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Production and Use of Synthetic Nitrogenous Fertilisers.

AMONG the factors that are shaping the course of nations to-day, few are more important than the possession or control of raw materials. Nature, in her perverse way, has not only made men very unequal in character, energy, and ability, but she has also distributed so capriciously their means of sustenance and development that no civilised country is, or can expect to be, entirely self-supporting in the economic sense. There are many signs that the question of raw materials for food and industry will profoundly affect, if not dominate, international relationships. The United States is crying aloud for sources of supply of rubber, potash, mercury, manganese, long-staple cotton, and sisal ; Germany, by her loss of territories in Europe and overseas, has become more dependent than ever upon foreign countries for a host of basic raw materials ; Italy, Belgium, and Japan are asking the League of Nations to appoint a committee to consider the subject.

The question is, however, not entirely an economic one ; its ramifications penetrate many spheres of human activity, including that of science and its applications, for chemistry, physics, physiology, botany, and entomology are all playing their parts in alleviating the consequences of Nature's haphazard distribution of the necessaries of life and progress. From chemistry and physics we may, perhaps, expect most, for are they not showing us every day how to satisfy our primary needs by fabricating the raw materials of food, of clothing, and of shelter from such simple materials as air, water, fuel, and vegetation ?

Of all the basic needs of man, food is the most essential ; and, as Sir Daniel Hall recently reminded us at Oxford, the old problem of its supply still awaits solution. Man ever tends to multiply beyond his means of subsistence ; land suitable for agriculture is limited in extent ; its fertility declines, and must not only be restored but also increased to meet our ever-growing needs. Civilisation, through the sanitary authority, has made us abandon the economic practice (followed by Germany during the War, and by China from time immemorial) of returning to the soil the unassimilated plant nutrients of our food ; and as other organic manures are strictly limited in amount, the only solution is to manufacture fertilisers from natural products. Fortunately for us all, the continued application of fertilisers does not, as was formerly believed, sicken the soil, provided they are scientifically applied ; and the raw materials of their manufacture are very abundant, though some of them are very unequally distributed over the earth. The occurrence of potash is very localised, but the deposits are enormous, Germany and the Upper Rhine being estimated to contain no less than 21,000 million tons of crude potash salts situated at workable depths. Phosphate deposits are more numerous, although the life of the most important of them has been estimated at from twenty-one to seventy years ; there are, however, vast deposits that are poor in grade or badly situated. Apart from the Chilean nitrate-beds, which have a definitely limited life, and the wonder-workings of the nitrogen-fixing bacteria, the world is ill-supplied with natural nitrogenous fertilisers, but the chief raw material of these fertilisers—nitrogen—is extraordinarily abundant: no less than eight tons of it are present in the air over every square metre of the earth's crust ; and few human achievements can compare in importance with the recent work of physical chemists in making this mine of potential fertility available for agricultural purposes.

To Germany belongs most of the credit for having elaborated the manufacture of synthetic nitrogenous fertilisers by means of the Haber process. That process, together with the modifications due to Claude, Casale, and Fauser, consists in uniting nitrogen from the air with hydrogen from water to form ammonia ; and to-day it is by far the most important of nitrogen-fixation methods, the cyanamide process coming next and the arc process third. The estimated production of combined nitrogen in Germany during the fertiliser year 1925–26 (June-May) was 600,000 metric tons (equal to nearly 3 million tons of sulphate of ammonia), of which 90 per cent. was to be made by synthetic processes. Although the Haber and cyanamide processes were much used in Germany during the War, it was not until 1923–24 that Germany had sufficiently recovered from its effects to be able to export nitrogenous fertilisers ; for the year 1925–26 her estimated exports were about 135,000 tons of fixed nitrogen, equivalent to about 675,000 tons of sulphate of ammonia. Following Germany's lead, the manufacture of synthetic ammonia has been taken up in many lands, and although, in general, achievements have not so far corresponded with effort and *réclame*, there is no doubt that within the next decade production will attain a figure undreamed of before the year 1914. It is satisfactory to note that, next to Germany, Great Britain is the most important producer of synthetic nitrogen compounds, an achievement that is due to the initiative and enterprise of Messrs. Brunner, Mond and Co., Ltd., through its associated company, Synthetic Ammonia and Nitrates, Ltd.

The future of the British nitrogen industry, its ability to retain the home market and to withstand foreign competition in the outlying parts of the Empire, are matters of national concern, not only in respect of the peace-time manufacture of fertilisers, but also in respect of the war-time production of nitric acid and high explosives. In Great Britain the chief source of supply of manufactured nitrogenous fertilisers has long been, and is still, the ammonia that is obtained from coal as a by-product in the manufacture of metallurgical coke and town's gas. This ammonia is converted into ammonium sulphate, which is still the most popular of manufactured nitrogenous fertilisers, and of which very large quantities are sold at home and abroad. Our total production of nitrogen as ammonium sulphate in the year 1925–26 was 429,517 tons, of which 238,611 tons was exported. Exports and prices, however, are falling as the result of severe German competition, and the outlook is not cheerful. At the recent International Conference on Nitrogen Propaganda in Biarritz, it was stated that the British Sulphate of Ammonia Federation, of which Synthetic Ammonia and Nitrates, Ltd., is a member, had made an arrangement with the German Nitrogen Syndicate by which new German nitrogen compounds that are suitable to English conditions would be made available to English farmers ; but nothing in the nature of a *quid pro quo* was mentioned. Now the Germans are very active in producing new fertilisers, which play an important part in their propaganda.

Dr. J. Bueb told the conference at Biarritz that when Germans enter a foreign market they are very careful to 'push' only well-known fertilisers until they have obtained a firm foothold ; then they introduce their novelties, usually mixed fertilisers, that are especially suitable to the local conditions. In 1919–20 it was recognised in Germany that ammoniacal nitrogen could never completely replace nitric nitrogen (as in Chile saltpetre) ; and the hygroscopic and explosive ammonium nitrate being regarded as unsuitable, efforts were concentrated on producing mixed fertilisers like ammonium sulphate-nitrate and ammonium-potassium nitrate. To compete with Chilean nitrate, a white calcium nitrate of the same nitrogen content, but without its bad effect on 'sticky' soils, has been successfully marketed. In 1924 the manufacture of urea was started on a large scale, and this highly concentrated fertiliser (46 per cent. nitrogen) is selling very well, being especially valuable for tobacco, hops, vine, garden plants, meadows and pastures. Pure di-ammoniumhydrogen phosphate ('Diammonphos'), and a mixture of it with ammonium sulphate ('Leunaphos'), are among the chief products of the well-known 'Badische' company ; whilst a compound fertiliser containing nitrogen, phosphoric acid, and potash in the ratio 1 : 0·75 : 1 has been specially worked out for sale in China under the name of 'Leunaphosphate.' Variety of form, low price, and intensive propaganda are the outstanding features of the rapidly expanding German trade in fertilisers.

With regard to the security of the British home market, it appears highly probable that Synthetic Ammonia and Nitrates, Ltd., will come to an arrangement with the German Nitrogen Syndicate whereby spheres of influence will be defined and selling prices will be fixed and adjusted in ways advantageous to both. Failing the conclusion of such an arrangement, or in the event of its future collapse if made, competitive ability will depend upon quality, manner of marketing, production costs, selling policy and salesmanship. On the score of quality we need entertain no fear. British goods are not always best, as the Government post-mark asserts (though they may be always the best to buy), but in the case of chemical products made by a firm of the standing of Brunner, Mond and Co. there is no doubt that they can hold their own against all comers. In the matter of producing costs there is much less certainty. The cost of labour and fuel, together with paralysing taxation, constitute at present enormous handicaps to cheap production; and it is unlikely that any Government would succeed in restricting foreign competition under the provisions of the Safeguarding of Industries Act. On the other hand, it is understood that Synthetic Ammonia and Nitrates, Ltd., has effected a number of improvements and economies in the Haber process; it commands a personnel, financial and administrative as well as technical, that is second to none; and it has ample capital resources.

Competition at home is not to be feared, for synthetic nitrogen compounds will be produced at a cost which, in the event of unrestricted competition, would oust by-product ammonium compounds from the market. Both coke-ovens and gas-works will have to toe the line set by the nitrogen factory. The gas companies will continue to produce sulphate of ammonia, because they will not be allowed to turn their poisonous gas-liquor into streams and estuaries; and what they lose on the swings of ammonia they will make up on the roundabouts of gas and other residuals. Coke-oven works will suffer an important loss of revenue, so that the price of metallurgical coke may rise, and with it the prices of iron and steel. The home industry will therefore be able to present a solid front to the foreigners who would invade the home market; but if that market is to be preserved, producing costs must be kept low by all possible means; and if labour is refractory we must cheapen overhead costs by extending sales, the possibilities of which are very considerable. The recent appointment by Synthetic Ammonia and Nitrates, Ltd., of Sir Frederick Keeble to take charge of research into the application of synthetic nitrogenous compounds to agricultural purposes, and to be director of propaganda, is of especial significance, for it shows that the company is fully aware of the possibilities of the application of science and scientific method to the problems of industry, and of the value of trained experience in organising propaganda among potential consumers.

Among the more promising new outlets for nitrogenous fertilisers is their application to meadow and pasture land. In the past only arable land has been fertilised in this manner, but three years ago the German manufacturers initiated a series of large-scale tests on the use of nitrogen, with or without phosphates, for grass-land, and the results have shown that the treatment is economically profitable, provided that due regard is had to the nature of the soil and the vegetation, although the increased returns are lower than in the case of arable land. The capital cost of this extension to farming practice would undoubtedly put an additional burden on the small farmer, but the constantly diminishing price of combined nitrogen, and the increasing cost of artificial feeding-stuffs, are factors that should encourage him to undertake the risk. Another possibility lies in the breeding of new types of the most important species of cultivated plants that will assimilate much larger quantities of nitrogen than existing types, and so yield much bigger crops from the same acreage. Such an achievement is held to be quite feasible, although many years may elapse before it is consummated. Further progress would result from the devising of means to retain in the soil the nitrogen that is applied to it in the form of nitrogenous fertilisers and manures. Sir John Russell estimates that under good farming conditions only about one-half of the applied nitrogen is recovered in the first year's crop, and but very little of the residual nitrogen in later crops. Such an economy would at first sight appear to be disadvantageous to the manufacturer, but the farmer would be able to extend his purchases of fertiliser and bring under intensive cultivation land which could not previously stand the cost of artificial dressings.

Quite apart, however, from novel developments of the above kind, there is no doubt that the field of consumption of nitrogenous fertilisers is capable of almost unlimited extension. Russia, Argentina, Canada, Australia, and South Africa are practically virgin fields for the use of manufactured fertilisers, whilst of all the countries that already use them, only Germany, the United States, France, Great Britain, Holland, and Italy are important consumers. The order for consumption of fertilisers of all kinds is that given; for nitrogenous fertilisers only, it is Germany (easily first), the United States, France, Great Britain, Holland, Italy, and Egypt. A better view of the present position is, however, obtained by considering the consumption per unit area of cultivated land. From the statistics published by the International Institute of Agriculture at Rome for nitrogen consumption in the fertiliser year 1921–22, it is seen that Holland comes first, followed closely by Germany, and then at a long interval come Egypt, Belgium, Great Britain, Japan, France, and Sweden, whilst the United States and Canada rank very low indeed.

When we consider that intensity of cultivation differs very greatly in these countries, and that experts in Germany maintain that her soil would respond to twice the quantity of fertilisers which are now applied, we obtain some idea of the great possibilities in store. There is big business in fertilisers to-day; there will be bigger business to-morrow; and no progressive country will be able to afford to neglect provision of these basic raw materials of food production. With expansion of the world's demand for them, we may expect the chemical industry to occupy a more prominent place in the industrial world than it does to-day, and even the chemist may receive that meed of recognition for which he has been striving so long. In Germany to-day it is openly said that the I.G.—the enormous combine of chemical manufacturers—*is* the Government.

If Great Britain is to hold her own in the world's markets, better men must be attracted to the profession and industry of chemistry by offering more adequate rewards; and salesmanship and propaganda, which are playing an increasingly important part in mundane affairs, must not be neglected. We must abandon the attitude of 'take it or leave it,' and study actual demands, local conditions, and the psychology of our customers. The farmer is proverbially one of the 'toughest nuts to crack.' Conservative by nature, he is also frequently regarded as simple. In reality he is very astute, although his time-reactions are slow. He is also suspicious, as he has good reason to be, because of his past experience of quack wares and of good wares sold at extortionate prices. He is apt to regard the adjective 'chemical' with grave suspicion: did not his forbears denounce nitrate of soda as 'the scourge'? He is also more resistant than the average town-dweller to the lure of printed advertisements; but he is not impervious to the advances of the well-qualified agricultural lecturer, and still less to the evidence of the demonstration plot. What does appeal to him strongly is the success of a neighbour or a rival in obtaining yields and results which he has been unable to achieve; and, of course, he is very susceptible to the argument of *l. s. d.*; in other words, he should be approached through his primary instincts of positive self-feeling and acquisition. In this respect he is not markedly different from the rest of us; as Goethe said, "Mankind progresses, but man remains the same."

Peasant and Pundit in India.

Bihar Peasant Life: being a Discursive Catalogue of the Surroundings of the People of that Province. By Sir George A. Grierson. (Prepared (in 1885) under Orders of the Government of Bengal.) Second and revised edition. Pp. iv + 4 + 443 + xvii + clv + 40 plates. (Patna: Government Printing Office, 1926.) 10 rupees.

BIHAR, the homeland of Buddhism, came under the East India Company in 1765, and remained merged in Bengal until 1912, when it reappeared as senior partner in the new province of Bihar and Orissa. In area Bihar is larger than Hungary; its population (nearly 600 to the square mile) is greater than that of Canada, Australia, and the Union of South Africa combined. Of its people, only 8 per cent. live in towns, a fact not easy for the 80-per-cent.-urbanised Englishman to appreciate.

The Bihari peasant is reputed boorish, but a certain young civilian who landed in India in 1873 found him well worth study. There is only one way to get to know a peasant, and that is by talking to him. His language is not the language of poets and pundits, nor can it be learned from a dictionary, for many of its concepts have no equivalents in English and many of its words are as strange to literature as 'zoles' and 'spitters' (unless he come from Devon) to the average professor of classical Greek. So it was that one of the most masterly linguists of the age became the peasant's pupil; "every word in this book," writes the author, "has been collected from the mouths of the people." The task took seven years.

The plan of the book is modelled on a work by the late Dr. Crooke. It is a pity that the lead was not followed in every province of India; for a better key to the life and mind of the ryot could not be proffered to the new-fledged civilian.

Sir George Grierson describes his book as a "discursive catalogue." It is more than that; for, though intended only as a foundation for serious research, it throws in vivid relief the things that count in Indian peasant life. Its main interest centres, of course, in the land; the rich belt nearest the home, the leaner belt on the village outskirts, and the belt between; land new made and land washed away by the vagaries of rivers; soils sandy, clayey, loamy, saline, or stony; soils water-logged and soils which will not retain moisture; the ploughing and reploughing—"a hundred ploughings for cane, fifty for wheat," as they say in Gaya—the sowing, transplanting, irrigating, weeding, and watching; and then the harvest, and the division of the crops between landlord and tenant; the deductions and remissions, and the perquisites due to the village carpenter and blacksmith, the weaver and shoemaker, the sweeper, the accountant, the weighman, and the watchman; a tough business was this settlement of grain rents, by custom and without contract, and the variety of tenures is bewildering. Then there is the problem of labour; the serf who cannot leave his job, or marry, or do anything without his lord's consent; the debtor who binds himself to work until his debt is cleared; the one-year servant and the half-day servant; the man who, in lieu of wages, borrows a plough and oxen one day in three; the pair of cultivators who join and till each other's land in turn; and, in the background, advances of grain and cash, and loans and mortgages on terms unthinkable in generous England.

Other sides of peasant life there are, subsidiary always to the land; the live stock, the home life, the cottage industries. It would puzzle a lexicographer to discriminate in English between the 140 odd varieties of earthenware vessels named (the list is not exhaustive), let alone vessels of metal, wood, or leather, baskets, boxes, and nets, the 100 or so different kinds of jewelry, or the 250 or more different kinds of food.

Of domestic ceremonies, the rites of birth, marriage, and death, the treatment is necessarily cursory; such subjects can only be dealt with adequately by an intensive study of each separate community, for in no two castes are they exactly alike. The same applies to religion generally, for each cult requires separate handling, and more than a hundred cults are named.

The list of country craftsmen, so unlike anything European, shows how little the simple self-contained culture of the Indian peasant is dependent on Western industrialism. Of local products, the only one of industrial importance was (before German chemistry strangled it) indigo.

In mechanics, the Bihari shares with the rest of India the oil-mill and the water-lift, but his masterpiece of ingenuity is the two-wheeled 'large complete country cart,' in which the art of adjusting strains and stresses seems to run riot; the why and wherefore of its three pairs of intersecting spokes, which run from felloe to felloe, its twin axles, one for each wheel, and its 'spinal curvature,' deserve an expert monograph.

Needless to say, Sir George Grierson is scrupulous to observe the niceties of scientific writing, the neglect of which too often impairs the value of books on India. He is careful to define his geographical units, and to explain them with a map; each vernacular word is printed twice, once in the vernacular script, and again transliterated in italics; and, a point most necessary in a land of more than 200 languages, plants are given their botanical names, though the terms used are sometimes out-of-date and generic names seldom begin with capitals. To question Sir George's accuracy would be presumptuous, but (p. 401) Bakr-Id does not always fall in December or Barah-Wafat in March; these festivals, like the rest of the Moslem calendar, fall a little earlier year by year.

Events in India in recent years have somewhat obscured the ryot's interests, and the timely reissue of this valuable work is to the credit of the Bihar and Orissa Government. But in 'get up' this second edition is a sorry travesty of its former self. The first edition was neatly printed on excellent paper, smartly bound and lettered, and beautifully illustrated. In the new volume the paper is coarse, the binding clumsy, the printing dirty and irregular, the pictures blurred; while the errata list covers 29 printed pages and yet records but a fraction of the misprints which disfigure almost every page of the text, making it everywhere untrustworthy, and sometimes unintelligible. Such being the case, it is not a little surprising to read in the 'Foreword' that the proof-reading was entrusted to two distinguished officers who are thanked by the Government "for the care they have taken to produce an accurate reprint." F. J. R.

Wilhelm Hofmeister.

Wilhelm Hofmeister: the Work and Life of a Nineteenth Century Botanist. By Prof. Dr. K. von Goebel. With Biographical Supplement by Frau Professor Ganzenmüller. Translated into English by H. M. Bower, and edited botanically by Prof. F. O. Bower. (Ray Society Volume (No. 111) for 1925.) Pp. xi+202. (London: Dulau and Co., Ltd., 1926.) 12*s*. 6*d*. net.

THE Ray Society has just published a translation into English of a volume which appeared in Leipzig in 1924 to celebrate the centenary of the birth of Wilhelm Hofmeister, a botanist to whom is generally assigned the premier place in plant-morphology during the nineteenth century. This version follows as a fitting sequel to the volume of Hofmeister's researches published in English in 1862 by the same Society under the title "On the Germination, Development and Fructification of the Higher Cryptogamia, and on the Fructification of the Coniferæ," which for more than sixty years has been held as a classic by all English-speaking students of plant-morphology. The volume last named was, however, not merely a translation of works already published by him in German: its text was specially revised and enlarged by the author himself for the Ray Society, so as to be a complete record of all known at that time on the subject to which it related. Thus on two occasions, far apart in date, the Ray Society has promoted the interest of botany by presenting in English works concerned with the same great discoverer.

The centenary volume was written by Hofmeister's most distinguished living pupil, Dr. K. von Goebel, now professor of botany in Munich: a man whose outstanding position in science has recently been recognised afresh by his election as foreign member of the Royal Society of London. He is the heir to Hofmeister's dominant place, not only as a formal morphologist but also as a philosophical biologist. This union of the study of form and function has indeed been stereotyped by the title given by von Goebel to his own great work, "Organographie."

Botanists, and biologists generally, recognise in Hofmeister the exponent of alternation of generations in plants. They admire his keen and unswerving perception of the homologies of those successive phases which in divers plants are so often disguised by differences of form and proportion. He first disclosed, in 1851, that underlying cycle of events which normally characterises Archegoniate plants, including the Coniferæ. The similarity of the constant cycle in them all was indeed shown to be so close that when Darwin's "Origin of Species" was published, the common underlying plan appeared at once to gain evolutionary significance.

