aurora in space. Reference is made to the exceptional occurrence of aurora in England, whilst it is said that in high latitudes aurora seems to be the rule, rather than the exception, when the sky is free from cloud and the absence of strong moonlight permits. It is suggested that the spectrum of aurora at different heights may add to our knowledge of the composition of the atmosphere and throw light on the electrical conditions of the air, whilst relations to wireless phenomena are also foreshadowed. The occurrence of aurora, associated with the sun-spots in May, although apparently of little importance in England, may in more northern latitudes afford useful information.

WE understand that part 1 of vol. iv. of "Annual Tables of Constants and Numerical Data: Chemical, Physical, and Technological," is now ready. The work since 1910 has been published under the patronage of the International Union of Pure and Applied Chemistry. Copies are obtainable from M. Ch. Marie, 9 rue de Bagneux, Paris 6e.

MR. W. H. ROBINSON, 4 Nelson Street, Newcastle-upon-Tyne, has just circulated a lengthy catalogue (No. 3, 1921) of upwards of 1000 second-hand books. The contents are of a varied character, but many items should be of interest to readers of NATURE, *e.g.* a number of books illustrated by Thomas and John Bewick, folk-lore publications, and those in the large section devoted to science and technology. The prices asked appear very moderate.

Our Astronomical Column.

OCCULTATION OF VENUS.—A daylight occultation of Venus will take place on Saturday morning, July 2 (civil reckoning). The planet's stellar magnitude will be $-3\cdot9$, and it should be plainly visible to the naked eye, especially with the lunar crescent as a guide. The following table is extracted from the B.A.A. Journ. for May, p. 302:—

Place	Summer time of Disap. h. m.	Summer time of Reap. h. m.	Angle from N. Pt. °	°	Altitude °	°
Greenwich ...	5 3·4	6 9·5	67	262	23	33
Edinburgh ...	5 11·8	6 14·2	58	273	22	31
Liverpool ...	5 6·6	6 10·4	62	268	22	31
Dublin ...	5 6·3	6 8·2	59	271	20	29

The times are for the centre of Venus; they should be diminished by about 0·5m., owing to the error of the moon's place. Venus will be just half-illuminated. The occultation (disappearance and reappearance) of the illuminated limb will take place about 28s. later than the centre. Accurately timed observations of the different phases will be of use for correcting the places of moon and planet.

Circular No. 10 of the Cracow Observatory gives full details of the circumstances for about 400 stations spread over Europe. These circulars are written in Prof. G. Peano's "Latino sine flexione," which is easily read by anyone with an elementary knowledge of Latin or the derived languages.

THE TOTAL AMOUNT OF STARLIGHT.—Prof. Newcomb pointed out the importance of ascertaining the total amount of light given to us by all the stars, including those that are altogether invisible as units in the largest telescopes. It is only in this manner that limits can be fixed to the amount of light given by the fainter and more distant stars. Prof. Newcomb himself made observations for this purpose (*Astrophys. Journ.*, vol. xiv.); he was followed by Mr. G. J. Burns (*Astrophys. Journ.*, vol. xvi.), Mr. L. Yntema (Groningen Publications, No. 22), and Dr. P. J. Van Rhijn. The last-named has now made a new and more complete research (Groningen Publications, No. 31), utilising the experience previously gained, and analysing the total skylight into its components. An artificial star of magnitude about 5 was used, formed by reflection from a bulb; its light was compared with that of standard stars, and then spread out by changing the focus until it became equal to the skylight. The observations were made at Mount Wilson; the nearest towns were distant 13 km. and 26 km., and the effect of their lights was found to be inappreciable above altitude 35°. Use was made of the star counts in different galactic latitudes to estimate the increase of starlight as the galaxy is approached. The final result is that the total starlight is equal to 1440 first magnitude stars (Yntema found 1350), and that the skylight is made up as follows:—Starlight, 17 per cent.; zodiacal light, 43 per cent. (this varies at different hours of the night); perpetual aurora, 15 per cent. (it is noted that Prof. Slipher found the green auroral line on all photographs of the sky spectrum); the preceding sources scattered by the atmosphere, 25 per cent. The starlight has been reduced to the zenith by the application of Abbot's coefficients of atmospheric absorption. The starlight per square degree in various galactic latitudes is:—Lat. 0°, 0·085; lat. 10°, 0·065; lat. 20°, 0·044; lat. 30°, 0·026; lat. 40°, 0·015; lat. 50°, 0·014; lat. 60°, 0·012; lat. 70°, 0·011; lat. 80°, 0·010; and lat. 90°, 0·010 (the unit is mag. 1·0).

PERIODICITY OF VARIABLE STARS.—In order to facilitate further research on the cause of the periodicity of variable stars, Dr. J. G. Hagen has collected together in the May number of *Scientia* the salient differences between the stars of period less than three months and those of greater period. The short-period stars change less than 1·5 magnitude, while those of long period change three or four magnitudes. For the former the minima are sharp, followed by a rapid recovery, while for the latter the minima are flattened and the recovery relatively slower. The long periods oscillate, while the short change in the same direction with time. The former collect about 300 days, the latter about half a day and five days. The long-period stars are generally orange-red in colour and are spread evenly over the sky, while the short-period stars are whitish-yellow and collect in the Milky Way.

Dr. Hagen looks forward to the appearance of the results of the Mount Wilson measurements with the new 100-in. telescope, and hopes that it will then be possible to test whether the phenomena can all be explained by the theory that the variable stars are binaries.

Royal Sanitary Institute: Folkestone Congress, June 20–25.

THE Royal Sanitary Institute was founded in 1876. For more than forty years it has been, as it were, a chorus to interpret to the official and general public the methods of applying scientific ideas to the improvement of the environment and to the promotion of individual health. Among its earliest congress presidents it included Edwin Chadwick, Ward Richardson, Douglas Galton, and others well known in the history of the modern public health movement. The annual congress has always been a convenient occasion either for the announcement of some fresh application of hygienic ideas or for the discussion of administrative difficulties in their realisation. This year the congress was held at Folkestone. The Earl of Radnor was president. In his address he pleaded for the retention of the voluntary hospital system, arguing that unpaid medical service is somehow superior to paid service. There is, perhaps, a sense in which the consultants of the great and small hospitals are unpaid, but it is an abuse of words to suggest that they are philanthropists. The hospital problem, however, is rapidly coming to a point when discussion will yield to action, and with their usual elastic adaptivity our institutions will emerge into something better. The "science" of the transition will not be traceable until after the event. His lordship's plea was put with lucidity and dignity—a typically good illustration of a voluntary administrator's attitude. The later discussion on hospital service and medical service generally took a much wider sweep, and made manifest how far we have already travelled along the lines of official medical organisation. But this is a practical rather than a scientific question, and may safely be left to the administrators.

Not so the question of smoke prevention. Doubtless it is a practical question, and is probably as old as the oldest British health congress. It is one of the by-products of the industrial revolution. From the merely commercial point of view the waste has been incredible, whether we think of the factories or of the home fires; but not until the last twenty or thirty years have the evil effects of smoke-spoiled light and air begun to be understood or studied scientifically. More than twenty years ago, at Glasgow, Sir William Ramsay in a popular lecture put forward the suggestion that the fog-clouds due to smoke absorbed the sun's violet and ultra-violet rays, and, therefore, prevented those rays from having their proper germicidal effect on the bacterial life of the streets; hence the increase of microbic epidemics. The remedy, he said, was to use gas-fires. Sir William Ramsay at a later stage bettered this when he suggested the production of energy from coal without bringing it to the surface. These suggestions deserve exploiting. But Prof. Leonard Hill, of the Medical Research Council's Department, put the whole problem in a new setting. This is what we should expect from a man whose experimental work has given a richer meaning to the term "ventilation," and shown that our cardinal practical concern should be with the cooling-rate of the body in relation to the air. On the present occasion he explained the peculiar effects of light, particularly the visible rays. "Men live long who work in the clean moving air and sunshine of the fields. While the expectation of life for females (1911–12) in Westmorland was 66·6 and in the rural districts of Norfolk and Suffolk 61·03, it was in the county boroughs of the North 49·93, in Middlesbrough 46·65." It need not be assumed that the whole responsibility for this rests on smoke, but the cumulative case against it is very strong. On the other hand, the positive value of light in its effects on metabolism is extraordinarily high. This is accepted in therapeutics. "The visible (luminous) rays of sunlight are of immense importance, because they penetrate the skin and locally warm up the blood, which absorbs them in the subcutaneous vessels, while the body as a whole is kept cool by the cool moving air." (This refers to the sun-treatment of tubercular bones and joints in Alpine sanatoria.) "On the other hand, the dark heat rays are absorbed by the surface of the skin and make this warm. The ultra-violet rays have also no power to penetrate. They are absorbed by as little as one-tenth of a millimetre of the outer horny layer of the skin." It is, then, the luminous, not the ultra-violet, rays that have "so powerful an effect on health." The inference from this double fact is obvious. "Sunlight warming the blood locally, cold moving air keeping the body cool and stimulating metabolism, open-air exercise—these are the great factors for health next to good food and sufficient sleep, and of these the people of the cities are largely deprived." There are many practical deductions, but it will take the medical schools and the administrative authorities a long time to exhaust the value of this piece of science revealed by research.

