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Research and Education in the Geddes Report.

THE first and second sections of the interim Report of the Committee on National Expenditure, presided over by Sir Eric Geddes, were published on February 10 (Cmd. 1581, 4*s*. net; Cmd. 1582, 3*s*. net), and the particulars of expenditure and proposed economies in the various supply services are receiving much public attention. Throughout the Report reductions are recommended in expenditure on education and research, on the general principle that the reduced resources of the nation at the present time make all possible economies essential. Thus we have such sweeps of the axe as :—Research for Army purposes to be reduced from 625,000*l*. to 312,000*l*.; Naval scientific services (400,000*l*.) to one-half; aviation research from 1,500,000*l*. to 500,000*l*.

The attitude of the Committee towards education and research, which is disclosed in the supercut of 18,000,000*l*. in the Board of Education Vote, is dominated by the narrow commercial view of goods to be delivered for money expended. The contemptible sum doled out to agricultural education and research before the war, when compared with the amounts spent in foreign countries—notably in the United States—was notorious. During the post-war reconstruction, as we noticed at the time, important administrative reforms were introduced, directed mainly to the future recruitment of the best scientific talent, which justified the hope that this country would regain the pre-eminence in agricultural science which it once enjoyed. In England and Wales the cut proposed involves a drop from 365,000*l*. to 250,000*l*.; in Scotland from 112,000*l*. to 62,000*l*. In the former case the provision for research is reduced from 109,000*l*. to 75,000*l*., and if carried out literally will involve the dismissal of staff holding pensionable posts, and, possibly, the abandonment of land and buildings specially equipped for scientific purposes.

In some respects these recommendations are as astonishing as any contained in the report; for under the provisions of the Corn Production (Repeal) Act of 1921—passed, be it noted, after the economy campaign was begun—a sum of 1,000,000*l*. was voted for *additional* expenditure on agricultural education and research. It would almost seem that the Committee, which professes to exclude this sum from consideration, has deliberately aimed at opening an abyss into which this million shall disappear. For it should be noted that, in terms, the cut includes the Development Fund, and as that fund is almost on its last legs (the balance now in hand will little more than suffice for one year's normal requirements), the operation suggested is one which, in the vernacular of some members of the Committee, is known as "taking the breeks off a Highland man." Even if the Development Commissioners, in the exercise of the discretion which the Committee leaves them, use the Corn Production Fund to fill the gap created in the old fund, the remedy would be temporary only, and, in any event, would create the anomaly of giving preferential treatment to agricultural education and research. What does business acumen think of adding a top story to a building and at the same time destroying the ground floor?

The activities of the Forestry Commission are threatened with extinction by the Report, which recommends that the scheme of afforestation by the State shall be discontinued, that the vote of 275,000*l*. for the ensuing financial year shall not be allowed, and that steps should be taken to cancel the remaining 2,822,000*l*. of the 3,500,000*l*. authorised for the decade following 1919, the date of the Forestry Act. In the Report no complaint is made about the work or the administration of the Forestry Commission. It simply says: "We recognise the enthusiasm and public spirit of the Commissioners, but in the present state of the country's finance we cannot recommend that this expenditure—which will always show a heavy loss, and which cannot reach full fruition for something like eighty years—should be continued."

Foresters believe that afforestation will show a

profit rather than a loss, but this is not the real issue. The Committee ignores the main argument for afforestation in Great Britain—namely, national security. This country, without an adequate supply of timber within its own shores, is exposed to great peril in time of war. During the Great War the expenditure incurred on foreign timber was 200,000,000*l.* more than if the prices of 1913 had prevailed, and the enormous cargo space needed for such a bulky import endangered our food supply from overseas, and at one time brought us to the brink of starvation. The insurance against such a calamity—350,000*l.* annually—is a trifle. No heed is given in the Report to the cheapness of the afforestation, which is carried out in many cases on leased land, no capital expenditure for land purchase being required. The Government in November last actually allotted to the Forestry Commission an extra 250,000*l.* out of the Unemployment Fund, which puts 5000 idle men at work in replanting the woodland areas felled during the war. The Forestry Commission has acquired large areas of land; it has entered into many leases and contracts; it owns millions of seedling trees ready for transplanting; it has established schools for woodmen and instituted research. It is evident that the "scrapping" of such an efficient service would result in an immediate great loss of money and be a waste rather than an economy.

The section of the Report dealing with education is of special interest in so far as it carries to extreme limits that separation between the finance of education and education proper which is the characteristic tendency of the business man of to-day when he considers such matters. The obvious danger of this tendency is that finance comes to be looked upon as the only thing which matters in education, and this danger is particularly exemplified in the Report.

It should be clearly understood that the Report is the product of business men accustomed to deal with affairs on a large scale, especially in respect of railways and shipping. They are men who have made their reputation mainly in transport services, but apparently know little or nothing about education from the inside, and, so far as we are aware, make no claim to any expert or special knowledge of the subject. For example, their recommendation that children should not be taken into State-aided schools until they have reached the age of six is based, as they are careful to explain, upon the opinion of others. Obviously they do not pretend to understand the educational bearing of the question, and wisely throw the onus upon others whom, still more wisely, they carefully omit to name.

All the same, we naturally expect them to show a masterly grasp of finance, and we are not disappointed. They handle figures running into hundreds of millions with an ease and freedom and a dexterity which cannot but provoke our admiration. Occasionally—but only occasionally—they lose their balance and their business acumen, and, in their desire to cut down the Estimates, suggest proposals which would actually increase the public cost of education. A flagrant instance of this is their recommendation to withdraw Parliamentary grants from a certain type of secondary school, regardless of the fact that local education authorities have helped to support such schools "because it was cheaper for them to do so than to set up secondary schools of their own." Even a committee of business men can be too solicitous of the Exchequer!

In the main, then, as regards education, the Report deals with finance, and only incidentally or by implication with education *per se*. The task of the Committee is to cut down the Estimates, and the net result of the proposals, if adopted, would be, as we have said, to reduce the education grant by 18,000,000*l.* This is to be achieved by reducing the salaries of teachers and making them contribute 5 per cent. of their reduced salaries for superannuation purposes; by increasing the number of pupils for each teacher in elementary schools; by limiting the number of those granted free secondary education; by a reduction in the number of scholarships; by discontinuing the State scheme of scholarships at the universities; and by cutting down the annual grant to the universities. In addition, the Committee recommends the abolition of the percentage grant system, which it characterises as a money-spending device. "The vice of the percentage grant system," so runs the Report, "is that the local authority, which alone can really practise economy in these services, loses much of its incentive to reduce expenditure, especially when the larger proportion is paid by the taxpayer through the Exchequer." As a substitute, fixed grants or grants based on some definite unit are recommended. In this way the Committee hopes that the local education authorities will be discouraged from spending money on education, and is not ashamed to avow this. No charge of wanton waste or of useless expenditure is laid against local authorities.

The danger of dissociating the finance of educa-

tion from education is obvious when a Committee can make such drastic proposals without giving some assurance that the recommendations would not reduce national efficiency. It may be easy to deal with educational finance on the shipping and railway plan, but it is not possible to deal with education on the same plan. Education means something bigger than business accountancy. It means knowledge, vision, a sense of humanity, and some recognition of the spiritual aspects of civilisation.

Apart from considerations such as these, Sir Eric Geddes and his Committee have made one or two cardinal blunders. Even as business men they have shown themselves singularly short-sighted. To deprive the universities of 300,000*l.* a year may relieve the income tax of one-twentieth of a penny for the moment, but in the long run the effect will be disastrous. This is just the sort of policy which cripples the nation in the higher reaches of commerce and industry. Similarly, as business men they ought to know that, in a profession such as teaching, in which the financial rewards at the best are meagre compared with those in other walks of life, there is a salary limit below which it is impossible to recruit the profession with men. During the past twenty years the statistics show a serious relative decline in the number of men teachers. If the proposals of the Committee are adopted, the decline will be still more serious. In another respect the Committee seems to us to have gone astray. Its proper function was not to show how to reduce the quantum and efficiency of education, but rather to demonstrate how these could be maintained, if at all possible, at a lower cost to the country, and it has failed to do this.

On the other hand, we are not disposed to maintain that our educational system is flawless, or that it cannot be administered with greater efficiency and at less cost. Undoubtedly there could be a saving all round, and one might very reasonably begin with the Board of Education itself, which, to a large extent, seems to have escaped the financial criticisms of the Committee. Nor are we disposed to take too seriously the Committee's observations regarding the impotence of this Board, which has hitherto shown no great anxiety to limit its own powers.

Fortunately, however, another and wider tribunal will decide upon the larger questions of policy involved in the Report, and, in the light of knowledge and criticism, determine the value or otherwise of the recommendations. There is little doubt as to the verdict; most assuredly these recommendations will not be endorsed in their entirety by Parliament or by the more thoughtful section of the community outside Parliament. National efficiency and progress must be the first consideration, and any action which would lower the standard of either of these may be immediate retrenchment, but would not be economy.

The Supply of Gaseous Fuel.

Modern Gasworks Practice. By Alwyne Meade. Second edition, entirely rewritten and greatly enlarged. Pp. xii+815. (London: Benn Bros., Ltd., 1921.) 55*s*.

AMONG the many truths brought home to the country by the two national struggles in which it has recently been engaged, the importance of the coal distillation industry stands out conspicuously. The rational treatment of coking coal by such means before its combustion (a process which has been carried out in our chief cities for more than a century) provided during the world war enormous quantities of material for belligerent use. It was no less effective as an instrument of social peace during the coal war, for our town-dwellers of all classes throughout the length and breadth of the land satisfied much of their requirements for the cooking of food, and in most cases for lighting their homes, by a mixture consisting chiefly of the lightest of the common gases, hydrogen, fortified with carbon in various combinations, produced in the main by the direct or indirect gasification of coal. Its centrally organised provision has now become a necessity of modern life in all our towns and most of our villages, just as are those for the supply of water and electric energy, and for the disposal of sewage. These have been almost wholly developed as engineering problems, though in the three latter cases the mathematician and the chemist, the physicist and the bacteriologist, have from time to time laid down certain principles to be followed. It will not, however, be denied that the finger of science was too often disregarded in working out the processes ancillary to the production of town's gas, and it is interesting, therefore, to observe that a change of this attitude is indicated in the pages of this latest work upon the subject.

In this exhaustive compilation, profusely illustrated with diagrams and working drawings, the technologist's debt to science, whether in the compounding of refractories or their usage, the composition of the coal or of its treatment in the cold

or by heat with the view of obtaining the highest yields in products, is fittingly acknowledged. The general public is becoming aware that there is in progress a complete revolution in the computation of gas charges, arising out of Sir George Beilby's suggestion that thermal value be substituted for mere volume as their basis (a therm of 100,000 B.Th.U. constituting the standard). A curious commentary upon these proposals is that they were carried only in the face of considerable opposition on the part of the administrators of gas undertakings. In Mr. Meade, however, they find a doughty champion whose support for them in the volume under review proclaims a teaching as sound as his practice is progressive. It is, however, unlikely that his doubt as to the intention of the gas referees substantially to prescribe the installation of continuously recording calorimeters is well founded. This body of men of science (among whom is Prof. C. V. Boys), now entrusted with the regulation of gas supplies, would probably be the last to admit that the design of such instruments offers insuperable obstacles, or that their use is not at least as necessary as the recording voltmeters of the suppliers of electric energy.

The nickel process for the purification of the finished gas from carbon disulphide by its conversion to hydrogen sulphide with subsequent removal by iron oxide is discussed in conjunction with other proposals for effecting this widely sought object. The nickel process, which it has taken something like ten years to bring to its present condition, has now become almost a complete replica of the experimental laboratory apparatus used by the late Prof. Vernon Harcourt. The general attitude towards gas lighting might have been a very different one had an earlier generation of gas engineers examined with a more intelligent sympathy the proposals of this chemist. A town's gas yielding on combustion only carbonic acid and water (such as today appears possible) would have occupied another *rôle* in the lighting of our houses than that furnished by the variable mixtures of gaseous combustibles with more or less deleterious diluents and sulphur-compounds endured by a long-suffering public with patience during the war.

The author uses the therm expression freely throughout his pages, and his calculations of efficiencies have thus an added value, especially those of the yields of the several systems of gasification. The importance of such a basis of comparison had been frequently overlooked until Sir Dugald Clerk drew forcible attention to it in discussing the relative values of the conversion of coal into electric and gaseous energy.

The author rightly classes naphthalene and cyanogen as impurities, not because they influence the products of combustion, but because of their harmful effect upon distributing systems. The work of Dr. J. S. G. Thomas upon the vapour tension of naphthalene finds its appropriate place in the chapter devoted to hydrocarbons, and the influence of this research upon the methods adopted for dealing with the difficulty is another instance of the value of scientific investigation in the laboratory as a guide to the large-scale practice of industry. Indeed, the most encouraging aspect of the volume under review is not only that a practical man has produced it, but that it has been produced for his practical *confrères*. Naturally consulting it for its wealth of technological information, they cannot fail to be impressed with the fact that each of the processes, in which as technicians they are interested, is shown to depend upon a foundation of science. Mr. Meade has thrown himself into his task with enthusiasm and has produced a compendium invaluable to those concerned in present-day gas supply, and one which is certain to affect considerably their future outlook. It is not his fault if it is to this class of reader that his work must mainly appeal, for, as has been said, he is a practical man writing for practical people. Yet there is room for another study upon altogether broader lines, which would lift up from the somewhat narrow circle of the literature of gas undertakings this remarkable example of industrial chemistry practised so long and so widely, yet so severely neglected by investigators and thinkers outside the pale of the gasworks. An unlimited supply of pure gas at low prices would revolutionise the aspect of, and the conditions pertaining to, life in all our towns. But the average member of the public judges town's gas by what it has done, not by what might be expected when some part of the time and thought bestowed upon its competing service is given to gas supply, now well on the road of its second century of usefulness.

Mathematical Recreations.

New Mathematical Pastimes. By Major P. A. MacMahon. Pp. x+116. (Cambridge: At the University Press, 1921.) 12*s.* net.

MAJOR MACMAHON, the author of the well-known "Combinatory Analysis," presents here, as a pastime, certain problems in tessellation and designing. Everything that he writes is carefully finished, and recreations invented by him are sure to be worth attention on their merits, while in this book the numerous scraps of poetry, with which, like Sylvester in former days, he adorns his pages, add a distinctive personal touch.

The work is divided into three parts. In the first and longest of them the object is to fill, subject to certain rules, a defined area by polygons all of the same shape and size, but each coloured or numbered, like dominoes, according to a different scheme. In the second part arrangements made according to the methods expounded in the first part are "transformed" so as to give a number of pieces of the same colour but of shapes which are all different; the result is the production of a jig-saw puzzle. In the third part we deal again with pieces all of the same size and shape, and the object is to design repeating patterns which can be used to cover an area.

The first part of the book involves the consideration of how to fill in a certain way a prescribed area with wood or cardboard polygons, which may be regarded as super-dominoes. The shape of an ordinary domino is a rectangle (the breadth of which is immaterial) with two ends or faces, on which numbers or pips can be inscribed, and, if we like, each number may be taken to indicate a particular colour: by using n numbers we can get $n(n+1)/2$ different linear dominoes. If our dominoes are triangular in shape, and from some central point within the triangle we draw lines to the angular points, we get dominoes with three faces, on each of which numbers or pips can be inscribed, and as before each number may be taken to indicate a particular colour: by using n colours we can get $n(n^2+2)/3$ different triangular dominoes. Similarly, by using n colours we can get $n(n+1)(n^2-n+2)/4$ different square dominoes, $n(n^4+4)/5$ different pentagonal dominoes, and so on. With each of these sets we can make up puzzles.

A particular instance will illustrate the kind of questions treated. Consider the case of equilateral triangular dominoes. If four colours are used we get a set of twenty-four different dominoes, and these can be put together (preferably fitting in a shallow box cut to the right size) to make a regular hexagon. Naturally the point in each domino from which the lines radiate to its vertices will be taken at its centre, thus dividing each triangle into three equal compartments, and facilitating the formation of symmetrical patterns. A consideration of what conditions can be imposed for arranging the dominoes next arises. For example, we may require the arrangement to be such that the colours of adjoining faces shall be alike, as also those of all the exterior faces; the solution, subject to this condition, is, among others, given.

The patterns formed are elegant, and the puzzle of fitting the dominoes together according to some imposed condition is sure to interest a good many people, some of whom are likely to become enthusiasts in the game. In the book the colours are indicated by numerals, and thus the results appeal to the mind rather than to the eye; this is a loss.

If the dominoes are right-angled triangles, we get a hexagon arrangement of a different shape. Further, we can play with sets selected from a particular full set and arranged in suitable geometrical figures. Similar problems arise from the use of square dominoes, hexagonal dominoes, etc.

In the second part, the author concerns himself with "transformations," necessarily unlimited in number, of arrangements like those above described. This is, in effect, an exposition of a method of making jig-saw puzzles of a certain type. Probably this has never before been reduced to a system, and it may be doubted whether those who cut out such puzzles will care to proceed by rule in the matter; but, if they do, here are hints and directions for their use.

In the third part, the previous investigations are applied to the formation of "repeating patterns," built up by arranging sets of pieces which fit together. Here the author enters on a field of decorative work in which there are already excellent technical books. He says that he has developed this subject much further, and that he has in hand a work entirely devoted to it. The subject is of importance to architects and pattern-makers, and is a recognised branch of arts and crafts.

The results of the problems set out in the first part of this book are singularly effective when colours are used, and provide numerous novel and interesting recreations of a certain type. We share the author's disappointment that the cost of printing nowadays has rendered it impossible to produce the book in colour. The questions considered in the second and third parts are of a more technical character, and are likely to appeal to the specialist rather than to the general reader: to the former they will open new and interesting lines of development.

The Fishing Industry and Scientific Research.

Ocean Research and the Great Fisheries. By G. C. L. Howell. Pp. 220+20 plates+3 charts. (Oxford: At the Clarendon Press, 1921.) 18*s.* net.

THE reconstruction spirit of the years 1918–9 was nowhere more evident than in its relation to the fishing industry. Even before the date of the armistice the owners of trawling and drifting vessels had met repeatedly and prepared a very noteworthy memorandum, which was presented to the President of the Board of Agriculture and Fisheries later on. At that time emphasis was very

naturally placed on the importance of a highly trained fishing population in regard to questions of national defence, and the immediate object of the memorandum was to interest the Government in this and other purely economic questions. In 1919, however, a series of committees met at Fishmongers' Hall under the presidency of Sir Edward Busk, and detailed recommendations dealing with administration, publicity, education, and scientific research were prepared, printed, and circulated. A beginning was made with the work of consolidating the statutes relating to fishery. Later on the British Trawlers Federation was formed, and proposals for the creation, by Royal Charter, of a British Fisheries Society were drafted. The author of the book under notice was mainly responsible for all this organisation. Throughout the whole movement scientific research was kept in the foreground, and its absolute necessity in any possible scheme of fishery reconstruction was recognised by everyone concerned. It was understood that the industry itself was prepared to back financially a sound programme of scientific and industrial research, and, without doubt, such programmes of education and research would now have been in practice but for the wholly unexpected partial collapse of the fishing industry that occurred in 1920.

These remarks will make clear what is the attitude taken up by Mr. Howell in writing his book. It is an account of the life-histories and economic significance of the various species of marine fishes, and it is very well done indeed. Apart from a few errors, inevitable, perhaps, in a work of this kind, it is a trustworthy account of the material of the marine fisheries, written in a plain but very attractive manner, fortified with clearly constructed statistical statements, very well illustrated and beautifully printed. But, much more than all that, it is a plea, on almost every page, for the further prosecution of marine research in relation to the fisheries, and it aims at the communication of the results of such work to the fisherman and owner of fishing vessels. It is a useful protest against the pedantry of the fisheries investigator. Little of what has been discovered has ever been presented in such a manner as to be understood by the industry in general—though this is quite practicable, as the book itself proves. Men of science almost always write for other men of science, though sooner or later their results must receive application, and this application would come all the more quickly if there were a true *liaison* between the administrators, the scientific workers, and the industry. The furtherance of such a working agreement is, all the way through, the main object of Mr. Howell's admirable book.

J. J.

Wegener's Displacement Theory.

Die Enstehung der Kontinente und Ozeane. Von Prof. Dr. Alfred Wegener. *Die Wissenschaft: Sammlung von Einzeldarstellungen aus den Gebieten der Naturwissenschaft und der Technik.* Herausgegeben von Prof. Dr. Eilhard Wiedemann. Band 66. Zweite gänzlich umgearbeitete Auflage. Pp. viii + 135. (Braunschweig: Friedr. Vieweg und Sohn, 1920.) 30 marks.

THIS book makes an immediate appeal to physicists, but is meeting with strong opposition from a good many geologists. This opposition is to be expected, for the author replaces the whole theory of sunken continents, land bridges, and great changes of earth temperature by a displacement theory.