Hofmeister's work on the Archegoniatæ is doubtless his best-known title to fame. But it is far from being the actual sum of his achievements. It is one of the great merits of von Goebel's book now under review, that it places the life-work of a master of technique and of thought in its true relation, not only to the period in which he lived, but also to the general march of science. It shows Hofmeister as a man of singularly alert mind and clear vision, coupled with a remarkable capacity and enthusiasm for work. There was something almost prophetic in his outlook on science. His perception of alternation was the natural precursor of the discovery of the cytological cycle as we now know it. But more significant still was his pursuit of causal morphology, as developed in his other great work, entitled "Allgemeine Morphologie." This book is unfortunately unpopular in style and almost plethoric in content. But it touched many matters that are still in eager debate: none more so than the inheritance of acquired or impressed characters. On the last page of that work he says: "It appears to me probable that only gradually, in the course of many years' development, the influential effects on outer form appeared and became hereditary." Twenty years later, Sachs advocated the same idea, saying with regard to the perpetual operation of gravity and light: "Many of these effects we are able to-day artificially to call forth or hinder; but others have become entirely hereditary and constant. Evidently one of the most fruitful regions of botanical research lies here before us." It is well to accord full weight to such expressions from great experimental botanists, while considering the later view put forward by Weismann with special relation to animals.

It is impossible in a short review to do justice to von Goebel's thoughtful estimate of his master's life and work. The pupil is, however, also a critic, and he does not hesitate to expose points where Hofmeister's views are out of harmony with later aspects of the science. This feature, associated with the broad outlook of an unusually penetrating mind, makes von Goebel's volume a most valuable addition to philosophical botany.

The remarkable wealth of facts early observed by Hofmeister, and the acute comparisons based on them, revealed the young bookseller as already a leader in his science. Recognition followed quickly. In 1851 he was awarded the honorary doctorate of philosophy of the University of Rostock. A few years later, in 1854, he received a call to the chair of botany in Heidelberg; and in 1863 he was appointed to Tübingen. As professor, he could not be called a popular lecturer. But the list of such pupils as Askenasy, Engelmann, Kienitz Gerloff, Müller, Pfitzer, Timiriassieff, Millardet, Zacharias, and von Goebel shows how powerful and prolific was his advanced teaching. He was, in fact, "a heaven-gifted genius such as in every science appears only at long intervals of time."

This volume presents Hofmeister both as a genius and also as a personality. His character is not only indicated by the pupil who saw him at near hand, in the laboratory and in the field, but also more fully by his daughter, Frau Prof. Ganzenmüller, in a chapter telling of his family life. Several vivid letters to his wife are quoted, and reveal a vivacious and very affectionate nature. But, as said in the translator's introduction to the English version: "The story which the daughter relates of her father's family happiness, and of his phenomenal success in a profession he was never trained for, becomes poignantly tragic as the tale of grievous bereavements quickly following one another reaches its sad climax in solitude of spirit. Her closing paragraphs, as well as his works, claim remembrance for one who, overtaken in 1877 by sickness and death, had persistently devoted almost his last broken powers to the science he had so brilliantly illuminated."

Radioactivity.

A Manual of Radioactivity. By Dr. George Hevesy and Dr. Fritz Paneth. Translated by Dr. Robert W. Lawson. Pp. xix + 252. (London: Oxford University Press, 1926.) 15*s*. net.

IN the hands of the translator and the Oxford University Press, the modest, beautifully printed "Lehrbuch der Radioaktivität" of 1923 has become the imposing, beautifully finished, and handsome English edition of 1926; the little German two-seater is now a handsome blue Daimler saloon complete with coat-of-arms on door.

This book is intended as a manual for senior students and young research workers. In size and scope it is not unlike the earlier books of Fajans and of Russell; and like that of the former, but unlike that of the latter, it pays attention more to the physical than to the chemical side of the subject. This to our mind is a pity, because it was on the chemical side of the subject of radioactivity that the authors made their names, and, whereas the physical side can be expounded by many, a fuller informed discussion by the authors of the chemical problems involved would have been invaluable.

For the most part, the English follows the German edition closely, but whereas the latter takes account of the literature up to the beginning of 1922, the former has been considerably modified and extended, particularly in the sections relating to atomic structure, to embody the results of more recent research. Several of the figures in the German text are now reproduced as plates, which, of course, are much clearer. These include the famous one in which the newly-born nucleus of atomic number 8 and mass 17 is seen bending thickly round to the right while the ejected hydrogen particle makes a bee-line to north-west almost in line with the α-particle which begat it.

The book is not fully documented in the ordinary sense, but many references to the literature during the period 1916–1925 are collected in an appendix, and these suffice for the purpose of the work. The first nine chapters deal with the specially physical side of the subject: the theory of disintegration, the constitution of the atom, and the nature of radioactive particles and rays. This is well but much too briefly put, is up-to-date, and is well illustrated. Too much information is packed away in these chapters which, in length, are not much more than sections, and they are made weightier because any looseness of thought or of statement which the authors have allowed themselves in making clear their subject is sternly corrected in their copious footnotes.

In Chap. x. the transformation series are given. In our opinion the authors are unduly conservative in taking the view that the actinium series arises as a branch from the main uranium series, instead of the more likely view that it derives from a uranium isotope of mass 235 (or 239). In a work of this scope, however, there is little room for a discussion of this point.

Several chapters are devoted to the subject of isotopes, radioactive and non-radioactive, and the possibility of their separation, a subject in which the senior author has done notable work. The three chapters which deal particularly with the chemical side of the work could be enlarged with advantage, since they embody the research work of the authors themselves on such subjects as the chemical behaviour of extremely small concentrations of substances and the use of radio elements as indicators.

A long chapter deals with the various effects of the rays from radium and other radioactive substances, such as their chemical or physiological action or their use in promoting atomic disruption. Few workers are aware how far investigation has penetrated in these regions. Of particular interest at the moment is the work of Lind and his collaborators on the chemical effects of radium rays on liquids and gases. The translator must not, however, call hydrocarbons hydrocarbonates (p. 242), for that may remind chemists of the physicist who in translating a text-book of organic chemistry rendered throughout as *carbohydrate* the German for hydrocarbon. Geologists as well as physicists will find the bearing of radioactivity on geology, and particularly on the age of minerals, ably discussed in Chap. xxvi.

The authors have included a chapter on the historical development of the science of radioactivity. This, we consider, is unnecessary. To the uninitiated the names of all but the greatest of the pioneers convey very little, while those who have borne the burden and heat of the day know that the real history is not that given in any text-book. The translation is very good, and it is quite clear that the translator has contributed considerably to the excellence of the volume. He should, we think, use more extensively the nomenclature of the Chemical Society in rendering chemical terms; for example, *protoactinium* is preferable to *protactinium*, and the name of a chemical element should be written out in the text, the symbol being reserved for chemical equations.

Here then is a book, well-translated, clear, informed, up-to-date, and all too brief, which can be heartily recommended to the student and research worker. May the reviewer, with all respect, give it an affectionate 'pat on the back' in memory of happy days with the senior author in Sir Ernest Rutherford's laboratory in Manchester, in the great days before the War?

A. S. R.

Our Bookshelf.

The Further Studies on Decrementless Conduction. By Prof. Genichi Kato. Pp. vii+163+7 plates+88 figures. (Hongo, Tokyo: Nankōdō, 1926.) n.p.

IN this second monograph Prof. Kato describes further numerous experiments which he and twenty collaborators at Keio University have carried out on the passage of the impulse in narcotised nerve. An abundance of evidence is adduced to support the now well-known theory that there occurs no gradual decrement of the nerve impulse in its passage through a narcotised region of nerve, but rather diminution to a steady level, as soon as the fully narcotised region is gained. Owing to diffusion at the border of the narcotising chamber, the nerve at that place must needs show a decreasing depth of narcosis at the outer part. This region (the 'limit length') is 6 mm. long and can be accurately defined by mechanical stimulation. Electrical stimulation is attended by the pitfall of 'escape of current,' which, the author maintains, has not been avoided by previous workers. Crushing the nerve is not a proper control of 'escape of current.' 'Escape' or 'spreading' must be differentiated into 'external spreading' along the surface of the nerve (for some 2 mm.) and 'internal spreading' among or within the nerve fibres. This latter, which may amount to some 25 mm., is stopped and therefore not controlled by nerve-crushing. It is estimated in the present series of experiments by determining the apparent diminution of the latent period of the muscle twitch on a smoked record as the stimuli are made stronger and the effective kathode thereby approaches the muscle. This method, though accurate enough, might have been subordinated to one of the elegant and precise electrical methods which are now in vogue for observing nervous phenomena. In most experiments the nerve-muscle preparation of the large Japanese toad has been used. From the few with frog-nerve, there is some evidence that in this tissue the spread of current occurs less readily.

Later chapters describe decrementless conduction in narcotised regions of the vagus and sympathetic trunks and in narcotised muscle—skeletal and cardiac. Experiments have also been made bearing on the relative refractory phase of nerve-fibres. Since the existence of decrement is so much in doubt, the conditions during that phase have had to be investigated from the new point of view. It seems probable that the principle of the all-or-none response is true for the relative refractory phase.

A further communication is promised which, if it is as provocative of thought as the present monograph, will be most welcome to physiologists.

Francis Jenkinson, Fellow of Trinity College, Cambridge, and University Librarian: a Memoir. By H. F. Stewart. Pp. viii+152+6 plates. (Cambridge: At the University Press, 1926.) 10*s*. 6*d*. net.

BIOGRAPHIES of men of renown and national heroes—naval, military, and political—are necessary for the due appraisement by the historian, not merely of the men themselves but also of the times in which they lived. Of greater personal interest are the lives of men of talent, fulfilling faithfully and unostentatiously their daily round, raising their everyday duties to a high level by infusing them with conscientiousness and energy.

Such records are, to most of us, of greater value because they set an example and a standard to which the average can strive to attain. In his memoir of Francis Jenkinson, Fellow of Trinity College, Cambridge, and for more than thirty years University librarian, Mr. H. F. Stewart brings clearly before us the character, as revealed by his daily acts, of one of the most lovable of men. We see Francis Jenkinson as a man of many talents, as a naturalist, a lover of music, and, greatest of all, as a bibliographer and a book-lover. The work he accomplished was little short of marvellous when we know that he rarely felt in perfect health. Though not successful in winning any of the great University prizes, he took as high a place as his limited physical capacity would permit, and was consequently a marked man from the first, and he found his true *métier* as a bibliographer. Succeeding Henry Bradshaw, with whom he had previously been associated and whose methods he whole-heartedly admired, he maintained as librarian the high standard of scholarship exhibited by his predecessor, and carried on in the same spirit the enrichment of the library which was under his care.

The author has related the main events of Jenkinson's official life in a most entertaining book, not overweighted, as many biographies are, with insignificant detail. His subject's efforts, which were largely instrumental in winning the battle of the Copyright Bill and in establishing the unique War Collection, are vividly narrated. Other chapters tell us of his hobbies and recreations — entomology, ornithology, music, gardening—so that we have presented to us an engaging picture of the man as he was and as he will live in the memory of his many friends. The last lines of J. D. Duff's inscription in the ante-chapel of Trinity College admirably sum up his nature:

"Naturam musicam libros
Sed magis homines homo amavit."

His portrait, painted by Sargent in 1915, excellently reproduced here, forms a fitting frontispiece to the memoir, the writing of which has clearly been a πόνος ἄπονος.

H. H. S.

The Migration of Symbols: and their Relations to Beliefs and Customs. By Donald A. Mackenzie. (The History of Civilization Series.) Pp. xvi+219+16 plates. (London: Kegan Paul and Co., Ltd.; New York: Alfred A. Knopf, 1926.) 12*s*. 6*d*. net.

MR. MACKENZIE deals here with four symbols or groups of symbols—the swastika, the spiral, ear symbols and tree symbols—and the religious beliefs associated with them. As a devoted adherent of the 'diffusionist' school, he sees in each the manifestation of an idea or complex of ideas, which, notwithstanding certain local variations in detail, on the whole is universal and derivative from a common origin. The swastika represents the sun, the four cardinal points, the deities of these points, givers of life associated with the deities, such as gold, and so forth.

While in the case of such a highly specialised form as the swastika there may appear to be a reasonable possibility of a common origin, it might well be argued that a form of such frequent occurrence in both natural and artificial objects as the spiral might have a multiple origin even within a single cultural area. It has been suggested, for example, that in Egypt it is derived from the lotus, while Dr. H. R. Hall derives it from coiled wire used purely for ornament. Mr. Mackenzie does not deny the possibility, although he thinks that the earliest form may have been the spiral derivative from a shell in view of the magico-religious ideas appertaining to shells among the peoples of Upper Palæolithic age in western Europe. He holds, however, that, whatever the material origin, a precedent condition was the fundamental idea of movement, as in whirlpools and the whirlwind, as a giver of life. This opens up an interesting field of speculation in which it is not possible to follow the author here. He has gathered together a large number of examples, which he interprets to support his views in the case of each symbol, and if all are not equally cogent and the argument not in all cases equally convincing, they will at least serve to stimulate discussion.

The Secretion of the Urine. By Dr. Arthur R. Cushny. (Monographs on Physiology.) Second edition. Pp. xii+288. (London: Longmans, Green and Co., Ltd., 1926.) 16*s.* net.

THE appearance of the second edition of this monograph reminds us of the great loss which science has suffered in the untimely death of Prof. A. R. Cushny. It is indeed fortunate that the book was almost ready at the time of his death, since it reflects the considered views of the author on the subject of the function of the kidneys in the light of the most recent researches in this province of physiology. The theory put forward in the first edition nine years ago has formed the starting-point of the majority of the researches carried out on the secretion of the urine during this period: that the work stimulated research is shown by the increase in the number of references from four hundred to six hundred.

The author considers that the modern theory of filtration through the capsule with reabsorption of an optimal fluid in the tubules has been greatly strengthened by the more recent work: in fact, reabsorption has been definitely proved to occur. A slight modification of the theory has been necessary, following the increase in our knowledge: the distinction between threshold and no-threshold bodies, that is, between those substances which do not appear in the urine unless their concentration in the blood exceeds a certain value and those which are excreted, whatever their plasma concentration, appears to be less clean cut than was formerly supposed. Thus, with a modification affecting the nature of the optimal fluid absorbed in the tubules, the author considers that the theory covers all the more recently discovered facts.

We note that the chapters on the perfusion of the kidney and on nephritis have been largely re-written: the latter especially is noteworthy in its broad outlook upon clinical problems and in its suggestion for the best methods of investigating the functions of the kidneys in disease in the light of the modern view of renal secretion.

The Mammals of South Australia. By Dr. Frederic Wood Jones. (Handbooks of the Flora and Fauna of South Australia, issued by the British Science Guild (South Australian Branch), and published by favour of the Honourable the Premier.) Part 3 (conclusion), containing *The Monodelphia.* Pp. 271-458. (Adelaide: R. E. E. Rogers, 1925.)

THE appearance of the third and concluding part of Prof. Wood Jones's work on the mammals of South Australia is a timely reminder that Australia has quite an extensive indigenous fauna of non-marsupial mammals. The overwhelming interest of the marsupials has led to the neglect of the other native mammals, even by the professional zoologist, and adequate material for study is wanting. This state of affairs should be remedied as a result of this memoir. More than one hundred species of monodelphians are known from Australia, over seventy of which are carefully described and figured by the author. His appeal for more work on the Australian non-marsupial mammalia comes with all the stronger force when so useful a guide to them accompanies it, and it is made not a moment too soon, for the inroads into the native fauna by introduced species extends equally to these mammals as to the marsupials. Prof. Jones tells a sad tale of the effects of rabbits, rats, mice, foxes, and cats on the indigenous species. His chapter on the dingo is of special interest. He believes it to be an introduced domestic dog of the true northern wolf type, and the evidence he brings forward on this point is convincing. We are glad to have so authoritative an opinion on the origin of this animal.

The completed work is a most valuable study of Australian mammals, for though only dealing with South Australia, it is virtually a guide to the whole continent. The author and the South Australian Branch of the British Science Guild are to be congratulated on the publication of so valuable, useful, and much-needed a work.

Psycho-Analysis for Normal People. By Geraldine Coster. Pp. 232. (London: Oxford University Press, n.d.) 2*s.* 6*d.* net.

"THIS little book on a big subject" (preface) aims at giving, more particularly for nurses and women teachers, an elementary introduction to the theories of Freud, Adler, and Jung in a form more acceptable than that of "the early exponents of analytic psychology . . . [who] succeeded for the most part in arousing disgust and revulsion" (p. 173). It would seem to be an attempt to neutralise certain ill-effects of 'psychoanalysis' in its rôle of 'rather dangerous plaything of society' (p. 14).

Under the headings instinctive energy, fear, the power instinct, the sex instinct, dreams, sublimation and religion, we are given an account of the libido theory that may possibly be wholly acceptable to some sections of the Jungian school of thought. The bibliography consists of three books on psychology, twelve on the so-called 'new psychology,' and forty-two novels.

R. J. B.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Calculation of the Ages of Radioactive Minerals.

IT is now well known that, granted certain conditions of suitability, the age of a primary radioactive mineral is given to a first approximation in millions of years by the formula $Pb . C / (U + k . Th)$, where k is the amount of uranium which is equivalent in lead-producing capacity to 1 gm. of thorium, and $1/C$ is the amount of lead produced by 1 gm. of uranium in a million years. Unfortunately, there has been a serious divergence in the values adopted for these constants by different authors, as a consequence of which the calculated ages are not always directly comparable. It is greatly to be desired that uniformity should be attained in this respect, and we feel that the time is now ripe for the adoption of agreed values of k and C by the various workers in this field of research, at least until unequivocably better data are available.

In a recent paper by one of us (A. Holmes: Estimates of Geological Time with Special Reference to Thorium Minerals and Uranium Haloes, *Phil. Mag.*, May, 1926, p. 1055) the value 6600 was accepted for C. This value was given by Dr. H. Jeffreys in his book, "The Earth," as "the revised value obtained by Lawson and Hess." We have now found, however, that it involves errors both in interpretation of the data and in arithmetic, and that, on the experimental data of Hess and Lawson, the value should have been 7400. On the other hand, H. V. Ellsworth and C. W. Davis in recent papers in the *Amer. Jour. Sci.* have used $C = 7900$, a value suggested by Lawson in 1917; and still more recently in the same journal L. A. Cotton uses $C = 8000$, while O. Hahn in a German publication adopts $C = 8200$.

Probably the most accurate determination of the number of α-particles emitted per second by 1 gm. of radium is that made by Hess and Lawson, using the electrical method of counting. Their value, $3{\cdot}72 \times 10^{10}$, almost exactly corresponds with the measured heat production by radium (NATURE, 116, 897, 1925), and for this and other reasons we believe it to be the most trustworthy at present available. Accepting it, and combining it with the ratio of radium to uranium in uranium minerals, $3{\cdot}40 \times 10^{-7}$, we find $C = 7400$, which we propose as the most trustworthy value on current data.

The values adopted for k have varied between 0·3 and 0·4. Rutherford and Geiger's scintillation experiments on uranium and thorium indicate that per annum 1 gm. uranium gives $1{\cdot}26 \times 10^{-10}$ gm. uranium-lead, and 1 gm. thorium gives $0{\cdot}485 \times 10^{-10}$ gm. thorium-lead. Whence it follows that 1 gm. of thorium produces lead at the same rate as 0·38 gm. of uranium. Judged by later experience, the individual results for uranium and thorium are both probably rather low, but they were reached by the same method in either case, and are thus directly comparable. A slight correction to each of the results makes no appreciable difference to the ratio between them, as in each case it is in the same direction and of the same relative order. We therefore propose $k = 0{\cdot}38$ as the most reliable value at present attainable.

The approximate age of a mineral (omitting the time-average correction) is, therefore, on present data, given most reliably by the formula:

$$\text{Approximate Age} = \frac{Pb}{U + 0{\cdot}38\ Th} \times 7400 \text{ million years.}$$

The application of the time-correction has the effect of reducing the value of the age so obtained. The corrected age can be most conveniently obtained by means of the formula:

$$\text{Corrected Age} = \text{Approximate Age} . \left(1 - \frac{x}{2} + \frac{x^2}{3}\right);$$

where $x = 1{\cdot}155 . \dfrac{Pb}{U + 0{\cdot}38\ Th}$.