In supplement to Prof. Hill's paper, Dr. Owens, of the Committee on Atmospheric Pollution, gave actual figures as to the tons of matter per square mile deposited from the air. The broad facts are (*a*) that industrial smoke is a small fraction of the whole and can be completely controlled by existing methods, and (*b*) that domestic smoke accounts for a vastly greater quantity, and at present cannot be controlled. That is the smoke problem.

There were many other practical discussions, each involving a good deal of nascent science. For example, the discussion of infant feeding is, in spite of the innumerable army of skilled observers, still losing itself among unresolved factors. Dr. Vynne Borland showed that in certain cases the overfeeding of infants results in wasting. This conclusion was based on carefully analysed cases. Dr. Jervis gave other cases to show that in certain forms of malnutrition no variation of food has any effect, and that here we are face to face with unknown factors, such as deficiency or excess of secretion in the endocrinal glands. It seems clear that until the relatively rough work of clinical treatment can be better illuminated by the work of the laboratories we shall have to continue our practice empirically.

Science is taking a steady grip of industrial fatigue. Mr. Wilson, of the Industrial Fatigue Research Board, gave a summary of results under the title "Some Effects of Environment on Efficiency and Safety." Temperature, humidity, ventilation, and lighting, all have definite relations to output, but the precise effects are not easy to estimate. Heavy work in high temperatures produces more in winter than in summer. Good ventilation is found to neutralise the reducing effects of humidity. In silk weaving artificial light reduces production by 10 per cent. compared with daylight. There is an obvious case for continuing research into these "raw materials" of industry, if only to secure some scientific basis for a system of "welfare work."

The science of rat destruction was represented at the congress. Research has not got much beyond the "aniseed" of the older rat-catchers and certain familiar poisons. Mr. Claremont, of the Ministry of Agriculture, gave a careful summary of facts. The rat, it appears, is "peculiarly susceptible [to poisons], for it has a very delicate stomach, and, I believe, cannot vomit; at any rate, does not readily do so." There is room for an extended biological and psychological study of the rat, for it does seriously affect the commerce of the world both directly as a consumer and indirectly as the international carrier of plague.

Perhaps the most fascinating item of the congress programme was the popular lecture by Prof. Mellanby, of Sheffield, on "Vitamins." A health congress without a discussion on diet would be a solecism, and to-day the whole theory of diet has been transfigured by the "vitamin" hypothesis. It is well to regard the word as provisional, for in this way the methods of research are likely to remain more fluid. No one has established a better right than Prof. Mellanby to be heard on the recent developments. He set forth the data with persuasive lucidity. He showed that experiment discredited the old view that diet could be exhaustively expressed in terms of proteins, carbohydrates, fats, salts, and water. There is a *sextum quid*. From Eyckman's discovery that beri-beri was due to rice robbed of certain portions by "polishing" to the latest experiments with puppies to show the production and arrest of rickets, Prof. Mellanby made clear the reasons for assuming the existence of the three factors: Fat-soluble A, water-soluble B, and the anti-scorbutic factor. The work of Prof. Mellanby and his wife in this field is well known to the technical and official public, but there is much need to spread the ascertained facts among the wider public, for this is the only way to generate sufficient pressure to secure that the consumer shall have the benefit of the latest discoveries. The fact that hypotheses are disputed is no reason for not making them known. In this matter the facts even as now ascertained are of high practical value. The physiological and biochemical departments of the various schools ought to work in more intimate touch with the administrative public, especially with the clinical investigators.

Of the congress as a whole it can be said truly that the mayor and councillors did everything to show that they understood the importance of the institute's educational work, and as we parted in the clean air and light of a perfect summer day we assured each other that on the scientific, as well as on the social, side it had been "a very nice congress."

The Importance of Research in the Development of the Mineral Industries.[1]

By SIR RICHARD REDMAYNE, K.C.B.

THE present state of the civilised world is, economically, paradoxical. The need for commodities is very great, yet the production of them is so costly that industry is languishing for lack of orders. On the termination of the war, after four years of excessive waste and destruction, the world is found short of houses, food, and other commodities; railways and rolling stock are in sad need of repair, restoration, and expansion; the output of fuel, the life-blood of our economic existence, is greatly decreased, and the mines from which it is produced are in a backward state of development.

The cessation of hostilities was succeeded almost at once by a period of feverish industrial activity—it would be erroneous to apply the words "general prosperity"—followed by a cycle of great depression. The demand for goods is great, but production is falling. What is the explanation? It lies, I think, in a combination of circumstances:—

(1) A feeling of insecurity due to unsettled political and financial conditions. Hence a disposition to conserve rather than to utilise in commercial ventures such capital as is available.

(2) The incidence of rate of exchange.

(3) The high cost of production consequent on the high cost of living and the higher standard of comfort demanded (and rightly demanded) by the labouring classes than formerly obtained.

(4) The lower, and still apparently decreasing, productive power of labour.

The first two conditions will in part right themselves in process of time as the various political problems are solved, or partly solved, and rates of exchange will then tend towards the normal; but a very great deal depends upon the last two conditions, as the future position of production is not easy to forecast. Higher and cheaper production is a difficult desideratum to obtain in view of the high rate of wages now ruling and the diminishment in working time either achieved or claimed by the manual workers of the day, and these are demands which are not likely to show much abatement in the future. What is the solution? The answer I venture to give, the solution which I presume to propound, to this problem, is "research." To discover by research cheaper means of production, and by research to create new outlets.

The object, then, of my address to-day is to direct attention to the necessity for research work in the mineral industries. Let me make more clear what I have in mind by taking one special case in point, a most important case—that of coal. It is an axiom that a cheap and plentiful supply of suitable fuel is necessary for our prosperity as a manufacturing country. This situation will remain, and is bound to remain, until some other means of producing power cheaply is discovered.

I think it may be taken that, roughly speaking, the rate per cent. of return on the capital invested in coal-mining in Great Britain over the last hundred and fifty years has, on the average, not varied much —reckoning in, say, periods of ten years—yet the progress made during the last two or three generations in every respect, except in the rate of return on capital, has been enormous.

Thus such everyday features of a colliery working at the present time as shaft cages and guides, the safety lamp, the steam locomotive, the trade in coke and by-products, ventilating fans, wire ropes, mechanical haulage, mechanical screening, the use of compressed air, the application of electricity to signalling, lighting, and motive power, and the mechanical cutting of coal have all been introduced in the course of the last hundred and twenty years. There is scarcely an appliance (save the simplest tools) or a machine in use at a modern colliery which could have been made at the beginning of the nineteenth century; and during this period the wages of the workmen—I omit the war period and the present abnormal time from consideration—have been increased certainly between 200 and 300 per cent., and this though the price of coal did not greatly increase; as a matter of fact, between the years 1828–1900 the variation was small and the price was lower in the latter year than in the former.

It was *because* of the improvements introduced into coal-mining that it was possible to keep down the

[1] Address delivered at the annual meeting of the British Science Guild held at the Goldsmiths' Hall on June 8.

cost of production, allowing of an increasing trade being done and the maintenance of a fair return on the capital invested in the industry. Further improvements are, to my mind, the only satisfactory solution to our present economic difficulties. Let me repeat: Lessen the cost of production by applying new methods, the result of research, and by research discover extended and new uses for minerals. Let me briefly indicate examples of possible research work in the mineral industry.