Prof. Wegener's thesis is that the continents are of lighter material, and float like icebergs on a heavier plastic which reaches its highest level at the bottom of the oceans; the poles are not fixed relative to the plastic, and have occupied widely different positions, as, for instance, when Central Europe was a Sahara, or, again, when the great coal fields were laid down along a great circle (equator); land masses under gravitational influence move away from the poles and westwards.

Thus the Americas in their westward drift have heaped up the Andes and the Rockies. The South Atlantic opened early, but the northern portion did not exist until much more recent times. At the great Ice age, in fact, the glaciation in both hemispheres was due to an ordinary polar ice cap. India once stretched down over the Indian Ocean, being united to Africa and Australia. Since that time the Himalayas have been piled up, and Australia has left New Zealand far behind.

Actual measurements of continental and sea levels establish the fact that instead of there being a random distribution about one level there are two well-marked averages, a fact difficult to explain on any subsidence theory. Again, it was shown by Wilde that the earth's magnetic field can be closely imitated on a globe where iron sheets are placed over the ocean areas. On the present theory this is due to the plastic interior being richer in iron and rising higher under the oceans, where there is thus a thicker layer below the temperature at which iron loses its magnetic properties. Recent astronomical work has shown that the latitude of North American and European stations is increasing, but in the absence of measurements from the Far East we cannot prove that this is not due to a displacement of the pole.

The book brings forward a mass of geological

corroboration, although the author only claims to have "got it up" since the idea came to him. The revolution in thought, if the theory is substantiated, may be expected to resemble the change in astronomical ideas at the time of Copernicus. It is to be hoped that an English edition will soon appear.

The Earliest Forms of Society.

(1) *Primitive Society: The Beginnings of the Family and the Reckoning of Descent.* By Dr. E. S. Hartland. Pp. v+180. (London: Methuen and Co., Ltd., 1921.) 6*s*. net.

(2) *Primitive Society.* By Dr. R. H. Lowie. Pp. viii+453. (London: George Routledge and Sons, Ltd., 1921.) 21*s*. net.

IT is interesting to place these two books side by side in order to contrast the methods of attacking the problems involved in the study of primitive society which have been adopted by the respective schools to which the authors belong. (1) Dr. Hartland is one of the leading exponents of the view that there is a reasonable presumption that in the evolution of society wherever the patriarchal system now exists it has been preceded by the matriarchate. In the volume under notice he restates this view and summarises the evidence on which it is based in popular form. (2) Dr. Lowie, however, maintains that this theory is based upon an *a priori* assumption, and that Morgan and his followers, in their desire to formulate a logical scheme of social evolution, have distorted the facts by confining their attention to a single group of data. Pouring scorn on the heads of "the older school of anthropologists," he insists upon the empirical character of the evidence, and would have each case taken on its merits, subjected to intensive study, and treated as a whole.

After a review of the evidence on these lines, Dr. Lowie concludes that the theory of unilinear development is entirely fallacious and unwarranted. So far from the group organisation of the *sib* or clan being the foundation of primitive society, it is only one, and that frequently not the most important, of a number of forms of organisation to which the individual may belong. While he is prepared to allow that duplication of conditions may produce duplication of a sequence, as in the relation of polyandry and female infanticide, he formally abjures independent reproduction of the same series of "stages." He goes so far as to say that he is "not convinced of the reality of the totemic phenomenon," and for him the problem of totemism resolves itself into a "series of specific problems not related to one another." If, however, he believes in independent development only in the very limited degree indicated, neither is he a whole-hearted supporter of diffusion; while attaching full weight to diffusion, particularly in continuous areas, he recognises that it does not necessarily preclude independent invention within a limited scope.

It must be acknowledged that if Dr. Lowie's argument in favour of empiricism fails to carry conviction, he has done good service in emphasising the necessity for intensive study of all the facts of a given area as a whole. By concentration on the group organisation of the kin, the supporters of the evolutionary theory have sometimes been led astray. The existence of the family as a social unit at an early stage has been obscured by the view that the family emerged from the group. Dr. Hartland, indeed, speaks of "sexual promiscuity—relieved perhaps by temporary unions in the nature of monogamy." At the same time, owing to his preoccupation with kin organisation, he is unable "to bring Andamanese society within any category at present known." This fact does not, however, suggest to Dr. Hartland a modification of his conclusions, as might perhaps be expected; he prefers to await further evidence.

Our Bookshelf.

The Calendar: Its History, Structure, and Improvement. By Alexander Philip. Pp. xii+104. (Cambridge: At the University Press, 1921.) 7*s*. 6*d*. net.

THIS is not the kind of work that we expect from the Cambridge University Press. It contains numerous historical errors, and is not free from astronomical errors also. The author has endeavoured to guard against criticism of the latter by stating in his preface that his astronomical facts have been derived from the commonly available sources, and that he has disregarded "qualifying refinements known to modern astronomy but irrelevant to a calendrial purpose." This ambition has not prevented him, however, from stating the length of the tropical year to hundredths of a second, or the length of 4000 tropical years to an exact number of minutes. The introduction of these refinements, "irrelevant to a calendrial purpose," might have been pardoned, if they were accurate, which, unfortunately, they are not. But it is in the history of the calendar that the defects of the book are particularly displayed. The author ignores the two most valuable treatises on the subject, Ideler's "Handbuch der Mathematischen und Technischen Chronologie," and Ginzel's work which bears the same title. He writes in an easy way of Egyptian, Chaldean, and Chinese calendars;

but his knowledge of things "Chaldean" may be gauged by a footnote on p. 4, part of which is repeated in a footnote on p. 48. We quote the fuller note: "The 365-day year appeared at Babylon from Egypt after the overthrow of the Assyrian Empire by Nabonassar; but Chaldea subsequently developed a luni-solar, Egypt a solar, calendar." Comment is superfluous.

Bartholomew's General Map of Europe, showing Boundaries of States according to Treaties, 1921. Size 35 in. × 23 in. (Edinburgh: J. Bartholomew and Son, Ltd., 1921.) 1*s*. net.

THIS map of Europe, on a scale of 1 to 5,500,000, is designed to show the political boundaries and the chief lines of communication by land and sea. It makes no attempt to show the surface features of the land, and in that respect is open to criticism, although the adequate depiction of relief would certainly necessitate a reduction in the number of names. As regards boundaries, railway lines, and place-names, the map is full and accurate. We note, however, that the small States San Marino and Liechtenstein are shown by distinct colours, but are not named, while the principality of Monaco is named, but not indicated as an independent State. The map extends no farther north than about lat. 60° N., with the result that the new Finno-Russian boundary with the Finnish outlet to the Barents Sea cannot be shown. On the east its limits exclude the greater part of the Caucasus and the new States in that region. There is a small inset map showing the boundaries in 1914. The excellence of the colour printing and the legibility of the names make this a useful map for general reference purposes.

Oil Firing for Kitchen Ranges and Steam Boilers. By E. C. Bowden-Smith. Pp. ix + 102. (London: Constable and Co., Ltd., 1920.) 9*s*. net.

THE bulk of this book is taken up with descriptions of the Scarab burner and its application during the war to kitchen ranges in Egypt. The relative prices of coal and oil fuel in Egypt make it a big advantage to employ the latter, and the Scarab burner appears to have been of great service on account of its simplicity of construction. In the hands of quite unskilled persons kitchen ranges fitted with this burner have given very little trouble, and show a large saving in the cost of fuel. Thus the Turf Club at Cairo spent £E13·75 per week on coal and wood, and after conversion to oil fuel the weekly expenditure amounts to £E5·92. The drawing and descriptions of the burner and of the methods of fitting it to ranges will be readily followed even by non-technical readers. Some chapters are included on oil-firing steam boilers. It may be well to mention that a supply of compressed air is required; this presented no difficulty in Cairo, since there is a public service of compressed air in connection with the main drainage system, and air was taken from the mains.

The Chemistry of Colloids and Some Technical Applications. By Dr. W. W. Taylor. Second edition. Pp. viii + 332. (London: Edward Arnold and Co., 1921.) 10*s*. 6*d*. net.

THE second edition of this work, like the first, is well adapted to introduce the general student to the subject, the theoretical portions and the accounts of experimental procedure being well balanced. The amount of revision, however, appears, on examination, to be rather less than the author's remarks in the preface lead one to expect. Thus the "Valency Rule" still appears in its old and, as recent shattering criticism has shown, very spurious simplicity. Although earlier "complex" theories are given, Pauli's later and more thorough work is not mentioned. Recent results on protection and anomalous adsorption might also have found a place. With a subject in constant flux it is of course difficult to draw the line, but the author appears to have done so distinctly on the side of caution. In spite of these defects the book is still one of the most useful general text-books of colloid chemistry available in English.

The Fireman's Handbook and Guide to Fuel Economy. By C. F. Wade. Pp. viii + 84. (London: Longmans, Green, and Co., 1920.) 2*s*. 6*d*. net.

A GOOD deal of information which will be of service to firemen in helping them to understand what goes on in furnaces and boilers will be found in this little book. The author, however, is not quite happy in some of his fundamental explanations. Thus on p. 3 we read that "heat is a form of energy that can be measured as to quantity by means of a thermometer." Again, on p. 7 appear the following curious statements: "The only heat of the steam that does useful work is the amount added to the water to bring it just to boiling point." "It is much more economical to work at the highest possible pressure so that the latent heat may be low and the useful heat as high as possible." The sketches given in the book are clear, and will be understood readily by stokers.

A First German Course for Science Students. Second edition, revised. By Prof. H. G. Fiedler and Prof. F. E. Sandbach. Pp. x + 99. (London: Humphrey Milford: Oxford University Press, 1920.) 4*s*. 6*d*. net.

To many students of science an introductory course in German constructed to meet their special needs will be very welcome. The first portion of the work under notice consists of a number of passages descriptive of chemical and physical phenomena and experiments by means of which German technical phrases and words are introduced to the reader. Each passage is based on numbered paragraphs appearing in the outline of German grammar which constitutes the latter portion of the book. Here the examples given are, so far as possible, of a scientific nature. A useful vocabulary completes the book.

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.*]

Test-plates for Microscopes and Microscopic Definition.

IN NATURE of September 1 last (vol. 108, p. 10) I suggested that dry films of some of the aniline colours might prove suitable surfaces on which to rule the very fine lines required for test-plates. Since that time I have made some trials with films, using various dyes and various materials for the ruling-point. The dyes were eosin, saffranin, cyanine, methyl-green, methyl-blue, and methyl-violet. The last of these gave the most uniform films, leaving, on the evaporation of the solvent, a bright surface free from structure. Cyanine gave good films, though not quite so opaque as the methyl-violet for the same thickness. The others, either from a tendency to crystallise or from drying with a dull surface, were not so satisfactory.

The points for ruling were of steel, garnet, carborundum, and diamond. In all cases, except that of steel, the natural points found among broken fragments were chosen, and I doubt whether, without a somewhat elaborate grinding tool, an artificial point could be made so sharp as that given by the natural breakage.

The points have to be selected by trial, as the microscope is of little assistance in determining their real terminal shape. The only apparatus which was at hand for ruling purposes was a Cambridge rocking microtome, and the minimum interval between the lines (which corresponds, of course, with the thinnest section it could cut) was somewhat greater than 1/60,000 of an inch. No great accuracy in the spacing of the lines could be expected, but it is to the credit of the design of this microtome that there was no difficulty in getting well-separated lines at 30,000 per inch, and occasionally the 60,000 lines were quite apparent.

The uncertainty with these close lines was due, I think, chiefly to the rather rough workmanship of the bearings of the rocking arms, but in part, perhaps, to those of the point-holder.

The only real difficulty in close ruling is that of finding a fine enough point and applying it to the surface with a small enough force.

As mentioned in my previous communication, this force must not exceed a small fraction of a grain, and should remove the film but not scratch the glass. In the trials the point-holder was made as shown in Fig. 1, the materials being reed and split-cane put together with silk splicing and shellac cement.

This light and rigid frame could rock on the needle-points, one of which entered a conical pit, and the other a **V**-shaped groove in a fixed fitting which replaced the knife of the microtome. The whole forms a pendulum the effective weight of which (a few grains) is, say, w, of length L, which if displaced by an amount a exerts a force wa/L in the direction opposite to the displacement. Thus by placing the plate to be ruled at a suitable distance from the undisturbed position of the ruling-point the force can be adjusted as required.

While the film is being advanced for a fresh line the ruling-point is withdrawn by means of a silk fibre leading from the swinging frame to a bell-crank mounted on the fixed support.

A few photographs of bands ruled with this apparatus are given in Fig. 2. All these were made with diamond points. With a newly ground hardened steel point the 30,000 band was well shown, but the tool soon became too blunt for any spacing less than 15,000 per in. Garnet and carborundum points lasted fairly well for 30,000 per inch lines, but, as might be expected, were inferior to diamond so far as wear was concerned.

In the earlier trials from ten to sixty lines were ruled for each band, but later it was found that four or five lines were quite sufficient to show all the effects which various kinds of stage illumination have on the definition.

It is only with opaque and very thin objects that

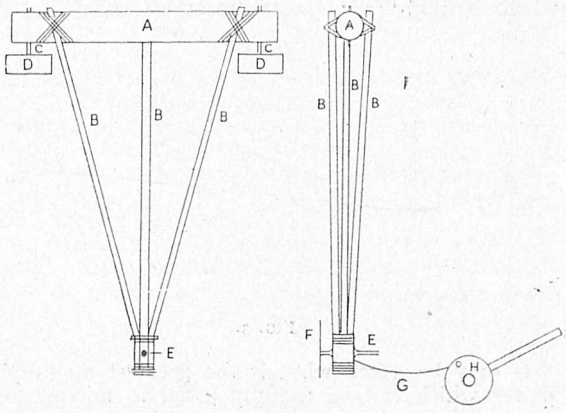

FIG. 1.—Holder for ruling point. A, Reed; BBB, split cane; CC, needle points; D, fixed support; E, diamond point; F, aniline film; G, silk fibre; H, bell-crank.

these can be examined to any advantage, thinness in this case being in comparison with the wave-length of light.

The methyl-violet films from which the photographs were taken were less than one-tenth of a wave-length in thickness, and, though not quite opaque, transmitted only a deep blue with some little red. The measurements of thickness were made by noting the displacements of the Newton's rings formed between a lens and the film at a place where part of the latter had been removed.

Test objects, such as diatoms, are much thicker than this, and, with them, what is seen in the field

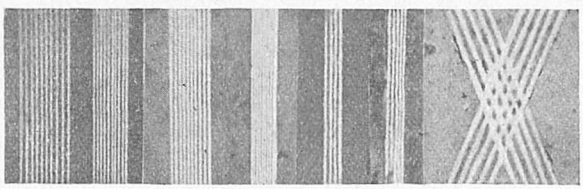

FIG. 2.—Photograph of bands ruled on films of methyl-violet.

a,	10 lines about 15,000 per in. × 350	e,	4 lines about 37,000 per in. × 600
b,	,, ,, 20,000 ,, ,,	f,	5 ,, ,, 35,000 ,, ,,
c,	,, ,, 17,500 ,, ,,	g,	Intersection of bands 17,500 ,, ,,
d,	,, ,, 25,000 ,, ,,		

The photographic lines are not nearly so well defined as they appear when examined by the eye.

is merely a phenomenon in which the thickness and wave-length are both concerned.

I think that the late Lord Rayleigh was the first to emphasise the fact that optical definition in general depends on the difference of the optical length of the paths of the rays the convergence of which forms the images of contiguous objects. Let A_1, A_2 (Fig. 3) be two objects in a line making an angle β with the focal plane of the lens, B_1, B_2 their images, and f_1, f_2 the conjugate focal lengths.

The difference of length of the paths A_1, B_1, A_2, B_2 of rays making an angle i with the principal axis is $a \sin(i+\beta)$, and unless the average of this for all values of i exceeds $\lambda/4$, the images B_1, B_2 will appear connected, and will not be clearly separated until the average is about $\lambda/2$. From this it may be seen that not only is it impossible to separate the images of objects in the focal plane which are much closer together than $\lambda/2$, but also that the same limit defines the distance out of focus at which objects may be placed without altering the character of their images. This is a point which is well brought out by the lines on the aniline films.

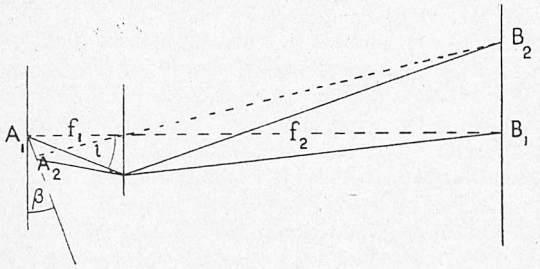

FIG. 3.

It may be asked what is the greatest magnifying power which can be usefully given to microscopes? Since objects closer together than $\lambda/2$ cannot form separate images, the greatest useful magnification is that which makes $\lambda/2$ visible to the eye.

A very good eye can just distinguish minutes of arc, or say objects separated by 1/350 in. at the distance of the eye from the stage. Then, taking the half-wave-length as the 1/100,000 of an inch, all details would be visible with a magnification of 100,000/350, or a little more than 280. Not all eyes, however, are capable of distinguishing minutes, and for convenience of observation, magnifications of twice this amount or more are used in practice, but the extra power reveals no new detail.

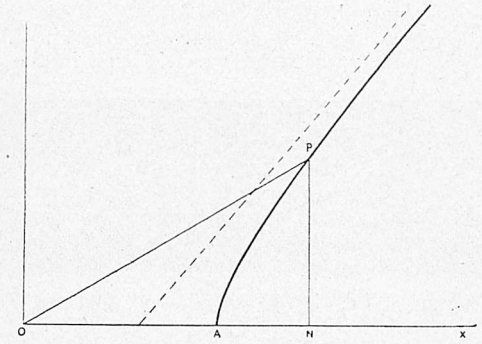

FIG. 4.—Form of plano-convex lens for the conversion of divergent rays into a parallel beam. O, Radiant point; OX, principal axis; PA, section of lens surface.

An idealised lens is merely a means of changing the radius of curvature of a wave-surface from f_1 to f_2 while preserving the constancy of the optical length of all the rays from focus to focus.

From these conditions the form of the lens which will achieve the result may be deduced. As a simple example, find the form of a plano-convex lens which will convert spherical waves originating at O (Fig. 4) into a parallel beam.

Let the convex surface of the lens cut the principal axis OX at A, and let the refractive index of the material be μ. The form of the surface is determined by the relation $OA+\mu AN=OP$. Elementary algebra shows that the curve PA is a hyperbola the asymptotes of which make an angle $\tan^{-1}\sqrt{\mu^2-1}$ with the axis of the lens. The complexity of actual objectives arises from the necessity of effecting the change of radius of curvature by means of spherical surfaces.

A. MALLOCK.

9 Baring Crescent, Exeter.

The Antitrades.

I AM glad to support the appeal for observations of the motion of cirrus-clouds in the inter-tropical region and elsewhere made by Prof. van Bemmelen in his letter on the Antitrades (NATURE, February 9, p. 172). It is very interesting that the results which he has obtained by direct observation, with only such additional information from dynamics as may be got from a consideration of the general character of the Australian pressure, should coincide so excellently with results which we obtained here from the calculation of the distribution of pressure at various levels, and the assumption that the wind flows along the isobars.

There are some details in Prof. van Bemmelen's maps which indicate a flow of air *across the equator* which I should be disposed to modify in view of the peculiar conditions under which such a transference of air must take place. I hope to give the details of the information that we have compiled about this subject at some future time, and confine myself for the present to saying that the atmosphere seems to be able to use the circulation of air round a strip of doldrum region as a means of providing for currents which flow westward on the south side, and eastward on the north side, of the equator in a general slope of pressure from south to north across the equator. Thus the doldrum region becomes a sort of elongated clockwise "centre" for the winds of the monsoon north and south of the equator.

I would add also to Prof. van Bemmelen's appeal for observations of cirrus a plea for the extension of observations with pilot balloons. Methods are now so well understood that the authorities could easily provide a *technique* which could be followed by those accustomed to surveying and others, and would provide invaluable information The committee of the British Association which concerns itself about the upper air has already taken up the question, and if anyone who is in a position to help in this matter would communicate with me or with the secretary of the committee, Capt. C. J. P. Cave, of Stoner Hill, Petersfield, we shall be greatly obliged.

NAPIER SHAW.

School of Meteorology, Royal College of Science, South Kensington, S.W.7, January 12.

The Isotopes of Mercury.

IT appeared to be so definitely one of the fundamental assumptions of physics that pure mercury has a constant density under given physical conditions that when Brönsted and Hevesy announced that they had separated it into fractions of different density (see NATURE, September 30, 1920, p. 144) it appeared desirable that the separation should be confirmed by other observers. One of us finds that when mercury (purified chemically and by distillation in a vacuum) is distilled in a very high vacuum the first sixth of the original mercury condensed is of lower density than the last sixth. The difference in density found for these fractions was 44 parts in 1,000,000. This

difference does not appear to be due to error in the density determinations for the mass found in different experiments, for a constant volume of the same specimen of mercury is constant to one part in a million, and with special care it is constant to a few parts in ten millions.