Adopting the factors here advocated, the Middle Pre-Cambrian pegmatites of Ontario, Texas, Colorado, Sweden, and India have an age of about 1000 to 1100 million years.

ARTHUR HOLMES. ROBERT W. LAWSON.
The University, Durham. The University, Sheffield.
September 4.

Protoplasmic Viscosity as determined by a Temperature Coefficient of Biological Reactions.

IN a previous note [1] I have shown that the majority of biological processes depend on temperature according to the formula:

$$y = \frac{a}{x^b},$$

when x is temperature in degrees centigrade, y time, a and b constants. I have given some examples which seem to indicate that this equation is very general. I have also mentioned that the constant b, which is a real temperature coefficient (because it does not change with temperature), probably has a wider biological interest.

Let us compare the values of b for one and the same reaction in different species:

Reaction.	Species.	Author.	b.
Amœboid movement .	Marine amœbæ	Pantin [2]	0·90
,, ,, .	Human leucocytes	McCutcheon [3]	2·14
Embryonic development .	*Cyclops fuscus*	Ziegelmayer [5]	1·16
,, ,, .	Drosophila	Loeb and Northrop [4]	2·10
,, ,, .	*Rana virescens*	Lillie and Knowlton [6]	2·36
,, ,, .	Chick	cf. Morgan [7]	4·10
Heart-beat . . .	Anodonta	Koch [8]	1·10
,, . . .	*Rana temporaria*	Clark [9]	1·06–1·48
,, . . .	*Emys europaea*	Galeotti and Piccinini [10]	1·44
,, . . .	*Hynobius lichen.* larva	Inukai [11]	1·15
,, . . .	Duck embryo	,,	2·92
,, . . .	Dog	Frank [12]	2·06
,, . . .	Rabbit	,,	3·00
,, . . .	Cat	Langendorff [13]	2·38

As may be observed from these data, b is generally higher in homoiothermic than in poikilothermic forms. But this is evidently not an exclusive feature of homoiothermy, since b is relatively high also in poikilothermic forms living at high temperatures:

1 Bělehrádek, NATURE, 118, p. 117, 1926.
2 Pantin, *Brit. Journ. Exp. Biol.*, 1, 1924.
3 McCutcheon, *Amer. Journ. Physiol.*, 66, 1923.
4 J. Loeb and Northrop, *Journ. Biol. Chem.*, 32, 1917.
5 Ziegelmayer, *Zeits. wiss. Zool.*, 126, 1925.
6 Lillie and Knowlton, cf. Morgan (7).
7 Morgan, "Experimental Zoology," New York, 1907.
8 Koch, *Pflüger's Archiv f. d. ges. Physiol.*, 166, 1917.
9 Clark, *Journ. of Physiol.*, 54, 1921.
10 Galeotti and Piccinini, *Archivio di fisiol.*, 8, 1910.
11 Inukai, *Japanese Journ. of Zool.*, 1, 1925.
12 Frank, *Zeits. f. Biologie*, 31, 1907.
13 Langendorff, *Pflüger's Arch. f. d. ges. Physiol.*, 46, 1897.

Reaction.	Species.	Author.	b.
Cleavage of egg	Strongylocentrotus	J. Loeb [14]	0·99
" "	Ascaris	Fauré-Fremiet [15]	2·50
Growth in plants	Lupinus (moderate)	Vogt [16]	1·90
" "	*Scirpus Kisoor* (tropical)	Bose [17]	9·50

When we consider further a given reaction in one and the same species, we may observe that *b* increases with the age of the individual:

Reaction.	Species.	Author.	b.
First cleavage of egg	Strongylocentrotus	J. Loeb [14]	0·99
Second " "	"	"	1·13
Heart-beat	*Amblystoma* larvæ, 8, 2-9, 1 mm.	Laurens [18]	1·41
"	*Amblystoma* larvæ, 13, 0-25, 4 mm.		1·50
Larval stage	Drosophila	Loeb and Northrop [4]	2·10
Pupal stage			2·28
Imaginal stage			1·56 (see later for discussion)

I have calculated the constant *b* also for the rate of development in different stages of the beetle *Dytiscus semisulcatus*, according to observations by Blunck.[19] In this case also the value of *b* increases with age:

Period.	b.
1. Embryonic	1·10
2. First larval instar	1·14
3. Second " "	1·26
4. Third " "	1·38
5. Præpupal "	1·48
6. Pupal "	1·60

These results, when plotted against time, give a regular S-shaped curve (Fig. 1). From Krogh's [20]

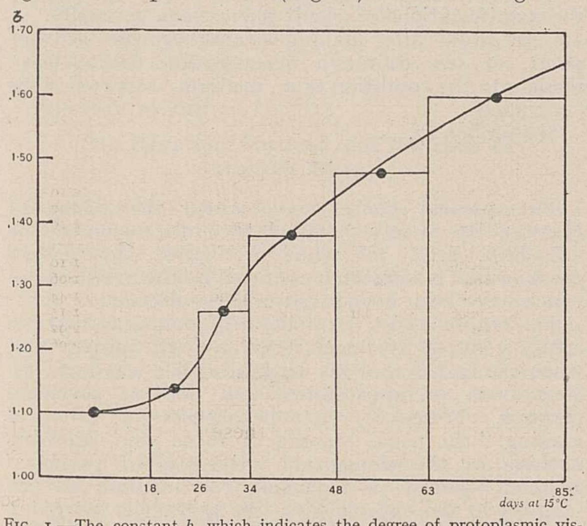

FIG. 1.—The constant *b*, which indicates the degree of protoplasmic viscosity, increases with the age of individual; development of *Dytiscus semisulcatus*.

experimental data concerning the embryonic development of the frog (*Rana fusca*), I have found that *b* increases with time in a similar way, as follows:

Period.	The Beginning and the End of the Period characterised by Stages.	b.
1	Fertilisation—end of the first cleavage	1·20
2	End of the first cleavage—closure of neural fold	1·64
3	Closure of neural fold—formation of external gills	1·76
4	Formation of external gills—formation of gills with 3 branches	1·92
5	Gills with 3 branches—embryo 7 mm. long	1·69
6	Embryo 7 mm. long—embryo 7·8 mm. long	2·52

The graph of these values plotted against time probably corresponds to the first part of an S-shaped curve, the most advanced stage in Krogh's experiments being embryos only 7·8 mm. long.

The following example will show that *b* is also increased under the action of narcotics:

Pulsation of vacuole, *Paramaecium caudatum*, normal (Khainsky [21]) . . . . . 1·60
Pulsation of vacuole, *Paramaecium caudatum*, under chloretone (Cole [22]) . . . 1·87

The next example, computed from Hennings' [23] experimental data, demonstrates that *b* increases not only with the age of individual, but also that it is higher in a dry than in a humid atmosphere:

Tomicus typographus.	b in Dry Atmosphere.	b in Humid Atmosphere.
Embryonic stage	2·02	1·87
Larval	3·52	2·98
Free beetle	2·90	2·44
Total development	2·48	2·37

From these data it may be seen that the coefficient *b* varies not only for different biological reactions, but also that it changes even in one and the same reaction under varying external and internal conditions. It would be therefore impossible, at least at present, to identify biological reactions by means of our new formula. But the variations of *b* may be understood without great difficulty if we assume that *b* indicates the degree of protoplasmic consistency (or, physically, viscosity and rigidity). It has been partly demonstrated, partly made highly probable by different investigators, that the viscosity of protoplasm increases with the age of individual as well as under deeper narcosis (see F. Weber [26]). The case of embryonic development in *Tomicus typographus*, cited above, would then indicate that the protoplasm may become more viscous owing to loss of water in dry air.

The S-shaped curve which represents the increase of *b* with age fits well with my previous experiments made on cells of *Elodea densa*, in which the protoplasmic viscosity, plotted against the age of cells, also gives an S-shaped graph.[24] In the development of insects, it may be noted that *b* drops suddenly between the larval period and the imaginal stage (see above, Drosophila and Tomicus). This points to the possibility that protoplasmic viscosity decreases during metamorphosis, which then would involve some sort of rejuvenation. But as the material upon which my calculations are based is not sufficiently large, I do not venture to accept this idea as a definite explanation.

[14] J. Loeb, *ibid.*, 124, 1908.
[15] Fauré-Fremiet, " La cinétique du développement," Paris, 1925.
[16] Vogt, cf. Jost, " Vorlesungen über Pflanzenphysiologie," Jena, 1913.
[17] Bose, *Trans. Bose Research Inst.*, Calcutta, 1, 1918.
[18] Laurens, *Amer. Journ. of Physiol.*, 25, 1914.
[19] Blunck, *Zeits. f. wiss. Zool.*, 121, 1924.
[20] Krogh, *Zeits. f. allg. Physiol.*, 16, 1914.

[21] Khainsky, *Arch. f. Protistenk.*, 21, 1911.
[22] Cole, *Journ. Gen. Physiol.*, 7, 1925.
[23] Hennings, *Biol. Centralbl.*, 27, 1907.
[24] Bělehrádek, *C. R. Soc. de Biol.*, 92, 1925; *Publ. Fac. de Médec.*, Brno, 1925.

The difference in the constant b which exists between poikilothermic and homoiothermic organisms seems to indicate that the protoplasmic viscosity is regulated with regard to the thermal adaptation of a given species.

Any biological reaction is a complex of many physical and chemical processes forming a chain. In determining the temperature coefficient of such a complex, we in effect determine the temperature coefficient of only one of the underlying processes, namely, that which is least accelerated by rising temperature and is therefore the limiting factor of the whole complex (Blackmann's and Pütter's principle). In the majority of cases, however, the rate of molecular diffusion in the protoplasm is the limiting factor (see W. M. Bayliss [25]). As the rate of diffusion depends on the viscosity of the reacting system, our hypothesis is justified also from a purely physicochemical point of view.

Thus the protoplasmic viscosity may be studied by simply measuring the effect of temperature on any biological reaction in which the new formula holds good. Further investigations will show whether this way of determining the protoplasmic viscosity would be not only less injurious to the living system, but also more accurate than the existing methods of protoplasmic viscosimetry (see F. Weber [26]).

J. BĚLEHRÁDEK.

Zoological Department,
King's College, London,
August 12.

Science and Psychical Research.

HAVING read with interest the correspondence in recent issues of NATURE arising out of Dr. Tillyard's article on Sir A. Conan Doyle's "History of Spiritualism," I beg space for the following remarks which I shall try to confine so far as possible within the editorial limits stated in the issue of September 11 to be the main point of the reviewer's article of July 31, namely, "that scientific men generally presented an unscientific attitude to the subject of psychical research." But Dr. Tillyard in his article appears to prefer the substitution of the term 'supernormal phenomena' to the term 'subject of psychical research.' Therefore my remarks will deal almost wholly with that department of 'psychical research' which concerns itself with such supernormal phenomena as may be included under the head of *accounts given of communications between living persons and the* 'discarnate' spirits, or 'intelligencies,' or 'ghosts' of those who are normally called the dead, and thus omit here all reference to much of the material studied by the Psychical Research Society, for example, telepathy, etc., as quite irrelevant to this correspondence.

All the statements regarding the above-named accounts hitherto published and believed to be true by some of all descriptions of persons, including such as are or have been students of various branches of science, lack any evidence of a character which could make possible their submission to strict scientific investigation, the requirements of which I need not repeat in these pages. In this statement I include all the accounts given or referred to by Sir A. C. Doyle or his reviewer in the "History of Spiritualism." Recently when talking with Sir Ray Lankester about a review he had written of Sir A. C. Doyle's book, and the ghost-stories it contained, he brought to my notice the following quotation from some remarks made by Mr. T. P. O'Connor in the *Sunday Times* of August 15 in connexion with a conversation with Sir Edward Clarke, the chief counsel for the plaintiff in the case of O'Shea *v.* Parnell. In the course of this case it was proved that there was no 'fire-escape' in the house in question. "This," says Mr. O'Connor, "was not the first time I realized the truth of the statement that you cannot be quite sure that you know all the facts of any historical or personal transaction. I never trust implicitly any historical statement. I have rarely seen any of the historical transactions in which I myself have taken a part strictly recorded according to the facts." Sir Ray thoroughly endorsed Mr. O'Connor's attitude as to placing no reliance on such 'story-telling,' and holds that it applies equally to reputed researches by eminent scientists—all hearsay—and useless as evidence.

On all of the many occasions, within a period of more than fifty years, when I have given serious attention to allegations of facts made by students of the 'occult' or so-called 'supernormal phenomena,' I have found that the actual necessities for carrying out scientific investigation were unattainable, the consent of the 'medium,' whether 'professional' or not, being withheld.

Scientific men generally do not refuse to examine into any matters of reputed or seeming importance on the ground of certain alleged facts being impossible, or even highly improbable. They cannot, however, but refuse to make inquiry into any matter when the conditions of investigation, necessarily required, are denied or restricted and actual experiment thus excluded. As one example only of an unproved statement made in the course of the present correspondence, I quote that of Dr. Tillyard's in which he says that in a certain class of cases "the medium is actually in trance and does not know what is going on." I do not know what he means by the word 'trance,' but his statement would seem to be of some importance to spiritualists and the Psychical Research Society, as in the present dispensation of their doctrines the 'entranced' medium plays a most important part in the manifestations of occult phenomena generally. I am not aware, after making several inquiries into this point, of any thorough investigation having been made into the condition of a 'medium' reported to be 'entranced.'

BRYAN DONKIN.

September 17.

THE present controversy, which the editor of NATURE has wisely confined to a discussion of the "*scientific* study of what are called *supernormal phenomena*," is somewhat confused by the irrelevancies which have been introduced into the debate.

The entomologist, Dr. Tillyard, complains that his critics confuse psychical research with spiritualism, when the fact is that his original article was a review of a book on spiritualism and not on psychical research. Moreover, when he accuses Dr. Lotsy of making "the usual blunder of those who, knowing nothing of the elementary principles of psychical research, persist in regarding the medium as the 'guide' in the experiments," he himself is betraying his lack of acquaintance with the subject. This is readily excusable since, I believe, his experience with physical mediums is limited to less than a dozen sittings. Apart from this, Dr. Tillyard's statement strikes at the root of the present discussion. The majority of scientific men suspect that what Dr. Tillyard denies is true, namely, that the medium is the 'guide' in the experiments. In this they are right, although the words 'and his/her manager' might be added to the word 'medium.'

The conditions of experiment are usually arranged

[25] Bayliss, "Principles of General Physiology," London, 1918, p. 41 *seq.*
[26] F. Weber, *Abderhalden's Handb. d. biol. Arbeitsmeth.*, vol. 11, 2, 1. half, 1924.

by the medium or by the manager in conformity with a set of arbitrary rules laid down by generations of spiritualists for reasons into which we need not enter here. The séances are of the nature of performances at which the 'investigator' takes his place in a 'chain' of believers, who see that he does not violate the rules, which are framed in such a way that any real investigation is impeded. Can Dr. Tillyard tell us of any single medium who can produce some simple raps, under conditions which render their normal production impossible? He will doubtless reply by stating that 'supernormal' phenomena are subject to certain conditions and it is only under certain conditions that they occur. This appears reasonable, but Dr. Tillyard's experience is too slight for him to be able to recognise that the conditions are not "just exactly what the researchers choose to make them" (NATURE, September 11, 1926, p. 370), but what the medium plus his manager or employer have chosen to make them.

In this respect the cordial invitations which are so often extended to prominent persons are highly suggestive. It is now becoming a common thing when a new medium appears for his or her manager to invite scientific men in other spheres of work, journalists, actors, etc., to be present at the 'experiments.' Great care is taken to prevent the systematic attendance of critical psychical researchers and others with much experience of mediums, for these are not likely to be impressed by the trappings of a pseudo-investigation, and are also acquainted with those sources of error which, from their very nature, must remain unknown to the ordinary scientific worker, who has not specialised in this line of inquiry.

There is a good case for the scientific study of what are called supernormal phenomena. The difficulty lies in obtaining the opportunities for any such investigation under conditions satisfactory to those whose experience leads them to adopt a critical attitude towards the problems in dispute.

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The Egyptian Shadouf and the Rate of Human Work.

THE interesting paper by Drs. Haldane and Henderson in NATURE for August 28, p. 308, merits emphasis on two or three points. Above all, the mechanical beauty of the shadouf, in spite of its crude construction, deserves notice. It will be observed that trunnion bearings, which would wear and need lubrication, are replaced by almost frictionless hinges in the form of ropes. These ropes, in addition to their antifriction qualities as hinges, confer an important property on the system, namely, elasticity.

In short, the shadouf is a pendulum, and almost without doubt the men who work it move with it in its natural free period. If this is so, it would constitute a remarkable anticipation of recent developments in Germany, where many reciprocating machines have been constructed on resonance principles with marked gain in efficiency.

About the middle of last century, when most cranes and winches were operated by hand, it was necessary, for purposes of design, to have some standard of human activity. A widely accepted figure for such work was one-tenth of a horse-power or 3300 foot-pounds per minute. D. K. Clerk, a respected authority of that period, gave this rate as "the average net daily work of an ordinary labourer at a pump, a winch or a crane, for eight hours a day." "For shorter periods, from four to five times this rate may be exerted." Taking the rate given by Clerk for eight hours, we have 1,584,000 foot-pounds per day, in close agreement with the shadouf worker's 1,550,000 foot-pounds.

As to exteme rates of activity for short periods, comparisons are most difficult. Probably the highest rates are exhibited by professional wrestlers and strong men, whose feats are sometimes performed at a rate of the order of four horse-powers.

H. S. ROWELL,
Director of Research,
Research Association of British Motor and Allied Manufacturers.

Chiswick, W.4,
August 30.

THE figures of 4290 foot-pounds per min. for raising water, and 4230 foot-pounds per min. for raising earth, given by Dr. Haldane and Prof. Yandell Henderson in NATURE of August 28, as examples of the rate at which work can be kept up for lengthy periods, are confirmed by the common experience of hill climbers. A man of average weight, dressed in climbing kit, and carrying a load of, say, 15 or 20 lb., may be assumed to weigh about 180 lb. To walk uphill at the rate of 1250 feet per hour, at low or moderate altitudes, is quite ordinary; while 1500 feet per hour is generally considered as distinctly fast. Such figures would apply to persons in good training, and to ascents lasting for, say, 4 hours. The rate to correspond with 4200 foot-pounds per min. would be 1400 feet per hour.

It would be interesting to measure the rate of oxygen consumption of persons walking uphill for lengthy periods; for given rates of ascent and for various gradients; and to compare the results with figures obtained from the same individuals working an ergometer in a laboratory. The question of gradient cannot be entirely ignored. Clinometer measurements of Alpine paths indicate that the economic gradient is about 18°, or 1 in 3. It certainly lies between 16°, which is unnecessarily flat, and 20°, which is uncomfortably steep.

P. J. H. UNNA.

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August 31.

Antagonistic Action of Electrolytes and Permeability of Membranes.

THE problem of the antagonistic action of electrolytes in biological systems has attracted attention for a long time, but a similar effect on inorganic colloidal systems has been investigated only in recent years. This study has, however, thrown considerable light on the mechanism of such antagonistic action, and we are now probably able to give a rational explanation on the basis of these physico-chemical investigations. About a decade ago Clowes (*Jour. Phys. Chem.*, **20**, 407, 1916) showed that a marked analogy exists between the transformation of an emulsion of oil-in-water into an emulsion of water-in-oil, or of blood plasma into a blood clot, or of a casein suspension into a casein clot. In all these cases salts of calcium promote and alkalis and salts of sodium inhibit the transformation of a system consisting of a non-aqueous phase dispersed in water into the reverse type of system, consisting of water more or less perfectly dispersed in a non-aqueous phase, and the ratio in which given electrolytes, say sodium or calcium chloride, exert a compensatory effect upon one another, is almost the same as that in which the electrolytes in question exert antagonistic or compensatory effects on one another in biological systems.

In some recent papers (*Zeit. anorg. Chem.*, **142**, 345; **149**, 139, 1925; *Jour. Phys. Chem.*, **29**, 517, 1925) I have examined the behaviour of several colloidal solutions from this point of view, and have shown that a general explanation for all these cases of ionic antagonism is that the similarly charged ion goes to stabilise the suspension, which effect is antagonised by the presence of a coagulating ion. The equilibrium in biological systems, the inversion of emulsions, and the coagulation of colloids in the presence of mixtures of salts can all be explained from this simple view, which is also supported by experimental facts.