Coal—mineral fuel—naturally occurs at once to the mind. I am one of those who believe that the cost of production can be reduced by the wider application of the most up-to-date methods of the "getting" of the coal, in the transport and usage of the coal, but I doubt very much, even if and when these methods are applied to the fullest extent practicable, whether it will be possible to reduce the price to quite the pre-war level.

In some of our largest industries coal, next to wages, is the highest item of cost. The way of research would, therefore, appear to lie along the lines of the more efficient *use* of coal.

We know in the smelting of Cleveland iron in Yorkshire under present methods that about 74 per cent. of the total available heat of the fuel used is usefully applied, which for economy of smelting large quantities of iron is a remarkable result to have achieved. But is it beyond the bounds of possibility to reduce the consumption of one ton of coke to produce one ton of iron? And, as was pointed out by the Coal Conservation Committee in their final report of 1918, the economy of fuel which would result from the combination in single units of coke-ovens, blast furnaces, steel furnaces, and rolling mills would be very great indeed. The idea was foreshadowed in Belgium and Germany in the early years of the present century, and in 1910 Mr. T. C. Hutchinson, in his presidential address to the Cleveland Institution of Engineers, expressed the view "that the time would shortly come when ironstone would be brought in at one end of the works and finished steel would be turned out at the other, only such coal being used as was required for the coke-ovens to make sufficient coke to smelt the ironstone." In 1913 Mr. Hutchinson repeated this belief at the Brussels meeting of the Iron and Steel Institute, and in 1912, in his presidential address to the Iron and Steel Institute, Mr. Arthur Cooper also expressed the belief that the time was close at hand when the iron and steel industries would be forced by the stress of competition to adopt this reform.

The economic utilisation of low-grade fuels is a matter of great moment. There are in the United Kingdom, as in all coal-producing countries, vast quantities of coal which it does not pay to work owing to the low price realisable thereon. Probably the use of so-called colloidal fuel offers a solution, and will render the use of these low-grade coals practicable and profitable; for very fine coal mixed in about equal quantities with fuel oil produces a fuel which can be burnt in the same way as oil, and, bulk for bulk, though not weight for weight, gives in thermal values results equivalent to those of the fuel oil alone.

The recovery of coal and its more perfect cleaning by the froth flotation process, for some years applied to the recovery of metalliferous ores from their associated gangue, presents features of interest and probable profitable results.

The low-temperature carbonisation of coal, too, is at present occupying the minds of many investigators and may lead to the more extensive use of low-grade fuels. But to be commercially successful such a process should be continuous, and the resultant fuel capable of being sold at a price below that of coal.

Oil Shale.—The stores of liquid mineral oil will not last for ever; indeed, it is probable that the next fifty years will see, if not the exhaustion of this source of oil, a great reduction in the supplies available. We must turn, therefore, towards distillation of oil-bearing mineral—oil shales and coal—to take the place of our present petroleum supplies. Although there are very few retorts erected in the United States for the treatment of oil shale, and such as are are being applied to experimental purposes only, yet even that country of oil supplies is turning its attention to the consideration of its oil-shale potentialities. Research work would naturally be directed towards the economic desulphurisation of the oil and the minimising of losses in refining, so allowing of oil shales being worked which at present cannot be made available. The loss in refining oil from Scotch oil shale is about 23 per cent. of the crude oil treated, as compared with a loss of $3\frac{1}{2}$–4 per cent. only in the case of straight-run refining of American petroleum. The process of refining is the process of getting rid of offensive substances, but in those cases where refinement results in such high losses, as in the case of shale oil, it is probable that other than the objectionable substances are lost—substances which might be retained with advantage in the finished product.

Iron.—I have already alluded to the cheaper reduction of iron ores. The available reserves of high-grade iron ores in Great Britain are vastly nearer exhaustion than are the coal supplies. More and more, too, the world will have to turn to the poorer grade of ore—a wide field is here offered for research work in devising economic methods for their reduction. The economic smelting of ferruginous sands, in which connection may be mentioned those of Sweden and New Zealand, has so far defeated the efforts of metallurgists, rich in iron though these sands are.

In connection with blast furnaces, two products, the possible recovery of which is worth investigation, are those contained in the dust in the gases, namely, iron and potash; these dusts contain a high percentage of iron.

The possible economic recovery of vanadium, a mineral much in request in respect of the manufacture of a certain class of steel, from ashes of carbonaceous substances has been mooted.

Minerals Used to Harden Steel.—In respect of several minerals which until of late years were unimportant, or comparatively so, an important use has been found in connection with steel. One of these is tungsten. Tungsten metal powder is, as all metallurgists know, required for the manufacture of high-speed tools. The position in respect of tungsten is one which is at present exercising the minds of those interested in its extraction from wolfram; the business is now practically unprofitable. During the war high-speed steel was in great demand; now the demand has fallen away. Cannot new uses be found for tungsten? I have heard that the metal can be used for making piano-strings. The application of tungsten to branches of industry other than to steel offers a fruitful field for research.

I incline to the belief that, given a cheap and abundant production of some of the minor metals, uses will be found for them; and, conversely, with the discovery of uses enhanced production will be forthcoming. A case in point is the recent development in the production of stainless cutlery, which is made of chromium steel, and is in process of providing an important outlet for supplies of chromium ore.

Probably 95 per cent. of the world's production of manganese ores is used directly or indirectly in the manufacture of iron and steel. Self-hardening steels, made before the development of "high-speed tool steels," contained from $3\frac{1}{2}$ to 4 per cent. of manganese. Nickel steels containing from 5 to 6 per cent. of manganese and from 20 to 25 per cent. of nickel have been largely used for many years for electrical resistance wires. But the output has fallen away considerably. India is now our great source of supply of manganese. The output from that country was, however, for 1919 only about five-eighths of that for 1913, and the cost of production has greatly increased owing to the increased rate of wages demanded by the native labourers. The rupee exchange and high freights also hamper the export trade. The value of the ore for metallurgical purposes, as indeed in the case of the ores of nearly all metals, depends on three factors :—

(1) The percentage of the metal contents (the metals in the case of manganese being manganese and iron).

(2) The percentage of the impurities (which in the case of manganese are phosphorus, silica, alumina, copper, cobalt, lead, zinc, barium, etc.).

(3) The physical condition in which the material is delivered to the furnace.

There are fairly extensive deposits of low-grade and impure manganese ores which research might render available, if not for metallurgical, then for chemical uses.

The position of zinc is interesting. The British zinc industry is in a very depressed state, and to this matter the Imperial Mineral Resources Bureau has been devoting much anxious thought. The Bureau was fortunate in having the benefit of the views on this subject of Mr. Gilbert Rigg and other well-known experts. Mr. Rigg, in a paper which he contributed on the subject of the position of the zinc industry at the close of 1919, points to the successful application of the electrolytic reduction of zinc ores in the face of much scepticism as to its commercial possibilities, and concludes his paper with these words :—"What is going to be the position of England's spelter industry in the next five years? If we are going to compete successfully, having regard to the high cost of fuel and materials and high cost of labour and labour difficulties, we must start to put our house in order. Fuel and labour are going up in price all over the world. The relation of labour to the general scheme of production is changing, and generating more or less friction in the process, and the successful competitors will be those who have tackled the problem of spelter production most radically and with least regard to hampering tradition." Wise words these.

Another instance of the value to the mineral industry of scientific research of possible far-reaching results may be mentioned. Mr. Picard, in his admirable presidential address to the Institution of Mining and Metallurgy in 1919, covering a wide survey of recent metallurgical progress, said :—"In the province of general metallurgy the increasing use of the Cottrell process deserves special mention. As an example of painstaking research in developing a practical process from long known, but unused, scientific fact it has few equals. We have to go back to 1870, to the work of Tyndall, for the first disclosure of the phenomenon on which the process is based. This was further examined by Frankland, Lord Rayleigh, and Oliver Lodge; but for the useful application of the principles involved we had to wait for Dr. Cottrell. He first applied the method to depositing sulphuric acid produced in the contact process, and it is still being used for this purpose. It is satisfactory to report that the merits of the invention have been recognised in this country, the first plant to be erected here in 1917 being at one of the Government acid plants. It is also in use here for the precipitation of fumes from metallurgical works, following established practice in America; its further application in this country seems certain. The advantages of the process are far-reaching; not only are valuable products recovered, but agriculture in the neighbourhood of the operations is saved from serious damage."