These experiments indicated, too, that any process of distillation would give some separation of the isotopes of mercury, and the question naturally arose: Upon what evidence has the density of mercury been regarded as constant? The matter had been investigated at the International Bureau of Weights and Measures by M. Marek in 1883, and he writes of the results which he obtained: "It is noticed in comparing these figures that the density of mercury varies slightly from one sample to another according to the method of purification. This result has already been obtained by Dr. H. Wild in a study of this subject specially undertaken." The results which Dr. Wild published in 1874 are not available to us. M. Marek, however, quotes results communicated to him by Dr. Wild, which, although ambiguously stated, make it appear as not improbable that Dr. Wild more than forty years ago separated mercury into specimens of different density.

T. H. LABY.
W. MEPHAM.

Natural Philosophy Department, University of Melbourne, December 30.

Where did Terrestrial Life Begin?

THE question raised by Dr. Macfie in his letter in NATURE of January 26 concerning the place of origin of life on the earth is not one which directly concerns the meteorologist, but Prof. J. W. Gregory's comments upon it seem to call for discussion from the meteorological point of view. Dr. Macfie suggests that in the gradual cooling of the earth mountain-tops would first reach a temperature to make them habitable for human life, while the sea would for further centuries remain above the critical temperature. Prof. Gregory feels hesitation in accepting the conclusion reached that life would first be found on the mountains, considering that while "the mountain summits would have stood like islands above a sea of hot mist . . . any wind would have at times submerged the mountain summits beneath the lower atmosphere, and they would have been subject to violent fluctuations in temperature and moisture which would have been unfavourable to primitive life."

Now with an atmosphere of homogeneous composition it is impossible to warm a mountain summit by immersing it in warm air drawn from the lower layers; if the conditions are initially stable, adiabatic cooling sees to it that the warm bath of air becomes a cold one before the summit is reached. We must therefore assume that in these early days the earth's atmosphere was not homogeneous, but that hot layers of dense gas occupied the lower levels, while lighter constituents of low temperature floated above. In these circumstances a stirring up of the lower layers might raise the temperature at higher levels temporarily, but is there any evidence that such a condition existed? No trace of separation and stratification of the different gases under gravity is found in the troposphere at the present time, atmospheric turbulence being sufficient to maintain a similar constitution at all heights. If the gases were stratified in the manner suggested it would afford proof that vertical turbulence did not occur, and thus the very existence of stratification would show that the layers below never rose to the mountain-tops

Meteorological evidence does not seem to support Prof. Gregory's conclusion that the mountain-tops would be subject to such violent fluctuations of temperature as would render life impossible.

J. S. DINES.

66 Sydney Street, S.W.3, February 6.

DR. MACFIE'S letter (NATURE, January 26, p. 107) accepts the common idea that the surface of the earth was formerly very hot—an assumption which is probably not well founded. If the earth was formed by accumulation of meteoric matter, it began its existence as a cold body the interior of which afterwards became heated by condensation, aided by atomic disintegration, while its surface was kept at a moderate temperature by radiation. It is difficult to believe that a globe so small, comparatively, as the earth could produce enough heat to raise its surface temperature anywhere near to the melting point; all igneous rocks are probably formed at some distance beneath the surface.

I imagine the first beginnings of life to have occurred at a very early epoch in the earth's evolution, namely, as soon as (1) the surface became warm enough and (2) elements capable of forming labile energy-storing compounds were present. It is not certain that solar radiation was necessary at first; the kinetic energy (heat and electricity) may have been derived from the earth itself.

Life at this stage would be of the humblest kind; we should scarcely recognise it as life nowadays. There would be no definite organisms, only diffuse substances trading in energy. Between this stage and the development of *cellular* organisms an immense period may have elapsed, and that period may have witnessed many intermediate stages. The achievement of the cell-form in living organisms must have marked a most important epoch in the history of life.

Chlorophyll may have been evolved at quite a late stage, as the culmination of a series of attempts at the formation of energy-fixing pigmentary bodies, most of which probably had iron as an essential ingredient.

The high stage of development shown in the earliest known fossils suggests that the geological period occupied by their evolution was vastly greater than the period since. The dawn of life may have occurred before there were either mountains or seas; all evidence of such early life has been obliterated by the metamorphosis and fusion of the deeper rocks.

Further discussion on this subject may be found in a paper by the present writer in the Proceedings of the Birmingham Natural History and Philosophical Society, vol. 11, pt. 1.

F. J. ALLEN.

8 Halifax Road, Cambridge, January 28.

Rainfall and Drainage in 1921.

I HAVE read with interest the letter of Mr. W. D. Christmas in NATURE of January 26 concerning the rainfall and drainage at Rothamsted during the very dry year 1921.

A few years ago three rain-gauges were installed at Craibstone, the experimental farm of the North of Scotland College of Agriculture. Like the Rothamsted gauges, each of these is one-thousandth of an acre in area, and contains a block of soil which has been enclosed in its natural condition without disturbance. The soil at Craibstone differs greatly from the heavy loam of Rothamsted, and is composed of sharp granitic drift which is easily pervious to

water. Each of the gauges is 40 in. in depth. The rainfall alongside them is measured by an ordinary 5-in. Snowdon rain-gauge. The total rainfall recorded for the year 1921 was 17·86 in. In 1920 it was 32·25 in.; the average is probably about 30 in., but we have not yet obtained a record over a sufficiently long period to establish a trustworthy average. No. 1 drain-gauge is unmanured, and the figures quoted below refer to it. The drainage for the year from this gauge was 4·93 in. No drainage at all came through from early June to nearly the end of October, and during seven months, from the middle of May to the middle of December, the total drainage was 0·046 in., or less than one-twentieth of an inch. On the other hand, in 1920, when the rainfall was 32·25 in., the drainage was 18·09 in., and there were only two months, July and August, when there was no drainage.

In many parts of this district springs failed which were never known to have failed before, and there was great difficulty in many places in obtaining a sufficient water-supply. The reason for this is apparent when we find that from the middle of May until the end of the year practically no water passed through the subsoil.

Although the total rainfall for the year was so low, it was well distributed throughout the year and rain fell in every month. Quite a good crop was grown upon Craibstone Farm. The drain-gauges themselves as well as the surrounding field were under turnips, and both yielded a good crop.

The year 1922 so far as it has gone provides a great contrast to 1921. During the month of January more drainage came through No. 1 gauge than during the whole of the previous year. The rainfall recorded was 5·61 in., while the drainage from No. 1 gauge was 5·69 in. There were only two days during the whole month on which rain or snow was not recorded. The underground water-supplies are now being well replenished, and, although all the springs have not yet responded, there is no doubt that after the rainy month of January they should soon begin to recover.

JAMES HENDRICK.

Agricultural Department, Marischal College,
Aberdeen, February 3.

Scientific Literature for Russia.

AT the beginning of last year a British committee was formed with the object of sending books and other publications to men of letters and science remaining in Russia.

The committee was assured that any such works, if addressed to the House of Science or the House of Literature and Art in Petrograd, would reach their destination and would be much appreciated by literary and scientific men meeting there who were cut off from the intellectual life of the rest of the world.

An appeal was therefore made for funds to purchase works of a non-political type for dispatch to Petrograd, and Prof. Oldenburg, permanent secretary of the Academy of Sciences, furnished a list of books and other publications much needed by Russian *savants*. The books particularly desired were those which included accounts of current problems and developments of pure and applied science.

As the result of this appeal the sum of 448*l.* 17*s.* 5*d.* was subscribed, and several scientific societies, including the Royal Society, entrusted the committee with their publications for transmission to Petrograd. The Russian Trade Delegation undertook the dispatch of the books, and ten cases have been forwarded.

Prof. Oldenburg, writing on December 21 last, expressed the deepest gratitude of scientific workers in Petrograd for this stimulating intellectual aid, and says that they have been placed in a special reading-room at the House of Savants, where they are consulted by a large number of students throughout the day, and have been the means of reviving scientific interests and work. He sends the most cordial thanks of men of science in the city to all who have contributed towards the stimulus to scientific investigation which the new publications have given them.

Having thus established contact with scientific men in Russia and enlightened them as to the progress of research from which they have been separated by political circumstances beyond their control, the committee is of the opinion that its task has been accomplished. Of the fund remaining in its hands the sum of 50*l.* has been expended upon books desired by the University of Latvia, and a small balance will be handed over to the Universities Committee of the Imperial War Relief Fund.

The committee gratefully acknowledges the generosity of the response to its appeal, and believes that the intellectual relief thus afforded will do much to strengthen Russian scientific life.

A statement of accounts, audited by Messrs. W. A. Browne and Co., chartered accountants, will be sent to anyone who desires a copy.

R. A. GREGORY,
Chairman.
C. HAGBERG WRIGHT,
Hon. Secretary and Treasurer.

British Science Guild Offices, 6 John Street,
Adelphi, London, W.C.2, February 11.

Cyclic Conditions and Rejuvenation in Hydroids.

SEVERAL colonies of *Tubularia indivisa* which have lived in the aquaria for three years are noticed as exhibiting alternating periods of activity and rest. Broadly speaking, the hydranths die off about midsummer and reappear about midwinter, the times in one particular case for the growth of new lengths of hydrocaulus and for the formation of new hydranths being December, 1919, January, 1921, and January, 1922, and in another January, 1920, January, 1921, and December, 1921, the hydranths in each case finally dying off in the intervening periods between the end of May and July. Colonies obtained from moderate depths in January generally show clearly marked new ends to their hydrocauli, such new growth often being an inch or more in length.

At the same season died down colonies of Stauridium and Melicertidium in the aquaria, and Clava, Syncoryne, Campanularia, Antennularia, Plumularia, Halecium, etc., in the sea are found showing signs of rejuvenation.

In a paper on "The Effect of Hydrogen-ion Concentration and Oxygen Content of the Water on Regeneration and Metabolism in Tadpoles" (*Journ. Exper. Zool.*, 1920), M. E. Jewell shows that rate and amount of regeneration increase with increase of oxygen content of the water, but decrease with decrease in temperature, and that the optimal P_H for regeneration is at or near neutrality. In connection with these experimental results it is interesting to note that the above regenerations begin when the sea temperature is approaching its minimum, at which time the oxygen content is greatest, and continue with increasing rapidity during spring, when increasing alkalinity further stimulates growth and an ever-increasing food supply is available.

In view of our incomplete knowledge of the interrelations of physical factors in the sea it is extremely

hazardous to make binding statements, but it seems probable that increase of light stimulating photosynthesis will tend to set back the incidence of maximum oxygen content, especially in a partly closed area like the Clyde Sea area, so that it does not actually coincide with minimum temperature, in which case it would appear that light and high oxygen content are the primary factors influencing these rejuvenations. RICHARD ELMHIRST.

Marine Biological Station, Millport.

Tin Plague and Arctic Relics.

IN view of the apparent public interest in my letter in NATURE of January 19, possibly a further note on the subject may be permitted. One letter I have received was from a Government Department concerned with food supplies for the Navy, and I was asked a number of questions. The first one (to my surprise) was "The name of the firm who produced the article referred to." That had never occurred to me! However, in an endeavour—which proved successful—to reply to that query, I found a note which seems worthy of reproduction here.

In an "Appendix to the Narrative of a Second Voyage in Search of a North-West Passage and of a Residence in the Arctic Regions during the Years 1829, 1830, 1831, 1832, 1833, by Sir John Ross," pp. cxi–cxiv, is "an analysis of fluids, etc.," from which the following extract is made, in addition to which is a report on brine, wine, rum, lemon-juice, and mustard, from Fury Beach:—

"I am indebted for the following article to my friend, Mr. Thomas Rymer Jones, who, in conjunction with Mr. Hemmings, submitted the articles I gave them to a careful examination, and made the following report, which requires no comment, as the acquirements of these gentlemen are known to qualify them highly for such an investigation:—The provisions, of which the following account is given, had been lying exposed to the climate for eight years, in the latitude of seventy-three degrees and forty-seven minutes north, and longitude of ninety-one degrees and forty-seven minutes west, and very little above high-water mark. The preserved meats, with few exceptions, were the manufacture of Messrs. Gamble and Co., and being enclosed in tin cases, could not be discovered by animals who depend on the sense of smelling; these were cylinders of various sizes, the ends of each becoming concave or convex, according to the degrees of contraction or expansion caused by the climate, secured them against bursting from its effects, and the contents were found to be in nearly the original state: these consisted of beef, roasted and boiled; veal, mutton, spiced meat of various kinds, turnips, parsnips, and carrots, all of which were found to be in excellent preservation. The soups, which were preserved in quantities from a quart to a gallon, were excellent, and we left a considerable quantity behind, but no meat of any kind. The flour, which was preserved in iron-bound casks, and had been likewise exposed for eight years to the climate, was found to be in good condition; for although in many cases the hoops had slackened, so as to admit moisture into the cask, it penetrated but a short way, while the whole of the interior was perfectly sound. The bread, of which there were many casks, was in a good or bad state, according to the soundness of the cask which contained it, and we employed ourselves in separating the bad from the good and put all into repaired casks. A part of this, and also of the flour, is sufficient with the addition of the remaining soup to sustain the life of twelve men for a year. Owing to the pickles being also in cask they had suffered much, the vinegar having leaked out of most of them: fifty of these, and twenty-five of lemon-juice, are also left, at a little distance south of the house, and covered with coals, as the most effectual way of preserving both."

T. SHEPPARD.

The Museums, Hull.

A New Series of Spectrum Lines.

WITH a long hydrogen tube, viewed end on, as a source, lines have been observed at $4{\cdot}0^5\mu$ and $2{\cdot}6^3\mu$, which, according to Bohr's theory, may be explained as due to an electron falling from the fifth to the fourth and from the sixth to the fourth rings respectively, forming the first two members of a new series.

Lines have been observed at wave-lengths $1{\cdot}8^8\mu$, $1{\cdot}2^8\mu$, $1{\cdot}0^9\mu$, $1{\cdot}0^1\mu$, and $0{\cdot}9^5\mu$. These form the first five members of the Paschen series due to an electron falling into the third ring from the fourth, fifth, sixth, seventh, and eighth rings respectively. The first two of these were observed and accurately measured by Paschen.

The first line of the new series is approximately one-fourth the intensity of H_α; the first Paschen line, more intense than H_α in the ratio 4 : 3.

F. S. BRACKETT.

Johns Hopkins University, January 24.

Araucaria imbricata.

REFERRING to the note in NATURE of January 19, p. 87, about this archaic tree ripening seed, may I say that it will do so regularly in this country if it gets a chance? But whereas it is dicœcious, seed is produced only where male and female trees are planted near enough to each other for the wind to carry the pollen from the male catkins to the female cones. In 1906 I took Dr. Augustine Henry over to Castle Kennedy. There had been a heavy gale a few days before, and the ground about the fine avenue of Araucaria was thickly strewn with ripe seed, whereof we collected a bagful. Some we ate, treated like chestnuts, and found them excellent. Others I caused to be sown, and have now a hilltop planted with more than twelve hundred monkey-puzzles, some of which are 12 ft. high. The female tree produces seed only in alternate years as the cones take two seasons to ripen. HERBERT MAXWELL.

Monreith, Whauphill, Wigtownshire, N.B.

Some Problems of Long-distance Radio-telegraphy.

IN the portion of the abridgment of my Trueman Wood lecture on the above subject published in NATURE of February 2, p. 140, I quoted an instance taken from a paper by Dr. Van der Pol of the ratio between the observed receiving aerial current and that calculated by the diffraction formula for the case of the Nauen–Darien transmission. It appears, however, that a numerical error was made in Dr. Van der Pol's original calculation, which, however, he corrected in the *Phil. Mag.* for July, 1920. This correction, unfortunately, I overlooked. It appears that the correctly calculated value of the received current is not $0{\cdot}6\times10^{-12}$ amp., but $1{\cdot}9\times10^{-10}$. Hence the actual current is only seven thousand times that predicted by the diffraction formula, and not two million times. This discrepancy does not, however, invalidate the conclusion that wave-diffraction alone cannot account for long-distance wireless telegraphy. J. A. FLEMING.

London, February 14.

Flowering Dates of Trees along Main British Railway Routes.

By J. EDMUND CLARK.

A FEW months ago the Editor of NATURE sent me, as joint editor of the Phenological Reports published by the Royal Meteorological Society, an interesting problem. He said:—"It has been pointed out on several occasions that in travelling from the West of England (Devon and Cornwall) to London, fruit trees are usually seen to be much more forward as regards flowering nearer London than in the West." I was therefore asked whether I had, among the "phenological observations, records of such flowering dates arranged according to longitude so as to determine whether fruit trees do, normally, bloom earlier near London than far away, and whether this is true also in passing from London to the East."

Our thirty years' records give no basis for a direct reply, since of set purpose garden flowers and fruits were excluded by the late Edward Mawley from the thirteen selected blossomings. These begin with the hazel (mean for the British Isles, February 13) and close with the ivy (October 2). The many varieties of most of our fruit trees is the obvious ground for their exclusion.

It seemed, however, worth attacking the problem indirectly, even though at first the supposed earliness appeared to be improbable. The four fruit-time plants in our list, blackthorn, garlick hedge-mustard, horse chestnut, and hawthorn, average two and a half days earlier in England, S.W., than in England, S.E. and E., in our thirty years' means.

The basis for investigation required:—

(1) Sufficient stations. For the first time in the thirty years 1920 supplies these, thirty-five being available.[1]

(2) The blackthorn gives us the opening, the other two trees the closing, stages of fruit flowering.

(3) Unfortunately 1920 was abnormally early, and therefore prolonged. This is shown by the following table, giving the days early compared with the mean:—

1920		S.W.	S.E.	E.
Blackthorn, early	days	30	24	20
Chestnut and may, early ..	,,	10½	18	12
Prolongation, fruit flowering ..	,,	19½	6	8

The possible results on relative conditions may well be serious, especially as to insolation. Obviously any such effect would be most marked in England, S.W.

(4) The isophenes (lines of equal flowering date) have for the first time been tested for agreement with Prof. Hopkins's Bioclimatic Law, recently formulated and found to hold well in the United States. Starting from a given station, this postulates a retardation of four days in flowering for every additional 400 ft. of altitude, 1° of latitude and 5° eastward in longitude[2]; the reverse for negative values. Both he and we have found it fairly trustworthy for the British Isles, and he for Western Europe. This has enabled me to reduce the records to sea-level, so as to see whether there is any factor other than the higher elevations along most of the way until London is approached.

(5) Since it is most difficult faithfully to record the *average* date of first flowering, after taking the mean of the three trees for each of the thirty-five stations available (those within twelve to fifteen miles of the selected railway routes), the mean of two or more adjacent stations was taken, so far as possible. In this way we have fifteen sets of records available.

(6) Unfortunately the L.S.W.R. route from Exeter to London was useless, no records being available between Exeter and Fleet.

The results are shown in the following table:—

Mean Flowering Date, Sloe, Chestnut, May, 1920.

	Stations	Date
I.	Penzance, Camborne, Falmouth ..	April 8
II.	Polperro (2), Duloe	,, 6
III.	Launceston, Hexworthy, Tavistock ..	,, 6
IV.	Tiverton, Wellington, Taunton	March 30
V.	Winscombe, Portishead	April 2
VI.	Falfield, Bath	,, 1
VII.	Winsley, Marlborough	,, 6
VIII.	Oxford (2)	,, 3
IX.	Fleet, Farnham, Hampton Wick ..	March 29
X.	A. Harrow, Watford	April 9
	B. Purley (Surrey) (2)	,, 3
XI.	A. New Barnet, Woodford	,, 2
	B. Hayes and Bromley (Kent)	March 28
XII.	A. Maldon, Hatfield Peverel, Lexden ..	April 5
	B. Maidstone	,, 2

I. to IX. closely follow the G.W.R. from Penzance to London; X.A, XI.A, and XII.A continue on north of the Thames Estuary to Colchester; X.B, XI.B, and XII.B south of it to Maidstone.

Of I. to IX. the earliest date is just before reaching London; the latest in the foot of Cornwall. East Devon and Somerset fall little behind London; whilst East Cornwall, West Devon, and North Wilts are nearly as late as I. Hopkins's latitude and longitude corrections, however, intensify the contrast, the date relative to London working out to April 18.

Eastwards from London flowering dates north of the Thames are retarded, but to the south scarcely at all, Hayes and Bromley (Kent)—March 28—having the earliest date of all.

Before considering possible explanations, two cautions must be reiterated. The transfer here of Hopkins's Law values is still only tentative, and the dates of observation may well be subject to a margin of error of a day or two. Making full allowance for these, we may still believe that general observation is verified, the more so that,

[1] See our Phenological Report to the Royal Meteorological Society for 1920 (Part 3), 1921.