The effect of such non-electrolytes as the organic anæsthetics in antagonistic experiments is similar to the salts of calcium, as has been shown by Lillie and others. In these cases we are dealing with the coagulating effect of the non-electrolytes on the dispersoid system. Thus it is now known that copper ferrocyanide membranes, which also show under suitable conditions a reversible variation in permeability like protoplasmic membranes, can be coagulated by means of propyl and other alcohols, but in the presence of membrane-forming materials the coagulation of the membrane is retarded. This is to be attributed to an antagonism between the non-electrolyte and the electrolyte in question. Consequently a general statement of the observed antagonism in diphasic systems is that *all antagonistic actions occur between a peptising agent and a coagulating agent.* This antagonism need not be confined to two electrolytes only, but may occur between an electrolyte and a non-electrolyte. If the concentration of one of these is constant, then at a particular concentration of the other the whole system will be in equilibrium. In freely reversible systems the equilibrium ratio of these will be approximately constant, but this cannot be expected in systems which are irreversible. In the case of ionic antagonism, it has been found that the adsorption of similarly charged ions stabilises the suspension towards another coagulating ion and naturally, therefore, the nature of the electric charge on the surface of the dispersoid or emulsoid particles in the case of physiological systems must be of fundamental importance in showing a variable permeability under different conditions.

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Lightning.

DR. SIMPSON'S rejoinder accompanying my recent letter (NATURE, August 7) indicates that I have signally failed to convey to him the ideas which I endeavoured to present. For this I am sorry. A more detailed discussion, being inappropriate for these columns, will be presented elsewhere, but two items of his rejoinder should be mentioned here and now. Dr. Simpson quotes and by implication interprets an isolated sentence. I fail to see how this implied interpretation can be considered to be compatible with the remainder of the paragraph from which the sentence was taken. Second, he is quite mistaken in thinking that the electronic darts which I pictured are but little different from the negative discharges which he considered. His discussion of the latter contains no suggestion of such darts.

N. ERNEST DORSEY.

August 17.

DR. DORSEY complains that my interpretation of the sentence which I quoted from his letter is incompatible with the remainder of the paragraph from which it was taken. If this is so it is not my fault, for the paragraph in question contains the two following incompatible sentences: "the branches are not outgrowths from the trunks but ingrowths to it" (which is the sentence I quoted), and "a branch may grow in length and may branch."

I can assure Dr. Dorsey that I did my best to understand his difficult letter and to explain the points in which his theory appears to differ from mine. I cannot, of course, expect him to agree with me, but I regret that he considers that he has cause for complaint.

G. C. SIMPSON.

August 31.

The Absorption Spectrum of Formic Acid Vapour in Relation to Molecular Associations.

THE absorption spectrum of formic acid vapour at room temperature and above (to 145° C.) consists of about thirty-five bands, lying between $\lambda = 2565$ and 2250 Å.U.; at the ultra-violet end of this band spectrum there appears to be a continuous absorption.

The law of distribution of practically all the bands may be represented with close approximation by the formula:

$$\frac{1}{\lambda} = 41700 + n \cdot 1050 + p \cdot 385,$$

where $n = -2, -1, 0, +1, +2$ and $p = -7$ to $+7$.

The null-band ($n = 0$, $p = 0$) is the strongest band and corresponds to

$$\lambda = 2398 \cdot 0 \text{ Å.U.}, \ \frac{1}{\lambda} = 41700 \text{ cm.}^{-1}$$

There are two fundamental periods of atomic vibrations in the molecule, $\alpha = 1050$ and $\beta = 385$ cm.$^{-1}$. It is important to mention that the larger fundamental period is of the same order of magnitude (about 1000 cm.$^{-1}$) as is obtained for a number of molecules with a C-O group: formaldehyde (V. Henri and Shoù, $\alpha = 965$ cm.$^{-1}$), diacetyle (V. Henri and L. Light, 1100 cm.$^{-1}$), paraquinone (V. Henri and L. Light, 1110 cm.$^{-1}$), benzaldehyde (V. Henri and Almasy, 945 cm.$^{-1}$), furfurol (V. Henri and Almasy, 1080 cm.$^{-1}$), acroleine (V. Henri, 1260 cm.$^{-1}$), phosgene (V. Henri and Howell, 902 cm.$^{-1}$). In the infra-red there is a strong carbon monoxide band at $\lambda = 9 \cdot 2\mu$, $1/\lambda = 1087$ cm.$^{-1}$. It is therefore quite probable that this period 1050 cm.$^{-1}$ of formic acid vapour corresponds to the vibration of the oxygen relative to the carbon atom.

With increasing temperatures (using a constant mass of 60 mgm. in the absorption tube, between the room temperature and 145° C.) the absorption limit approaches the visible, and more bands of the same kind appeared towards the visible end of the spectrum.

The simplicity with which the above formula represents all the bands leads to the belief that these bands are due to the absorption of one kind of molecular species. The fact that at elevated temperatures the number of single molecules (HCOOH) is much increased, while the number of double molecules $(HCOOH)_2$ is decreased, leads to the conclusion that the banded absorption spectrum is due to the single molecules. (At 145° C. the ratio of single molecules to double is about 7 : 1, and at the room temperature it is about 0·3 : 1.)

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The Scope of Organic Chemistry.[1]

By Prof. J. F. THORPE, C.B.E., F.R.S.

THE chemistry of the compounds of carbon covers a wide field, wider than that covered by any other element. Its scope embraces all living matter, as well as the vast number of non-living substances which are produced through the agency of life. Moreover, it includes a very great number of compounds unrelated to life or to living processes which have been built up by the chemist in the laboratory by methods he has devised.

Already some 200,000 definite compounds have been tabulated in Richter's Lexicon and in the supplements thereto, and this number is increased yearly by several thousands through the agency of a band of zealous workers scattered over the globe. It may well be asked what is the good of continuing to increase this already astonishing number; and is the expenditure of time, labour, and energy justified which lead to the discovery of some new fact having, apparently, no useful application to any department of human activity?

The answers to these questions are quite clear and definite. We must acquire a knowledge of the simple before we can attack the complex with any hope of success. The element carbon has been used by Nature as the basis of organised life because the capacity of carbon to combine with itself is shared by no other element, and it is upon this capacity that Nature has relied in order to build up the tissues and reserve materials which form the living world around us. Moreover, since the compounds of carbon containing a moderate number of atoms of the element are usually crystalline or capable of becoming crystalline, and there are obvious disadvantages attaching to the use of potentially crystalline substances as the basis of living matter, it has been found necessary to employ the more complex carbon derivatives containing many hundreds of elemental atoms, which by reason of their high molecular complexities no longer possess, or seem capable of acquiring, a crystalline structure, but belong to the class of jelly-like or colloidal substances.

Until we can determine how a small number of carbon atoms combine one with the other, we cannot hope to obtain any insight into the manner in which the more complex natural substances are built up, or any information regarding the way in which they are utilised to bring about the changes occurring during animal and vegetable metabolism.

STRUCTURE.

The science of structural organic chemistry is only just fifty years old. It was born when the genius of van 't Hof gave to the world the clue upon which the three-dimensional formula we now use is based. It is therefore no inconsiderable achievement to have gained in so short a time a knowledge of many of the reactions and properties of the more simple complexes of carbon in combination with oxygen, nitrogen, and other elements. But much yet remains to be done before we can attack with any real hope of success the problems which the chemistry of Nature presents.

[1] From the presidential address to Section B (Chemistry) of the British Association, delivered at Oxford on August 5.

It is true that the knowledge already gained has led to the synthetic preparation of quite a number of natural products, many of which are of service in relation to human needs. Many of the alkaloids, colouring matters like indigo and alizarine, camphor, and a large number of natural products, have yielded the secrets of their structures and have been produced by laboratory methods and, where necessary, on the factory scale. But the synthesis of such compounds has not provided much insight into the mechanism leading to their production in Nature, and indeed the reason for their occurrence in the plant is not understood. They are, moreover, crystalline substances which either occur in the plant as such or are formed by the hydrolytic fission of some more complex plant materials. Their homogeneity is therefore not open to doubt, and their degradation into known fragments and the rebuilding of these fragments into the original substances, although by no means easy, is nevertheless comparatively simple when the difficulties attending the investigation of more complex natural products are taken into account. Even so, some of the simpler type, for example, strychnine, still resist the attack of the chemist.

BIOCHEMISTRY.

In its earliest days the science of organic chemistry dealt only with those compounds which were derived from natural sources, and it was regarded as certain that such substances could be produced only through the agency of life and by no other means. Since then this theory has been shown to be wrong by the preparation in the laboratory of many substances identical with those formed during the operation of life processes. Nevertheless, the more complex substances which Nature utilises in building up her animal and vegetable structures still show no signs of yielding the secrets of their constitutions, or the mechanism by which they are produced. Indeed, although we can imitate in the laboratory certain natural operations such as the hydrolysis of starch to glucose, we are still quite ignorant of the means by which glucose is converted, by the appropriate enzyme, into alcohol and carbon dioxide, neither can we imitate this process in the laboratory.

When once the chemist has passed beyond the crystalline and the distillable he enters a region full of difficulties, because he has few means either of purifying the materials with which he has to deal, or of determining their homogeneity when they have been purified. These are the real difficulties which confront the biochemist when he approaches his subject from the structural side of organic chemistry.

It is far from my object to disparage the wonderful work which has been done and is being done by physiologists and pathologists in their attack on the mechanism of normal and abnormal life processes. Their record speaks for itself. But too little is being done to approach the problems from the purely organic chemical side, and too few of the people engaged in biochemical research have an adequate knowledge of organic chemistry or the methods of the organic chemist. The number of organic chemists who are co-operating with biologists in their attack on natural processes is too few. Indeed, the very difficult question arises here as to how best to organise methods for dealing with problems which are essential borderland problems between two great sciences.

It seems that the best method to attack problems in borderland subjects is by co-operation between two types of trained investigators. In the case of biochemistry, for example, by the provision of trained students of two kinds, one trained in physiology but with a sufficient knowledge of organic chemistry to promote sympathy with and knowledge of the chemist's point of view, and the other trained as an organic chemist with a similar knowledge of the methods and requirements of the physiologist. The former would be a trained physiologist who would devote his final year to organic chemistry, the latter an organic chemist who would devote his final year to a study of physiology. This is, of course, no new idea, but is one which is being carried out in at least one institution in Great Britain in connexion with other borderland subjects.

It is the absence of any real attempt to approach biochemical problems from the chemical side that renders it particularly desirable that the need for some such scheme should be emphasised. It is true that the fault is largely on the side of the organic chemists who, for the most part, seem appalled by the difficulties attaching to the study of natural processes. The difficulties are indeed great, but not insurmountable. We are far from gaining any insight into the meaning of life, but it is not unlikely that we shall, in the near future, obtain some information regarding the mechanism of the action of the enzyme, the important agent in the non-living transformation of living matter into chemical products. It may be that organic chemists are waiting to see how Willstätter, who has already made great progress in enzyme chemistry, will surmount the difficulties confronting him, and it may well be that this great organic chemist will introduce new methods of attack which will open up fresh fields for investigation.

PETROLEUM.

The complex hydrocarbons which form the main constituents of crude petroleum belong to a section of organic chemistry at present too little explored. Although many millions have been made through the production and sale of petroleum products, it is safe to say that the percentage of profit devoted to research in oil products has been infinitesimal. It is true that in the United States large sums are given by the oil interests towards research in other subjects, but until quite recently none of these was, curiously enough, given for the purpose of improving our knowledge of the science on which the utilisation and isolation of petroleum products depends. The reason is not far to seek. The apparently inexhaustible supplies of petroleum render it unnecessary to devise means for economical working. The crudest and most wasteful methods were employed, because economy and the conservation of the natural product were not paying propositions.

This applies not only to the methods used in fractionisation, but also to those employed for the purpose of 'cracking' the higher boiling fractions into liquids of lower boiling point. For at the present moment it is the fraction up to 200° C. which is the important product, because it is the 'petrol' of the internal combustion engine. Time was, before the introduction of this particular machine, when the light fraction from crude petroleum was a drug on the market, and in many cases was actually set on fire at the refinery because no use could be found for it. In those days the chief product was the kerosene fraction which was used as lamp oil. At the present time the rapid increase in the use of the motor-car for personal and commercial transport indicates that at no distant period, if progress continues to be made in the same direction, the amount of the 'petrol' fraction will be insufficient for the world's needs. This point has already been reached in America, where approximately 70 per cent. of the world's consumption of petrol (gasoline) is effected. During 1925 the consumption of petrol in the U.S.A. approached 800,000,000 gallons a month, which is about twelve times the amount consumed in Great Britain.

The 'cracking' operation is now carried out on an enormous scale by numerous processes, all subject to patents, but differing from one another only slightly on the question of principle. All depend on the well-established fact that hydrocarbons of high molecular weight will break down into those of lower molecular weight if they are subjected to the requisite degree of temperature. Pressure appears to play an important part in the character of the product, as does also the surface action of the container or material used in the container to promote surface action. All are wasteful, because little or no research has been carried out on the true chemical nature of the cracking operation. Much permanent gas is always produced, consisting for the most part of ethylene and propylene. In the States the ethylene is allowed to go free, because its obvious utilisation in the form of ethyl alcohol is attended with difficulties, but the propylene is usually absorbed in sulphuric acid, and thus converted into *iso*propyl alcohol, useful as a solvent.

The production of these two unsaturated hydrocarbons provides a clue to the mechanism of the cracking process which is of some significance. If you break a long-chain saturated hydrocarbon, one of your products must be an unsaturated hydrocarbon, and it is evident that cracked spirit contains a considerable proportion of such unsaturated bodies. Moreover, the cracking processes at present in use do not produce aromatic hydrocarbons, and it is on the presence of a proportion of these aromatic hydrocarbons that certain special properties of petrol depend. For example, the tendency at the present time is to produce for motor-cars internal combustion engines of increased compression ratio, in order mainly to diminish the petrol consumption and thus increase mileage per gallon consumed. For some reason, which research has not yet ascertained, the use of petrol which does not contain the right quantity of aromatic hydrocarbons of the benzene type leads to 'detonation,' 'knocking,' or 'pinking' when ignited in cylinders giving more than a small compression ratio. This detriment diminishes the value of cracked spirit as such for any but low-compression engines, and many have been the devices suggested in order to overcome this difficulty.

A vast number of substances, selected more or less at random, have been tried as 'anti-knock' materials, and as an outcome it has been found that one, namely, lead tetraethyl, possesses the property, when present in exceedingly small quantities, of preventing the 'detonation' of the explosion mixture in the cylinder. For a time lead tetraethyl (ethyl gas) fell under a ban in the States owing to a fatal accident which attended the spilling of a certain amount in one of the American factories, but it is understood that further investigation has led to a revision of the view first formed, and that considerable quantities of 'ethyl gas' are now being used. I remember visiting Wilmington in 1924, when some 500 gallons of lead tetraethyl were being made daily. Although there was naturally a strong smell of the material in the factory building, and I remained for some hours there, no ill-effects were noticed.

It is obvious that the conditions which produce 'knocking,' and the reason why certain substances are 'anti-knock' compounds, and why the presence of aromatic hydrocarbons prevents the phenomenon, must be made the subject of systematic research.

The question is also one of national importance, because in the case of high-compression engines, such as those used in aeroplanes, it is essential that a petrol should be used containing a high percentage of aromatic hydrocarbons. In war-time these aromatic compounds will be required for the manufacture of explosives, and it is quite certain that there will not be enough for both purposes.

Nevertheless, it must be remembered that it is only at the moment that the low boiling fraction of petroleum is the chief marketable product. It is probable that progress in the future will tend more and more to produce a motor-car engine of the Diesel type, or one having a carburettor capable of effectively vapourising the higher fractions of petroleum. In these circumstances it may well be that the low fraction will become the less important part of crude petroleum, and that, instead of having to resort to 'cracking,' a process of synthesis, by which the lower hydrocarbons can be converted into higher ones, will have to be adopted. As a matter of fact there are methods known by which this can be effected. Pure *iso*amylene can, for example, be converted into diamylene by interaction with stannic or aluminium chloride, and the process can be carried further, so that perfectly good lubricating oils can now be made by the polymerisation of the lower unsaturated hydrocarbons.

Polymerisation and depolymerisation are therefore the two operations which the petroleum industry must investigate and establish on a firm scientific basis by research, so that it may be in a position to supply the public need for any particular form of engine which the engineer may evolve. Especially is it desirable to ascertain under what conditions polymerisation leads to the formation of aromatic and naphthenic hydrocarbons. Considerable attention has been directed within recent times to what may be termed in general the Bergius processes for depolymerising organic substances. The operation, which consists in heating the material under high pressure in the presence of hydrogen, was introduced in the first instance for the treatment of coal. There can be no question that great and fundamental changes are brought about in organic substances by the treatment whether a catalyst is present or not, and that a wide field for research is opened up thereby, but it is doubtful if, at the moment, general operations of this type can be regarded as commercial propositions. The plant is exceeding costly and the conditions subject to wide variations which are difficult to control. Actually, it has been ascertained that in the 'cracking' of the kerosene fraction of petroleum, hydrogen is unnecessary and can be replaced by nitrogen without affecting the character of the final product.

Little is known of the constituents of crude petroleum, or indeed of the fractions into which it can be separated after purification and distillation. Some of the simpler hydrocarbons of the pentane and hexane type have been isolated and the presence of cyclic compounds has been established. Many of them are classed under the head of 'naphthenes,' but these are of uncertain structure. No doubt many are present in the crude oil, but it is certain that others are formed during the distillation process. It is clear that much opportunity for research work offers itself here, and it is probable that small alterations in the method of distillation may cause deep-seated changes in the character of the distillate, causing it to be of greater service for particular purposes. The occurrence of hydrocarbons of the naphthalene series in petroleum products has also been clearly established. The higher fractions which constitute the valuable lubricating oils also need attention, for it is now certain that viscosity bears no relation to oiliness, that is, the capacity for acting as an efficient lubricator. The addition of small quantities of 'polar' substances of the type of fatty oils or acids confers increased oiliness on these compounds, and although we are now gradually reaching a stage when we know more about the effects of such ingredients, the field for research is still a large and important one.

The formation of free carbon occurs during both the distillation and 'cracking' process, in some cases to a very considerable extent. The utilisation of this carbon for the purposes of making electrodes is an important part of the industry, and the formation of carbon in a condition in which it can be used by the rubber tyre manufacturers is also likely to become practicable as an outcome of the thermal decomposition of hydrocarbons.

At present we know nothing about the structure of the hydrocarbons present in the lubricating oils. Indeed, it seems possible that these may not be long-chain hydrocarbons with which the organic chemist is familiar, but rather polymerised products formed from unsaturated components liable to be formed or destroyed under comparatively mild conditions. The relative ease with which the oil in the engine sump of a motor-car loses its oiliness through continued use is not characteristic of the stability usually associated with an organic hydrocarbon.

It is clear, therefore, that the need for systematic research into the character of petroleum products is urgent, and it is gratifying to note that the Anglo-Persian Oil Company has established a research laboratory at Sunbury-on-Thames, in which the important principles underlying the industry have been and will be studied.

Dyestuffs and Intermediates.

Prior to the War, Germany manufactured three-fourths of the dyestuffs required for the world's markets. Of the remaining one-fourth, one-half was made from German intermediates and was therefore dependent on Germany. Switzerland, although without a domestic source of raw materials, ranked second with about 7 per cent. of the world's production. Great Britain produced about one-tenth of her requirements, and France produced in French-owned and operated plants from 10 to 15 per cent. of her consumption. In order to meet the patent requirements of France and Great Britain, German manufacturers operated plants in those countries where the final assembling operations were completed. The small dye industry of the United States was almost entirely dependent upon German intermediates. At the present time Great Britain produces 80 per cent. of the dyestuffs required for its own use, and we are therefore in a position to review the conditions which have led to this remarkable change and to consider the procedure necessary to strengthen it.