The Cottrell electrostatic recovery process of flue-dust and furnaces consists, as you are doubtless aware, in separating solid and liquid substances from gases in which they are held in suspension and electrically precipitating them.

There are many more fields of research on minerals which I should have liked to discuss had time permitted, such, for instance, as the extraction of aluminium from clays and from the felspar labradorite; the possible utilisation of magnesia cement for the protection of mine timber; the use of ferro-boron in making remarkably strong and tough steels; the possibility of extracting on a commercial scale potash from orthoclase felspar; the cheapening of the production of thorium nitrate from monazite—large residues of cerium compounds are obtained as a by-product, formerly regarded as useless, but now used for supplying the cerium required in the manufacture of the alloy ferro-cerium used in sparking devices—and so on. But all minerals present a field for research, and time does not permit my passing these fields in review. The few instances I have given have been selected with the view of emphasising the point I started off with, namely, that scientific research is one of the factors, and an important one at that, necessary to the development of the mineral industries and to our commercial prosperity. Much more extensive research work is necessary if we are to take full advantage of our mineral resources (with which a bountiful Providence has provided us) by rendering available ores and products therefrom which cannot now be used, and extending the use of those already in commercial consumption and producing them more cheaply.

How should research be organised and carried out? Empirical investigations must be based upon a scientific foundation if they are to be of ultimate and practical value. It has, however, been well said that if an investigator does not possess the inventive faculty as well as the purely scientific, the value of the work is apt to be largely lost. The discovery of new facts or principles is one thing, and is a characteristic of the academic type of mind, whereas the discovery of new uses for such facts or principles is another thing, and is typical of the commercial mind.

In this work of research the universities are peculiarly fitted to take an important, a leading, part. The research should not necessarily be pursued along definite lines with a definite object in view; the great discoveries were not made in that way. The Department of Scientific and Industrial Research might well endow university scientific research on chemical, metallurgical, and engineering work, supervising and co-ordinating and publishing the results. Effort is largely commensurate to the prize offered, and the discoverer should be rewarded for his labour and genius; but that would be a matter easy of arrangement. A certain amount of overlapping in scientific work is not inadvisable, but the Department would see to it that there was not undue overlapping. I offer the suggestion for what it is worth. Research associations undoubtedly perform useful, even highly valuable, functions, but the wind of science bloweth where it listeth, and the time is ripe for a realisation of the fact that scientific research cannot profitably be hampered by restrictions confining the efforts of those who are employed therein. It is of the essence of research that it should be free and untrammelled.

The Imperial Mineral Resources Bureau is not a

Bureau for research, as research is ordinarily understood, but owing to the nature and extent of the machinery which it has at its disposal, including its corresponding members throughout the Dominions and Colonies, its technical advisory committees—active bodies comprising some 151 members, who are among the leading authorities on the respective minerals and the industries connected therewith—it is in an exceptional position for disseminating suggestions, shaping problems to which they give rise, and carrying out the necessary preliminary surveys, without which it would be difficult to advise as to whether a problem should be brought before organisations such, for instance, as the Department of Scientific and Industrial Research, the province of which is the carrying out of research.

The Genetics of Sex.

By PROF. R. RUGGLES GATES.

THE investigation of the chromosomes in a large number of insects and other animals has shown that the so-called X- and Y-chromosomes furnish a mechanical basis for the determination of sex in the fertilised egg, its inheritance in later generations, and the usual occurrence of approximate equality of the two sexes when one of them is heterozygous (XY or XO). The fundamental character of this relation between the X- and Y-chromosomes and sex is now generally admitted. It would appear that the difference in the chromosome content of the nuclei in the two sexes affects the metabolism during development in such a way as to produce one sex or the other, and in some groups to affect the secondary sexual characters as well. Combined cytological and breeding investigations have shown further that in most insects and mammals, including man, the male is the heterozygous sex, while in the Lepidoptera and birds the female is heterozygous.

Recent work on the subject of sex in animals accepts this situation, and is building upon it a further analysis of sex-differences. The most active lines of work have been (1) in connection with the discovery and interpretation of intersexes in various animals and plants, and (2) in the explanation of the departures from equality in the numbers of the sexes under a variety of conditions, normal or experimental. It is now clear that these results do not negative a chromosome hypothesis of the fundamental distinction between the sexes, at least in animals, but rather supplement it in an important way. Sex intergrades have been studied by Goldschmidt in the Gipsy moth, by Banta in Daphnia, and by Sturtevant and others in Drosophila; also in plants there have been the studies of intersexes in Mercurialis by Yampolsky and in Plantago by Bartlett and others. These investigations are still in progress, and it is only necessary to say that they are not out of harmony with a chromosome hypothesis of the origin of the sex-differences, although the situation in plants remains to be cleared up.

Of more immediate interest here are the cases where one of the sexes preponderates. Mr. Julian Huxley (see reference in NATURE, March 24, p. 116) has recently shown how in the millions fish (*Girardinus poeciloides*) a great preponderance of females, followed by a lesser preponderance of males, and finally by equality of the sex-ratio, can be best explained by assuming that the chromosome-constitution of the individual has been temporarily overridden by external influences. The important work of Riddle in controlling the sexes in pigeons may ultimately receive a similar explanation.

In an article by Mr. Alan S. Parkes (*Science Progress*, April, 1921) the author has applied somewhat similar conceptions to the explanation of the well-known departures from equality of the sex-ratios in man. The statistics from the reports of the Registrar-General, 1838–1914, show an average for this period of 1040 males to 1000 females. There is a similar preponderance of male births in most parts of the world, but in a few regions females preponderate. It is also a remarkable fact that fluctuation in the proportion of male births follows closely the rise and fall in the price of food. Statistics appear to show further a remarkable rise in the proportion of male births throughout Europe during the war, and it is suggested that war conditions were "in some obscure way beneficial to the welfare of the Y-gametes." That racial differences in the sex-ratio exist is shown by comparing Jews with Christians; it appears that the former in all countries show a greater excess of male births, while the crossing of races is also known to disturb the sex-ratios.

From a study of a number of genealogies of British families Mr. Parkes finds that families occur in which the preponderance of males is much greater than 1040 : 1000, and that this condition is inherited through the male, some strongly male-bearing strains producing more than 58 per cent. in excess of the above frequency considered as the normal.

A new type of inheritance of secondary sexual characters has recently been discovered by Schmidt (*C. r. Trav. Lab. Carlsberg*, vol. xiv., No. 8) in the fish *Lebistes reticulatus* from Trinidad. He shows that the inheritance of a black patch on the dorsal fin of the males in one race is transmitted exclusively from male parent to male offspring, never appearing in the female line at all. This is explained by assuming that the spot is determined by the Y-chromosome, for it is distributed in inheritance as the Y-chromosome is distributed. Hitherto in all cases investigated the Y-chromosome has appeared to be inactive in inheritance, the only evidence against this being the fact that males of Drosophila which lack it are sterile. The chromosomes of *Lebistes reticulatus* are now being investigated.

On the basis of this result of Schmidt, Castle (*Science*, April 8, p. 339) has built up an interesting speculation concerning the origin and relationships of the various types of sex-determining chromosomes. Briefly, his suggestion is that the X-chromosome was originally a cytoplasmic body handed on exclusively through the egg, like a plastid, and determining the female condition by its presence. This becomes included in the egg nucleus and is duplicated by splitting, thus giving rise to the condition XX in females and XO in males. If it does not split, a Y element may "develop" as its synaptic mate in the egg, passing later into male offspring, and, through non-disjunction (as in Drosophila), ultimately producing YY males which are assumed to be viable; they would give rise, as in Abraxas, to the condition in which the female is the heterozygous sex. In criticism it may be said that there is no cytological evidence of the transformation of a cytoplasmic body into a chromosome, unless the "chromatoid body" of Wilson be such a case. But it occurs in addition to the

X-chromosomes. The sex-chromosomes, it is true, frequently differ in their behaviour from the other chromosomes, but the usual assumption that the Y in insects is undergoing gradual reduction has strong evidence in its favour, and the XO condition in males can be accounted for either by its ultimate disappearance in this way or by non-disjunction. This, however, admittedly leaves unexplained the origin of the condition in moths and birds, in which the female is the heterozygous sex.