[2] As a fact, the law is more general, governing all seasonal plant phenomena; the regressive phases, of course require the reverse of the above statement.

as noted already, the earliness of 1920 was most strongly marked in England, S.W. We therefore conclude that London is at least a week earlier than Penzance in its fruit flowering; also that, at any rate in an early season, while further advance eastward south of the Thames estuary results in little change, there is a decided retardation on the opposite bank as one proceeds in a north-easterly direction. It is difficult to account for the Harrow-Watford delay. Further on the cooling influence of the North Sea and of east winds may come into play. The isophenes cut the East Coast, the direction varying N.E. to N. East-wind exposure may partly account for the retardation at Purley (Surrey) and on the Wiltshire downs. It is not easy offhand to suggest the reason affecting the extreme south-west, which must be largely influenced by ocean conditions. One would expect the fruit-flowering season to share in the relative earliness shown by the means of all twelve flowers (omitting ivy), ranging from February 6 to July 15. One may, however, note that, for the first six months, isotherms and isohels taken together slightly favour the London area, but in April the reverse was the case.

The East Devon and Somerset earliness was fully expected. Each year the isotherms show a remarkable uprush of warmth along the Severn sea and watershed and a corresponding lie of the isophenes. In 1920 the isotherm bulge reached the borders of Yorkshire.

Having thus considered the query raised, an extension of the subject may be of interest along two other lines through London, which I have worked out for the sake of comparison. These are: (1) The L.B.S.C.R. from the Isle of Wight and on by the East Coast route to Edinburgh and Ross-shire; (2) from East Sussex and on by the West Coast route to the Glasgow district. Round London much the same stations come in along all three lines. The comparison is best made by placing the two series side by side, arranged roughly by latitude ($50\frac{3}{4}°$ to $57\frac{3}{4}°$). The numbers in brackets show the number of stations in each group.

As one expects, both series give a decided delay with latitude and longitude. Hopkins's corrections for these from London to Ardross Castle ($+6\frac{1}{4}°$ and $+4°$) give the relative date for the latter April 18. For Glasgow ($4\frac{1}{2}°$ and $4°$) we get April 26, the value round the Firth of Forth ($4\frac{1}{2}°$, $3°$) being April 12.

Either Hopkins's Law needs modification for the period in question, more than is indicated by the whole period, or there are special influences at work, such as oceanic effects, prevalence of east winds, and propinquity of hill and mountain masses. Nor need these be mutually exclusive.

To investigate them more complete data are required. For instance, we hope shortly to have mean values for a considerable number of stations over the thirty years of our records. The most obvious effect at present is perhaps the retardation for the spring period in question, due to high elevation, and even more the propinquity of hill and mountain masses. Is this due to the lag effect of their winter cooling? Snow would still be lying on the Welsh mountains in blackthorn days.

May I, in conclusion, direct the attention of readers of NATURE to the need for yet further observers, especially in the districts indicated by the lacunæ in the tables and the fact that the L.S.W.R. from Exeter could not be used? Either my colleague, Mr. H. B. Adames (33 Holcombe Road, Ilford), or myself (Asgarth, Purley) will gladly give further information, or observing forms can be had direct from the Assistant Secretary of the Royal Meteorological Society, Cromwell Road, S.W.7. When we see the prominent position elsewhere, especially in the United States, taken by phenological work in its bearing on horticulture and agriculture, we realise the need in this country for greater unification in and concentration on its investigations.

Since the above was in print Prof. Hopkins has sent us the typed copy of an unpublished exhaustive discussion of the bioclimatic association

Mean Flowering Date, Sloe, Chestnut, May, 1920.

East Coast Route (41 stations)		Latitude	West Coast Route (45 stations)	
Groups	Date		Groups	Date
Hants and W. Sussex coastal (9)	April 4	$50\frac{3}{4}°$	Sussex, etc. (4)	April 8
S.W. and S. London area (6)	March 31		S.E. and S. London (3)	,, 2
N. London area (3)	April 5	$51\frac{1}{2}°$	N.W. London (3)	,, 5
			Herts (4)	,, 10
Herts to Northants (4)	,, $5\frac{1}{2}$		Bucks and Oxon (4)	,, 8
		$52\frac{1}{4}°$	S.E. Warwick, etc. (7)	,, 11
			Birmingham district (3)	,, 18
			N. Welsh coastal (4)	,, 18
			Cheshire (2)	,, 8
North Notts and Lincs (3)	,, 10	$53\frac{1}{2}°$	S.W. Lancs (3)	,, 16
Central Plain, Yorks (4)	,, 10		N.W. Lancs and Lakes (5)	,, $24\frac{1}{2}$
Durham and Northumberland (4)	,, $28\frac{1}{2}$	$54\frac{3}{4}°$	Wigtown (1)	May 14
Firth of Forth coastal (7)	,, 27	56°	Glasgow district (2)	,, 11
Ardross Castle (1)	May 15	$57\frac{3}{4}°$		

between North America and Eurasia. He has correlated the two continents by using for the four years 1916–1919 the flowering date of hawthorn, *Crataegus oxyacantha,* at our station of Tenbury, Worcestershire, with the date for the leafing of the hickory, *Carya alba,* at his own station of Kanawha Farm, West Virginia, adopted as base for intercontinental correlations. Working from the latter, he found the closest agreement with our 25-year mean; less divergent, he considers, than errors of observation.

In order to test his calculation, and again starting from his U.S.A. base, Prof. Hopkins worked out the theoretical means for the eleven British meteorological districts. Scotland N. and Ireland S. differed by 11 days, Scotland W. by 5. These three districts are our worst, from paucity of observers. But this year we have completed (see Q.J. Roy. Met. Soc. for October last) the 30-year mean values, worked out entirely afresh and carefully weighted for defective records. Compared with these far more trustworthy figures, the discrepancies found by Prof. Hopkins are reduced to three, one, and four days respectively, the eight other districts also giving closer agreements. Thus, though as yet unknown to Prof. Hopkins, his results are well confirmed.

The success obtained seems to imply that from absolutely trustworthy phenological records of seasonal changes for a single station in the northern hemisphere for one single plant, the whole seasonal phenology for any other plant or crop can be postulated for any other spot in North America, Europe or Asia. The publication of this paper should be an important step in this branch of applied science.

Obituary.

Dr. James Francis Bottomley.

BY the death of Dr. Frank Bottomley—due to pneumonia following influenza—which occurred on January 16 at the early age of forty-seven, the country has lost the services of a chemist, physicist, technician, negotiator, and manager of men of quite exceptional ability and integrity.

Heredity and environment conspired to make Dr. Bottomley a man of science. His great-grandfather was Dr. James Thomson, professor of mathematics in Glasgow University; his great-uncles were Lord Kelvin and James Thomson, F.R.S., professor of engineering in Queen's College, Belfast, and Glasgow University; while his father was the present Dr. James Thomson Bottomley, F.R.S., of Glasgow University. His mother died when he was three years old, but five years later his father married the widowed sister of Lord Kelvin, and between the boy and his stepmother there arose an attachment which deeply influenced his character.

From eight to thirteen years of age Dr. Bottomley was educated at Bloxham, near Banbury, where he became interested in science, but his school career was cut short by influenza in the epidemic of 1888. After a long period of convalescence he entered the University of Glasgow—first as a non-matriculated, and afterwards as a matriculated, student—under Prof. Ferguson, Lord Kelvin, and Prof. Jack. In his second year he was laid up with scarlet fever and so lost the chance of taking his degree. In 1894, at nineteen years of age, he went to Germany, and, after about six months with a German family, entered the University of Heidelberg. Here he came under the influence of Victor Meyer and Prof. Gattermann, and also studied physics under Prof. Quincke, mathematics under Prof. Konigsberg, and mineralogy under Prof. Rosenbusch. In 1897 he obtained the Ph.D. degree "multa cum laude," and returned to Glasgow, where he entered the university chemical laboratory and physical laboratory.

In 1898 Dr. Bottomley was awarded a research studentship for three years, the first of which he spent at Glasgow, the second at Owens College, Manchester—where he was elected research student and afterwards research fellow under Prof. W. H. Perkin—and the third at University College, London, under Sir William Ramsay. Here, according to Ramsay, he showed "manipulative skill of the highest order," and proved himself "an accomplished chemist and a courteous gentleman." In 1901 he joined the standardising laboratory of Kelvin and James White, and a year later was associated with the Newcastle-upon-Tyne Electric Supply Co., and became also chemical expert to the firm of Merz and McLellan (then C. H. Merz), consulting electrical engineers.

In 1902 Dr. Bottomley began his great work on silica fusion on a commercial scale by means of the electric furnace. The research was carried out at Wallsend, and by skilful and systematic experiment he eventually solved the many technical difficulties which had defeated prior experimenters, and, as managing director of the Thermal Syndicate, Ltd., became responsible for the commercial, as well as for the scientific and technical, development of the work. In 1910 his company received the gold medal for its exhibit of fused silica ware (vitreosil) at the Brussels Exhibition, and the gold medal for a similar exhibit at Turin in 1911.

In 1914 the process, which was by this time well established, afforded almost the only material then manufactured in the United Kingdom in which acids could be concentrated for the manufacture of explosives. The output of the works was increased tenfold, and the burden of designing and supervising the necessary extensions and of the technical management fell, for the most part, on Dr. Bottomley. So successful was he as a manager that throughout the war and up to the time of his death the works were entirely free from labour troubles. After the armistice he was mainly occupied in

developing methods of manufacture of vitreosil globes for incandescent gas lighting, which he brought to a successful conclusion only shortly before his death.

Quiet and diffident in manner, slight in build, and far from robust, Dr. Bottomley gave little outward sign of the strength that was in him both of character and ability, and as he published but little and never advertised himself at all, he was not well known except to his associates. By these he was recognised as a man of exceptional judgment, business ability, and integrity, and, besides "being" the Thermal Syndicate, he was a director of Kelvin, Bottomley, and Baird, of Chas. Tennant and Co., and of the Blagdon Manure and Alkali Co. He was also (until the war) a director of the Deutsche-English Quartz Schmeltz G.m.b.h., which carried on the quartz fusion processes in Germany.

Dr. Bottomley was married in 1913 to Miss Dorothy Couves, and leaves a widow and two children. He was an outstanding example of the advantage of giving administrative and business responsibility to a man of character and scientific training. R. A. S. PAGET.

PROF. MAX VERWORN.

BY the death of Prof. Max Verworn at Bonn on November 23 last, a notable figure, who could ill be spared on account of the breadth of his outlook, has been lost to biology. Verworn had just completed his fifty-eighth year, having been born in Berlin on November 4, 1863. He received his school and early university education in his native city, and graduated Ph.D. in Berlin in 1887, and later M.D. in Jena in 1889. After graduation in medicine, his interests being then largely zoological, he paid a long visit to Villefranche and Naples, and later continued his investigations along the coast of the Red Sea. On his return to Jena Verworn was appointed assistant in the Physiology Institute, and in 1891 was duly approved as *Privatdozent*. After a few years' work, including a second visit to the Red Sea, he became extraordinary professor of physiology in Jena in 1895. In 1901 he was called to Göttingen as professor of physiology, and in 1910, on the death of Pflüger, he became the professor of physiology at Bonn. Verworn received many academic distinctions. In this country he was an Sc.D. of Cambridge and an LL.D. of St. Andrews. He was also an honorary or corresponding member of many of the Continental scientific societies, in Moscow, Vienna, Rome, Halle, etc. Twice he was invited to visit America, on the second occasion as Silliman lecturer in the University of Yale.

Verworn owed his special, almost unique, position in physiology to the catholicity of his interests. He had been impressed from his earliest student days with the value of zoology, and much of his best and most original work was done in the physiology of the invertebrates of all classes, although perhaps those of the marine fauna engaged his warmest attention. He used this material with skill and ingenuity in his interpretation of physiological problems in general. Undoubtedly the work by which Verworn is best known is his "Allgemeine Physiologie," which was translated into English by Prof. Lee. This book, which is a mine of information in the lesser-known aspects of general physiology, appeared in 1894, and was immediately recognised as a work of outstanding merit. It has gone through many editions. His Silliman lectures on irritability brought together his special views on the nature and function of the nervous system, a subject which had interested him from the first; indeed, one of his earliest contributions (in 1889) to attract attention bore the title "Psychophysiologisch Protistenstudien." He also held very definite views on the functioning of living tissue in general, and his name will always be associated with his interesting biogen hypothesis.

That Verworn's interests were not confined to the study, in any strict sense of the word, of ordinary physiology and zoology is evidenced by his writings on the psychology of primitive art and on the evolution of the human spirit. Certainly for many years before the war he was very interested in archæological and ethnological problems, and the writer has a most vivid memory of a conversation with Verworn, in which he gave an extraordinarily enthusiastic account of a visit to several of the Indian tribes resident in the south-west of the United States. He had visited these tribes to study the nature of their art, more particularly their colour combinations. Verworn also had a profound knowledge of the history of early art in Europe, and a very genuine interest in numismatics.

In spite of his many interests, Verworn managed to edit, with success, two physiological journals, one the *Zeitschrift für Allgemeine Physiologie*, founded by himself, and later, after his appointment to Bonn, the famous Pflüger's *Archiv*. E. P. C.

COL. WILLOUGHBY VERNER.

COL. WILLIAM WILLOUGHBY COLE VERNER, who died on January 25 at his home at Algeciras, was in many ways a remarkable man. He was a product of the Army at its best and a living denial of the too-often-quoted saying that Army officers think little and have no interests beyond sport and their "shop." Col. Verner will be remembered not only as the writer of the history of the Rifle Brigade and as the inventor of the luminous magnetic and prismatic compass and of other aids for military sketching and surveying, but also as an authority on the wild birds of South Spain and the discoverer of many of the rock shelters in South-West Spain that had been painted and decorated by Neolithic or Eneolithic man. Articles on the latter were published by him in the *Saturday Review*, and these brought him into relationship with the Abbé H. Breuil. The result was a careful survey of the whole district with regard to prehistoric man. Col. Verner, while bird-hunting near Ronda, had once noticed paintings on the walls of a cave near the top of the "sierra." This led to the publication by Breuil, Obermaier, and Verner of the first of an interesting group of Palæolithic cave paintings, which recall the northern group of France and Cantabria. But the memory of Col. Verner

will always live in the hearts of those who were privileged to be with him for a time at his little shooting cottage near the Laguna de la Janda. His kindness, knowledge, and interest in everything were especially noticeable, but at the same time his soldierlike love of order was never absent. Woe betide the guest who returned the salt-jar to the place where the pepper-pot should have been! The Army has lost a competent officer who continued to work for it in many ways after being physically incapacitated during the South African War from active service; science has lost an earnest follower; but, above all, some of us have lost a real friend.

M. C. BURKITT.

Current Topics and Events.

SIR FRANCIS GALTON was born on February 16, 1822, in the same year as Mendel. The Eugenics Education Society is celebrating the anniversary in a dignified way with addresses on Galton's contributions, not only to eugenics, the cause that was nearest his heart, but to statistics and geography as well. Galton was in more than one striking way the complement of his cousin, Charles Darwin, but especially in this respect: that his imagination was fired with the idea of man's evolution going on. Darwin thought more perhaps of the descent of man, Galton of the ascent; but it is very interesting that the *doyen* among eugenists should be Darwin's own son. The Eugenics Education Society has been fortunate in having had Major Leonard Darwin for many years at its helm. Of course, Charles Darwin and Francis Galton were entirely at one, though the angle from which they regarded man was a little different. What Galton grasped so firmly was the idea of *man evolving*, and that no longer mysteriously, but under the influence of factors which are discoverable by, and amenable to, scientific methods. He had the vision of the control of life, of applying our knowledge of the factors in evolution to the guidance and acceleration of that evolution. This was to him, as he said, "a virile creed, full of hopefulness, and appealing to many of the noblest feelings of our nature." In celebrating the anniversary there is reason for congratulation and encouragement, for Galton's doctrines have made rapid headway. It must be confessed, however, that the need for more enthusiasm is great. Thus we see from Prof. Karl Pearson's letter to the *Times* of January 18 that although the Galton Laboratory is nobly housed, its undertakings—especially in the way of publication—are sadly hampered by lack of funds. The same hindrance affects the Eugenics Education Society, and it is plainly a matter for regret that new knowledge of high importance should be lying unpublished and that educational efforts to diffuse the "virile creed" should have to be slackened when they are so urgently needed.

ON February 19 occurs the tercentenary of the death of Sir Henry Savile, to whom Oxford owes the foundation of the Savilian professorships of geometry and astronomy. Accounted by his contemporaries—among whom were Casaubon and Scaliger—"a man of admirable skill in the Greek and Latin languages and a laborious searcher and generous publisher of the remains of venerable antiquity," Savile was one of the first scholars of the age. Born near Bradley, Yorkshire, in 1549, he matriculated at Brasenose College, became a fellow of Merton College, was elected a proctor of the University, and at one time taught Greek to Queen Elizabeth. From 1585 he was Warden of Merton, and from 1596 Provost of Eton, holding both positions until his death, which took place at Eton. The chairs of geometry and astronomy were founded by him in 1619, Briggs being appointed to the former and Bainbridge to the latter. Among the distinguished men who have held one or the other have been Halley, Sir Christopher Wren, Bradley, Baden-Powell, Pritchard, H. J. S. Smith, and Sylvester. Before Briggs took over the duties of the chair of geometry Savile himself delivered thirteen lectures upon the first eight propositions of Euclid's "Elements," and these were published in 1620. Though Savile's contemporary, Sir Henry Billingsley, sheriff and Lord Mayor of London, had published the first English translation of Euclid's "Elements" in 1570, and the chair of geometry at Gresham College had been founded in 1596, the preamble to the deed of foundation of the Savilian professorships stated that "geometry is almost totally unknown and abandoned in England."

A BILL was introduced in Parliament on February 8 providing that summer time should begin on the last Saturday in March (or, if that is Easter Eve, on the preceding Saturday) and end on the first Sunday in October. These dates have been fixed in agreement with France and Belgium, as a difference in the dates causes confusion in through services. Many astronomers suffer some inconvenience from the use of summer time, but probably most of them would make little of this if they were persuaded that the majority of the community recognised it as a boon. All must agree that, if used, it is well to have its beginning and end fixed in a regular manner. On theoretical grounds, of course, the principle of summer time does not differ from that accepted long ago, when Greenwich time was introduced for the whole of Great Britain. This involved the use of a standard meridian, differing for some places 7° from the local one, and the increase from 7° to 22° is a matter of convention; the first has no more basis in theory than the second. On scientific grounds the main objection to summer time is the confusion due to the varying standard, and the measure now proposed should do something to remove the difficulties thus caused.

ON January 24 Mr. T. East Lones, of the Patent Office, read a paper before the Newcomen Society on "Mechanics and Engineering from the Time of Aristotle to that of Archimedes." Aristotle contains little of interest to engineers, but it was the extraordinary

belief in his views that led to the trouble after Galileo, by his experiments from the Leaning Tower of Pisa, had shown the falseness of Aristotle's dictum that the velocity of a body falling in a given medium was proportional to its weight. The works of Archimedes are of a much more valuable nature. His solution of problems regarding floating bodies, his determination of the centre of gravity of various surfaces, his invention of the Archimedean screw, and his investigation of the lever place him among the greatest pioneers in the acquisition of knowledge. Though it is generally believed that Archimedes asserted that he could move the earth with a lever had he a place to stand upon, it appears that Archimedes contemplated the use of compound pulleys for this purpose, and not the lever. After referring to the engines of war of those days, Mr. Lones gave interesting details of the two great aqueducts which led water into Rome, the old Roman roads, and other civil engineering works. He also referred to the tools used by the ancients in the execution of their works.

IN an article in the *Quarterly Review* for January Mr. E. Howell discusses at length the problems connected with river control in Mesopotamia. The Tigris and Euphrates are exceptional rivers in the way that their lower reaches break down, throwing off effluents, although eventually they unite and enter the Persian Gulf through a single mouth. Between Bagdad and Ezra's Tomb, a distance of some four hundred miles, the Tigris receives only two tributaries, but throws off five huge effluents besides innumerable smaller channels. The Euphrates in the same portion of its length shows even more marked degeneration, breaking into a thousand petty waterways in the tract known as Shamiyah, reuniting near Shamawah, and again spreading into a waste of shallow waters in Lake Hammar. There seems to be much evidence that this state of affairs is the outcome, not of natural causes, but of man's interference with the river acting through long ages and accentuated by the difference in both rivers between the levels of low water and high flood. It is suggested that if this interference is scientifically regulated the rivers will revert to former conditions, in which their value to man will be greatly enhanced in respect of definite channels and deeper beds. Unregulated riparian cultivation for ages has resulted in the formation of many effluents and the blocking of the river-bed by silt dug from the channel at low water in the construction of the irrigation canal from the shrunken river to the squatter's date-grove. Mr. Howell, quoting Major Walton, explains the process in full, and contends that the remedy lies in the control of riparian cultivation, the regulation of the course and nature of irrigation channels, and the construction of dams or locks on the chief effluents. Some work of this nature carried out from 1916 to 1919 has had noticeably beneficial results on the navigability of the Tigris.