It cannot be said that any fundamental advance in the chemistry of the dyestuffs has been made since Bohn discovered indanthrene in 1901, although great advances have been made since then in the preparation of new colours belonging to this and other known series. Consequently, the research work necessary in order to establish our position as a dye-making country has been mainly along known lines, involving the extension of reactions which had already been established rather than the discovery of new ones. Nevertheless, it is no inconsiderable achievement for our research chemists to have established a position such as that indicated above in so short a space of time, for many of the preparations, the details of which could only be found in the patent literature, had to be worked out *de novo* and the correct conditions found for their adaptation to the technical scale.

It is probably along the lines of decreased cost of production that research work in the immediate future will be mostly engaged, and especially is this the case with the intermediate products from which the dyestuffs are derived. Moreover, the intermediate products are of the greatest importance for other industries, for example, the fine chemical industry, the perfumery, and the explosives industries, and any improvement in the processes for their manufacture or the production of new compounds having enhanced value from the commercial point of view is of the greatest importance to all these industries alike. The parent substances of the intermediate products are the hydrocarbons of coal-tar or the coke-oven by-products. The operations required to convert these hydrocarbons into the finished intermediates often involve many stages, any one of which depends for its cost on the purity and yield of the product. There is thus a wide field for research into the improvement of technical methods which may well occupy the attention of our dyestuffs chemists for some time to come.

On the other hand, the question of fundamental research into new processes, both for the preparation of new intermediates and new dyestuffs, must not be lost sight of. The intermediate determines the character of the dyestuff, and it is always possible that a new intermediate may be discovered which will yield a dyestuff with just that difference of shade as to catch the public fancy, and will lead to the replacement of the older dyestuff on the market. The sulphonic acids of naphthol, naphthylamines, and amino-naphthols are cases in point. These substances are used extensively for the preparation of azo dyes. There is a great number of these compounds theoretically possible, but only a few have found technical application, owing mainly to the high cost of producing the others. The high cost is nearly always caused by poverty of yield, an objection which may be at any time removed by the discovery of an improved process. The same argument holds good for the dyestuffs themselves.

It is futile to say that the vast field of organic chemistry has been thoroughly explored for the production of new types. At any moment one or other of the men or women engaged in fundamental research may repeat Bohn's discovery of 1901, and obtain a new compound which will be the forerunner of a new series of dyestuffs. It is perhaps too much to ask an industry which is struggling to hold its own to expend large sums on the prosecution of abstract research, most of which will be of no use to it, but it is not too much to expect that the industry will take every means to foster and encourage abstract research in our university institutions, and even to give some lead as to the direction in which its experience leads it to think that advances may be made. There is at present no organisation which can bring the manufacturers of dyestuffs and intermediates into touch with the work being carried on in our university laboratories, and it is possible that if at the present time a valuable discovery were to be made it would be unrecognised as such, and, following the usual course of academic research, would be published and thus lost to the country. What is required is a lead from manufacturers which will indicate the matters which they regard of importance, but which they do not consider as likely to yield results sufficiently quickly to justify them in employing their own research staff for investigating them.

This aspect is of all the more importance at the present time, when organic chemistry is entering on a new phase which will undoubtedly revolutionise many of the existing processes of manufacture. It is now recognised that the presence of a small quantity of a catalyst may either alter the course of a reaction or may lead it to proceed to completion where otherwise a totally inadequate yield would be obtained. The catalyst may either be added or the containing walls of the reaction vessel may act in this capacity. The well-known example of the oxidation of naphthalene to phthalic anhydride by vanadium pentoxide is an example of this, but similar cases are continually recurring, and it has only recently been found that the classical method for preparing ketones by the distillation of the calcium salt of the appropriate acid can be utilised in the most unexpected directions if the thorium salt instead of the calcium salt is employed.

Francis Bacon and Scientific Method.

By Dr. C. D. BROAD.

I.

FRANCIS BACON, who died on April 9, 1626, and whose tercentenary is to be celebrated at Cambridge on October 5 of the present year, was born at York Place, Strand, on January 22, 1560/61. His father was Nicholas Bacon, Lord Keeper to Queen Elizabeth, and his mother was Anne Cook, daughter of Sir Antony Cook, who had been tutor to Edward VI. Bacon went to Trinity College, Cambridge, at a very early age; he was only fifteen when he finally went down in 1575. He was sent to France by his father, who died while he was there, leaving Bacon ill provided for. He decided to follow the career of a lawyer, and was admitted to Gray's Inn on November 21, 1576. During Elizabeth's reign Bacon had much legal work to do, and received many promises of preferment, but he was not greatly rewarded either in money or in offices. Under James I. his advancement was rapid. He rose to be Lord Chancellor and Baron Verulam in 1618 and Viscount St. Albans in 1620–21.

This was the culmination of Bacon's career. On May 3, 1621, he pleaded guilty to a charge of corruption; was fined 40,000*l.*; imprisoned in the Tower during the King's pleasure; made incapable of sitting in Parliament or holding any office of State; and banished from the verge of the Court. The King soon freed Bacon and remitted his fine; but the fallen statesman retired to his estate at Gorhambury, and devoted the rest of his life to those literary, scientific, and philosophic labours which had always been his main interest. His most important philosophical and scientific works are the "De Augmentis" and the "Novum Organum." There are in addition a great many fragments and sketches which throw much additional light on his scientific and methodological theories. Bacon died a martyr to experimental science, and might well be made the patron saint of the cold storage industry. In extremely cold, snowy weather he stopped his coach near Highgate, bought a chicken, and stuffed it with snow, in order to see whether this would preserve the meat. He caught a severe cold, which was aggravated by the damp bed into which he was put at Lord Arundel's mansion, where he had stopped for the night, and he died in his sixty-sixth year.

In order to understand Bacon's dissatisfaction with the science of his time, we must try to imagine a state of affairs in which physics and chemistry were in much the same position as psychology and sociology are now. There were various sects or schools of physicists, following various masters, wrangling with each other, and producing much heat, little light, and less fruit. Existing scientists are divided by Bacon into two classes: (1) the extreme rationalists who rush to wide general principles from a few common-place and badly analysed facts, and then profess to explain everything by means of these principles; and (2) the mere empiricists, who investigate with extreme diligence but no scientific method some small region of phenomena, and then put forward theories of the universe in terms of the small corner of it with which they happen to be best acquainted. Nothing satisfactory can be reached in either of these ways. The theories of the rationalists are more plausible than those of the empiricists, but they lead to no practical results and give us no control over Nature. The empiricists (*e.g.* the alchemists) have sometimes stumbled by chance on useful practical results. But each of these is isolated from the rest, and Nature cannot be controlled practically until its structure and laws are understood theoretically. So Bacon demands that the sciences shall be built up again from better foundations and by a new method, which shall combine the careful observation and experiment of the empiricists with the generality and systematic connexion of the rationalists. Like other philosophers of his time, Bacon made the mistake of thinking that, because a good method is necessary in order to accomplish anything, it is sufficient in order to accomplish everything. He compares it to a ruler or a compass in drawing; and, like Descartes, he thinks that it will reduce all human intellects to a level.

Now Bacon holds that science has so far failed, partly because the human mind has not had an adequate, trustworthy, and properly selected set of data to work upon, and partly because it has not applied a suitable instrument of interpretation to the data which have been available. He thinks the first defect more serious than the second; for he says that important generalisations could be gained even by the present imperfect logical processes from an adequate natural history, whilst even the most perfect logical instrument would be powerless to elicit truth from the present scanty and unreliable data. In order to remedy this evil, Bacon holds that the first necessity is to prepare the mind for collecting a proper natural history and for interpreting and generalising from this history. The mind of any grown man is a highly distorting mirror, and our first business is to plane and polish it as far as may be. The factors, innate and acquired, which cause bias and error are called by Bacon "Idols." Certain of these are common to the human race, *e.g.* the tendency to ascribe to Nature the particular kind of orderliness and simplicity which is pleasing to men. These are called "Idols of the Tribe." Others vary from individual to individual; *e.g.* some men tend to dwell on resemblances and neglect differences, whilst others have the opposite bias. These are called "Idols of the Cave." Then, again, the suggestions and associations of language are a fruitful source of error; since words and phrases embody theories which are often false and observations which are often mistaken. These are called "Idols of the Market Place." Bacon admits that these three kinds of Idol can never be completely eliminated. But we can be put on our guard, so that we allow for them and thus render them harmless. Finally, there are false systems of philosophy and science erected by bad logic on flimsy foundations. These are called "Idols of the Theatre"; and there is no reason why they should not be completely removed, partly by pointing out their fallacies and their unfruitfulness, and partly by substituting good reasoning and properly attested data.

The human mind has, however, many deficiencies as well as positive sources of error. When the latter—the Idols—have been removed, it is time to provide aids to supplement the former. The senses have two defects. In the first place, they are sensitive only for a small range of stimuli. Secondly, their deliveries are always infected by subjectivity; they tell us of things, not as they are in Nature, but as they affect a particular organism at a particular time and place. The first kind of defect can be remedied to a large extent by suitable instruments. The second can be remedied by comparison between different senses of the same observer, or the same sense of different observers. Bacon holds that the deliveries of the senses, when properly compared, criticised, and neutralised, are trustworthy, and are the only possible foundation of science.

When the mind has been thus purified and helped, it is time to give it directions for collecting a complete natural history. Bacon recognised that the actual collection of such a natural history would be a work which would take much time, trouble, and expense, and in which many men would have to co-operate. He hoped to secure such co-operation, and to confine himself to giving directions and to completing the logical principles for interpreting and generalising the facts. Unfortunately he received no help either in money or in kind, and so he was forced to collect his data for himself, a task for which he was obviously ill-fitted.

Bacon's scheme for a complete natural history was as follows. It was to consist of an account of the normal course of Nature, of abnormalities spontaneously produced in the course of Nature, and of results deliberately produced by the interference of man. Bacon attached very great importance to deliberate experiment as compared with passive observation. He also attached great weight to the observation of spontaneous abnormalities. They set us free from prejudices, and they suggest means of producing new substances and changes artificially. Bacon explicitly recognised that there is no fundamental distinction between natural and artificial products. In the history of the normal course of Nature we are not to neglect what is commonplace or to omit what is filthy. The method of selection is to be the following. Data are to be chosen, not for their intrinsic interest or for their immediate practical usefulness, but for their capacity to throw light on the structure and laws of Nature. Bacon's views on practical applications in science are admirably just. On one hand, he regards the practical control of Nature as the ultimate end of science, and ability to produce observable results as the ultimate test of any scientific theory. On the other hand, he fully recognises that Nature can be controlled practically only by being understood theoretically; and he constantly asserts that to aim directly at particular applications is fatal to pure science and short-sighted even from the point of view of practice.

Bacon gives rules for recording and arranging the data of the natural history when they have been collected. The following are the most interesting. All data that can be accurately measured should have their values recorded; where accurate measurement is impossible, upper and lower limits should be assigned. All difficult experiments must be fully and carefully described, so that others can criticise and, if necessary, repeat them. The data must be tabulated and classified from the very first. But we must recognise that at first the natural history will almost certainly contain some alleged facts which are not genuine, and that our first classifications will be partly inappropriate. If, however, the bulk of the data recorded are genuine facts, they will suffice to establish the general laws and structure of Nature; and, in the light of this, the few errors will stand out as anomalies and can be reinvestigated and corrected. Similarly, it will be necessary to return to the natural history again and again as our knowledge of the general laws and structure grows, and to reclassify the data in the light of this increased knowledge. Probably a work like Beilstein's "Dictionary of Organic Chemistry" would be a good example of what Bacon meant by a natural history. Yet of course the classification of compounds within this dictionary depends entirely on chemical theory, whilst Bacon wanted his natural history to be as free from theory as possible. The solution of this apparent contradiction is that the natural history and the theories induced from it act reciprocally and successively on each other. The first and crudest form of the natural history involves the minimun of theory and gives rise to the crudest inductions. The natural history is now corrected and reclassified in terms of these inductions. It thus imbibes an additional dose of theory, and becomes the basis for more accurate inductions which in turn react on itself.

(*To be continued.*)

Antarctic Weather.

THE recent publication of Dr. Simpson's interesting Halley Lecture of 1923 focusses attention once more on the little-known causes which are responsible for the weather of the Antarctic continent. In his lecture Dr. Simpson dealt particularly with the meteorological conditions as they affected adversely Capt. Scott's journey to and from the South Pole, and justified Scott's own view that the conditions on the last stage of the return journey were such as could not have been foreseen. This impossibility of forecasting weather conditions is of course shared by the Antarctic continent with many other regions of the earth, but there is some reason for believing that the contrasts in weather conditions from year to year and from day to day are very pronounced, at least in the region of South Victoria Land, to which area these remarks chiefly refer.

A visitor's first sight of the still active volcano forming the summit of the ice-clad Ross Island is indeed prophetic of the contrasts he will later experience; he will be no less surprised to discover that the continent, roughly circular and of radius some 1200 miles, is almost entirely covered with ice and snow, though it could, so far as precipitation is concerned, be classed almost as a desert. The general surface circulation is anticyclonic, the air flowing outward from the continent with an easterly component due to the earth's rotation. Superposed on the normal distribution of wind velocities appropriate to the anticyclone is a fairly frequent and high south-easterly wind. These blizzards are inclined to commence more suddenly in winter than in summer, and to occur more frequently during the darker months. On the floating Ross Barrier the yearly excess of precipitation over loss from the surface is only some 8 in. of solid ice, on the average. On the plateau, the net gain to the surface is probably a good deal less than this, the gain being balanced approximately by the downward flow of ice in glaciers of various types. The ice covering differs from that in other regions of the globe in that it does not melt appreciably on land and often pushes a floating 'tongue' for many miles into the sea before a point is reached where melting can set a limit to its advance. Practically the whole of the small snowfall must be formed during blizzards; it is also during blizzards that evaporation from an ice surface is a maximum, at least in the winter months.

Though possibly not in the most logical manner, this leads us to consideration of the blizzard of the western Ross Barrier—that blight of English expeditions. On account of its geographical position and the lower temperature of the Barrier, the pressure over it is higher than over the Ross Sea. This causes a preponderance of surface air-flow from the south and east, on the western side of the Barrier; any increase of this pressure difference—for example, in the form of a moving pressure wave—causes a blizzard. Simpson has indeed showed that blizzards occurred in McMurdo Sound, which lies at the north-west corner of the Barrier, when the pressure difference between that place and Amundsen's headquarters, at the north-east corner, increased; high northerly and light southerly winds, or calms, occurring when the pressure difference decreased. Even when no snow is being formed, the air during a blizzard is filled with vast quantities of loose snow scooped up from the surface, and, at the same time, the temperature generally rises. These characteristics and the gustiness of the blizzard suggest a thorough mixing of the cold surface air with warmer air above it. Blizzards may be of short duration or may last a week or longer; that during which Scott and his party perished lasted for at least ten days. The position of a party storm-bound for many days in a tiny tent is not particularly comfortable, especially when the sun is low, and one can readily imagine the earnest—even fierce—and interminable discussions which accompany the blizzard: Is a wind of 60 miles an hour and a temperature of $-30°$ F. worse or better than a wind of 50 miles and a temperature of $-40°$ F.? How much cream goes to the making of cream cheese? Is it better to sleep with the fur side of the sleeping bag inside, or with the skin side inside?

The western barrier blizzard occurs most frequently in the winter and the adjacent months. To appreciate the reason for this, it is necessary to consider the intensity of radiation to and from the surface, bearing in mind that air receives or loses heat chiefly by contact with the surface. On the snow-covered Barrier, the surface is peculiarly sensitive to radiation on account of the low specific heat and low heat conductivity of the loose snow covering, in comparison with the corresponding constants for the sea which bounds it on the north. Over the sea, convection is operative, and there is a normal temperature gradient in the air above it. The same is true over the Barrier when the inward directed radiation is sufficiently intense, the surface temperature being, however, naturally unable to rise above freezing point. When outward directed radiation predominates, the snow surface rapidly cools and an inverse temperature gradient is established in the air above, provided the horizontal air flow is not too great. This results in a large daily amplitude of temperature on the Barrier—a variation which is almost exactly in phase with the sun's altitude. In appropriate conditions, a mean amplitude of 20° F., corresponding to a variation in the sun's altitude from 10° to 30° above the horizon, has been measured, a range which equals the mean daily amplitude in India, where the sun nearly reaches the zenith and is below the horizon for almost twelve hours.

Due to the same causes, the yearly variation of temperature lags only eight days behind the sun. For the summer 1911–1912 the mean temperature on the plateau for the midsummer month was $-9°$ F., with a mean temperature of $-19°$ F. for the following month. These figures are suggestive of what is likely to occur on the plateau in the depth of winter when the temperatures on the Ross Barrier, which is almost at sea-level, fall at least to the minus seventies. Except in summer, the mean temperature of the Barrier is fixed largely by the frequency of the southerly blizzards, each of which causes a rise in temperature. The low Barrier temperatures, which played so great a part in the disaster to Scott's party, were such as could be expected to occur occasionally; what was entirely unexpected was the length of the cold spell, or, in other words, the unusual paucity of blizzards in late February and March. When the blizzard did come, it was of unusual duration and came at a critical time, when the party was within eleven miles of One Ton Depôt.

March and April are probably critical months, since the formation of a permanent winter ice covering in McMurdo Sound seems to be conditioned largely by its ability to reach a sufficient thickness between blizzards, before the winter weather sets in.

Travel on the Barrier at a time when the sun is setting, or has set for the winter, is indeed an unpleasant business, and considerable advantage is gained by choosing a time for the commencement of a long journey so that Christmas falls practically in the middle of the period. Apart from the necessity of avoiding the bad weather of the autumn, one should strive by this means to avoid the bad sledging surfaces associated with low temperatures. We have no quantitative information about the relative friction at temperatures about and far below 0° F., or in fine and coarse-grained snow, but the differences are known to be very important, and the great wear of the sledge runners is quite sufficient indication of the increased friction at really low temperatures. On cold, freshly-fallen snow of a 'floury' consistency the effort of hauling is so great that one has the feeling that the friction is a friction, not between snow and runner, but between adjacent snow grains.

Much more data are required before the weather of the Antarctic can be known in more than its broad outlines—data which can only be gathered by concerted action and by the permanent occupation of temporary observatories. The present poverty of the country is such that no well-found expedition is likely to be launched in the near future, but the time will come when further information will be urgently required, and this will be the time for insisting on the importance of such conditions as will obtain the fullest scientific value for money expended. It is hoped that the Scott Polar Research Institute, the formal inauguration of which has recently taken place at Cambridge, will have some influence in determining questions of this nature. C. S. W.

Obituary.

PROF. F. W. GAMBLE, F.R.S.

A DISTINGUISHED English zoologist, a remarkably fine teacher and a man of a singular charm of character, has been lost to science by the death, on September 14, of Prof. Frederick William Gamble, Mason professor of zoology and comparative anatomy in the University of Birmingham. He was born in Manchester on July 13, 1869, and was educated at the Manchester Grammar School and at the Owens College. At the College he came under the influence of the late Prof. A. Milnes Marshall, and catching his enthusiasm for the study of animal morphology, devoted himself to zoological studies. After taking his degree with first-class honours in the newly established Victoria University and gaining the Bishop Berkeley research fellowship, he went abroad and studied for a time in the University of Leipzig. The first two papers from his pen, one on our rare British Nudibranchs, published in 1892, and the other on the British marine Turbellaria, published in 1893, were descriptive and systematic in character, but already they showed evidence of the tendency of his mind towards the experimental side of the subject.

After a short period as a junior demonstrator, Gamble was made lecturer and senior demonstrator in zoology in the University of Manchester, and in 1896 he completed his account of the flatworms and Mesozoa for the "Cambridge Natural History," a most interesting and valuable contribution to that excellent text-book. It was about this time that the lug-worm (Arenicola) was introduced as a type in the schedule for the first M.B. examination of the Victoria University; and finding from laboratory experience that the current accounts of the structure of this worm were inadequate and in many respects inaccurate, Gamble and his colleague J. H. Ashworth prepared and published in the *Quarterly Journal of Microscopical Science* a very careful and elaborate description of its anatomy. This study led to the important discoveries by Ashworth, at a later date, of the structure and function of the giant nerve cells and nerve fibres of the Polychæta.