Finally, it may be added that the discovery of sex chromosomes in the liverwort Sphærocarpos by Prof. Allen (Proc. Amer. Phil. Soc., vol. lviii., p. 289) places the sex differentiation of this group of plants in a new light, and affords a basis for an instructive comparison with the conditions in animals. For a large X-chromosome is found in the nuclei of the female gametophyte, and a small Y in the cells of the male gametophyte. The fertilised egg then contains an X and a Y, which are separated in sporogenesis. Half the spores contain an X and half a Y. This is quite different from the situation in insects where the XY combination produces a male. It is also simpler, the differentiation of the sexes arising through segregation of the X and Y, and the chromosome combination of the sporophyte corresponding to that of males in animal species in which the male is the heterozygous sex.

University and Educational Intelligence.

CAMBRIDGE.—Mr. P. Lake, St. John's College, has been reappointed to the Royal Geographical Society's readership in geography; Dr. J. A. Crowther, St. John's College, appointed University lecturer in physics as applied to medical radiology; and Mr. S. E. Hollingworth, of Clare College, elected to the Harkness scholarship in geology. The Wiltshire prize in geology has been awarded to Mr. A. G. Brighton, Christ's College, and Mr. H. C. G. Vincent, Fitzwilliam Hall.

Mr. W. Campbell Smith and Mr. R. H. Thouless have been elected fellows of Corpus Christi College.

LIVERPOOL.—Dr. McLean Thompson, of the University of Glasgow, has been appointed to the Holbrook Gaskell chair of botany in succession to Prof. R. J. Harvey-Gibson, resigned.

LONDON.—At a meeting of the Senate held on June 22 Sir Sydney Russell-Wells was re-elected Vice-Chancellor for the year 1921–22.

Dr. G. Cook was appointed to the University chair of mechanical engineering tenable at King's College, and Mr. L. Hawkes to the University readership in geology at Bedford College. The title of emeritus professor of philosophy and comparative psychology in the University was conferred on Mr. Carveth Read.

Grants were made from the Dixon Fund to Mr. F. J. F. Barrington, Mr. E. J. Evans, Prof. J. P. Hill, Miss G. Z. L. Le Bas, Mrs. M. M. Neilson-Jones, Prof. Karl Pearson, Mr. J. W. D. Robinson, Mr. D. M. Shaw, Mr. H. G. Smith, and Miss D. M. Wrinch.

The following doctorates were conferred :—*D.Sc. in Zoology:* Mr. W. A. Cunnington. *Ph.D. in the Faculty of Economics:* Mr. S. G. Panandikar. *Ph.D. in the Faculty of Science:* Mr. H. E. Cox and Mr. H. H. Morgan.

MANCHESTER.—The sum of 1000*l*. has been contributed to the appeal fund by Alderman H. Plummer.

OXFORD.—On Wednesday, June 22, the honorary degree of Doctor of Science was conferred on Prof. C. S. Sherrington, president of the Royal Society.

IT is announced that Mr. F. S. Edie, lecturer in biochemistry at Aberdeen University, has been appointed to the chair of biochemistry in the University of Cape Town.

M. E. DEUTSCH DE LA MEURTHE has made a donation of 10,000,000 francs to the University of Paris to provide for a university quarter where students may live at a moderate cost.

MR. W. J. JONES, senior lecturer in chemistry in the University of Manchester, has been appointed professor of chemistry in the University College of South Wales and Monmouthshire, Cardiff; and Prof. A. W. Sheen, of the Welsh National School of Medicine, to the chair of medicine at the same institution.

THE Aitchison memorial scholarship of the value of 36*l*., tenable in the full-time day courses in technical optics at the Northampton Polytechnic Institute, Clerkenwell, is being offered. The examination for the scholarship, open to both sexes, will be held on September 27 and 28. Full particulars can be obtained from Mr. H. F. Purser, 35 Charles Street, Hatton Garden, E.C.1.

TWO scholarships, each of the value of 200*l*., are being offered by the Rubber Advisory Committee of the Northern Polytechnic Institute, Holloway, to enable students who have obtained a good degree in chemistry to attend for a year's special training in rubber technology. Applications, with particulars of the candidates' careers, copies of recent testimonials, and names of referees, must be sent to the Principal of the institute not later than July 5.

THE announcement which appeared in the daily Press last week of the retirement of Prof. Henri Bergson from his chair at the Collège de France merely meant to his friends that he had at last given effect to an intention long contemplated. Owing to the strain of the international work which he undertook for the French Government with such fervour during the critical years of the war, he was compelled to avail himself of the privilege which the Collège allows its members of nominating a deputy, and for some time past M. Edouard Le Roy has occupied his place in the lecture-room. Now that Prof. Bergson is able to take up again the interrupted work of philosophy, he finds that he can hope to do original research only by obtaining relief from the routine work of lecturing. This, and nothing else, is the reason of the resignation which is now announced. The Collège de France, in which Prof. Bergson has held the chair of philosophy for more than twenty years, is a unique institution. Founded by Francis I. in 1530, in opposition to the Sorbonne and the universities, it has retained its high position and character. It is perhaps the only educational institution which survived the Revolution unchanged. Its lectures are without exception open to the public and free. Even a registered student cannot obtain the privilege of a reserved seat. When a professorial chair becomes vacant the successor is elected by the professors, who are not handicapped in their choice by academical regulations of any kind. The appointment entails the duty of delivering two courses of lectures in each session, neither of which may be a repetition of a course previously delivered either in the Collège or elsewhere.

Calendar of Scientific Pioneers.

June 30, 1817. Abraham Gottlob Werner died.—The most renowned geologist of his day, Werner for forty years was professor in the Mining School at Freiburg, which became under him "the European lodestar for the study of mineralogy and geognosy."

June 30, 1857. Alcide Dessalines d'Orbigny died.—Distinguished in early life for his journeys in South America, d'Orbigny in 1840 began the publication of his great work, "Paléontologie Française." In 1853 a chair of palæontology was specially created for him at the Musée d'Histoire Naturelle.

June 30, 1919. John William Strutt, third Baron Rayleigh, died.—Born in 1842, Lord Rayleigh succeeded to the title in 1873. He was educated at Cambridge, succeeded Maxwell in 1879 as Cavendish professor of experimental physics, and in 1887 followed Tyndall as professor of natural philosophy at the Royal Institution—a position he resigned in 1905. His scientific writings embrace every branch of physics, and are known for their extreme accuracy and definiteness. His name is associated with that of Ramsay in the discovery of argon.

July 1, 1881. Henri Etienne Sainte-Claire-Deville died.—Professor of chemistry at the Ecole Normale and in the Sorbonne, Sainte-Claire-Deville carried out important investigations on dissociation.

July 1, 1899. Sir William Henry Flower died.—Flower was Hunterian professor of comparative anatomy and physiology, and for fourteen years acted as director of the British Museum (Natural History).

July 2, 1621. Thomas Harriot died.—The contemporary of Napier and Briggs, Harriot made important improvements in algebra, and his "Artis Analyticæ Praxis," published ten years after his death, did much to bring analytical methods into general use.

July 3, 1672. Francis Willughby died.—An original member of the Royal Society, Willughby was the companion of Ray, and wrote on birds and fishes.

July 4, 1850. William Kirby died.—Rector of Barham, in Suffolk, from 1796 to 1850, Kirby was known for his writings on entomology.

July 4, 1901. Peter Guthrie Tait died.—Tait succeeded Forbes in the chair of natural philosophy at Edinburgh. He was known for his collaboration with Lord Kelvin, his advocacy of quaternions, and his work on thermodynamics and other subjects.

July 4, 1902. Hervé Auguste Etienne Alban Faye died.—President of the Bureau des Longitudes from 1874 to 1893, Faye in 1884 published his "Sur l'Origine du Monde."

July 4, 1910. Giovanni Virginia Schiaparelli died.—A great observer of comets, meteors, double stars, and especially of the planets, Schiaparelli from 1862 to 1900 directed the Milan Observatory.