FROM the report on the administration of the Meteorological Department of the Government of India in 1920–21 it appears that the suspension of wireless telegraphy from ships at sea during the war has rendered it more difficult to give information as to the development and path of storms. The system was started again in May, 1920, although it will necessarily take time to regain the former efficiency. The absence of such wireless information apparently led to wrong deductions relative to the movement of a storm in the Arabian Sea between June 6 and 13. There was, fortunately, little loss of life, but in Junagadh State the storm did a large amount of damage; 16,000 houses are said to have fallen, 22,000 trees were uprooted, and 7700 cattle died. Upper-air observations are being made in connection with military flying on the part of the Royal Air Force and for the use of civil aviators when the route Bombay–Calcutta–Rangoon is opened. The number of special forecasts and warning messages sent from Simla during the year was 2994, and from Calcutta 929. In connection with cases of heat-stroke among British soldiers, information was supplied to local medical authorities when the wet-bulb temperature rose above 75° F. Registration of rainfall has been carried out during the year at 2915 stations, for which the returns are published. The growth in departmental activity and changes in total cost are shown by diagram for the last thirteen years. Mention is made of the loss to the Indian Service of Dr. G. C. Simpson through his appointment as Director to the Meteorological Office of the Air Ministry.

THE Royal Astronomical Society was founded as the London Astronomical Society in February, 1820, but did not gain the prefix "Royal" until 1830. At the annual general meeting of February, 1920, the president, Prof. A. Fowler, gave an address on the origin and early days of the society, which had Sir W. Herschel for its first president. There was some opposition to its formation on the part of the Royal Society, but this did not last long. The centenary of the society will be celebrated next June; it will open with a conversazione on the evening of June 8. On June 9 there will be an historical meeting in the morning and a scientific one in the afternoon; at the former three addresses will be given, one introductory by the president, an historical address by Dr. Dreyer, and a biographical address by Prof. Turner. The society will dine together in the evening. A volume dealing with the history of the society is in course of preparation, and may be issued during the year. It is divided into ten decades, and is the work of several collaborators, but Dr. Dreyer, who is well known as an astronomical historian, has contributed the largest share. It will be illustrated by portraits of some of the more celebrated presidents of the society.

THE *Times* of February 13 makes the following announcement:—A Committee has been appointed to discuss the co-ordination of the work of the various Admiralty chemical laboratories. It will consider the scope of all work now carried out at the various laboratories in the Admiralty service, and will report

whether any changes can be made with due regard to the requirements of each department interested in the work to avoid dissipation of energy, overlapping of duties, and unnecessarily different conditions of service. Mr. W. J. Evans, Director of Establishments, is chairman, and Mr. J. Lang, of the Admiralty C.E. Branch, is secretary; the other members being Eng. Vice-Adm. Sir George Goodwin, Engineer-in-Chief; Capt. R. R. C. Backhouse, Director of Naval Ordnance; Comdr. L. E. H. Llewellyn, Chief Inspector of Naval Ordnance; Mr. F. E. Smith, Director of Scientific Research; Mr. W. J. Berry, Director of Warship Production; and Mr. F. Ward, Deputy-Director of Armament Supply.

THE Fuel Research Board of the Department of Scientific and Industrial Research has appointed a Committee to advise upon the sampling and analysis of coal. The *personnel* of the Committee is as follows:—Prof. T. Gray (chairman), Prof. J. W. Cobb, Mr. J. T. Dunn, Dr. J. S. Flett, Mr. G. Nevill Huntly, Mr. S. Roy Illingworth, Mr. J. G. King, Dr. C. H. Lander, Dr. R. Lessing, Mr. C. A. Seyler, Mr. F. S. Sinnatt, and Prof. R. V. Wheeler. Secretary, Miss N. Renouf. It is intended that the methods recommended by the Committee shall be adopted in connection with the physical and chemical survey of the national coal resources. Communications for the Committee should be addressed to the secretary at 16 and 18 Old Queen Street, Westminster, London, S.W.1.

WE are glad to see that the Portsmouth Literary and Philosophical Society, which was established in 1869 but was afterwards discontinued, has been revived. There must be many citizens of all classes in such a place as Portsmouth, with the adjacent residential district of Southsea, who will find interest and stimulus in the activities of the new society. The programme for the current session includes descriptive lectures, field excursions, and sectional meetings of students and workers in various departments of knowledge, such as literature, history, geography and geology, botany and zoology, psychology, and social science. The president, Sir Richard Gregory, will deliver his presidential address on "The Influence of Science" to-morrow, February 17. Mr. E. Heron-Allen, F.R.S., and Sir John Brickwood are vice-presidents of the society, Lt.-Col. J. H. Cooke chairman of council, and Mr. C. W. Ball, Whittington Chambers, King's Road, Southsea, honorary secretary.

CONTINUING its discussion of the State and provincial museums, the *Museums Journal* in its February issue suggests that this country is not merely falling behind others, but has even taken a step backward. "The post created for dealing with provincial museum work at the Board of Education has now been vacant for more than a year." The regulations formerly "laid before Parliament annually, as part of a Board of Education command paper, setting forth the conditions upon which loans of objects and grants of money were made to provincial museums, were last issued in 1910." These alleged facts seem curiously inconsistent with the activity of discussion on the educational use of museums that prevailed a few years ago at the Ministries of Reconstruction and Education. This is not altogether to be explained by the necessity for economy, since what is wanted is not so much fresh expenditure as the co-ordination and utilisation of the means ready to hand.

DONATIONS to the Maidstone Museum during the past year include an albino specimen of the American grey squirrel, shot near Maidstone; a lower jaw of the woolly rhinoceros found in Maidstone, and remains of the cave lion and the mammoth from the river-drift at Aylesford; a miscellaneous collection containing many fine minerals, formerly the property of Prof. Arthur Connell, F.R.S., of St. Andrews; fragments of a baked earth bowl associated with a calcined flint nodule (? a pot-boiler) found at Borough Green; three pieces of Late Celtic pottery from the Cherry Orchard Estate, near Maidstone; and a copy of William Smith's "Delineation of the Strata of England and Wales, etc.," published in 1815. The large number of other donations bears witness to the confidence placed in the curator, Mr. J. H. Allchin.

As from April 1 next, the importation into the United Kingdom of the plumage of birds not expressly excepted under the Importation of Plumage (Prohibition) Act, 1921, will be prohibited. The Board of Trade may, however, under section 2 (4) of the Act, "grant to any person a licence subject to such conditions and regulations as they may think fit authorising the importation of plumage for any natural history or other museum, or for the purpose of scientific research or for any other special purpose." All applications for licences under this sub-section should be addressed to the Imports and Exports Licensing Section, Board of Trade, Great George Street, Westminster, S.W.1.

THE annual meeting and excursions of the Somersetshire Archæological and Natural History Society will be held at Clevedon on July 4–6. The president-elect is Sir William Boyd Dawkins.

MR. G. V. COLCHESTER has been appointed to the post of geologist on the Geological Survey of the Anglo-Egyptian Sudan in succession to Mr. C. T. Madigan, who now holds a lectureship in geology at Adelaide University.

AT a meeting of the Institution of Automobile Engineers on February 8 Mr. E. L. Bass read his paper on "Engine Lubrication," for which the Daimler premium for the session 1920–21 was awarded. Lt.-Col. D. J. Smith was elected president for the session 1922–23.

ON Tuesday next, February 21, Sir Arthur Keith will begin a course of five lectures at the Royal Institution on "Anthropological Problems of the British Empire," Series 1: Racial Problems in Asia and Australasia. The Friday evening discourse on February 24 will be delivered by Prof. J. Joly on "The Age of the Earth."

THE thirty-first annual meeting of the Royal Society for the Protection of Birds will be held at the Middlesex Guildhall, Westminster, S.W.1, on Tuesday,

February 21. The chair will be taken at 3 p.m. by the Duchess of Portland, and an address on the work of the society will be delivered by Viscount Grey of Fallodon.

AT the annual general meeting of the Royal Meteorological Society on January 18 the following officers were elected:—*President:* Dr. C. Chree. *Vice-Presidents:* Mr. C. L. Brook, Mr. W. W. Bryant, Mr. R. H. Hooker, and Dr. E. M. Wedderburn. *Treasurer:* Mr. W. Vaux Graham. *Secretaries:* Mr. J. S. Dines, Mr. L. F. Richardson, and Mr. Gilbert Thomson. *Foreign Secretary:* Mr. R. G. K. Lempfert. *Council:* Dr. J. Brownlee, Mr. D. Brunt, Mr. C. J. P. Cave, Mr. J. E. Clark, Mr. R. Corless, Mr. Francis Druce, Mr. J. Fairgrieve, Col. H. G. Lyons, Mr. Henry Mellish, Sir Napier Shaw, Dr. G. C. Simpson, and Mr. F. J. W. Whipple. Communications should be addressed to the secretaries at 49 Cromwell Road, South Kensington, S.W.7.

THE following officers and members of council of the Royal Astronomical Society were elected at the anniversary meeting on February 10:—*President:* Prof. A. S. Eddington. *Vice-Presidents:* Dr. J. L. E. Dreyer, Sir F. W. Dyson, Prof. A. Fowler, and Prof. H. F. Newall. *Treasurer:* Col. E. H. Grove-Hills. *Secretaries:* Dr. A. C. D. Crommelin and the Rev. T. E. R. Phillips. *Foreign Secretary:* Prof. H. H. Turner. *Council:* Prof. A. E. Conrady, Dr. J. W. L. Glaisher, Mr. P. H. Hepburn, Mr. J. Jackson, Dr. H. Jeffreys, Prof. F. A. Lindemann, Dr. W. H. Maw, Prof. T. R. Merton, Prof. J. W. Nicholson, Mr. J. H. Reynolds, Lt.-Col. F. J. M. Stratton, and Mr. H. Thomson.

THE annual general meeting of the Physical Society of London was held on February 10, and the following officers and members of council were elected:—*President:* Dr. A. Russell. *Vice-Presidents:* Lord Rayleigh, Prof. T. Mather, Mr. T. Smith, and Prof. G. W. O. Howe. *Secretaries:* Mr. F. E. Smith, "Redcot," St. James's Avenue, Hampton Hill, and Dr. D. Owen, 62 Wellington Road, Enfield. *Foreign Secretary:* Sir Arthur Schuster. *Treasurer:* Mr. W. R. Cooper. *Librarian:* Dr. A. O. Rankine. *Other Members of Council:* Mr. C. R. Darling, Prof. C. L. Fortescue, Dr. E. Griffiths, Dr. E. H. Rayner, Mr. J. H. Brinkworth, Mr. J. Guild, Dr. F. L. Hopwood, Dr. E. A. Owen, Dr. J. H. Vincent, and Dr. G. B. Bryan.

A TRANSLATION of the Nobel Prize address delivered by Prof. Max Planck before the Royal Swedish Academy of Sciences on "The Origin and Development of the Quantum Theory" will be published at an early date by the Oxford University Press.

READERS in search of book bargains should see Catalogue No. 454 of Messrs. William Glaisher, Ltd., 265 High Holborn, W.C.1, and Catalogue No. 424 of Mr. F. Edwards, 83 High Street, Marylebone, W.1, in which are to be found the titles of many science books offered at greatly reduced prices. The works in the first-named list are publishers' remainders; those in Mr. Edwards's are second-hand.

Our Astronomical Column.

FIREBALL OBSERVED IN SUNSHINE.—Mr. W. F. Denning writes that on February 7, at 3.55 p.m., he observed a brilliant fireball descending in the northern sky. The sun was shining at the time, and the firmament was almost cloudless. The fireball moved with moderate speed, varying in size and lustre as it fell, and its motion was directed to the north-north-west point of the horizon, but it disappeared when 21° in altitude. Its brilliancy was such that had it appeared at night the heavens would have been strikingly illuminated. The fireball was observed from other places, and it appears certain that it was moving from a radiant point near the star Capella. There is a well-known shower of brilliant meteors from this region in the month of February. It is hoped that further observations of the recent fireball will come to hand so that its height, velocity, and exact direction may be computed.

A PRINTING CHRONOGRAPH.—The printing chronograph was invented by Prof. G. W. Hough, of Dearborn Observatory, in 1885. It is briefly described by Prof. Sampson in the Monthly Notices, R.A.S., for April, 1903. Its use leads to a decided increase of accuracy in the recording of transits or other time observations as compared with older forms of chronograph. This becomes of particular importance now that the use of the recording micrometer has considerably reduced the errors in the signals sent from the telescope to the chronograph.

The Société Genevoise, 95 Queen Victoria Street, E.C.4, is now showing a new printing chronograph. There are three discs, marking minutes, seconds, and hundredths, which revolve in an hour, a minute, and a second respectively; the first has to be set by hand to agree with the clock; the adjustment of the others is effected automatically. When a signal is sent the discs are pressed momentarily against a typewriting ribbon, behind which is a paper tape; the tape is moved automatically after each signal; there is thus no waste of paper between the signals, and a night's record is comprised in moderate limits; this counterbalances the greater awkwardness of a tape record as compared with a cylindrical one for a long night's work. The discs are electrically driven by a motor the E.M.F. of which is 12 volts, supplied by secondary cells. The net weight of the installation is 66 lb., and gross weight 110 lb.

NOVA PUPPIS 1902.—The *Gazette Astronomique* for December last records the discovery of a new star by Miss Woods from the negatives taken at the Harvard Observatory. The position of the nova was R.A. 8h. 9m. 36·4s., decl. −26° 15·8′ (1900); the star was thus situated on the fringe of the Milky Way, the region in which novæ are usually found. The following is a summary of the facts recorded:—1901 (invisible), <16 mag.; 1902, September 24, <10·3 mag.; November 19, 7 mag.; December 6, 7 mag.; 1903, June 3, 10·5 mag.; and 1905, <14·5 mag. (invisible afterwards). More than 400 negatives of the region were examined. Judging from the facts recorded, it looks as if the nova reached its maximum some time before November 19, 1902, because it is not usual for new stars to maintain their maximum magnitude for such a long period as seventeen days. No photographs of the spectrum were taken.

Research Items.

BIRTHDAYS IN RELATION TO INTELLIGENCE.—In the Proceedings of the Royal Society of Edinburgh (vol. 41, No. 17) Mr. M'Callum Fairgrieve discusses the annual incidence of intelligence. He experimented with 368 boys, using chiefly the American Army tests, supplemented by some of the tests used by Dr. Cyril Burt. His object was to see whether the time of year of birth bore any relation to intelligence. The results seem to show that boys born in the late spring months are in danger of developing less intelligence than those born about October. It is pointed out that naturally there are exceptions, some of the clever boys having birthdays in the less intelligent period, but that on the whole, and his ages range from ten years to eighteen years, the generalisation is correct. The author suggests that it would be valuable if the test were repeated in other districts. Certainly it is a problem worth studying systematically.

APOGAMOUS REPRODUCTION.—In a short account of experiments in apogamous reproduction with some species of Hieracium, Dr. C. H. Ostenfeld (*Journal of Genetics*, vol. 11, No. 2) describes the occurrence of several apogamic mutants which remain true in apogamous reproduction. It is believed that the numerous microspecies in the subgenus Archieracium have been produced in this way, being the after-effects of earlier crossing. The cytological studies of Rosenberg with species of this group have shown that there are irregularities in the chromosome distribution during the reduction divisions. The occurrence of apogamic mutants is plausibly accounted for on the assumption that some such irregularity may occur in the development of the egg-cell, thus producing an aberrant individual which will breed true later by apogamous reproduction.

SEX-REVERSAL.—In a very interesting paper on sex-reversal in frogs and toads Mr. F. A. E. Crew (*Journal of Genetics*, vol. 11, No. 2) discusses all the recorded cases of females exhibiting all intergrades towards the male condition. In extreme cases the transformed animal appears as a typical male, but may retain the Müllerian ducts or a few ova amid the spermatic tissues. Such an animal behaves and functions as a male, but that it retains the germinal constitution, *i.e.* the chromosome complex, of a female has been shown by crossing such a transformed female with a normal female. The young (774) were all females, showing that the chromosome complex of these "somatic" males had remained unchanged. The transformation acts through the internal secretions of the gonads, and the process of sex-reversal is very similar to that which causes the production of freemartins in cattle, as described by Lillie. The general opinion that Bidder's organ in the frog is a rudimentary ovary is questioned on the basis of these experiments.

COTTON IN THE FRENCH SUDAN.—The shortage of raw cotton for the mills of France, due largely to the decreasing export from the United States, has directed attention to the possibility of large-scale cotton production in the French Sudan. With this end in view the Comité du Niger has been formed. Some details of the schemes which this committee proposes, together with a large-scale map, are given in *La Géographie* for December last. Briefly, the idea is to irrigate certain areas along both banks of the Niger in the vicinity of Segu, which it is proposed to connect by rail with both Grand Bassam and Dakar. On the left bank the Nyamina irrigation canal would leave the Niger near Bamako, the railhead of the line from Dakar. A barrage would be erected at Sotuba and another at Sansanding, some twenty-five miles below Segu, from which the Sansanding Canal would run eastward for about 140 miles. Land on the right bank is to be irrigated by the Segu Canal and its branches, which leaves the river at the Sotuba barrage. These schemes, if carried out in full, would give some 10,000 square miles of irrigated alluvial ground. Farther east along the Niger towards Timbuctu vast areas of useful land could also be reclaimed for cotton-growing.

POTASH IN MARL AND GREENSAND.—The value of glauconitic marl and greensand as sources of potash is once more raised in the Annual Report for 1920 of the Department of Conservation and Development, New Jersey. At Elmwood Station, where green marl is 49 ft. thick, an acre of land covers approximately 9400 tons of potash. The average potash-content of the marl over a wide area is as high as 6·60 per cent.; but commercial development, unfortunately, awaits new methods of extraction.

ANTARCTIC GEOLOGY.—Mr. J. M. Wordie's report (Trans. Roy. Soc. Edin., vol. 53, pt. 2, 1921, 4*s*.) on "Geological Observations in the Weddell Sea Area," in connection with the Shackleton Antarctic Expedition of 1914–17, is specially notable on account of its photographic illustrations. The view of South Georgia in Plate 1 provides an exceptionally fine picture of a land escaping from glacial control, with its high cirques in the background, frost-sculpturing on the arêtes, a valley glacier still pushing out to sea, and the bared bed of another, preserving the very form of the terminal fan, though the ice itself has shrunk back towards the hills.

RAINFALL IN MYSORE.—Rainfall registration in Mysore for 1920 is the subject of a report by Mr. N. Venkatesa Iyengar, Meteorological Reporter to the Mysore Government. During the year rain was observed at 226 stations. The greatest rainfall recorded in one day was 11·88 in. at Agumbi, in the Shimoga district, on July 24; in the previous year the heaviest fall was 15·40 in. at Nagar on June 20. The mean rainfall for the year in the State was 28·96 in., whilst the average is 36·07 in.; in 1919 the mean for the State was 38·97 in. There was a deficiency of rainfall in 1920 in every district, ranging from 6 per cent. in the Shimoga district to 49 per cent. in Tumkur. Data are given showing the monthly rainfall for the several districts and the mean percentage departure from the average. Similar information is given for the seasonal rainfall, the four seasons into which the year is divided being cold-weather period, January and February; hot-weather period, March, April, and May; south-west-monsoon period, June, July, August, and September; and the retreating south-west-monsoon period, October, November, and December. In the hot-weather period, the south-west-monsoon period, and the north-east-monsoon period there was a general shortage of rain. Rainfall is collated for the several river-basins for 1920 and compared with the average fall for twenty-seven years, 1893–1919. The monthly average fall is given for each station. The average rainfall for the year ranges from 316·59 in. at Agumbi, in the Shimoga district, to 15·61 in. at Nayakanhatti, in the Chitaldrug district. The geographical distribution of rain in 1020 and the average are well shown in two maps at the end of the report.

BURST TUBES IN THE CLAUDE PROCESS.—In the synthesis of ammonia under pressures of 1000 atmospheres and at reaction temperatures of 500°–550° C., as in the Claude process, many working difficulties might have been anticipated One of these is described by M. Georges Claude in the *Comptes rendus* of the Paris Academy of Sciences for January 16. In the reaction between the hydrogen and nitrogen large amounts of heat are produced, and these were removed by the circulation of molten lead round the vertical reaction tubes. This system has led to accidents through bursting tubes, and it has been found that the crack starting the break in the tube always commences on the outside, and the effect is shown to be due to the difference of temperature between the inside and the outside of the thick-walled tube. This difference, about 200° C., causes the warmer internal layers to exert an enormous pressure on the cooler outer layers, and this is in addition to the normal pressure of working. The tubes are now packed in kieselguhr to prevent this dangerous temperature-gradient, and other means will have to be adopted to remove the heat set free in the combination of the two gases.