While the work on Arenicola was still in progress, Gamble's interest was attracted to the colour changes in the 'Phantom' shrimp *Hippolyte varians*, and, working now in partnership with a colleague in the botanical department, Mr. (now Sir Frederick) Keeble, a series of experiments were made at the fisheries' station at Piel which led to very interesting and remarkable results. The discovery of a blue nocturnal phase in all the colour varieties of this shrimp was in itself a novel and startling fact, but when the researches were extended to the higher forms of Crustacea, many other very important systematic and physiological results were obtained. In 1903 another paper by the same authors, working on the coast of France, appeared in the *Quarterly Journal of Microscopical Science*, on the bionomics and physiology of the remarkable turbellarian worm *Convoluta roscoffensis*, in which it was proved that the green corpuscles of the Convoluta represent a phase in the life-history of a flagellate organism allied to the genus Carteria, and that this organism infects the eggs after they are laid. It is not an exaggeration to say that this study in symbiosis has become one of the important classics of the subject. It is frequently referred to by later writers as the chief authoritative statement on the physiological relationship of host and guest.

It is not possible in this place to refer in detail to other scientific work Gamble did when this partnership was dissolved. It was characterised by the same love of the experimental method, accurate observation, and cautious deduction that was shown in his earlier writings.

With all his love for scientific research Gamble combined all the great qualities of a conscientious and explicit teacher. He spared no pains to make his lectures and demonstrations effective, with the result that he earned the respect and gratitude of a large number of his pupils and colleagues. In the two admirable little books which he published, "Animal Life" and "The Animal World," he has left some indication of the way in which he presented the problems of biology to an unscientific audience; and his account of the Radiolaria in Lankester's "Treatise on Zoology" shows his power of mastering the literature of a large subject and presenting the substance of it in an intelligible way to the more advanced student.

By the death of Gamble many of us have lost a most sincere and devoted friend. His quiet, modest manner, his constant readiness to help his colleagues and his pupils, and his unblemished character, endeared him to a wide circle of friends and acquaintances. He was elected a fellow of the Royal Society in 1907 and appointed professor of zoology in the University of Birmingham in 1909. He was president of Section D of the British Association at the Toronto meeting in 1924, where he delivered a very interesting address dealing principally with the question of the metabolic gradients.

Gamble married, in 1904, Ellen, daughter of the late Rev. J. M. Bamford, of Arnside, who survives him. He left no children.

WE regret to announce the following deaths:

Prof. Rudolf Eucken, from 1874 until 1920 professor of philosophy in the University of Jena, and author of many works on philosophy, on September 14, at eighty years of age.

Dr. Paul Kammerer, of the Biologische Versuchsanstalt, Vienna, known for his experimental work on the inheritance of acquired characters in amphibia, on September 23, aged forty-five years.

News and Views.

THE report of the Government Chemist upon the work of the Government Laboratory for the year ended March 31, 1926 (London: H.M. Stationery Office, 1926; 1s. 6d. net), though mainly a statistical document, is a standing witness to the value of this adjunct to the Government services. Unlike their medieval predecessors, Sir Robert Robertson and his merry men are not called upon to produce gold from base metal, to read the stars and to cast horoscopes; their task is the more prosaic but far more practical one of safeguarding the revenue and, to a certain extent, the health of the country, by means of chemical tests. Their work, however, extends beyond this, for in addition to serving the Board of Customs and Excise, the Board of Trade and the Ministry of Health, they do much chemical work for other Government departments, such as the Ministry of Agriculture and Fisheries, the Air Ministry, the Office of Works, the War Office, the Post Office, and the Inland Revenue. Not content, apparently, with these primary duties, the comparatively small staff of the Government Laboratory undertakes occasional research work of no mean importance, and provides representation on a number of scientific committees. Chemical analysis is, however, its main activity, and the number of samples analysed during a year, no less than their diversity, inspires us with a feeling of profound respect, if not of awe. During the year 1925–26, no fewer than 445,606 samples were examined, of which more than 110,000 related to beer and brewing materials, 106,395 to wines, 48,587 to spirits and spirituous preparations, 72,289 to tobacco, 61,003 to sugar and sugar products, 39,391 to tea, and 13,128 to cocoa and chocolate. The number of samples of imported beer, cocoa-goods, and imported spirits and spirituous preparations was considerably in excess of the number analysed in 1924–25.

THE work of the Government Laboratory indicates in no uncertain way the trades that are especially marked out to bear the burden of taxation, and it also reflects important changes in legislation. Thus in the year 1924–25 no samples of silk were examined in the Laboratory, but last year, following the imposition of duties, 12,237 samples were taken and tested, of which 10,313 were from imported materials, 1803 from exports, and 121 from home factories. Developments, industrial and fiscal, in the Irish Free State have been responsible for recent fluctuations in the number of tobacco samples examined. The Safeguarding of Industries Act necessitated the examination last year of 9645 samples of imported goods, whilst the Dyestuffs Act accounted for 195 samples, as compared with 535 in the previous year. Although mainly of interest to the analytical chemist, the report contains many items that will appeal to the student of affairs, and the layman's perusal of it leaves the impression that on the score of impurities and adulterations, the public have little reason to complain. From the large number of miscellaneous samples examined for the Post Office, it is interesting to note that, although 'gold thread' figures in the list, there is no reference to 'red tape'; analyses of lubricating oil for H.M. Stationery Office suggest a welcome acceleration of motion in that department; and the recovery of radium from disused compass-dials, gun-sights, etc., for the Treasury evokes memories of a war, and of a Damocletian weapon in the form of an axe that never fell.

A BRIEF Reuter message from Batavia in the daily press of September 27 announces the discovery by Prof. Heberlein of what is said to be a complete skull of the type *Pithecanthropus erectus*, the well-known Java skull. The discovery was made at Trinil, the village near which Dubois in 1892 found the skull-cap, thigh bone, and two teeth, to which the name *Pithecanthropus erectus* was given and about the human character of which so much controversy has since raged. Should later detailed information confirm the character of the new find, its importance will amply reward the patience, time, and money which have been expended, since Dubois' discovery was made known, on searching the neighbourhood for further relics of this earliest known and most primitive of the human types. Dr. Aleš Hrdlička, the American anthropologist, on his return last year from an anthropological tour of the sites on which relics of early man have been found, pointed out the importance of an early investigation in Java, where he had seen in the hands of natives an abundance of relics of man, apparently of considerable antiquity, which were being lost to science. It is therefore gratifying to note the announcement that the American Museum of Natural History intends to raise funds to carry on the work of excavation.

THE sixth (interim) report of the Sea Action Committee of the Institution of Civil Engineers is dated October 1925, and deals with researches carried out in 1924 or early in 1925. Its publication by the Stationery Office in September 1926 cannot therefore be called premature. The report contains summary reports on the periodical examinations of the steel test-pieces exposed at various harbours, but it is pointed out that "no really definite results can be expected until the bars are taken up for final examination." The experiments on painted specimens are also at an inconclusive stage, but the results are fairly consistent in showing that some of the paints are decidedly better than others. The biological work carried out for the Committee consists in series of experiments on the toxicity of various compounds to Teredo larvæ and to adult Limnoria. It is concluded that "substances that are toxic to Teredo do not necessarily confer any very high degree of protection against Limnoria." No comment is made on the discrepancy between this result and that obtained by the American Committee, the report of which, published in 1924 and summarised at the end of the present one, states that "the toxicity of the various compounds was approximately the same" for Limnoria and for the Teredinid Bankia. Prof. Barger reports that experiments by Dr. C. M. Yonge at Plymouth have shown that organic arsenic compounds of the type of D. M. (phenarsazine) are the most effective in poisoning the larvæ of Teredo. Tests on adult Limnoria at Edinburgh by Dr. F. D. White proved that it was not specially susceptible to organic arsenic compounds, the most effective substance being fluorenone, which, however, is too expensive for practical use. Dr. Yonge found that the poisons had no repellent effect on the Teredo larvæ, which settled as readily on wood impregnated with D. M. as on untreated wood, although in the former case they were speedily killed by the poison.

THE paper by Dr. Huber-Stockar, formerly chairman of the electrical department of the Swiss Federated Railways on the Electrification of Railways, which was read to the World Power Conference at Basle, is of interest at the present time. Dr. Huber-Stockar points out that when a railway is once electrified it never returns to steam traction. At first sight it is difficult to understand why so many railway companies are hesitating whether to adopt electric traction or not. The delay is due partly to economic considerations. Electrification involves expenditure, and this expenditure is not justified unless the traffic increases. Every new capital expenditure makes the railway more sensitive to a decrease in traffic. Electrification on a modest scale has not much effect on the prosperity of the railway. The hesitation of railway companies is also partly due to the difficulty in deciding which system is the best. State owned railways are as much interested in economic considerations as privately owned railways. In Europe a number of countries have experienced beneficial effects from electric traction which have justified its adoption. Favourable factors for changing to electric traction are cheap electric power and expensive coal and manual labour. The conditions are also favourable when the traffic is heavy and the gradients are long and steep. Dr. Huber-Stockar concludes that no definite and easily applied rules can be given for determining whether a railway is ready for electrification or not. It would be a great help to engineers if details of installations and working results were always given in similar forms, so that they could be readily compared.

THE excavations at Beisan of the Palestine Expedition of the University Museum, Philadelphia, which were resumed on August 24, have already produced finds of importance in throwing light on the extension of Cretan influence in this direction. In the *Times* of September 23, Mr. Alan Rowe, field director of the Expedition, records the discovery of cult objects, one a cylinder terminating in a pig's head, which is compared with and closely resembles a Cypriote vase, a basalt model of a chair of Minoan type, and a model of a table, also of Minoan type. The chair, although Cretan in form, bears Egyptian emblems—a winged Set animal, a vulture with outstretched wings, and the *ded* pillar emblem with arms and hands holding the Sign of Life. These finds, taken in conjunction with those of 1925, which, however, were of later date, point to a strong Cypro-Mycenæan influence in the religion of Beisan from 1375 B.C. onwards, of which the final phase was the Philistine domination ended by David about 1000 B.C. A bronze axe-head with a blade at one end and four curved prongs at the other, is similar to an axe-head held by a king figured on the gate of the Hittite capital in Anatolia. This would accord with the fact that about the time this temple of Amenophis IV. was being built the Hittites were advancing in northern Syria. The discovery of faience objects bearing the cartouche of Amenophis III. below the level of the floor of the temple confirms the attribution of this building to Amenophis IV. (1375–1358 B.C.).

AT the recent meeting of the British Association in Oxford, a registering balloon ascent was made by the Meteorological Office from the quandrangle of Keble College, in the presence of the guests assembled for the Meteorological Luncheon held on August 10. The balloon and meteorograph fell at Caxton, near Cambridge, a distance of 94 km., N.E. by E. The balloon reached a height of 20·1 km. before bursting. The meteorograph employed was a light barothermograph without clock, but it is possible to infer from the known approximate vertical velocity of the balloon that the total time of flight from ground to ground again was about 1½ hours. This indicates an average horizontal velocity of about 18 m. per second. The balloon was seen to enter a cloud of mammato cumulus form at a height of about 1½ km.; the record shows a small lapse rate of 4° per km. just below that height. From this point upward to 3·0 km. the atmosphere was in a slightly unstable condition with regard to saturated air; then there occurred traces of a reduced lapse rate, while above that again slight instability prevailed up to 7 km. It is probable that 3 km. marked the upper limit of the clouds seen from the ground. The stratosphere was found at 9·9 km., with a temperature of 231° Abs., and above that not more than 2° change of temperature, plus or minus, occurred at any point up to the maximum reached. The ascent was made in the south-westerly current to the south-east of a depression centred south-east of Iceland, with a gradient wind of about 8 m. per second.

A FUND for research fellowships, to be known as the "Eric Knight Jordan Research Fellowships in Geology," has lately been established by Dr. and Mrs. David Starr Jordan as a memorial to their son, who died on March 10 last. This fund is to be administered by the Stanford University, of which Dr. Jordan was the first president. The founders attach two conditions to the gift: first, that their son's name shall be perpetuated in the foundation; and secondly, that the principal sum shall be forever kept inviolate, only the interest thereon being used. The founders as an initial step have contributed a sum of about 1000*l.*, but expect to add to this later on, and invite friends of their son to contribute also E. K. Jordan in his all too short life (1903–1926) had shown great promise. No less than eleven important papers stand to his name, all published in the last six years. Beginning with one on recent mollusca, followed by a temporary digression into the subject of Hawaiian fishes, the remainder are concerned with the tertiary and quaternary molluscan faunas of localities in Lower California and Mexico, or expeditions in connexion therewith.

PROFS. H. BENNDORF and V. F. HESS are at present engaged in writing a comprehensive treatise on "Atmospheric Electricity and Allied Phenomena," to be published next year. As is well known, the funds available for the libraries of the Austrian universities are far from adequate, and it is extremely difficult to maintain scientific journals, especially the bulletins and proceedings of scientific institutions and societies of foreign countries. Profs. Benndorf and Hess write asking physicists and meteorologists in all English-speaking countries to send them reprints of their publications. Papers are required on atmospheric electricity dealing with the electric field of the earth and atmosphere, atmospheric ionisation, electricity of thunderstorms, electric properties of rain and snow, radioactivity of the earth and atmosphere, rays of cosmic origin, electric currents in the atmosphere, the aurora, theories of the origin of electro-atmospheric phenomena, and propagation of electric waves round the earth. Any reprints on these subjects would be gratefully received; they should be addressed to Prof. Benndorf or Prof. Hess, Physikalisches Institut, Universität, Graz (Steiermark), Austria.

DURING the past summer Prof. G. F. Sleggs, professor of biology at the newly established Memorial University College of Newfoundland and oceanographer to the Newfoundland Government, a former graduate of the Oceanography Department of the University of Liverpool, has carried out biological and hydrographical research in Bonavista Bay, Trinity Bay, Conception Bay, and other important Newfoundland fishery grounds. Samples of water have been obtained from a wide area and from accurately known depths for a study of plankton and temperature variations. A drift bottle experiment has also been carried out, a satisfactory proportion of the bottles having already been recovered. The work is in cooperation with the North American Committee on Fishery Investigations and is the first of its kind to be officially supported by the Newfoundland Government.

AMONG many brightly written and well illustrated articles in the *Scientific American* for September is one on the decreasing level of the great lakes. From a diagram, showing the variations in level of Lakes Huron and Michigan from 1860 to the present year, it would appear that apart from minor fluctuations a general lowering of level set in about 1890, after which the level has never reached previous maxima and has generally stood well below previous minima. Since 1909 the level, with one or two exceptions, seems to have been steadily falling. It is now about two feet lower than it was in 1860. The Chicago drainage canal, which was opened in 1900, has a flow of 8800 cubic feet a second, while other canals and artificial outflows from Michigan, Huron, and Erie account for 57,000 cubic feet a second. It is, however, pointed out that during the period 1917–1925, while the lakes stood at their lowest level, the rainfall deficiency over the lakes and their drainage area was at least two inches a year, and in some areas in certain years rose to six inches. Thus it is by no means certain that canal construction has been entirely to blame in robbing the lakes of water, though, if the decrease continues, the construction of weirs will become necessary.

IN view of the recent discussion at the British Association, attention may be directed to a brief historical review of the question of the species concept by Fridthjof Okland in *Naturen* (1926, pp. 75-87). From this he draws the following conclusion: "Even if we realise how uncertain the species concept is, biologists can and must continue to work with some such delimitation of forms. At the same time the obvious hopelessness of finding any biological concept of the species that shall be universally applicable gives distinct proof that the limits between forms are often more apparent than real. Our classification does not always give a true picture of relationships and connexions in living Nature." On which one is impelled to ask: Can it, and should it?

THE twenty-fourth annual report of the Rhodesia Museum, Bulawayo, for 1924, records the appointment of Mr. A. Frost to the post of geologist, vacant since 1915. Mr. Frost arrived soon after the discoveries of platinum ore in the Transvaal and found his time almost entirely occupied in reporting on samples submitted by prospectors. A special platinum exhibit was arranged, illustrated by maps and sections. A platinum panning, supplied by Mr. Milligan, of the Anglo-French Exploration Co., is available for prospectors to see and 'tail out' for themselves. It is to be hoped that some of the many who receive assistance will become members of the Museum, which is so poor that it does not possess even a rock-cutting apparatus.

THE Meteorological Department of the Government of India issued during the early part of August a forecast of the probable amount of rainfall during August and September, together with a memorandum on the rainfall experienced in June and July. The monsoon was very weak in June but normally active in July. The June rains were generally in defect, but in July there was a marked improvement. The inferences from the data most likely to have influence on the rains of August and September, show that the monsoon rainfall of the two months is likely to be normal in north-west India and normal or in excess in the Peninsula. Forecasts which are required by the Indian Government were issued by Mr. J. H. Field, Director-General of Observatories.

THE Atlantic weather, which has been brought to general notice more than usual of late by the disastrous hurricane in Florida and the West Indies, is thoroughly discussed in the *Marine Observer* published by the Meteorological Office, Air Ministry.

The issue for October deals with wind and fog at coast stations in the British Islands and in the south-west approaches to Great Britain and Ireland. It is concerned also with the sea temperature over the North Atlantic computed from observations for the period 1855 to 1917. In the south-west approaches to Great Britain, by far the greatest frequency of fog and mist occurs with easterly and south-easterly winds, while on the coasts of England the greatest frequency in October occurs on the south-west and east. The sea temperature around the coasts of Great Britain in October is 10° to 15° warmer than in a corresponding latitude on the American side of the Atlantic. The Meteorological Office is dependent on the Admiralty and the mercantile marine for its observations, and the present issue of the *Marine Observer* especially asks for observations in tropical revolving storms. Observations of hurricanes, cyclones, and typhoons are required from as many ships as possible in the vicinity of these storms for the development of the "Laws of Storms."

Dr. S. G. Barker, head of the Physics Department of the British Research Association for the Woollen and Worsted Industries, has been appointed Director of Research in succession to Mr. H. J. W. Bliss, who has resigned.

A correspondent writes advocating the use of the word "bioplasm" to denote living protoplasm; "protoplasm" without an adjective would then denote dead protoplasm. We see little advantage in the suggestion: it would merely encumber biology with another superfluous technical term and introduce an element of uncertainty for future readers into the interpretation of a vast mass of biological literature.

The Chemical Society will hold its first ordinary scientific meeting this session on Thursday, October 21, at 8 p.m. At the following meeting, on October 28, the lecture founded in memory of the late Dr. Hugo Müller will be delivered in the lecture theatre of the Institution of Mechanical Engineers at 8 p.m., by Prof. S. P. L. Sörensen, of Copenhagen, who has chosen as his subject: "The Composition and the Characterisation of Proteins."

The inaugural sessional address of the Pharmaceutical Society of Great Britain will be delivered by Dr. J. F. Tocher, University of Aberdeen, on October 6. The address will follow the presentation to Mr. J. G. Jones of the Pereira Medal. This is a silver medal provided and endowed out of the proceedings of a fund raised by subscription in 1853–4 as a memorial to the late Dr. Jonathan Pereira, a former professor of materia medica of the Pharmaceutical Society. The promoters of the fund resolved "that the medal should be awarded as a prize for researches or proficiency in Materia Medica," and it is presented annually for competition among the students in the advanced course in the Society's School.

The publication of a golden jubilee number of its journal, entitled "A Half-Century of Chemistry in America, 1876–1926," marks the commemoration of the fiftieth anniversary of the American Chemical Society. The origins and developments of the Society are described by members who were themselves present at the first meetings, among the earliest being the Priestley centenary, which was held at Northumberland, Pennsylvania, on August 1, 1874. The journal contains reviews of the contributions made by American chemists to the various branches of chemistry, and it is illustrated by photographs of those who have been officers of the Society during its fifty years' existence.

The present number, vol. 10, part i., of the *Annals of the Royal Botanic Gardens, Peradeniya*, also forms Section A (Botany) of the *Ceylon Journal of Science*. The *Annals* will thus appear in future in this new form but there will be no break in the series and no change editorially. The *Ceylon Journal of Science* has been established by the Ceylon Government, and in the first instance will consist of seven sections, namely, A, botany; B, zoology and geology (*Spolia Zeylonica*); C, fisheries (the *Bulletins of the Ceylon Fisheries*); D, medical science; E, mathematics, physics, and meteorology (including *Bulletins of the Colombo Observatory*); F, chemistry; G, archæology, ethnology, etc. Each section will be a separate publication with its own editor, appearing independently and with separate pagination.