July 5, 1833. Joseph Nicéphore Niepce died.—One of the pioneers in photography, Niepce began his experiments in 1813. He afterwards collaborated with Daguerre.

July 5, 1859. Baron Charles Cagniard de la Tour died.—Cagniard de la Tour made improvements in mechanical and chemical processes and invented the siren.

July 5, 1906. Paul Drude died.—A distinguished physical investigator, Drude applied the theory of Maxwell as developed by Hertz to the problem of light. He edited the *Annalen der Physik*.

July 5, 1911. George Johnstone Stoney died.—Stoney held important educational posts in Ireland, and contributed to physical optics and molecular physics. To him we owe the term "electron."

E. C. S.

Societies and Academies.

LONDON.

Royal Society, June 23.—Prof. C. S. Sherrington, president, in the chair.—E. F. **Armstrong** and T. P. **Hilditch**: A study of catalytic actions at solid surfaces. VI.—Surface area and specific nature of a catalyst: two independent factors controlling the resultant activity. The influence of the surface area of a nickel catalyst on its activity has been traced by examination of the bulk gravity of various types of catalyst: the most efficient catalyst occupies the greatest volume per unit mass. The rate of reduction in hydrogen of nickel oxide prepared in various ways has been examined at various temperatures. A light nickel oxide prepared from the precipitated hydroxide gave curves (hydrogen consumption/time) showing faint points of inflexion, which varied with the temperature of reduction; dense, fused nickel oxide gave a smoother curve, and nickel hydroxide deposited on kieselguhr as a support showed a smooth, continuous curve. The reduction curves are related to the physical conditions rather than to the formation of any definite compounds. When a support (kieselguhr) is overloaded with nickel hydroxide and reduced so that varying proportions of the nickel are in the metallic state, catalytic activity increases rapidly to a maximum, which is maintained until all the nickel hydroxide has been reduced to the elementary state. Catalytic activity is dominated by the condition of the surface layer of reduced nickel.—Sir J. B. **Henderson**: (i) A contribution to the thermodynamical theory of explosions; (ii) with Prof. H. R. **Hassé**. Advances in chemical thermodynamics, dealing with dissociation of gases and variation of their specific heats with temperature, are applied to the science of internal ballistics. Direct experiments on specific heats of gases are limited to temperatures below 1500° C., and extrapolation, based upon thermodynamic theory and extending to temperatures of 3500° C. and to pressures of 20 tons per sq. in., tests the theory severely. Part (i) contains the application of these theories to the calculation of the explosion-pressure of cordite in closed vessels, and the calculation of the curve of adiabatic expansion of the products of explosion by considering a series of states of equilibrium and, following thereon, the ideal indicator diagram of a gun. In part (ii) the curve of rise of pressure and the maximum pressure allowing for burning of cordite in parallel layers and for varying capacity of chamber during burning, due to movement of the projectile, are calculated. The results enable the indicator diagram of gun, maximum pressure, and muzzle velocity of projectile to be calculated accurately from the chemical composition of explosive used and rate of burning of the cords. They also show the effects produced by variations in initial pressure, density of loading, temperature of charge, diameter of cords, etc. The method is also applicable to internal-explosion engines using gas or oil.—S. **Butterworth**: Eddy current losses in cylindrical conductors, with special applications to the alternating current resistances of short coils. A general series for the eddy current losses produced in a non-magnetic metallic cylinder when placed in a transverse field of any form is developed. The theory gives an approximate solution of the problem of the effective resistance of two equal parallel wires carrying equal currents either in the same or in opposite directions. The "uniform field" theory is applied to determine the effective resistance of parallel wire systems, and, by calculating the mean square field acting throughout the section of the coil, formulæ are obtained for the effective resistances of single- and multi-layer solenoidal coils of either solid or stranded wire. Conditions producing the maximum value of L/R′ for a given length of wire of given diameter are deduced. The observed inferiority of stranded wire coils as compared with solid wire coils at high frequencies is due to the lack of internal spacing of the strands of the coils making the best conditions unattainable. —E. S. **Bieler**: The currents induced in a cable by the passage of a mass of magnetic material over it. The mass used is in the form of a spherical shell, and the deflection of a critically damped galvanometer in series with the cable is deduced. The results agree with those of experiments carried out in the laboratory on a small scale. The theoretical results are used to determine the law of variation of the galvanometer with different factors, and the relation between the galvanometer deflection and the E.M.F. which produces it.—Dr. G. **Barlow** and Dr. H. B. **Keene**: The experimental analysis of sound in air and water: some experiments towards a sound spectrum. The original sound vibration gives rise to an electric current of telephonic magnitude, which is analysed by a method of periodic interruption. A motor-driven interrupter with a range of interruption frequency from 3–2000/sec. is placed in series with a Broca galvanometer in the circuit containing the alternating current to be analysed. The speed of the interrupter is then slowly varied. When the interruptions synchronise with any component of the current, the galvanometer gives a steady deflection, the magnitude of which depends on the phase difference. Thus the amplitude of each component may be determined, and at the same instant the corresponding frequency is observed stroboscopically. Experiments were made (1) to test the trustworthiness of the method by analysing alternating currents containing known constituents; (2) to analyse different types of sound in air, using both carbon microphone and magnetophone receivers; (3) to analyse sounds in water. The variations of the sound spectrum with distance, depth, and direction are investigated, and the spectrum of a motor-driven boat is obtained under various conditions.—Dr. G. **Barlow**: The theory of the analysis of an electric current by periodic interruption. A mathematical treatment of the method of periodic interruption used in the experimental analysis of sounds described in the previous paper is given, with an explanation of the effects of periodic interruption on the intensity and quality of sounds heard in a telephone.

Geological Society, June 8.—Mr. R. D. Oldham, president, in the chair.—Dr. W. F. **Hume**: The relations of the northern Red Sea and its associated gulf-areas to the "rift" theory. The areas specially considered are the northern portion of the Red Sea and the "Clysmic Gulf" (from "Clysma," the Roman name for Suez), defined as the district lying between the fault-bounded ranges of Egypt and Sinai. Within its borders Miocene deposits are of wide distribution; beyond them they are absent. The folds within this region are from north-west to south-east, outside it the trend is frequently almost at right angles. A line prolonging the direction of the western coast of the Gulf of Akaba to the shores of Egypt divides the Clysmic Gulf from the Red Sea, the former being one of complicated fold-and-fracture effects, while in the latter only fold effects have been observed. It is concluded that the whole region underwent extremely slow submergence, the negative movements continuing from early Jurassic to late Cretaceous times. Emergence of new land probably took place near the close of the Eocene period. It is suggested that the area was occupied by an anticline plunging northwards in the Clysmic Gulf region, and that it was subject first to marine and then to subaerial erosion. This formed part of the continent on which grew the trees of the Petrified Forest, and on which wandered animals such as the Arsinoitherium and the earliest elephants. The continental period was most marked during late Eocene and early Miocene times, and the area dealt with here appears to have become one of very varied ridge and depression. The whole region was slowly invaded by the ancient Mediterranean during the Miocene and Pliocene periods. The pre-existing ridges became coral-reef centres and the intervening depressions were filled up, first by land-derived deposits and then by lagoon formations. The earliest of these formations appear to have been of Schlier (Middle Miocene) age. The whole region of the Clysmic Gulf became folded and fractured. There is strong faulting at the borders with the igneous hills, and fold-ranges are of asymmetrical anticline type. Compression of the area, with uplift of portions, offers the best solution for the fact observed. Dislocation so marked and so widespread could scarcely arise under rift formation as defined by Prof. J. W. Gregory, nor can the whole of the surface-differences be ascribed to erosion. No simple solution of the problem can be offered on the evidence at present available, especially in view of the fact that no important faulting has been noted on the western borders of the Red Sea. The portion of the Nile Valley about latitude 26° N., where faulting is most conspicuous, may have been initiated by erosion of a sharp anticlinal fold due to the compression of almost horizontal strata. Sharp folds exist in the desert east of the Nile, but their origin is doubtful.