INDUSTRIAL MOTION STUDY.—Most of our knowledge of "time and motion" study comes from America, and is chiefly dependent on the investigations of F. W. Taylor and F. B. Gilbreth. The object in view was the standardisation of human industry. Taylor picked out his best workmen and determined the shortest times taken by them to perform the various stages of the industrial operation under investigation. The times were added together, and, after the addition of a certain allowance for unavoidable delays, they formed the standard time or task. This required the workman to do three or four times as much work per day as he had done previously without much regard being paid to his state of fatigue. Gilbreth gave more attention to the methods of work, and endeavoured to ascertain what were the quickest movements possible in the various steps of an industrial operation. These he regarded as the best. In Report No. 14 of the Industrial Fatigue Research Board Mr. Eric Farmer gives a full summary of previous work on time and motion study, and subjects it to severe criticism. As the result of his own observations in industries such as that of sweets production, he concludes that the most important principle of motion study is rhythm rather than speed. The best set of movements is not the quickest set, but the easiest set. The quickest set may cause too much strain on the workers and produce undue fatigue. It is better to make the movements of the hands required in an industrial operation in curves, without sudden changes of direction, rather than in straight lines. Increased production was not specially aimed at, though, as a matter of fact, it invariably occurred when a proper system of movements was introduced. In the instances quoted it went up from 38 to 50 per cent.

ALCOHOL AS A MOTOR FUEL.—A brief survey of the work of the Fuel Research Board in regard to power alcohol since the publication of the Board's interim memorandum in 1920 is given in the second memorandum on "Fuel for Motor Transport," which has recently been issued. This publication contains the results of inquiries which have been made as to the possibility of producing commercial quantities of alcohol within the Empire at a price which would render its use practicable as a motor fuel. The facts that nearly all the vegetable substances proposed as raw materials for the manufacture of spirit are already in great demand as foodstuffs or for industrial purposes, and the usually high cost of production, provide the key to the main results of the inquiries. So far as the British Isles are concerned, there is little prospect of adding materially to the supplies of power alcohol from home-grown raw materials. The utilisation of molasses, however, in overseas countries where this by-product is not yet fully employed for other purposes, and the cultivation in the tropics of certain roots and tubers with a high starch content, offer prospects of a limited production of alcohol which may be equal to no more than local demands. Synthetic production on a commercial scale in the British Isles is unlikely, but in Canada and Australia, especially in the latter country, the process is not impossible with the development of available sources of cheap electricity. The best chance of the production of power alcohol on a large scale for export appears to lie in the perfection of a chemical or bacteriological process for the production of alcohol from the inexhaustible supplies of vegetation in tropical and sub-tropical regions. The researches to this end initiated by the Board have not yet resulted in a practical commercial process, but some progress has been made, especially on the bacteriological side.

ENDURANCE LIMITS OF METALS.—During the recent war the question of the strength of aeroplane parts and other problems of materials under repeated stress brought the whole subject of "fatigue" phenomena of metals to the attention of the National Research Council, U.S.A. The result was the organisation of an investigation by the co-operation of this body with the Engineering Experiment Station of the University of Illinois. We have received Bulletin No. 124 from the University entitled "An Investigation of the Fatigue of Metals," which is a progress report of the first part of this investigation, having for its object the determination whether or not there exists any clearly defined relation between static properties and the ability to resist repeated stresses. The work has been carried out by H. F. Moore and J. B. Kommers. Two types of rotating-beam testing machines were used, one reversed bending testing machine, and one reversed-torsion testing machine. The materials tested consisted of both carbon and alloy steels, the range of composition in the former case being considerable The authors conclude that for metals tested under reversed stress there is a well-defined critical stress at which the relation between unit stress and the number of reversals necessary to cause failure changes markedly. Below this critical stress the metals withstood 100,000,000 reversals, and, so far as can be predicted from test results, they would have withstood an indefinite number of such reversals. The name "endurance limit" has been given to this critical stress. No simple relation was found between this and the elastic limit. Rather curiously, the Brinell hardness test appears to furnish the best index of this figure, the reason for which is by no means clear. The authors find that the endurance limit for ferrous alloys can be predicted with very fair accuracy by the measurement of the rise of temperature under reversed stress applied for a few minutes. This is the development of a test proposed by Mr. C. E. Stromeyer. In none of the alloys tested did the endurance limit under completely reversed stress fall below 36 per cent. of the ultimate tensile strength; for only one alloy did it fall below 40 per cent., while for several alloys it was more than 50 per cent. The tests reported indicate the effectiveness of proper heat treatment in raising the endurance limit of ferrous alloys.

The Air Conference.

IT is yet too early to judge of the effects on the future of aeronautics of the official and unofficial speeches made in the course of the Air Conference at the Guildhall, London, on February 7 and 8, but there can be no doubt as to the seriousness of the various speakers or the representative character of the gathering. The dominant note of the Air Minister's address was lack of belief in the future of civil aviation in Europe, an expression of opinion not shared by the members of the conference. It was asserted by more than one speaker that a subsidy is needed by the London–Paris air service only because France has given a large measure of assistance to her designers, constructors, and pilots. Whilst the British aircraft companies have carried six passengers per machine on each journey, the corresponding figure for French aeroplanes is two; on the other hand, the major portion of the goods traffic has been taken in the aircraft of other countries.

The conference was opened by the Secretary of State for Air, Major F. E. Guest, but for the greater part of its proceedings Lord Weir was in the chair. Matters relating to the Air Force were not under review, as at the previous conference—a development towards secrecy in the new fighting Service which may be noted. Provision was made for the reading of papers on the first day, the morning being devoted to civil transport and the afternoon to technics and research for both aeroplanes and airships. The second day was fully occupied by discussion from the assembled experts from the various branches of aeronautics. The depression produced by Major Guest was not removed by the carefully prepared paper read by Lord Gorell, the Under-Secretary of State for Air, and speaker after speaker was moved to protest. Lord Gorell's paper showed that air activity is great in many parts of the world, and that other countries are spending more money on development than is Britain. Probably Lord Weir voiced the general sentiments when he indicated a better quality for the endeavours of this country, and suggested that enough had been learnt to justify the development of the Imperial air route, England–Egypt–India. A permanent committee is now being formed to deal with the matter, and the only resolution put to the conference endorsed the view and was acceptable to the Air Ministry.

Col. Bristow, with an intimate knowledge of the working of the London–Paris air service, remarked that "it is lamentable in the extreme that in this year, the fourth after the Great War, the British commercial air fleet should consist, all told, of fewer than twenty aeroplanes; in fact, on the day the paper was written there were only six or seven."

The exhibits on the aerodrome at Croydon on the day preceding the conference must then have constituted the whole of the existing commercial air fleet, and the number may be contrasted with an output of 1000 aeroplanes per week at the close of the war. The smallness of the civil, as compared with the military, side was referred to by Sir Samuel Instone, of the Instone Air Line, on the following day, when he mentioned the fact that the subsidy for civil aviation is 200,000*l.*, whilst the expenditure on the Air Force has been 18,500,000*l.*; of the 200,000*l.* it is proposed that the spending of half on new craft should rest with the Air Ministry, and not with the transport companies.

The discussion on this section of the subject (civil transport) turned on the importance of civil aviation to progress. There was a strongly expressed view that the new system of transport has come to stay, and the president of the Federation of British Industries attended the conference to give the blessing of the business community and to announce adherence to the theory of a sound subsidy in the early stages of development. That the industry will ultimately support itself on a commercial footing was not doubted, but no one accepted as satisfactory the statement of the Air Minister that in certain directions Britain could wait for ten years and then start again.

Where is the principal stumbling-block? The Director-General of Civil Aviation indicated it as "the military be-all and end-all of aviation." The present complete stoppage of airship work and the unsympathetic attitude of the Air Ministry add further arguments in the same sense. Major Scott's paper on airships finished with an expression of opinion that commercial airships were immediately possible as technical devices, and support was given to this view in the discussion. Another instance of Air Force dominance is furnished by the experiments on a helicopter, mentioned by Lord Gorell and Gen. Bagnall Wild; it appears to be regarded by certain Air Force officers as important and a subject for immediate experiment and research; technical experts and men of science regard expenditure of money on the helicopter as waste owing to the lack of promise of success for very many years to come. The Brennan helicopter at Farnborough is being built in secrecy, and, so far as can be gathered, the Aeronautical Research Committee has not been consulted.

This lack of balance between military wishes and technical possibilities gave point to Col. M. O'Gorman's reference to the need for more scientific knowledge in high quarters at the Air Ministry. He pointed out that fighting now depends on technical complications beyond the understanding of military commanders, and that dependence on their opinions alone will necessarily lead to an unbalanced policy. The need for such remarks was shown by Lord Gorell when he said: "I do not speak in the least degree as a technical expert; probably in the position which I happen to hold it would be a disadvantage to pretend to any degree of technical qualifications." Col. O'Gorman was unable to see why technical and scientific knowledge should be a disqualification in a Minister.

During the discussion on civil transport much reference was made to the need for research, but in the afternoon the theme was research and yet more research. A deep impression on the conference was produced by Sir Richard Glazebrook's references to R38. Lord Gorell's paper contains the passage: "Since the decision of the Dominion Premiers was taken, the conquest of the air has suffered one of the greatest disasters of its history in the terrible accident to R38. It ought to be decisively said that the disaster has not affected, and will not affect, the belief in the future of airships. We are not so faint-hearted a race as to allow ourselves to be deterred even by such an event; *it is the toll that Nature inevitably exacts* from those who seek to probe her secrets—and it has been paid."

Sir Richard Glazebrook asked: "Was the loss of the airship R38, with its crew of officers, technicians, and men, necessary? Was it one of those dreadful and seemingly inevitable incidents in the evolution of a new craft?" and answered his questions by saying that "knowledge existed from experiments in the air tunnels which would have enabled the collapse of the ship to be foretold." The knowledge had not been applied because of a gap between model and full-scale experiments; attempts by the designers and the Aero-

nautical Research Committee to obtain facilities for full-scale experiment on R31, R32, and R33 had failed. He urged as a partial atonement for the sacrifice of the lives of brave men that the remnants of the airship fleet should be devoted to correcting, by full-scale experiments, the knowledge given by model experiments.

The situation with regard to aeroplanes was also said to be unsatisfactory. Prof. L. Bairstow pointed to the prevalence of accidents in aviation, the risks of flying being so great that life insurance companies are not prepared to cover them in a standard policy. This abnormal rate was attributed in part to a number of defects not needing more knowledge for their remedy. The failure of rubber joints in petrol pipes and the breakage of ignition cables were given as instances of easily remediable defects. The danger of such imperfections comes from the necessity for landing at once, when the engine ceases to turn, in country which is often unsuitable. So soon as an aeroplane can take the air it leaves the designer for the user, and its minor defects have not then developed. New design might be encouraged by placing responsibility for such matters on the designer, and not on an Air Ministry staff.

Other causes of failure in flight were said to need more knowledge before they could be removed. All aeroplanes are tricky at low speeds, and it does not accord wholly with fact to attribute an accident to "bad piloting causing the aeroplane to lose flying speed near the ground." Important research work is here called for, the conduct of which may be hindered by an unsuitable organisation as much as by lack of funds. It is reported that the Secretary of State for Air has the matter of the reorganisation of the Air Ministry under review, and has afforded the council of the Royal Aeronautical Society an opportunity for expressing the scientific and technical view of essential requirements for the carrying on of research. It is encouraging to note that Lord Gorell told the Air Conference that "success in the air, whether Service or civil, must depend primarily upon constant scientific research," and that the report of the Geddes Economy Committee, whilst asking for a reduction on the vote for experiment and research, accepts that view.

If research and care in design can reduce the accidents now occurring to one-third of their present amount—a very moderate estimate of early possibilities—the saving of money on flying risks, replacement of aircraft, etc., will very greatly exceed the cost incurred. The position is unusual in the fact that the effects of research on the final product are so clearly seen; such a state is largely due to the infancy of the science, but an important additional element arises from the unparalleled degree of freedom of the motion of aircraft as compared with that of other vehicles.

The Grain of the Photographic Plate.

THE unit of the photographic plate is the single grain of silver salt as it exists in the sensitive film. It is natural, therefore, that after many years and much labour had been devoted to the properties of sensitive films as films, attention should be turned to the unit. A great deal of work has already been done in this direction, but many problems, some of which seem to be of an elementary character, remain to be solved.

On Tuesday, February 14, Prof. The Svedberg, of Upsala, communicated to the Royal Photographic Society two papers containing important results that he has obtained. It is customary in such investigations to dilute the emulsion and so produce a film that contains only a single layer of grains. The characters of the grains are registered by photomicrography, using apochromatic objectives of the maximum practical aperture. As the photography of the grains before treatment must not affect their sensitiveness, Prof. Svedberg used a very deep red light and Ilford special rapid panchromatic plates. After exposure and development the plate may be photographed again, then either the metallic silver produced or the unaffected grains may be dissolved away, as desired, to facilitate the examination of the remainder.

Evidence in favour of the view that the halide grain is either wholly reducible (developable) or not reducible at all is accumulating, and this Prof. Svedberg finds definitely to be the case. By dissolving away the silver grains nothing whatever was left of them, except to the extent of about 1 per cent. of the thousand or so grains observed, which showed traces of incomplete reduction (development).

This independency of the grains is further proved by the unchanged appearance of the undeveloped grains and their unchanged sizes as measured. This holds even when the film is partly solarised by a strong light, when the grains are separated by only 1μ, and whether ferrous oxalate or metol-hydroquinone developer is employed. The author intends to try other conditions to see if, as appears to be the case, these results are general, and that feeding of the reduced silver grains at the expense of the undevelopable grains does not, in fact, take place.

In Prof. Svedberg's second communication he suggests that the larger and the smaller grains in one and the same emulsion are equally sensitive and "are built up of the same kind of light-sensitive material—just as if they were fragments of different sizes from one homogeneous silver bromide crystal." He assumes that by exposure (light action) "developable centres" are produced, and shows experimentally that the distribution of these "centres" takes place according to the laws of chance, so that there is no need to assume a superior sensitiveness of those grains that are made developable. The author is to be congratulated on using the term "centre," which expresses all that is known and is non-committal, rather than "nucleus." Nuclei have been shown to serve, but the crystallisation of sugar on strings is not evidence of the presence of strings wherever sugar crystallises. This by the way.

The present writer in 1911 (Journ. Roy. Phot. Soc., p. 159) showed that by stopping development at a very early stage it was possible to get particles of silver too small to be visible microscopically. They were shown to be present by the colour imparted to the film, and were further demonstrated and measured by adding mercury to them in known and progressive proportions and measuring the enlarged particles. Prof. Svedberg by stopping development at a little later stage gets particles that are just definitely visible microscopically, and shows photographically the relation of these to the original grains of silver haloid. He thus demonstrates that "centres of development" are produced by exposure. A single developable grain may contain one or more (so far up to four) of these "centres." He treats also of other matters, such as the effect of Röntgen rays when used instead of ordinary light.

C. J.

Building Materials and Heat Insulators.

THE Department of Scientific and Industrial Research has issued two special reports on floors and thin walls, the result of work undertaken by an *ad hoc* Building Materials Research Committee appointed to investigate new materials and constructional methods in connection with housing schemes (H.M. Stationery Office, 1*s*. 3*d*. net and 6*d*. net respectively). Some eight types of floors were dealt with, comprising hollow tiles, brick and tile, reinforced concrete, ash concrete, and ordinary wood joists. Suitable sections or units of these floors were erected and tested for carrying capacity to destruction. The results are summarised in tabular form, showing the weight of the floor, load carried, deflection, breaking load, age on testing, elastic limit, and so on. These results are also plotted diagrammatically, and drawings are given showing the construction of each floor to scale. The ash concrete proved weak, and the ordinary joisted floor, though possessing obvious disadvantages from some aspects, appeared to hold its own in the matter of strength. The experiments on thin walls included the testing of brick and concrete blocks and slabs and coke-breeze materials. Consistent results showed that the crushing strength of the walls varied from 67 to 83 per cent. of that of cubes of the materials respectively employed. Lengths of wall of 14 in. and 3 ft. 6 in. and $2\frac{5}{8}$ in. to $4\frac{1}{2}$ in. thick were dealt with. These strips were 8 ft. 6 in. high, and the horizontal pull necessary to make the wider strips collapse was measured. The materials built in lime mortar on account of early failure under test give rise to criticism of lime as a binding agent, but surely the behaviour of walls so built after only twenty-four days cannot be fairly compared with that of similar walls built in cement which sets in a day or two. Lime was used in all our national buildings until comparatively recent years; it is cheaper in actual cost and labour than cement, and its wider use merits revival. These experiments are valuable and interesting; it has to be remembered, however, that the country builder usually fears new methods, and is apt to put unduly high prices on unknown forms of construction.

The fifth special report of the Food Investigation Board, issued by the Department of Scientific and Industrial Research, consists of an account of experiments on heat insulators suitable for use in cold stores. The work has been carried out at the National Physical Laboratory by Dr. Ezer Griffiths, and so far has been devoted to the determination of the thermal conductivity of a number of materials adapted to low-temperature insulation. In the experiments a warm surface, consisting of a metal plate electrically heated, was maintained at a steady temperature and placed opposite to a similar plate cooled by brine circulation, the material under test filling the space between the two plates. Special precautions were taken to eliminate errors arising from edge effects in the warm plate and air convection in the material, and when a steady temperature had been attained in both plates the heat passing through the lagging was deduced by measuring the watts furnished to the warm plate. The results obtained show that the conductivity in C.G.S. units for slab cork is 0·00011; granulated cork, 0·00011 to 0·00019; slag wool, 0·000102; and dry charcoal, 0·000122. A number of other substances giving higher values were also tested, and mention is made of a cellular form of rubber which from preliminary tests appears to be superior to any other material examined, its conductivity being about 0·000085. As an appendix to the report, a description is given of the apparatus devised by Dr. Griffiths for determining the specific heats of the materials under notice. Although other factors, such as moisture absorption and liability to organic growths, have to be taken into account in choosing a lagging for a cold store, the figures obtained by Dr. Griffiths should prove of much practical value to those engaged in the refrigerating industry.

Industrial Fatigue.

THE Industrial Fatigue Research Board, which has recently been reconstructed as an advisory body under the Medical Research Council, is to be congratulated upon the publication of two highly valuable and most interesting reports. These are doubtless a legacy to it from the older Board the wider sphere and greater liberty of action of which were recently brought to an end by the Treasury under the pretext of economy. They are published by H.M. Stationery Office at 1*s*. and 2*s*. respectively, Report No. 12 being on vocational guidance and Report No. 15 on motion study in metal polishing. The former of these reports, written by Mr. B. Muscio (who has since accepted a professorship in the University of Sydney), gives a detailed review of the literature on vocational selection. The list of nearly sixty books and papers at the end of the report indicates the diligence which the author has brought to bear on his task. The report is divided into three sections: (1) introductory, (2) summary of special investigations, and (3) future investigations. The second section, filling forty-two of the fifty-seven pages, contains a most able and critical account of the psychological tests that have been applied to clerical, engineering, and metallurgical occupations, music, printing, salesmanship, telegraphy, telephone exchange work, transport work, war experiments, etc. Prof. Muscio indicates in his last section the wide field which is now open for future investigations conducted on a broader scale and on a more systematic basis than hitherto.

Not less valuable is the Board's Report No. 15 on motion study in metal polishing by Messrs. E. Farmer and R. S. Brooke. These investigators prove very conclusively what an enormous wastage of effort now occurs in the "buffing" (spoon and fork polishing) trade owing to the lack of a systematic course of training for newly entering workers. They indicate the principles on which such a course should be based, and give data derived from the actual application of those principles, which "prove conclusively that a beginner, given adequate training, can become an expert dollier within a very few days, but left to herself, without proper instruction, she probably will never become highly skilled, and will continue all her life to waste her energy in unnecessary and unproductive movements." The influence of fatigue was ingeniously studied by means of a recording watt-meter which they applied to the machines employed for removing scratches and other imperfections from spoons and forks. It was found that as towards the end of the day the girls' output diminished and their

fatigue increased, they tended to give more vigorous and more numerous strokes, to pause longer between each stroke, and to take a longer time over each stroke. In other words, Messrs. Farmer and Brooke prove that the tired "rougher" is "not only working slower than when she is fresh. but is also expending her energy extravagantly."

University and Educational Intelligence.

LONDON.—The Franks research studentship in archæology, value 100*l.* for one year, is offered. Applications must reach the Academic Registrar, the University of London, South Kensington, S.W.7, by, at latest, March 2.

SHEFFIELD.—The council of the University has made the following appointments:—Mr. Douglas Hay to be professor of mining; Mr. A. J. Saxton, assistant lecturer in physics; Mr. L. W. Cole, assistant lecturer and demonstrator in botany; Mr. H. W. Southgate, lecturer in pharmacology; Dr. E. F. Finch and Mr. V. Townrow, assistant curators of the Pathological Museum; and Dr. A. G. Yates, demonstrator in medical pathology.

LAST year the Civic Education League organised a very interesting Easter visit to Belgium for the purpose of civic study. This year a similar visit to Holland is being arranged. Anyone interested in civic studies may join the party, and early application to Miss Margaret Tatton, secretary, Civic Education League, Leplay House, 65 Belgrave Road, S.W.1, should be made. Members of the party will have special facilities for first-hand contact with the work and *personnel* of the chief social and economic institutions of the country.