The Royal Botanic Gardens, Kew, and the British Museum (Natural History) continue to issue excellent sets of coloured post-cards which form in many respects complementary series. Kew provides illustrations of striking plants in cultivation; the new series include stove and greenhouse plants, roses, orchids and decorative plants, and the cards show, often very beautifully, the characteristic habit of the plant, sometimes in its typical position in the garden, sometimes in its natural habitat. The British Museum cards are confined to British plants; they are more formal in character, but very clear, and add illustrations of characteristic floral features as revealed by dissection. Both series should help to disseminate more widely a knowledge of flowering plants, garden favourites as well as interesting native plants. The British Museum series includes two sets (each set contains five cards) illustrating British orchids.

Applications are invited for the following appointments, on or before the dates mentioned:—An organiser of agricultural education for the Administrative County of Cambridge—The Clerk of the County Council, County Hall, Cambridge (October 18). An assistant naturalist in the Fisheries Department of the Ministry of Agriculture and Fisheries—The Secretary of the Ministry, 10 Whitehall Place, S.W.1 (October 18). A junior technical officer in the Ignition and Electrical Department of the Royal Aircraft Establishment—The Superintendent, R.A.E., South Farnborough, Hants (October 23, quoting A. 126). A senior lecturer in economics in the University of Cape Town—The Secretary, Office of the High Commissioner for South Africa, Trafalgar Square, W.C.2 (October 30). A lecturer in the department of physics of Transvaal University College—The Registrar, Transvaal University College, Pretoria (October 31). Male investigators in industrial psychology, having had training in experimental psychology—The Secretary, National Institute of Industrial Psychology, 329 High Holborn, W.C.1. A lecturer in electrical distribution and an instructor in machine drawing at Goldsmiths' College—The Warden, Goldsmiths' College, New Cross, S.E.14. An assistant in the physiology department of the University of Edinburgh—The Professor of Physiology.

Our Astronomical Column.

MARS.—Mars is drawing near to opposition; it will be nearest to the earth (distance 42½ million miles) on Oct. 27, in North Declination 14° 52′. The distance will be 8 million miles greater than in 1924, but this is far more than offset for European observers by its being 32° farther north. Observations have already begun, but no results have yet been published.

M. E. M. Antoniadi gives in the August issue of *L'Astronomie* a new map of the planet, based chiefly on his own observations made with the great Meudon refractor between 1909 and 1924. He rejects the narrow rectilinear network of canals, and those shown on his map are represented as broad diffused shadings. A very large number of round dark markings (the *luci* of Lowell) are shown: there are six on the Lacus Solis, and five more on the bands connecting it with the neighbouring dusky regions. This region of the planet appears to be specially unstable, since the drawings at different oppositions show notable discordances. It should be specially scrutinised at present. M. Antoniadi gives an interesting drawing, made at the suggestion of the late M. Camille Flammarion, showing the aspect of the planet from Phobos, the inner satellite. The planet subtends an angle of 42° from Phobos, and consequently a zone 22° in radius at each pole of Mars is permanently hidden. Also only 136° of the equator is visible at once, and the centre of the disc is seen under a much larger scale than the edges, since it is 2000 miles nearer. These points have been carefully attended to in the drawing, which is very instructive. The planet would appear to rotate in the opposite direction to its real rotation, owing to the rapid orbital movement of Phobos; the terminator would move quicker than the markings in the ratio of three to two (about).

SUNSPOTS AND MAGNETIC STORMS.—The August number of the *Publications of the Astronomical Society of the Pacific* gives an abstract of a paper by S. B. Nicholson on "The Magnetic Classification of Sunspots associated with Terrestrial Magnetic Storms." The author, working from data collected at Mt. Wilson, states that the spots which synchronise with the occurrence of magnetic storms are usually those with complicated magnetic polarities, classified as γ or $\beta\gamma$. Moreover, in most cases where there is a large spot and no corresponding magnetic disturbance, the polarities of the spot or group of spots are generally found to be unipolar or bipolar with regularly distributed polarities. These are interesting results which promise to go far in explaining some of the anomalies met with in the study of these two phenomena, the general relationship of which is so well established.

As mentioned in NATURE last week (p. 459), a large group of sunspots crossed the sun's central meridian on September 19. Two days later a marked magnetic disturbance was registered by the Greenwich magnetographs. There was, however, no sudden commencement, characteristic of magnetic storms, but at the culmination of the disturbance at about 6 hr. on Sept. 21, the declination magnet was nearly 40′ from its normal position. At this time the centre of position of the two sunspots was 1·7 days or 22° west of the central meridian. It may be noted that the leader spot of the group, which approximated in type to those commonly found to be bipolar, showed considerable changes of structure suggestive of complicated magnetic polarities. The Mt. Wilson observations of the polarities of this group of spots may be expected to appear in the December number of the *Publications of the Astronomical Society of the Pacific*.

ABUNDANCE OF FIREBALLS.—Mr. Denning writes that between Sept. 12 and 20 as many as seven fireballs were observed from various parts of England. On Sept. 12 one was seen from Bristol in Lyra, shooting from a radiant at 290° + 54°. On Sept. 15 a meteor twice as bright as Jupiter was noted from Oswestry with path from 340° − 17° to 328° − 27½°. It left a bright streak for twenty minutes. On Sept. 17 a splendid object was visible from near Bristol, Sheringham, and Whitstable. It exhibited an exceptionally long course, for the observer at Sheringham saw it come up apparently from beyond the crest of the North Sea, while the one at Whitstable followed it until it disappeared on the horizon of the English Channel or Normandy in France. The path must have ranged over 600 or 700 miles; radiant on north-east by east horizon. On Sept. 18 a fireball was noticed in the eastern sky from Faversham, Kent, and on Sept. 20, at 1^h A.M. G.M.T., another was viewed from London, which the observer described as falling like "a large drop of molten metal." On Sept. 20, at $19^h\ 2^m$ G.M.T., a splendid meteor was seen from Weymouth; Bude, Cornwall; Bruton, Somerset; Downend, near Bristol, and other places. It emanated from a radiant at 60° + 36° and pursued a lengthy flight of about 320 miles from above the North Sea about 90 miles east of Bridlington to 25 miles south of Portland Bill in Dorset.

THE NORMAN LOCKYER OBSERVATORY.—The report of this Observatory for the year ended on March 31 last begins with a weather analysis which shows that the number of clear nights was 165, being 32 in excess of the preceding year.

The 12-inch prismatic camera on the Frank McClean telescope was used for obtaining stellar spectra for classification and parallax work. The classification is now automatic, being based on numerical measures of line intensities. The parallax work has been on the B stars; it is based on a revised classification of spectral type, combined with estimates of the width and character of lines. Several photographs of Mira Ceti were obtained near the maximum last December, when the magnitude was 3·1. The next maximum will be on Nov. 4, when the star will be nearly in opposition with the sun. This telescope was worked chiefly by Mr. Edwards.

The 9-inch prismatic camera on the Kensington telescope was worked by the Director, Dr. W. J. S. Lockyer. Special attention was given to stars with bright hydrogen lines. The interesting star ϕ Persei, of type Bope, was followed for an entire period, 110 photographs being secured on 79 nights between Sept. 9 and Jan. 13.

Prof. Sampson of Edinburgh has tested the method of producing widened spectra by using a clepsydra for moving the plate. He finds that the widened spectra are as trustworthy as the original ones and much more convenient for measurement.

Research Items.

Ancient Bronze from the Transvaal.—At the meeting of the South African Association for the Advancement of Science held at Pretoria in July last, Mr. Percy Wagner presented a communication on the making of bronze by the ancient inhabitants of the Transvaal, which is published in the *South African Mining and Engineering Journal* of July 26. Tin mining and smelting were practised by an unknown people in the Transvaal long before the advent of the whites. Some years ago a lump of bronze was found alongside a furnace on a farm, Blaauwbank No. 433, about 40 miles west of Warmbaths. The bronze was remarkable in that it included 3 per cent. nickel and 2 per cent. arsenic. Some regarded this bronze as an accidental product due to the reduction of a composite ore; but a recent discovery has placed it beyond question that the ancient miners deliberately set out to make bronze. Recently on the same farm, Blaauwbank No. 433, have been discovered near a dry watercourse, thirty distinct smelting furnaces, with hand-cobbed tin and copper ore alongside. 'Slugs' and 'frills' of bronze were found in the furnaces. In regard to the presence of nickel in the bronze, there is at Blaauwbank a nickel lode carrying at the outcrop masses of apple green 'nickel-bloom' which remotely resembles malachite. The accidental introduction of this material may have led to its continued inclusion intentionally when its special qualities had been appreciated. The point is one of considerable archæological interest, as it is stated that no other ancient mines are known that could have furnished in one locality the ores for producing a nickeliferous bronze, and a nickel-bronze was known and in use in early Mesopotamia and Egypt.

The Family 'Trinity.'—In *Man* for September, Prof. Radcliffe-Brown puts forward an interesting theory to account for the relations of father, mother, and child in the primitive family. It has been pointed out that the natives of Murua (New Guinea) regard the incidence of childbirth as in the nature of a welding of personalities—a trinity of father, mother, and child. But this same conception is found among a great many primitive peoples. In the Andamans, for example, the family does not really exist as a properly constituted group until the birth of the first child—the relationship between husband and wife is not simply created by marriage. It is illustrated by teknonymy, the custom whereby one of the spouses addresses the other as "mother of," "father of" the child. The imposition of a special taboo points in the same direction. It differentiates the family as a group. It is only the first child that counts, the later born children being regarded as multiples of a single personality. This principle operates also in the polygynous family, where either the wives are, like the children, multiples of a single personality, especially if they are sisters, or the husband is separated into a number of units, each with a wife and her children—the form typically taken by the polygynous family in Africa. The other method, however, may be adopted there also, when a man marries two sisters, or where a wife is childless and another wife is obtained to bear children. The same principle applies to polyandry, but only when the husbands are brothers.

The Tabanidæ of the Canadian Prairie.—The biology of the blood-sucking flies belonging to the family Tabanidæ forms the subject of a recent paper by Prof. A. E. Cameron in the *Bulletin of Entomological Research* for July 1926 (vol. 17, Part I.). Hitherto most of what is known concerning these insects in North America has emanated from the United States, and information concerning the Canadian forms is very meagre. The genus most abundant in species is Tabanus, its most prevalent member being *T. septentrionis*. Of the genus Hæmatopota there appears to be but a single representative, *H. americana*, while the most abundant species of Chrysops is *C. mœrens*. Previous to the settlement of western Canada, the principal hosts of Tabanidæ were the larger game animals. The moose, deer and elk are still to be found in the northern regions where the white settler has not penetrated, and, along with the barren-ground caribou, these animals are the chief native hosts of prairie Tabanidæ to-day. In cultivated districts they attack live-stock and human beings indiscriminately. The theory that Tabanidæ are the insect-transmitters of infectious anæmia of horses appears to be very uncertain and requires critical investigation, as the disease may be rife on one farm, while on adjacent farms, which enjoy apparently similar environment, the animals may be devoid of any symptoms of the complaint. Tabanidæ are well known to be strong fliers, and if they do convey the disease it would appear that not all horses are equally susceptible to infection. Prof. Cameron discusses the technique of rearing the larvæ of these insects, and describes and very clearly figures both the larvæ and pupæ of a number of species.

New Plant Illustrations.—In *Curtis's Botanical Magazine*, vol. 151, part iii., Dr. Stapf figures and describes nine new Asiatic plants now in cultivation, namely, *Actinidia kolomikta*, *Rhododendron saluenense*, *Jasminum Beesianum* (which bears beautiful glossy black berries in cultivation in England), *Polygonum campanulatum*, *Pyracantha atalantioides* figured in flower and *P. yunnanensis* in fruit, *Primula siamensis*, *Berberis lycioides* which has the additional attraction for the cultivator that its decorative 'barberries' make a delicious jam, and *Fritillaria Olivieri*. In addition, a Spiranthes is described from the Argentine, a beautiful Cordyline from New Zealand, a Mammillaria from Mexico and a Mesembrianthemum from South Africa, but this distribution of the new records of cultivated plants shows the preponderating influence of new introductions from Asia in our gardens at present.

Burr-Knots on Apple and Crown Gall.—Certain varieties of apples have on their stems, generally at nodes, tumour-like swellings which sooner or later pass over into a crowded mass of wart-like projections. Some of the apple stocks most frequently used in England bear these 'burr knots,' and such stocks have been forbidden entry into the United States under the assumption that these structures were a form of a pathological condition known as 'hairy-root,' which has been found to be associated with the crown-gall organism *Bacterium tumefaciens*. Probably all British workers will, however, endorse the conclusions of R. G. Hutton, H. Wormald and A. W. Witt, in the *Journal of Pomology and Horticultural Science* (vol. 5, No. 3, July 1926), that these structures indicate the position of dormant, stem-borne root initials, and that if placed under moist conditions they will readily give rise to roots. One American worker, C. F. Swingle, has recently published a similar view, and the British workers publish a useful bibliography of earlier references to these structures, which, however, omits the important paper by Dr. A. W.

Borthwick (*Notes from Royal Bot. Gard., Edinburgh*, vol. 16, 1905), in which valuable anatomical data are supplied. Dr. Borthwick's paper supplied practically conclusive evidence that these structures were really root initials, but in view of the American point of view, it is good to have this later confirmation that all attempts to isolate a pathogenic organism from burr-knots have given negative results.

STATISTICS OF FIELD EXPERIMENTS IN AGRICULTURE.—The growing importance of field experiments in agriculture has led to the development of technique for eliminating errors of experimentation, and R. A. Fisher (*Journ. Minis. Agric.* 33) has investigated statistically the relative value of different methods of arranging field plots. A valid estimate of error can be obtained by finding the standard error, the square root of the variance, and a method of replication has been devised whereby this estimate can be obtained from the actual yields of the trial year. Great care is necessary that the arrangement of unlike plots shall be such as to provide a valid estimate of error, and a random arrangement appears to be the most suitable. For simple trials in which every possible comparison is of equal importance, the Latin square provides the most efficient arrangement, one Latin square being selected at random out of the total number possible. For more complex experiments in which comparisons involving single factors—*e.g.* with and without phosphate—are required, replication of randomised blocks is necessary in order that no possible interaction of the factors may be disregarded. With this method the conclusions drawn from the single-factor comparisons will be given, by the variation of non-essential conditions, a very much wider inductive basis than could be obtained by simpler methods without extensive repetitions of the experiment.

GRAVITY DETERMINATIONS AT SEA.—In 1923 Dr. F. A. Vening Meinesz made a submarine voyage from Holland to Java by way of the Mediterranean and the Indian Ocean. Gravity observations were made at thirty-one points, and the results of their isostatic reduction (carried out by the U.S. Coast and Geodetic Survey) were presented at the recent annual meeting of the American Geophysical Union. The average anomaly for all the stations with regard to sign is 0·012 dyne by the Bowie formula. It is of special interest that for ten stations in the Indian Ocean far from land the average anomaly is 0·009. Thus isostatic equilibrium beneath the Indian Ocean is as perfect as it is under the continental regions that have so far been investigated. Dr. Meinesz made additional submarine observations between Holland and Port Said in 1925, and these are now being reduced in America. At present Dr. Meinesz is continuing his work in a submarine voyage to Java via the Atlantic, the Panama Canal and the Pacific. Special attention is being devoted to the continental shelves and the oceanic deeps.

MAGNETIC SURVEY OF FRANCE.—An account of the latest magnetic survey of France, begun in 1921, is given by A. Baldit in *La Nature*, August 21, 1926; it is hoped to complete the survey this year. Earlier surveys of France were made by Lamont (in 1856–7, with 44 stations), Perry (33 stations, 1868–9), Marie-Davy (20 stations, 1875), and Moureaux. The latter made two surveys, one including 80 stations (1884–1885), the second, extending over eight years, 1888–95, being much more detailed, and including 617 stations. In regard to the density of the network of stations, the latter was the first survey of France approaching modern standards for a civilised country. It revealed many hitherto unexpected irregularities in the isomagnetic lines, some of which could be correlated with geological features of the country. The present survey is still more detailed, being intended to include 1440 stations; these are not uniformly distributed, being specially dense where the magnetic features of the country are of particular interest. Six observers have been engaged in the work since 1922. The instruments used are not new, and are of standard type, the magnetometer being of Mascart's design, and the inclinometer of d'Abbadie's. The accuracy anticipated is to 1′-2′ for declination, 2′ in dip, and about 20 γ in horizontal force. The period of the survey is one of magnetic calm, and the accidental errors due to disturbance are therefore minimised.

ATLANTIC OCEANOGRAPHY.—A summary of the important oceanographical work of the German *Meteor* expedition of 1925 is given by Dr. H. R. Mill in the *Geographical Journal* for July. The object of the expedition was to survey the ocean depths, including physical and chemical work, of the South Atlantic between lat. 20° S. and the Antarctic circle. The most important work began in June 1925 with the first cross-section of the Atlantic along the parallel of 40° S. from South America to Africa. Profile II. was westward along the parallel of 29° S. Profile III. was eastward on the parallel of 48° S. Then followed Profile IV. westward along the 35th parallel, and Profile V. eastward along the 55th parallel with a dip southward to lat. 64° S., where a sounding of 4380 fathoms was obtained somewhere to the east of South Georgia—the exact position is not yet published. Finally Profile VI. was run west along the Tropic of Capricon. Echo soundings were checked from time to time with wire soundings. Bottom samples, serial temperatures, and salinity observations were taken throughout the voyage. The upper air was investigated with kites and pilot balloons. The full results of this expedition will throw much light on oceanographical problems in the Southern Ocean.

ELECTRIC LAMP FIRE-DAMP DETECTOR.—It is nearly fifty years since Mr. E. H. Liveing first designed a method for measuring fire-damp in mines by sending an electric current through two spirals of platinum wire over one of which the mine air was passed: the increased luminosity produced by the combustion of the methane-air mixture on the heated wire gave a measure of the methane present in the air. The apparatus in skilful hands would certainly measure fire-damp, but its value lay rather in its promise than its practical utility. The Liveing principle has been the foundation on which many inventors have built, and has lately been embodied in the electric-lamp detector of Messrs. C. S. W. Grice and A. G. Gulliford. In the new detector the current of the lamp accumulator can be switched through a small length of fine platinum wire in a chamber to which the mine air has access through a wire mesh. The length of fine wire—3 mm.—between its metal clamps is so adjusted that the wire fuses when the methane reaches 3 per cent. of the atmosphere: below this percentage the wire glows brightly and indicates the presence of gas. It is evident that the utility of the invention will depend on how far the conductivity of the wire and the voltage of the accumulator can be maintained constant under working conditions.

SWEDISH RAINFALL.—In the note in NATURE of August 28, p. 318, on the Swedish rainfall statistics for 1925, the fact was overlooked that the means for each month and for the year are compared with the figures for 1925, which adds to the value of the volume.

The Alloys of Aluminium and Silicon.

THE very great interest at present being taken in the aluminium alloys containing from about 10 per cent. to 13 per cent. of silicon, is shown by the fact that no less than three of the papers presented to the Institute of Metals at the recent meeting at Liège dealt with this material.

Both from the practical point of view, regarding the material as one of considerable promise for the production of light alloy castings, and from the theoretical, these alloys are of more than usual interest. It has been known for some time that the structure may be greatly affected by the addition to the molten metal of small amounts of various 'modifying' reagents. Many theories concerning the reason for this change of structure have been propounded, but, hitherto, no completely satisfactory hypothesis has been available. Figs. 1 and 2, reproduced by courtesy of the Institute of Metals, illustrate the change in structure of the 10 per cent. alloy brought about by the addition, at 750° C., of 5 per cent. of sodium hydroxide. Fig. 1 represents the material in the ordinary chill cast state, and Fig. 2 the same after the 'modifying' treatment. The mechanical properties also are greatly improved when the alloy possesses the second type of structure.

FIG. 1.—9·86 per cent. Si, 0·45 per cent. Fe. Chill cast. Unetched. ×200.