Physical Society, June 10.—Dr. C. Chree, vice-president, in the chair.—Sir Ernest **Rutherford**: The stability of atoms. Traces of hydrogen and helium had been found in discharge tubes believed to be initially free from these gases; but it was impossible to establish that no source of contamination was available. It is necessary to attack the nucleus of the atom, and to do this successfully requires extremely swift particles. The effects produced when α-particles fired through hydrogen collide with an atom were shown, and experiments were described from which the conclusion had been drawn that when an α-particle collides with a nitrogen atom, a hydrogen atom is expelled from the nucleus. The speed of these is in excess of what can be obtained by collisions in hydrogen gas itself, so that the result must be due to the disintegration of the nitrogen nucleus rather than to contamination with hydrogen. Results on the disintegration of aluminium and other elements were also indicated.

Linnean Society, June 16.—Dr. A. Smith Woodward, president, in the chair.—Prof. A. H. R. **Buller**: The ocellus function of the subsporangial swelling of Pilobolus. The subsporangial swelling of Pilobolus functions as a squirting apparatus, and also as an ocellus, which receives the heliotropic stimulus which causes the stipe to turn the fungus gun towards the light. The swelling is transparent and refracts light. It appears to be the only orthoheliotropic plant organ known which has a special light-perceiving cell-structure, which is sometimes described as a simple eye.—Dr. N. **Annandale**: The vegetation of an island in the Chilka Lake. The area of the island is about one-third of a square mile, and the rocks are composed of garnet-bearing quartzite which yields an infertile and scanty soil on weathering. The climate is relatively dry. The vegetation consists mainly of trees, shrubs, and perennial creepers, with a great scarcity of herbs, ferns, and epiphytes, and a complete absence of palms, bamboos, screw-pines, and orchids. Several distinct zones of vegetation can be distinguished. The peculiarities of the fauna can be correlated directly with the vegetation.—Col. M. J. **Godfery**: The fertilisation of the orchid genus Cephalanthera. The author holds that Cephalanthera is an old genus, and was not derived from Epipactis.

PARIS.

Academy of Sciences, June 6.—M. Georges Lemoine in the chair.—The president announced the death of M. J. B. A. Gaillot, correspondant for the section of astronomy.—G. **Friedel**: The calculation of the intensity of X-rays diffracted by crystals: A correction.—S. **Pincherle**: An integral equation in the complex domain.—B. **Gambier**: Applicable surfaces and the equation of Laplace.—M. **Auric**: The theory of ideal algebraical numbers.—A. **Tian**: The stability and the reversibility of the transformations of the hydrosols obtained by the hydrolysis of salts.—Mlle. **Wolff**: Studies on the molecular refraction and specific rotatory power of furfuralcamphor and some of its derivatives.—Mlle. S. **Veil**: Allotropic varieties of oxides. The conductivity of various metallic oxides measured at varying temperatures has been shown to increase with the temperature, similarly to electrolytes. Magnetic iron oxide and cadmium oxide offer peculiarities, since the conductivity-temperature curves for these show points of inflection. These changes can be attributed to the formation of allotropic forms of the oxides.—C. **Chéneveau**: The variation of the specific refraction of dissolved salts in dilute solution. A study of the specific refraction of dilute solutions of ammonium nitrate, potassium chloride, and magnesium nitrate.—M. **Billy**: The peroxide of titanium. The hydrates of titanium, hitherto regarded as derived from the oxide TiO_3, are shown to be complexes of hydrogen peroxide and the peroxide Ti_2O_5.—E. **André**: Contribution to the study of the oils from grape-seeds.—J. **Martinet** and O. **Dornier**: Some new sulphonic derivatives of oxindol and of isatin.—A. **Mailhe** and F. **de Godon**: The preparation of mixed secondary and tertiary phenolic amines. The vapours of aniline and ethyl alcohol passed over alumina at 350° to 380° C. gave a mixture of mono- and di-ethylanilines. The method is shown to be of general application.—F. **Zambonini**: The palmierite of Vesuvius and the minerals which accompany it.—M. **Romieux**: The controversy as to the displacement of shore levels and the phenomena of equideformation.—J. **Cvijić**: Relief of the seashore and river terraces.—A. **Carpentier**: Discovery of a Weald flora in the neighbourhood of Avesnes.—P. **Schereschewsky**: Systems of clouds. Suggestions for a new system of cloud observations. Different states of the sky should be observed simultaneously from a number of stations spread over a wide area.—O. **Mengel**: Influence of the relief and of the heating of the soil on surface winds.—M. **Bridel** and R. **Arnold**: A method allowing the application to plants of the biochemical method of detecting glucose. The method is based on the property possessed by emulsin of causing the combination of glucose with the alcohol holding it in solution. Full details of the technique of extraction and purification of the plant product before submitting it to the action of the emulsin are given.—N. T. **Giung**: The botanical determination of foreign beans.—G. **Bioret**: The Graphideæ.—E. **Chatton**: False and true myogenesis in the pelagic Copepods. An error due to the non-recognition of cœlomic parasitic Peridinians.—C. **Pérez**: A supposed interstitial tissue in the testicle of lizards. A criticism of a recent communication on the same subject by M. Christian Champy.—H. **Bierry** and F. **Rathery**: Liver, blood plasma, and proteid sugar. The authors point out what they believe to be a function of the liver not hitherto noted, a qualitative and quantitative change in the composition of the blood plasma after passing through the liver.—J. P. **Langlois**: A moving belt for the study of walking and of work. A modification and improvement of a similar apparatus set up by Benedict at Washington.—MM. H. **Vallée** and **Carré**: Anti-aphthous hæmo-prevention and hæmo-vaccination.—G. **Bourguignon**: Chronaxy in neuromuscular Wallerian degenerescence in man.

NEW SOUTH WALES.

Linnean Society, April 27.—Mr. G. A. Waterhouse, president, in the chair.—G. I. **Playfair**: Australian fresh-water flagellates. An account of the forms known from collections made in the neighbourhood of Sydney and Lismore. Mention is made of 172 forms representing 39 genera, of which 96 forms and 1 genus are new.—Dr. R. **Greig-Smith**: Note upon the extraction of acids from cultures. In testing the products of fermentation of dextrose by a film yeast, succinic acid was obtained as the only fixed acid. The extraction of the fixed acids from bacterial or from yeast cultures is a monomolecular reaction. The preparation of salts by neutralising the acids until a pink colour is obtained in the presence of phenolphthalein may be faulty because the reaction is slower than is generally supposed.—Dr. A. B. **Walkom**: The occurrence of Otozamites in Australia, with descriptions of specimens from Western Australia. Three species of Otozamites and some obscure coniferous remains are described from near Mingenew. The rocks in which they occur consist of dark red ferruginous sandstone, which, with its wide distribution, constitutes an important stratigraphical horizon, and probably indicates a warm, moist climate for northern Australia in Jurassic time.

Books Received.

Le Mouvement scientifique Contemporain en France. No. 1: Les sciences naturelles. By Dr. G. Matisse. Pp. 160. (Paris: Payot et Cie.) 4 francs.

Relations intellectuelles avec les Centraux? "Ecrasons l'Infâme." By Maurice Lecat. Pp. viii+128. (Louvain, Ave. des Alliés 92; Bruxelles, Ave. bois Cambre 16: The Author.)

Faune de France. By P. Paris. No. 2: Oiseaux. Pp. iv+473. (Paris: P. Lechevalier.) 40 francs.

Handbook of Chemistry and Physics: A Ready-Reference Pocket Book of Chemical and Physical Data. By Prof. C. D. Hodgman and others. Eighth edition. Pp. 711. (Cleveland, Ohio: Chemical Rubber Co.) 3 dollars.

Imperial Institute: Indian Trade Enquiry. Reports on Timbers and Paper Materials. Pp. ix+57. (London: J. Murray.) 4*s*. net.

Psychoanalysis, Sleep and Dreams. By André Tridon. Pp. xiii+161. (London: Kegan Paul and Co., Ltd.) 7*s*. 6*d*. net.

A Dictionary of Chemical Solubilities: Inorganic. By Dr. A. M. Comey. Second edition, enlarged and revised. Pp. xviii+1141. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 72*s*. net.

La Radiologie et la Guerre. By Prof. Mme. P. Curie. Pp. 144+xvi plates. (Paris: F. Alcan.) 8 francs.