THE annual prize distribution at the Sir John Cass Technical Institute, Aldgate, E.C.3, was held on Wednesday, February 8, when the prizes were distributed by Prof. William Rothenstein, principal of the Royal College of Art. The chairman of the governing body, the Rev. J. F. Marr, in giving a summary of the work of the institute during the past session, stated that the increase in the number of students had been more than maintained, and that the capacity of the institute, especially in the science departments, had been taxed to the utmost. Twenty students had been engaged in research work during the session, and the total number of investigations published from the institute had now reached 115. The Department of Petroleum Technology, which was initiated at the commencement of the present session, is one of the institute's most important developments, and there were already 150 students in attendance. Representatives of the industry have acted as a consultative committee to advise the governors in respect to the courses of study which have been provided, and the chief oil companies of the London area have given generous support towards the equipment and maintenance of the department. In the course of an address on "Education and Industry" Prof. Rothenstein said he regarded every kind of education as something in the nature of a pursuit after truth. Whereas there was much lip-homage to science and art and the crafts by our merchant princes and captains of industry, these employers did not have the same faith in them as their employees. Commercial men in past civilisations somehow knew how to ask for the best, but that was not true of our own civilisation. What we required was a standard of commerce which knew how to utilise what was best in the arts and sciences, for he refused to believe that people, in general, did not value that which was good and beautiful in production.

Calendar of Industrial Pioneers.

February 16, 1890. William Jarvis McAlpine died.—Trained under Jervis, the chief engineer of the Delaware and Hudson Canal, McAlpine became State Engineer for New York, and was also State Railroad Commissioner. At the request of the Austro-Hungarian Government he prepared plans for the improvement of the Danube. He was the first American to become a member of the Institution of Civil Engineers, and in 1886 was president of the sister institution in the United States.

February 18, 1888. Thomas Turner Tate died.—In conjunction with Sir William Fairbairn, Tate was the author of memoirs on the vapour tension of superheated steam and on the strength of materials in relation to the construction of iron ships, and was the inventor of the double piston air-pump. For some years he was mathematical master at Battersea Training College, and was known for his educational works.

February 19, 1816. Jean Pierre François Guillot Duhamel died.—An early student at the Ecole des Ponts et Chaussées, Duhamel accompanied Gabriel Jars in his extended industrial tour throughout Europe, and on his return to France did much to improve the manufacture of steel. He afterwards became Government Inspector of Forges and Furnaces, a professor of metallurgy at the Ecole des Mines, and a member of the Paris Academy of Sciences.

February 20, 1825. Joseph Marie François Cachin died.—One of the most distinguished French civil engineers of his day, Cachin was intimately connected with the improvements of the harbour of Cherbourg, and in 1820 published his "Mémoire sur la digue de Cherbourg comparée au breakwater, ou jetée, de Plymouth."

February 20, 1826. Matthew Murray died.—With Fenton and Wood, Murray founded a mechanical engineering works at Leeds which became one of the rivals of Boulton and Watt. The firm built flax-making machinery and constructed some of the earliest Blenkinsop locomotives, and Murray is generally credited with the invention of the short D-slide valve for steam engines.

February 20, 1913. Sir William Arrol died.—The builder of many famous bridges, Arrol between 1882 and 1887 reconstructed the viaduct over the Firth of Tay, and between 1883 and 1890 built the Forth Bridge. This bridge, designed by Fowler and Baker, has always been regarded as one of the greatest engineering structures in the world. With a total length of 8295 ft., of which the three cantilevers account for 5349 ft., the bridge contains 51,000 tons of steel, while the towers rise to a height of 360 ft. and the line is carried 150 ft. above the water at high tide. Arrol was knighted at the opening of the bridge by Edward VII.

February 21, 1888. George Henry Corliss died.—The greatest steam-engine builder of America, Corliss about 1848 entered into partnership with Nightingale at Providence, Rhode Island. Adopting the trip gear of Sickells, he brought out the Corliss form of steam engine, which on account of its improved economy and regular turning movement became known all over the world.

February 21, 1912. Osborne Reynolds died.—For nearly forty years professor of engineering at Owens College, Manchester, Reynolds made many investigations of importance to engineers and shipbuilders, such as those on screw propulsion, the flow of liquids, the condensation of steam, the transmission of heat, and lubrication. He was the inventor of the compound turbine.

E. C. S.

Societies and Academies.

LONDON.

Royal Society, February 9.—Sir Charles Sherrington, president, in the chair.—Sir J. Alfred **Ewing**: The atomic process in ferromagnetic induction. In the old model representing the process of ferromagnetic induction, the Weber elements or ultimate magnetic particles were represented by pivoted magnets the alignment of which, in the absence of an impressed field, was determined by the forces which they exerted on one another. The model is unsatisfactory; when the range of stable deflection is sufficiently narrow the stability becomes too great. In the new model the idea of magnetic control is retained, with a Weber element in each atom, but the controlling force is supposed to be exerted between the electrons of the atom itself, namely, between the shell, which is held more or less fixed by its relation to neighbouring atoms, and an inner electron system which constitutes the Weber magnet. The control depends on the difference between two nearly equal opposing forces; this characteristic permits the model to combine a sufficiently weak control with a narrow range of stable deflection. In one model considered the structure is based on the grouping of electrons suggested by Hull in connection with his X-ray analysis of iron crystals; in another the electron orbits are assumed to have the nucleus of the atom at their common focus.—J. W. **Nicholson**: Problems relating to a thin plane annulus. Only first approximations of solutions of problems relating to a thin plane annulus appear to have been used hitherto. Higher approximations have now been obtained, and the actual difference of radii of the circles bounding the annulus is of comparatively small significance in such magnitudes as the electrical capacity of the annulus. The whole investigation is carried to the second order of significance by treating the annulus as a special case of the elliptic anchor ring, but it can be extended. The convergence of such approximate solutions appears to be analogous to the degree of convergence found by Lord Rayleigh in certain solutions of problems of vibration of discs in which eccentricity is taken into account.—T. H. **Havelock**: The effect of shallow water on wave resistance. An analysis of the wave resistance of a surface pressure symmetrical round a point and moving over the surface of deep water is extended so as to include the effect of finite depth of water. The wave resistance is given by a definite integral which is evaluated by numerical and graphical methods. The cases intermediate between deep water and shallow water show the effect of limited depth in lowering the principal wave-making velocity and in increasing the effects near the velocity of the wave of translation.—R. H. **Fowler** and C. N. H. **Lock**: The aerodynamics of a spinning shell. Pt. 2. Of the shells fired from two guns giving different degrees of axial spin, those fired from the gun giving the more rapid spin were all stable, most of the others being unstable, as shown by the larger yaw developed. For yaws up to 35° a solution of the equations of motion can still be obtained in elliptic functions which proves adequately general.—F. B. **Pidduck**: The kinetic theory of a special type of rigid molecule. The methods of Chapman and Enskog in the kinetic theory of gases are applied, with modifications, to a type of rigid molecule to discover how viscosity is affected by energy of rotation, and the relative transport of translational and rotational energy in thermal conduction. The molecule model is considered as a sphere which grips at each collision and rebounds without dissipation of energy. The results support Eucken's views on Chapman's constant f for polyatomic gases.—J. E. **Jones**: The velocity distribution function and the stresses in a non-uniform rarefied monatomic gas. From Boltzmann's equation a symbolic solution of the velocity distribution function is obtained; from the new equation, by an analogous treatment, the exact nature of the function is deduced. The rate of change of molecular properties by collision follows more directly from this equation than from that used by Maxwell. To illustrate the present method, the results obtained by Chapman and Enskog for a normal gas are calculated anew. The treatment is extended to a rarefied gas and expressions are obtained for stresses due to non-uniformity of temperature. The special Maxwellian model is considered and Maxwell's result confirmed. The molecular model of a gas consisting of rigid elastic spheres is then considered in detail. The numerical coefficient in this case differs by about 20 per cent. from that of the Maxwellian gas.—H. **Bateman**: The numerical solution of integral equations. An approximate solution of an integral equation of Fredholm's type is obtained by using an approximate representation of the kernel by means of a double series of known functions. One such series is written down immediately in the form of a determinant, and the solution of the integral equation with the approximate kernel is also written in the form of a determinant. The kernel of the integral equation can also be represented approximately by a polynomial.—W. B. **Hardy** and Ida **Doubleday**: Boundary lubrication: The paraffin series. The lubricating properties of normal paraffins and their related acids and alcohols have been studied under the conditions of boundary friction. Amonton's law, that friction varies as the loads and is independent of the areas, is rigorously true for the same bearing surfaces and lubricants. The friction is independent of the quantity of lubricant present. It is a linear function of molecular weight, so that $\mu = \text{friction} \div \text{load} = a - b\text{M}$, where M is molecular weight and b a pure function of chemical constitution; the slope of the curve is greatest for acids, and sensibly the same for paraffins and alcohols. Changing from one acid to another shifts the curves parallel to themselves, so for the same chemical series a is a pure function of the nature of the solid faces. Each solid face contributes one-half of a, and each molecule of lubricant furnishes a constant quantity to the total effect independently of the total number of molecules present.

Aristotelian Society, January 16.—Dr. F. C. S. Schiller, president, in the chair.—H. J. **Paton**: Plato's theory of *εἰκασία*. In Plato's account of the Line and the Cave in the "Republic" he distinguishes two sub-divisions of opinion (*εἰκασία*, or intuition, and *πίστις*, or belief) and two sub-divisions of knowledge (*διανοια*, or mathematical reasoning, and *νόησις*, or philosophical reasoning). This must be understood as implying a difference of objects in each of the four sub-divisions, just as the objects of opinion and knowledge are different—the changing individuals as opposed to the unchanging universals. The parallelism or analogy between the objects of the two main divisions and those of the sub-divisions is meant to be taken seriously throughout. In particular, the objects of the *εἰκασία*, or intuition, are the many appearances whether given in what we call sense or memory or imagination, from which we pass to the objects of *πίστις*, or belief—the solid bodies of the ordinary consciousness and of science, things relatively permanent and relatively intelligible in comparison with their many appearances, although changing and unintelligible in comparison with the really permanent and really intelligible *εἴδη*, or universals. It is a complete error to

regard εἰκασία and its objects as of no metaphysical importance, and an understanding of the nature of this section is necessary if we are to grasp Plato's general theory of knowledge. Even Plato's theory that art must be classified under this first cognitive activity of the spirit is in its essence sound, in spite of the fact that some of the conclusions which he derived from it were mistaken.

Association of Economic Biologists, January 27.—Sir David Prain, president, in the chair.—E. P. **Stebbing**: The importance of scientific research in forestry and its position in the Empire. In India a research institute was formed at Dehra Dun in 1906, and the fully equipped building completed by 1914. It has now become necessary to decentralise research work to some extent, and a fine institute is already in existence at Coimbatore, in Madras. Elsewhere in the Empire, with the exception of Canada and at home, the forest services are only in the initial stages of the introduction of the work. A start should be made in the branches of forest botany and forest economics. At home a well-equipped research institute is most urgently needed which would work in collaboration with the educational centres the staffs of which have time available to devote to research work. Until such a research institute is established full use should be made of centres the equipment of which is adequate for carrying on research on the lines which the Forestry Commission may suggest.

Physical Society, January 27.—Sir William Bragg in the chair.—T. H. **Littlewood**: The diffusion of solutions. An optical method is described for finding the concentration at various depths in a diffusing solution. The solution is contained in a closed vessel, the top and one side of which are of glass. On the glass side is a vertical scale. This vessel is immersed in water containing a mirror which can be rotated, and the position of which is read on a graduated scale by a telescope which carries a horizontal wire illuminated by sodium light. The mirror is adjusted so that the image of the wire, after twice passing through the liquid, is seen on the cross wires of the telescope, and the reading on the vertical scale is also observed. The concentration can be determined at different depths with an accuracy of about 0·05 gr. per litre. From a series of measurements at different times the coefficient of diffusion can be calculated. Sufficient data can be obtained in less than a day.—H. R. **Nettleton**: A special apparatus for the measurement at various temperatures of the Thomson effect. The short wire under test (S.W.G. 18) passes through electrical heaters which may quickly be brought to, and maintained at, steady temperatures differing by some 50° C. over the range 20° C. to 250° C. A short coil of the finest double silk-covered copper wire (S.W.G. 44) acts as the Thomson-Joule heat detector.—J. J. **Manley**: A defect in the Sprengel pump: its causes and a remedy. A plan whereby the limitations and irregularities of the Sprengel pump resulting from the presence of air skins upon the interior surfaces may be made negligible is described. The efficiency of the new pump is superior to that of the older forms, and appears to be constant.

DUBLIN.

Royal Dublin Society, January 24,—Mr. G. Fletcher in the chair.—H. H. **Poole**: Some notes on the distribution of activity in radium therapy under different conditions of screening. Tests were made of the screening effect of various materials on the complex radiation emitted from a thin-walled emanation tube. From these the activity at various depths in the tissues were calculated for several arrangements of surface applications and for emanation needles.

EDINBURGH.

Royal Society, January 9.—Prof. F. O. Bower, president, in the chair.—K. A. **Houstoun**: A new method of investigating colour-blindness, with a description of twenty-three cases. The method was based on Maxwell's colour diagram, and consisted in testing the power of discriminating between contiguous tints of colour as the tint was varied continuously by stages from, say, red to green by an increasing admixture of green with red. The results for each observer were represented by contour lines on the triangular colour diagram. The ability of the observer to discriminate between any pair of colours could be seen from his diagram at a glance, irrespective of the terminology of any particular theory. More than 1400 students of Glasgow University had been tested during the last four years. All the cases of colour-blindness investigated seemed to be trichromatic in Maxwell's sense, not dichromatic as stated in text-books. Also, two observers who confused ordinary greens and reds were found, on the whole, to have quite as good a power of discriminating colour as the normal. Their trouble was apparently due to their colour-vision being extra sensitive to changes of wave-length in the green part of the spectrum, and not sensitive enough to changes of wave-length in the yellow.—W. Gordon **Brown**: The Faraday-tube theory of electromagnetism and other notes. The author met his death in France in 1916 at the age of twenty-one, and these papers were written in 1915–16 while he was convalescing after his Gallipoli experiences. He had just finished school in 1914, and he joined the Forces immediately war was declared. In the principal paper he established, on the assumptions of moving tubes of electric force, the equations of the electromagnetic field, and in a shorter quaternion investigation he worked out certain results on the hypothesis that the mass operator which changes velocity to momentum is a linear vector function. A few months before his death he was treating the problem of the tubes of force along the lines of the four-dimensional analysis developed by Minkowski, and communicated his results in a letter written to Prof. Whittaker.—T. Bedford **Franklin**: Some simple experiments on the colloidal content of soils. The mechanical analysis of a soil is no guarantee of its physical behaviour, for although the soil colloids are mainly contained in the finer fractions, yet the colloidal content of these fractions, as shown by analysis, can vary over a very large range. The paper described simple experiments for estimating the colloidal content. Thus a soil is probably highly colloidal if (1) it takes up a high percentage of water on the dry weight of the soil before reaching "maximum plasticity"; (2) its rate of evaporation declines slowly with diminishing water content; (3) it freezes well below 0° C.; (4) it takes up, after drying or freezing, much less water before reaching "maximum plasticity" than in its natural condition; and (5) it absorbs and retains for a long time farmyard or artificial manure.

PARIS.

Academy of Sciences, January 30.—M. Emile Bertin in the chair.—C. **Lallemand**: The comparative advantages of the hexagonal abacus and the abacus with aligned points.—C. **Moureu** and C. **Dufraisse**: Auto-oxidation. The anti-oxidisers.—G. **Gouy**: The pressure in magnetised or polarised fluids.—M. Maurice d'Ocagne was elected a free academician in succession to the late M. J. Carpentier.—T. **Varapoulos**: A theorem of M. Montel.—A. **Angelesco**: The zeros of certain functions.—A. **Cahen**: Differential equations of the first order with fixed critical points.—M. **Auric**: The development as a continued fraction of algebraical numbers.—R. **Jacques**: Surfaces such that the axes

of the osculating circles with one family of lines of curvature belong to a linear complex.—E. **Belot**: The periodicity and the movement of the sun-spots in latitude explained by the pulsation of the nucleus. Assuming that the dense nucleus of the sun (barosphere) has a pulsation with a period of eleven years, the consequences are worked out and give an explanation of the currents from north to south in the perisphere, observed, but not explained, by Oppolzer; the movement of the spots towards the equator (Spörer); and the displacement of the latitude of the maximum number of spots, which, according to Faye, should be in latitude 37° 38′, and is, in fact, about 17°.—H. **Chaumay**: The measurement of insulation resistance by the method of accumulation.—M. **Dufour**: The relation between aberration and astigmatism for a point situated on the axis of a centred optical system.—J. **Rey**: Range obtained by a beacon light of great power fitted with metallic reflectors. This light is installed on the Island of Galiton, north-west of Bizerta, and is 165 metres above sea-level. The calculated range was 30 miles. It can be frequently seen from Tabarka, 33 miles away, and in clear weather at Ras-Enhelah (41 miles).—H. **Weiss** and P. **Henry**: The influence of temperature on the velocity of interpenetration of solids. The alloy studied was silver containing 14 per cent. of antimony; the results are given in a series of curves.—E. **Darmois**: Two new molybdo-malates of ammonium. Gernez has shown that the rotatory power of malic acid undergoes considerable variation when increasing quantities of ammonium molybdate are added to the solution. From a study of the rotation of solutions of malic acid and ammonium molybdate two definite compounds, $MoO_3 \cdot 2C_4H_6O_5 \cdot 2NH_3$ and $MoO_3 \cdot 2C_4H_6O_5 \cdot 4NH_3$, were indicated, the first being the more stable. The isolation of these two compounds is described.—MM. **Seyewetz** and **Vignat**: The action of sodium sulphite on nitrobenzene. Nitrobenzene is reduced by a boiling 10 per cent. solution of sodium sulphite. The main product of the reaction is *p*-amidophenol sulphonic acid.—C. **Jacob**: The structure of North Annam to the south of Thanh Hoa.—F. **Blanchet** and E. **Chagny**: New observations on the dislocation of the Montagne de la Bastille, near Grenoble.—C. **Corroy**: Some Neocomian fishes of the Haute-Marne and the Meuse.—L. **Joleaud**: The area of dispersion of Dyrosaurus, a fossil crocodile from North-West Africa.—A. **Boutaric**: Observations carried out on Mont Blanc. Details of polarimetric and actinometric observations made hourly, between 7 a.m. and 6 p.m., at the Vallot Observatory between July 31 and August 7, 1921.—L. **Gentil**: The climatology of Morocco. In the absence of extended meteorological observations the study of the vegetation furnishes a valuable guide to climatic conditions. The rainfall chart in eastern Morocco of M. Augustin Bernard cannot be accepted without reserve.—P. **Schereschewsky** and P. **Wehrlé**: The signification of cirrus clouds in the prediction of weather. Cirrus clouds have often been considered as indicating the approach of rain; the authors show that the cloud system must be studied as a whole. Cirrus clouds are always indications of the proximity of a cloud system, but it does not necessarily follow that the system will pass over the observing station. It is necessary for the meteorologist to be able to determine the position of the cloud system in relation to the observing station, its direction of motion, and its velocity of displacement, before utilising cirrus clouds as a means of weather prediction.—Mlle. C. **Veil**: The relation between the chlorine index and the nitrogen content of plant-soil. The chlorine index is given by the amount of active chlorine absorbed by the soil from a solution of sodium hypochlorite. It is shown that there is a relation between this figure and the amount of nitrogen in the soil.—P. **Dangeard**: The origin of the vacuoles at the expense of the aleurone grains during the germination of the Graminaceæ.—W. **Kopaczewski**: Surface tension and narcosis. As a general rule narcotics and anæsthetics lower the surface tension of the blood-serum, and there is a parallelism between the amount of lowering and the narcotic power. There are exceptions, morphine being the most notable.—R. **Jeannel**: The variation of the copulating organs in the Coleoptera.—L. **Léger** and E. **Hesse**: Microsporidia resembling bacteria in form, and an attempt at a systematic classification of the group.—Mme. Anna **Drzewina** and G. **Bohn**: The phenomena of auto-destruction and auto-agglutination in the Convoluta.—M. **Aron**: The morphological signification of the endocrinian glandular tissue of the testicle in the crested triton.

SYDNEY.