British Mammals. Written and illustrated by A. Thorburn. (In 2 vols.) Vol. ii. Pp. vi+108+plates 26–50. (London: Longmans, Green and Co.) 10*l*. 10*s*. net the 2 vols.

Common Stones: Unconventional Essays in Geology. By Prof. G. A. J. Cole. Pp. 259. (Common

Things Series.) (London and New York: A. Melrose, Ltd.) 6s. net.

Human Embryology and Morphology. By Sir A. Keith. Fourth edition, revised and enlarged. Pp. viii+491. (London: E. Arnold.) 30s. net.

The National Physical Laboratory: Report for the Year 1920. Pp. 132. (London: H.M. Stationery Office.) 5s. net.

Espace, Temps et Gravitation: La Théorie de la Relativité généralisée dans ses Grandes Lignes. By Prof. A. S. Eddington. Ouvrage traduit de l'Anglais by J. Rossignol. Pp. xii+262+iv+149. (Paris: J. Hermann.) 28 francs.

Liverpool Marine Biology Committee. Memoirs on Typical British Marine Plants and Animals. No. xxiv.: Aplysia. By Nellie B. Eales. Pp. viii+84+7 plates. (Liverpool: University Press.) 4s. 6d.

Memoirs of the Geological Survey. Special Reports on the Mineral Resources of Great Britain. Vol. xviii.: Rock-Salt and Brine. By Dr. R. L. Sherlock. Pp. vi+123+2 plates. (London: E. Stanford, Ltd.; Southampton: Ordnance Survey Office.) 5s. net.

Some Wemba Words: Some Meanings and Explanations. By E. B. H. Goodall. Pp. 140. (London: Oxford University Press.) 7s. 6d. net.

The Treaty Settlement of Europe: Some Geographic and Ethnographic Aspects. By Prof. H. J. Fleure. (The World of To-Day.) Pp. 83. (London: Oxford University Press.) 2s. 6d.

Diary of Societies.

THURSDAY, JUNE 30.

INSTITUTION OF CIVIL ENGINEERS (Engineering Conference), at 10 a.m.—W. W. Grierson: The Use of Reinforced Concrete on Railways.—H. J. Fereday: Impact Tests and Allowances.—A. H. Hall: The Influence of the Automatic and Semi-automatic Machine on the Skill and Resourcefulness of the Mechanic and Operator.—A. Musker: Mechanical Appliances and Labour in Loading and Unloading Ship's Cargoes.—Prof. W. E. Dalby: The Elastic Limit.—Prof. E. G. Coker: The Effect of Scratches in Materials.—C. P. Sandberg: Damage to Tires and Rails caused by Brakes or Slipping Wheels.—G. Hatton: The Existing Practice of Inspecting Work and Materials.—M. E. Denny: The Design of Fabricated Ships from the Labour-saving Point of View.—J. C. Telford: Economy of Labour on Shipbuilding as effected by Fabricated Ships, etc.—E. R. Mumford: Recent Tank Research in Screw Propellers.—E. H. Richards and M. G. Weekes: Straw Filters for Sewage-purification.—J. Haworth: Activated Sludge.—J. D. Watson: De-watering Sludge.—J. Dalziel: Battery Locomotives.

INSTITUTION OF MECHANICAL ENGINEERS, at 10.15 a.m.—Conference on the Means of Improving the Thermal Efficiency of Heat Power Plants.—H. E. Wimperis: Internal-combustion Engine Theory, with relation to Higher Economy.—F. Samuelson: High Steam-Pressure and other Means of increasing Economy of Steam-Engines.—E. V. Evans: Chemistry of Combustion.—A. Hutchinson and F. Bainbridge: Blast-Furnace Gases.—D. Wilson: Boiler-House Management (General Causes of Boiler Inefficiency).—Prof. W. A. Bone: Low Temperature Carbonisation.—H. Dunell: Engine-House Management (General Causes of Steam-Engine Inefficiency).—A. E. L. Chorlton: Super-Compression.

ROYAL SOCIETY, at 4.30.—Sir J. J. Dobbie and Dr. J. J. Fox: The Absorption of Light by Elements in a State of Vapour. The Halogens.—Prof. W. A. Bone and the late W. A. Haward: Gaseous Combustion at High Pressures. Part II. The Explosion of Hydrogen-Air and Carbon-monoxide-Air Mixtures.—Prof. A. E. H. Love and F. B. Pidduck: Lagrange's Ballistic Problem.—J. Proudman: The Principles of Internal Ballistics.—R. H. Fowler: A Simple Extension of Fourier's Integral Theorem and Some Physical Applications in particular to the Theory of Quanta.—Capt. D. Brunt: The Dynamics of Revolving Fluid on a Rotating Earth; and other papers.—The following papers will be read in title:—Takeo Shimizu: A Preliminary Note on Branched α-ray Tracks.—Takeo Shimizu: A Reciprocating Expansion Apparatus for detecting Ionising Rays.—Prof. R. W. Wood: The Time Interval between Absorption and Emission of Light in Fluorescence.

FRIDAY, JULY 1.

INSTITUTION OF CIVIL ENGINEERS (Engineering Conference), at 10 a.m.—R. G. H. Clements: Road Vehicles and their Relation to Road Surfaces.—A. Dryland: Advantages of Bituminous Macadam.—C. H. J. Clayton: The Conservancy and Maintenance of Rivers from the Point of View of Land Drainage.—R. F. Grantham: The Effect of Sluices and Barrages on the Discharge of Tidal Rivers.—G. E. W. Cruttwell: The Utility of Models for Estuarial Experiments.—H. C. Reid: The Relative Advantages of Dredging and Training-walls in Estuaries.—E. Latham: The Use of Inertia Gauges in Pile Driving.—A. L. Bell: The Bearing Power of Soils.—Sir James McKechnie: Internal-combustion Engines with Large Cylinders.—Sir Vincent L. Raven: The Mechanical Advantages of Electric Locomotives compared with Steam.—T. Crook: The Effect of the War on Mineral Supplies.—M. Deacon: The Utilisation of Exhaust Steam in Turbines.—W. C. Mountain: Steam *versus* Electric Winding.—S. Cowper-Coles: The Relative Values of Protective Metallic Coatings for Iron and Steel.—J. Richardson: Recent Progress in Large Diesel Engines for the Mercantile Marine.—R. J. Walker and S. S. Cook: Experience with Marine Turbine Reduction-gears.—E. Sandeman: Compensation Water.—F. W. Macaulay: Pipes for Pressure Conduits.—Dr. H. Lapworth: The Relation of Run-off to Rainfall.—Economic Limits of Distribution from Coal-fired Stations.—B. Welbourn: Low-voltage Overhead Distribution.

INSTITUTION OF MECHANICAL ENGINEERS, at 10.30 a.m.—Conference on the Means of Improving the Thermal Efficiency of Heat Power Plants.—R. Nelson: Waste-Heat Utilisation.—Sir Henry Fowler: Superheating.—Dr. W. R. Ormandy: Liquid, Colloidal, and Powdered Fuels.—H. Moore: Liquid Fuels (Internal-combustion Engines).—A. W. Bennis: Automatic Stokers.—W. H. Patchell: Air Heating for Boiler Furnaces.—C. E. Stromeyer: Feed-Heating and Economisers.—Prof. W. E. Dalby: The Indicator as an Aid to Economy.

GEOLOGISTS' ASSOCIATION (in Architectural Theatre, University College), at 7.30.—H. Bury: Some High-level Gravels of North-East Hampshire.

MONDAY, JULY 4.

ROYAL BOTANIC SOCIETY OF LONDON, at 3.—Prof. A. R. Bickerton: The Generic Simplicity and Great Importance of Basic Principles in all Scientific Work. (1) The General Graphics of Science.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street), at 8.—Dr. F. C. S. Schiller: Arguing in a Circle.

WEDNESDAY, JULY 6.

ROYAL SOCIETY OF MEDICINE (Annual General Meeting), at 5.—Presentation of Gold Medal to Sir Almroth Wright.

THURSDAY JULY 7.

MEDICO-LEGAL SOCIETY (Annual General Meeting) (at 11 Chandos Street, W.1), at 8.30.—Prof. A. Louise McIlroy: Some Factors in the Control of the Birth-rate.

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