Royal Society of New South Wales, December 7, 1921.—Mr. E. C. Andrews, president, in the chair.—C. A. **Sussmilch**: The geology of the Gloucester district. The strata of the Gloucester district (N.S.W.) belong to the Devonian Carboniferous and Permo-Carboniferous periods. During the Devonian period a thick series of shales, radiolarian cherts, and tuffs was laid down on a sea-floor. Submarine volcanic activity and important crustal movements took place during and at the close of this period. At the beginning of the Carboniferous period (Burindi stage) the region was under relatively shallow water. Long-continued slow subsidences allowed of the depositing of a very thick series of shales, limestones, conglomerates, and tuffs, aggregating 12,000 ft. in thickness. Later an uplift took place, and during the Kutting stage which followed volcanic activity was the most striking feature. The land flora (Rhæopteris, etc.) at this time consisted largely of ferns. Towards the close of the Permo-Carboniferous period a subsidence began which led to the formation of a large shallow lake. At intervals conditions became stable, the lake became a swamp covered by dense vegetation (the Glossopteris flora), and during these periods coal-seams were formed. There are at least eight coal-seams in the Gloucester district, the largest of which is 32 ft. thick. At the close of the Permo-Carboniferous period the region was subjected to intense folding forces, forming big mountain ranges. Since then there have been a succession of uplifts, the last of which took place at the end of the Tertiary period, and produced a tableland 2000 ft. in altitude.—O. U. **Vonwiller** The conduction of electricity in molybdenite.—G. J. **Burrows** and E. E. **Turner**: The preparation of certain ferrioxalates.—J. H. **Maiden**: An additional blue-leaf stringybark. A blue-leaf stringybark already described is *E. laevopinea*, R. T. Baker; the new species is more closely allied to *E. Blaxlandi*, Maiden and Cambage, and *E. capitellata*, Sm. It is a large tree, with sessile heads of small compressed spheroid fruits, which is confined, apparently, to New South Wales.—W. L. **Waterhouse**: The production in Australia of the æcidial stage of *Puccinia graminis*, Pers. Inoculations on barberry shoots with rust on wheat grown at Glen Innes, N.S.W., gave numerous infections from which æcidiospores were used to reinfect wheat.—A. R. **Penfold**: The essential oil obtained of the leaves of *Doryphora sassafras*, Endlicher. The yield of oil from leaves of the New South Wales sassafras tree was about 1 per cent., and it possessed the fragrance characteristic of sassafras oils. The principal constituents identified are safrol, camphor, pinene, sesquiterpenes, eugenol, and alcoholic bodies.

Official Publications Received.

Office Scientifique et Technique des Pêches Maritimes. Notes et Mémoires, No. 12: La Coopération de la Navigation Aérienne aux Pêches Maritimes. Extrait des Rapports sur les sorties en Dirigeable et en Avion effectués les 25 Août et 1er Septembre, 1921. Par H. Heldt. Pp. 8. 3 francs. Notes et Mémoires, No. 13: Recherches sur la Variation de l'Iode. Chez les principales Laminaires de la Côte bretonne. Par M. P. Freundler and Mlle. Y. Menager. Pp. 24. 4 francs. (Paris: Ed. Blondel la Rougery.)

Annual Report of the Department of Fisheries, Bengal and Bihar and Orissa, for the Year ending 31st March, 1921. Pp. vi+10+2 (Calcutta: Bengal Fishery Department.) 5 annas.

Ministry of Interior: Department of Refugees. Publication No. 6: The League of Nations and the Greeks and Armenians in Turkey. Pp. 62. (Constantinople.)

Imperial Department of Agriculture for the West Indies. Sugar-Cane Experiments in the Leeward Islands. Report on Experiments conducted in Antigua, St. Kitts-Nevis, and Montserrat in the Season 1919-20. Part 1: Experiments with Varieties of Sugar-Cane. Part 2: Manurial Experiments with Sugar-Cane. Pp. iv +57. (Barbados: Department of Agriculture.) 1*s*.

Memoirs of the Department of Agriculture, Trinidad and Tobago. No. 2: A Catalogue of the Trinidad Lepidoptera Rhopalocera (Butterflies). By W. J. Kaye. Pp. 163. (Trinidad.) 2*s*. 6*d*.

The Carnegie Trust for the Universities of Scotland. Twentieth Annual Report (for the Year 1920-21) submitted by the Executive Committee to the Trustees on 8th February, 1922. Pp. iv+83. (Edinburgh: The Carnegie Trust, Merchants' Hall.)

Comité International des Poids et Mesures. Procès-Verbaux de Séances. Deuxième série, Tome 9, Session de 1921. Pp. viii+110. (Paris: Gauthier-Villars et Cie.)

Madras Fisheries Department. Bulletin No. 12: Administration Report, 1918-19, and The Outrigger Canoes of Indonesia, by James Hornell; A Statistical Analysis of an Inshore Fishing Experiment at Madras, 1919, by M. Ramaswami Nayudu; Reports on the Fisheries of the Nilgiris, by the late H. C. Wilson: Notes on the Cichlid Fishes of Malabar, by N. P. Panikkar. Pp. iv+166+16 plates. (Madras: Government Press.) 4 rupees.

Diary of Societies.

THURSDAY, FEBRUARY 16.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. G. Perkin: Dyeing: Ancient and Modern (1).

ROYAL SOCIETY, at 4.30.—Prof. L. Hill, D. H. Ash, and J. A. Campbell: The Heating and Cooling of the Body by Local Application of Heat and Cold.—Prof. J. B. Cohen, C. H. Browning, R. Gaunt, and R. Gulbransen: Relationships between Antiseptic Action and Chemical Constitution, with Special Reference to Compounds of the Pyridine, Quinoline, Acridine, and Phenazene Series.—D. T. Harris: Active Hyperæmia.—B. B. Sarkar: The Depressor Nerve of the Rabbit.—Prof. A. Lipschütz, Dr. B. Ottow, C. Wagner, and F. Bormann: The Hypertrophy of the Interstitial Cells in the Testicle of the Guinea Pig under Different Experimental Conditions.

CHINA SOCIETY (at School of Oriental Studies), at 5.—Miss E. G. Kemp: Some Aboriginal Tribes in China.

LINNEAN SOCIETY OF LONDON, at 5.—Prof. R. R. Gates: The Inheritance of Flower Size in Plants.—W. Dallimore: Exhibition of Dwarf Trees, showing Wind Effect on Rocks at Llandudno.—J. L. North: Acclimatisation of the Soja Bean, *Glycine Soja*.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Sqdr.-Ldr. C. F. A. Portal: Methods of Instruction in Aeroplane Flying.

INSTITUTION OF MINING AND METALLURGY (at Geological Society of London), at 5.30.—J. M. Bell: The Occurrence of Silver Ores in South Lorrain, Ontario, Canada.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—F. P. Whitaker: Rotary Converters, with Special Reference to Railway Electrification.

INSTITUTION OF AUTOMOBILE ENGINEERS (London Graduates' Meeting), at 8.—L. F. Watson: Mechanical Efficiency.

CHEMICAL SOCIETY, at 8.—A. Lapworth: A Theoretical Derivation of the Principle of Induced Alternate Polarities.—W. O. Kermack and R. Robinson: An Explanation of the Property of Induced Polarity of Atoms and an Interpretation of the Theory of Partial Valencies on an Electronic Basis.

SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall, Essex Street, W.C.2), at 8.—E. B. Turner: Sex Relationships.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, W.1), at 8.15.—Major F. W. Cragg: Relapsing Fever in India.

SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, FEBRUARY 17.

GEOLOGICAL SOCIETY OF LONDON (Anniversary), at 3.—Presidential Address.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof Swale Vincent: A Critical Examination of Current Views on Internal Secretion (Arris and Gale Lecture).

INSTITUTION OF MECHANICAL ENGINEERS (Annual General Meeting), at 6.—A. T. Wall: Electric Welding applied to Steel Construction, with Special Reference to Ships.

BRITISH ELECTRICAL DEVELOPMENT ASSOCIATION (at Chartered Institute of Patent Agents, Staple Inn Buildings, W.C.2), at 7.30.—H. Harrison: Salesmanship in Relation to Electric Lighting.

JUNIOR INSTITUTION OF ENGINEERS (at Caxton Hall), at 8.—W. J. Leaton: Water Purification for Boiler Feed Purposes.

SOCIÉTÉ INTERNATIONALE DE PHILOLOGIE, SCIENCES ET BEAUX-ARTS (Celtic Section) (at 8 Taviton Street, W.C.1), at 8.—Dr. W. J. E. Scott: The Mines of El Dorado: an Historical Account of the Maritime Trade of Spain with Ireland, 2000 to 700 B.C. (2).

ROYAL SOCIETY OF MEDICINE (Electro-therapeutics Section), at 8.30.—Dr. G. W. C. Kaye: Radiology and Physics (Mackenzie-Davidson Memorial Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. D. S. M. Watson: History of the Mammalian Ear.

SATURDAY, FEBRUARY 18.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. E. A. Gardner: Masterpieces of Greek Sculpture (1).

PHYSIOLOGICAL SOCIETY (at School of Medicine for Women, Hunter Street, W.C.1), at 4.—J. S. Haldane: Working Model to Illustrate a Theory of Muscular Contraction.—C. da Fano: Permanent Golgi-Cox Specimens.—W. W. Waller: The Microscopic Appearances of Red Blood Corpuscles in Hypertonic Saline.—W. Cramer: Slides Demonstrating the Functional Activity of the Suprarenal Medulla.—W. D. Halliburton and D. H. de Souza: Secretin by the Portal Route.—J. W. Pickering and J. A. Hewitt: Some Physico-chemical Aspects of Blood Coagulation.—J. A. Hewitt and Dorothy B. Steabben: Note on the Fermentation of Inositol.—M. Bond: (*a*) Fat Soluble A Content of Bacon Fat; (*b*) Food Value of Dried Egg-white.—E. E. Hewer: Some Observations on the Results of Suprarenal Inoculations.—M. O. P. Wiltshire: Oxygen Intake of Women during Muscular Work.—W. C. Cullis and M. Ross-Johnson: Periodic Variations in Temperature in Women.—W. C. Cullis: Oxygen Consumption as a Test of Fatigue.—G. V. Anrep and R. K. Cannan: The Blood Sugar Metabolism of the Submaxillary Gland.—A. N. Drury: The Effect of Vagal Stimulation on Intra-auricular Block produced by Cold (Mammalian Auricle).—J. Trevan and E. Boock: Note on the Effect of Section of the Vagus on the Respiratory Centre of the Cat.—H. W. Haggard and Y. Henderson: Hæmorrhage as a Form of Asphyxia.

MONDAY, FEBRUARY 20.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—E. F. Hetherington and others: Discussion on The Emergency Use of Oil Fuel during the Recent Coal Strike.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—A. J. Davis: The Internal Decoration of Ocean Liners.

ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street, W.C.1), at 8.—Prof. H. Wildon Carr, Dr. Dorothy Wrinch, Prof. T. P. Nunn, and Prof. A. N. Whitehead: Discussion on the Idealistic Interpretation of Einstein's Theory.

ROYAL SOCIETY OF ARTS, at 8.—Prof. A. F. C. Pollard: The Mechanical Design of Scientific Instruments (1) (Cantor Lecture).

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—A. F. R. Wollaston: Natural History of South-western Tibet.

TUESDAY, FEBRUARY 21.

INSTITUTION OF ELECTRICAL ENGINEERS, at 3.—Meeting in commemoration of the First Meeting of the Society of Telegraph Engineers on February 28, 1872.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Arthur Keith: Anthropological Problems of the British Empire: Racial Problems in Asia and Australasia (1).

ROYAL SOCIETY FOR THE PROTECTION OF BIRDS (at the Middlesex Guildhall, Westminster, S.W.1), at 3.—Viscount Grey of Fallodon: Address on the Work of the Society.

ROYAL STATISTICAL SOCIETY, at 5.15.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. R. Broom: The Temporal Arches of the Reptilia.—Dr. H. Blegvad: Animal Communities in the Southern North Sea.—Dr. C. F. Sonntag: (1) The Vagus and Sympathetic Nerves of the Edentata. (2) The Vagus and Sympathetic Nerves of *Hyrax capensis*.—C. Tate Regan: The Cichlid Fishes of Lake Victoria.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Discussion on paper by Dr. H. F. Parshall on: Hydro-Electric Installations of the Barcelona Traction, Light and Power Company.—A. C. Walsh and W. F. Stanton: The Improvement of the Port of Valparaiso.

WOMEN'S ENGINEERING SOCIETY (at 26 George Street, W.1), at 6.15.—Mrs. H. Irving: Model Experiments in Aeronautics.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—D. R. Hutchinson: Types of Large Marine Engines.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—G. A. Booth: Natural History Photography.

WEDNESDAY, FEBRUARY 22.

INSTITUTION OF ELECTRICAL ENGINEERS, at 3.30 and 8.30.—Meeting in Commemoration of the First Meeting of the Society of Telegraph Engineers on February 28, 1872.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. C. W. Andrews: Description of a New Plesiosaur from the Wealden Clay of Sussex.—T. Landell-Mills: with Notes on the Petrography by Dr. A. Gilligan, and on the Palæontology by Dr. A. Smith Woodward: The Carboniferous Rocks of the Deer Lake District of Newfoundland.

ROYAL SOCIETY OF ARTS, at 8.—Dr. A. Scott: The Restoration and Preservation of Objects at the British Museum.

THURSDAY, FEBRUARY 23.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. G. Perkin: Dyeing: Ancient and Modern (2).

INSTITUTION OF ELECTRICAL ENGINEERS, at 3.30 and 8.—Meeting in Commemoration of the First Meeting of the Society of Telegraph Engineers on February 28, 1872.

ROYAL SOCIETY, at 4.30.—*Probable Papers*.—C. D. Ellis: β-ray Spectra and their Meaning.—Prof. A. E. Conrady: A Study of the Balance.—Dr. J. S. Owens: Suspended Impurity in the Air.—R. V. Southwell: The Free Transverse Vibrations of a Uniform

Circular Disc clamped at its Centre, and the Effects of Rotation.—A. E. Oxley: Magnetism and Atomic Structure. II. The Constitution of the Hydrogen-palladium System and other similar Systems.—T. Carleman and Prof. G. H. Hardy: Fourier's Series and Analytic Functions.—Prof. A. McAulay: Multenions and Differential Invariants. II. and III.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute, 90 Buckingham Palace Road, S.W.1), at 6.—A. E. Hayes: Phonoscript.

CONCRETE INSTITUTE, at 7.30.—H. K. Dyson: What is the Use of the Modular Ratio?

FRIDAY, FEBRUARY 24.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botanical Lecture Theatre, Imperial College of Science and Technology), at 2.30.—Dr. J. Rennie: (*a*) The Present Position of Bee Disease Research; (*b*) Demonstration of Polyhedral Disease in Tipula Species.

ROYAL SOCIETY OF ARTS (Joint Meeting of the Dominions and Colonies and Indian Sections), at 4.30.—Prof. W. A. Bone: Brown Coals and Lignites: Their Importance to the Empire.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—Dr. H. Levy: The Number of Radio-active Transformations as Determined by Analysis of the Observations.—Prof. C. H. Lees: A Graphical Method of Treating Fresnel's Formulæ for Reflection in Transparent Media.—Research Department of the General Electric Co., Hammersmith: Demonstrations of a Sensitive Method of Determination of Density, etc.—F. C. Dyche-Teague: Demonstration of the Physical Properties of Cellactite.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—H. Main: A Pilgrimage to Provence.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—E. G. Coker: Curved Beams, Rings, and Chain Links.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. J. Joly: The Age of the Earth.

SATURDAY, FEBRUARY 25.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. E. A. Gardner: Masterpieces of Greek Sculpture (2).

PUBLIC LECTURES.

(*A number in brackets indicates the number of a lecture in a series.*)

THURSDAY, FEBRUARY 16.

INFANTS' HOSPITAL (Vincent Square, S.W.1), at 4.—Dr. W. M. Feldman: Fœtal Physiology and Fœtal Nutrition.

UNIVERSITY COLLEGE, at 5.15.—Prof. J. E. G. de Montmorency: Welsh and Irish Tribal Customs (2).

KING'S COLLEGE, at 5.30.—Dr. O. Faber: Reinforced Concrete (5).—M. Beza: Nereids in Roumanian Folklore (2).

ST. JOHN'S HOSPITAL FOR DISEASES OF THE SKIN (Leicester Square, W.C.2), at 6.—Dr. W. K. Sibley: Seborrhœa and Psoriasis (Chesterfield Lecture).

FRIDAY, FEBRUARY 17.

METEOROLOGICAL OFFICE (South Kensington), at 3.—Sir Napier Shaw: The Structure of the Atmosphere and the Meteorology of the Globe (5).

KING'S COLLEGE, at 5.—Prof. R. Robinson: Orientation and Conjugation in Organic Chemistry from the Standpoint of the Theories of Partial Valency and of Latent Polarity of Atoms (2).

UNIVERSITY COLLEGE, at 5.—Prof. G. Elliot Smith: The Evolution of Man (2).

TAVISTOCK CLINIC FOR FUNCTIONAL NERVE CASES (at Mary Ward Settlement, Tavistock Place, W.C.1), at 5.30.—Dr. H. Crichton Miller: The New Psychology and its Bearing on Education (4).

SATURDAY, FEBRUARY 18.

ROYAL SOCIETY OF ARTS, at 10.30 a.m.—Prof. J. A. Thomson: The Migration of Birds (Lectures for Teachers).

LONDON DAY TRAINING COLLEGE, at 11 a.m.—Prof. J. Adams: The School Class (5).

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. E. Marion Delf: A Botanist in South Africa.

MONDAY, FEBRUARY 20.

UNIVERSITY COLLEGE, at 5.15.—Sir Gregory Foster: The University of London: Its History, Present Resources, and Future Possibilities (2).

CITY OF LONDON (BOYS') SCHOOL (Victoria Embankment), at 5.30.—Miss Rosa Bassett: The Dalton Plan of Self-education (3).

KING'S COLLEGE, at 5.30.—Prof. C. L. Fortescue: Wireless Transmitting Valves (5).

TUESDAY, FEBRUARY 21.

CANCER HOSPITAL (Fulham Road, S.W.3), at 4.—Sir Charles Ryall: Cancer of the Tongue.

SCHOOL OF ORIENTAL STUDIES, at 5.—Col. T. C Hodson: The Primitive Culture of India (5).

IMPERIAL COLLEGE (Royal School of Mines), at 5.30.—Col. N. T. Belaiew: The Crystallisation of Metals (1).

KING'S COLLEGE, at 5.30.—F. H. Rolt: Accurate Measurements in Mechanical Engineering: The Use and Testing of Gauges (3).

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 6.—Sir Josiah C. Stamp: The Administrative Factor in Government (2).

WEDNESDAY, FEBRUARY 22.

SCHOOL OF ORIENTAL STUDIES, at 12 a.m.—Miss Alice Werner: Bantu Mythology and Folklore (3). At 5.—C. O. Blagden: Matriarchy in the Malay Peninsula.

EAST LONDON COLLEGE, at 4.—Prof. F. E. Fritch: Certain Aspects of Freshwater Algal Biology (2).

LONDON (R.F.H.) SCHOOL OF MEDICINE FOR WOMEN (Hunter Street, W.C.1), at 5.—Dr. H. H. Dale: Some Recent Developments in Pharmacology (1).

HORNIMAN MUSEUM (Forest Hill), at 6.—W. W. Skeat: The Living Past in Britain (5).

UNIVERSITY COLLEGE, at 8.—The Current Work of the Biometric and Eugenics Laboratories (2).—Miss Ethel M. Elderton: The Inheritance of Intelligence.

THURSDAY, FEBRUARY 23.

INFANTS' HOSPITAL (Vincent Square, S.W.1), at 4.—Dr. W. M. Feldman: The Physiology and Pathology of the New Born; Initial Loss of Weight; Icterus Neonatorum.

UNIVERSITY COLLEGE, at 5.15.—Prof. J. E. G. de Montmorency: Welsh and Irish Tribal Customs (3).

KING'S COLLEGE, at 5.30.—Dr. O. Faber: Reinforced Concrete (6).

ST. JOHN'S HOSPITAL FOR DISEASES OF THE SKIN (Leicester Square, W.C.2), at 6.—Dr. W. Griffith: The Bullous Eruptions (Chesterfield Lecture).

BIRKBECK COLLEGE, at 8.—G. Bernard Shaw: The Failure of Education.

FRIDAY, FEBRUARY 24.

METEOROLOGICAL OFFICE (South Kensington), at 3.—Sir Napier Shaw: The Structure of the Atmosphere and the Meteorology of the Globe (6).

CANCER HOSPITAL (Fulham Road, S.W.3), at 4.—W. E. Miles: Cancer of the Rectum.

UNIVERSITY COLLEGE, at 5.—Prof. G. Elliot Smith: The Evolution of Man (3).

TAVISTOCK CLINIC FOR FUNCTIONAL NERVE CASES (at Mary Ward Settlement, Tavistock Place, W.C.1), at 5.30.—Dr. H. Crichton Miller: The New Psychology and its Bearing on Education (5).

SATURDAY, FEBRUARY 25.

LONDON DAY TRAINING COLLEGE, at 11 a.m.—Prof. J. Adams: The School Class (6).

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. W. A. Cunnington: Man's Sphere in Savage Africa.

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