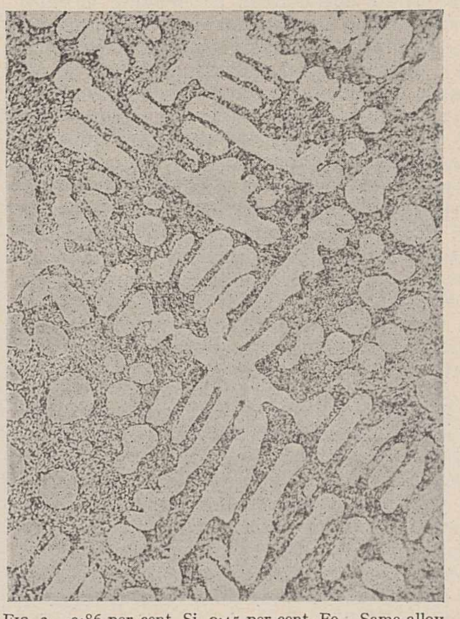

FIG. 2.—9·86 per cent. Si, 0·45 per cent. Fe. Same alloy as Fig. 1, but modified with 5 per cent. NaOH at 750° C. Chill cast. Etch HF. ×200.

Of the three papers now before us, that by Dr. A. G. C. Gwyer and Mr. H. W. L. Phillips (with an appendix by Dr. Stockdale and Mr. I. Wilkinson which is concerned with the mechanical properties of the alloys) is the most important. The properties of the material in the 'normal' condition are not very remarkable, but the addition of a small amount of a suitable metal or salt to the melt before it is poured endows the casting with far superior strength and ductility.

In the normal state these alloys consist of a simple eutectiferous system, with small limits of solid solubility at each end. The thermal-equilibrium diagram has been redetermined, and the eutectic point placed at 11·7 per cent. of silicon and at a temperature of 577° C. After 'modificatior' the eutectic contains an appreciably greater amount of silicon and is formed at a lower temperature, both the composition and the temperature being dependent on the rate of cooling and the treatment of the metal. Further, when the molten metal is stirred or remelted after 'modification,' or left in the molten state for an undue length of time after the addition of the modifying material, the normal structure and properties are obtained.

There are clear indications, therefore, that the 'modified' metal is in an unstable state. The authors mentioned now offer a new explanation of their own, which appears to approach far more nearly to the truth than anything which has yet been suggested.

This theory may be briefly stated as follows: When the aluminium-silicon alloy is raised to a temperature considerably higher than its melting point, it is probable that the silicon and aluminium are in true solution. When solid the greater portion of the silicon is present, dispersed in crystals of a size readily visible under the microscope. A small quantity, of the order of 0·5 per cent. at room temperature, remains in solid solution in the aluminium, but this may be disregarded at the moment. In solidifying, the silicon and aluminium pass from atomic dispersion to the crystalline form. At some stage during the process, therefore, the silicon and aluminium aggregates will be of colloidal dimensions. It is well known that the colloidal state is an unstable one, and that colloid particles tend to coalesce. Their rate of growth may be accelerated or diminished by the addition of protective agents.

Having regard to all the facts which have come to light, it appears to the authors that the most satisfactory explanation of the behaviour of 'modifying agents' is to assume that they function as colloid protectors. They do not, of course, confer complete protection upon the colloidal silicon and aluminium, but simply retard their aggregation. From the changes in the crystalline form of the constituents brought about by the process of 'modification,' it is probable that the protector itself is a colloid. It does not, however, appear that the assumption is justified that when sodium compounds are used for 'modifying,' the protector is necessarily metallic sodium. As a result of this action, the formation of the normal eutectic is inhibited, and aluminium continues to be precipitated from the metal until the super-solubility line is reached.

It is also shown that the protection of the modified structure can be obtained without the use of the ordinary reagents provided that the rate of cooling is sufficiently rapid.

From the theory that certain substances hinder the aggregation of the colloid particles, it should be possible to discover also other substances capable of accelerating this aggregation. The compound $FeAl_3$ is such a substance, and it has been experimentally substantiated that the presence of iron in melts of these silicon-aluminium alloys is detrimental.

A diagram has been drawn up for the 'modified' alloys indicating the manner in which under-cooling alters the normal process of solidification. The amount of the substances added to effect the 'modification' has been considered, and with sodium hydroxide, and for an alloy of about 12 per cent. of silicon, it is put at about 5 per cent. of the weight of the metal. Excess results in a deterioration of the mechanical properties.

The time which is allowed to elapse between the addition of the castings is also of importance, and, for the usual composition of alloy, should be about half an hour.

Since the general theory propounded is independent of any special constituent, it should be sufficiently general to apply to systems other than that immediately under consideration. This is shown to be the case, and exactly analogous results have been obtained in the systems copper-aluminium, aluminium-nickel, aluminium-manganese, lead-antimony, and copper-antimony.

The importance of the colloidal state in alloys at the moment of solidification, and of under-cooling, is thus shown to be far greater than has hitherto been generally appreciated. F. C. T.

The Twelfth International Physiological Congress in Stockholm.

EACH international congress, as a rule, discloses some special interest in one or another field of physiological science, as well as serving as a sure guide to the virility of the science in general. Contrasted with the last congress, held three years ago in Edinburgh, the present congress had no one central interest comparable to that excited by the isolation of insulin, but the fine attendance of the foremost representatives, with a considerable number of the younger workers, from all the continental European countries, was a welcome evidence of the general recovery of physiology from the devastating effects of the War, and of the steady and persistent advance in almost every branch of this science.

The congress in Stockholm was as beautifully arranged as in Edinburgh, and as regards the welcome and hospitality offered there is no need to say more than that it could not have been bettered. The scientific programme of the congress opened with an address by Sir Frederick Gowland Hopkins on "The Mechanisms of Biological Oxidations," in which he outlined the position attained by workers in this field, with especial reference to the work done in his own laboratory at Cambridge.

The routine work of the congress was divided into four sections which were grouped according to subjects, facilitating the attendance by each member at the discussions on those papers in which he was particularly interested.

Great interest was aroused by a number of papers dealing with the fundamental processes of life, as, for example, the communications of the recent important researches of Adrian upon the afferent impulses conducted by the single nerve fibre, and of Hill and Downing upon the measurement of heat production in nerve. An interesting summary was given by Kato (Tokyo) of his theory of decrementless conduction in the narcotised region of nerve, in which, as is well known, he is opposed to the findings of Keith Lucas and Adrian. The problem was the subject of a lively debate, and is probably now near to solution. Muscle physiology was represented by Embden, by Hill, and by Meyerhof.

Another point of great interest was the question with regard to tissue metabolism, mainly represented by Dale's school, in relation to insulin and to such problems as the development of rigor.

In the realm of the central nervous system, an interesting communication was made by Samojloff (Kasan) upon the nature of spinal inhibition. His experiments tend to support the theory of a liberation of some chemical substance affecting the synopses or the cellular structures in the spinal cord. Magnus (Utrecht) made a further contribution to the subject of local and segmental reflexes in the decerebrated animal.

Metabolism was represented by Lusk and Benedict, Boothby, Knoop, Mendel, Noyons, and de Barenne. A noteworthy tendency lay in the simplification of technique, and the applicability of the new methods to clinical practice. A summary was given by Mann (Rochester, Minn.) of his work on the dehepatised animal. Interest in the question of vitamins seems recently to have diminished, very few communications being made.

The study of digestion has now definitely shifted out of the hands of Pavlov's school to America, from whence the pupils of Carlsson, and particularly Ivy, brought communications dealing with the phases of gastric and pancreatic secretion.

Circulation was represented from America by Wiggers (Cleveland), who discussed the fractionate nature of ventricular contraction. The British school was represented by Anrep, who gave papers upon the central and reflex regulation of the coronary circulation (mainly in regard to the innervation of the coronary blood vessels), and upon the electrical measurement of coronary circulation during the single cardiac cycle. Heymans (Ghent) communicated the results obtained with his method of cerebral perfusion as applied to the study of the respiratory and cardio-inhibitory centres. Frédéricq (Liège) summarised the results of his recent work upon chronaxie, especially in relation to the influence of the vagus and sympathetic cardiac nerves.

Prof. Loewi (Graz), in one of the most interesting papers of the congress, gave an account of the various factors affecting the rate of destruction of the chemical substance determining the inhibitory action of the vagus upon the heart. The work of this school would seem to bring us one step nearer to comprehension of the ultimate mechanism of peripheral inhibition.

An important contribution to the problem of hæmophilia was made by Howell (Baltimore), who brings evidence that the determining factor in this condition lies in an unusual stability of the blood platelets. In a second communication, Howell discussed the chemical nature of the anti-coagulant substance heparin, which is so largely and successfully replacing hirudin in the experimental laboratories of the United States and Great Britain.

With regard to the chemistry of blood, Nicloux (Strasbourg), although unfortunately unable to be present in person, contributed a new spectroscopic method for the determination of small quantities of carbon monoxide in gas mixtures, applying his method to the determination of minimal quantities of it in blood. In a further paper this author presented a new determination of the oxygen content of methæmoglobin, fixing it at half the oxygen content of oxyhæmoglobin of the same blood.

In the present congress demonstrations played what might perhaps be called a secondary part. Many, such as those of Adrian, Kato, and Hill, were in demonstration of communications. Especially interesting in this group was a demonstration by Brinkman (Groningen) of his method of registering the attainment of *p*H equilibrium in H_2CO_3-bicarbonate buffer solutions. Barcroft gave a summary of his recent work on the spleen, supplemented by a demonstration. This seems, at last, to find some definite and important physiological function for an organ which has baffled physiological thought for centuries. Lim (Peking) gave a demonstration of a dog with transplanted stomach. Of especial interest also was a demonstration by Y. Henderson (New Haven) of his method of measuring the circulation by inhalation of ethyl iodide. This seems to be the simplest and most tangible method up to the present, and most probably will find a great future application.

America, as in eleven successive congresses previously, sent a strong contingent of workers, and as was only as fair as it was unanimous, the twelfth congress accepted the invitation of the American Physiological Society that the thirteenth congress be held in America in 1929.

It is, perhaps, of especial interest to mention also the good attendance from Russia, showing that the worst period in that country is approaching an end. Dr. Orbeli (Leningrad), who was present, did not, unfortunately, submit any summary of the results of his experiments upon the sympathetic innervation of voluntary muscle, a problem on which we know him to have been engaged for several years. Prof. I. P. Pavlov, the *doyen* of the congress, showed no sign of diminished activity in spite of his advancing years. There were no communications from his laboratory, although he informs us that a full description of his work on the cerebral cortex is being published in English towards the end of the present year.

The thanks and appreciation of all the members of the congress to their colleagues and hosts in Sweden was expressed by Profs. Gley, von Frey, and Starling at the final meeting of the congress at Upsala, and also previously and more lightly by the same representative speakers at the banquet given to the members of the congress by the City of Stockholm.

The Geological Search for Oil.

ONCE more the ubiquitous problem of the origin of petroleum is forced on our attention, this time as a practical matter rather than as a philosophical thesis. Dr. Murray Stuart writes a paper in the recent issue of the *Journal of the Institution of Petroleum Technologists* in which 'working hypotheses' in the geologist's search for oil form the main theme, the principal argument being that all exploration for petroleum is handicapped at the outset by the fact that little, if anything, is known concerning its origin. We appreciate the laws governing migration and accumulation of oil; we contemplate favourable geologic structures, providing the strata involved are oil-bearing, which are located with remarkable precision; but unless the oil manifests itself by seepage or in some indirect manner, there is little to guide the search. To this extent, it may be noted, the geology of petroleum differs from the geology of, for example, metalliferous ore deposits.

One of the earliest and best known working hypotheses in oil-geology is that attributable to David White, whereby the degree of progressive devolatilisation (or metamorphism) of coal is interpreted as a measure of the chances of obtaining oil or gas in commercial quantity in associated deposits, the percentage of fixed carbon (pure coal basis) being the determining factor. White's law has found ample vindication in the West Virginia oil-fields, but it is not of universal application, as pointed out by Wade in a recent paper on "The Search for Oil in Australia"; the author, however, seeks to amend the law to the extent of excluding the idea of subsequent 'metamorphism' in favour of carbon ratio variation being interpretable in terms of normal processes of sedimentary deposition. He visualises his carbonaceous material as part of a sheet of sediment in which transition from conglomerate ". . . through sand and shale to oil-bearing shale, . . . through something equivalent to Torbanite into more or less pure carbonaceous material . . ." is perceptible; carbon ratio variations are thus functions of original influences (mother-substance, environment, etc.), not of subsequent change in the course of geologic time. From this point of view is deduced the hypothesis that, assuming the carbon ratio of a fresh-water or estuarine coal seam to be favourable (*i.e.* 50 to 55), the seam will probably pass through torbanite into oil shale when traced in the direction from which the material composing the seam was initially derived. In the case of coals deposited under marine conditions, lateral variation into petroleum or into oil-shale (depending on the nature of the organic material incorporated in the sediment) is probable. A further hypothesis states that ". . . when formations containing abundant fossil-wood occur the underlying marine formations may contain liquid petroleum," and has been reasoned by the author in previously published papers.

The occurrence of oil in dolomitised limestones of lagoon formation furnishes the author with a contrasted, though in some respects parallel, line of argument; he examines this environment from a biochemical point of view, directing attention to the rôle of foraminifera and other protozoa, and also bacteria, in promoting essential mother-substance, whence he formulates the hypothesis that "all dolomitised limestones of lagoon formation are worthy of thorough investigation, provided that they prove, on microscopic examination, to be foraminiferal."

What we may term the 'coal-to-conglomerate' hypothesis of the author raises problems at least as controversial as those of the origin of petroleum itself, though there is considerable novelty, if not practical import, in the views he puts forward. For the "many examples known in the world of coal seams and lignite seams passing laterally into either oil-shales or oil deposits" there are as many in which no coal-oil association is apparent. The tracing of a coal seam into an oil-shale seam in existing economic circumstances would be little reward to the geologist bent on locating commercial oil-pools; but the chances of lateral variation from coal to petroleum would seem, according to the author's reasoning, to be somewhat localised. On the other hand, where coal, lignite, or torbanite is in evidence in deposits suspected or proved to contain oil, the hypothesis clearly merits the test: only by this method and in several different cases will its validity, hence its practical value, be established.

University and Educational Intelligence.

CAMBRIDGE.—The John Winbolt Prize has been awarded to H. Bateman, Trinity College, and R. J. Smith, St. John's College, for a joint dissertation on a theoretical investigation of some elastic problems in thin rectangular plates.

EDINBURGH.—In the Royal Botanic Garden, on Tuesday, September 21, the Right Hon. Sir Herbert Maxwell unveiled a tablet to the memory of the late Sir Isaac Bayley Balfour, who was Regius Keeper of the Garden from 1888 until 1922.

THE Wigan and District Mining and Technical College sends us a Calendar giving, in 142 pages, particulars of courses, some of them leading up to the final degree examinations of the University of London, in mining, mechanical and electrical engineering, chemistry, physics, mathematics, building trades, cotton technology, commerce, art, and art crafts. In 1925 six students obtained University of London degrees. Among other specialities is a two-years' Post Office engineering course.

THE London School of Economics and Political Science announces in its summary programme for 1926–27 a series of important public lectures by eminent authorities, open to the public without fee or ticket. These include, in addition to single lectures by Profs. Laski and de Paula and Mr. William Cash, a series of three by Prof. Toynbee on international history since the War, six by Prof. Salvemini on Italian communes in the thirteenth century, ten on office machinery, and twelve on accounting in public offices.

THE Battersea Polytechnic's prospeetuses for 1926–27 offer full day and evening courses in preparation for the University of London's intermediate and final degree examinations in science, engineering, and music. In consultation with the Incorporated National Association of British and Irish Millers, the London Flour Millers' Association, and the Board of Education, a two-year day course in science and engineering with special reference to the flour milling industry has been organised. Courses for health visitors and sanitary inspectors and in arts and crafts are provided. A separate prospectus deals with the Polytechnic's Domestic Science Training College. Another of London's Technical Colleges from which we have lately received a prospectus is the Cordwainers'. This provides both day and evening courses in the technology of boot and shoe manufacture and leather goods manufacture.

THE East London College announces in its calendar for 1926–27 the institution of a fund for the encouragement of original investigation by the staff and students, and an important addition to its resources for such purposes in the form of a bequest by the late Sir Sidney Lee of 5000*l.* for bursaries for post-graduation work in English literature. Three research studentships of the value of 50*l.* each for one year are awardable annually in July to students completing a three-years' course at the College. Special and advanced lectures announced include: a course of six on short electric waves in wireless, by J. H. Morrell, and six (for graduates) on biology of fresh-water algæ, by Prof. Fritch and Dr. Carter. In its recently constituted department of dramatic study and research there will be a weekly seminar for collective work on a dictionary of British drama. In aeronautical engineering a three-years' course is arranged, and students attending the last two years of this are able to take aeronautics instead of hydraulics in the new subject, 'Mechanics of Fluids,' in the B.Sc. (Engineering) degree examination. The College Council has recently purchased the freehold of a house in South Woodford for use as a hall of residence for men students. One for women students on the borders of Epping Forest with accommodation for thirty-two has already been opened.

THE Northern Polytechnic, Holloway (formerly Northern Polytechnic Institute), gives, in its prospectus for 1926–27, particulars of its important Department of Chemistry and Rubber Technology. It is the only institution listed under the heading of rubber technology in the Universities Bureau's summary of specialist studies in the universities and university colleges of Great Britain and Ireland. The courses are carried on in collaboration with the Institution of the Rubber Industry and provide suitable preparation for students proposing to enter for the examinations for the associate diplomas (A.I.R.I.) awarded by that body. An influential committee, representative of all sections of the industry, co-operates with the governors, and the workshops contain a full range of modern experimental rubber-plant. In addition to the advanced courses there is a Rubber Trades School, for boys of 14 or 15 years of age. The technical chemistry three-years' courses are designed for prospective analytical and works chemists. They include chemical technology, glass-working, chemical engineering, and (a two-years' course) plumbing. A series of important special public lectures have been arranged for the coming session, beginning with one by Raymond Unwin on October 14 on town planning.

THE Municipal College of Technology, Manchester, has resumed publication of its *Journal*. Volume 12, just issued, records investigations undertaken by members of the College between 1919 and 1924. It contains original articles on: losses in resistance connectors in single-phase commutating motors (Miles Walker), the discharging capacity of side weirs (G. S. Coleman and Dempster Smith), the aromatic character of the glyoxaline nucleus (F. L. Pyman), ferrous materials and corrosion (E. L. Rhead), values of the smallest zeros of harmonic functions (J. Prescott and H. V. Lowry), a null method for ionisation potentials (L. S. Palmer and W. Hubball), and a direct-reading refractometer (A. Adamson). The prospectus of the College for 1926–27 shows that since 1919–20 from ten to thirteen research scholarships have been awarded by it each year. The scholarships are open to graduates of any university in the British Empire and other persons possessing special qualifications for research. In awarding three of them, preference is given to Manchester ratepayers and their sons and daughters. Courses of advanced study and research are offered in mechanical, electrical, municipal, and sanitary engineering (including sea outfall and coast defence works), applied chemistry (including textile fibres, paper manufacture, metallurgy, rubber, brewing and allied industries, coal tar and dyestuffs, photography and photographic processes), textile industries, applied physics, and mining engineering.

Contemporary Birthdays.

October 5, 1861. Sir Thomas L. Heath, K.C.B., K.C.V.O., F.R.S.
October 7, 1842. Sir Philip Magnus, Bart.
October 8, 1850. Prof. Henry Louis le Chatelier, For. Mem. R.S.
October 8, 1857. Sir Richard C. Garton, G.B.E.
October 9, 1879. Prof Max T. F. von Laue.
October 9, 1863. Prof. Albert Charles Seward, F.R.S.

Sir THOMAS HEATH, who was born in Lincolnshire, was educated at Caister Grammar School and Clifton College, passing thence to Trinity College, Cambridge, where he graduated 12th wrangler, whilst also acquiring distinction in classical studies. Entering the public service, he was early attached to H.M. Treasury, fulfilling successively the highest offices. Since 1919 he has been Comptroller-General, National Debt Office. Among many dissertations and works, he is the author of "A History of Greek Mathematics" (2 vols., 1921). Sir Thomas is an honorary fellow of Trinity College, Cambridge, and Hon. D.Sc. Oxford.

Sir PHILIP MAGNUS, to whom very hearty congratulations are due on the approaching anniversary of his eighty-fourth birthday, was educated at University College School, graduating thence at the University of London. Organising director and secretary of the City and Guilds of London Institute from 1880 until 1888, he was afterwards and for nearly thirty years the able and zealous secretary of its Technology Department.

Prof. LE CHATELIER'S name is associated with important discoveries in several branches of chemistry. In conjunction with Mallard he conducted elaborate investigations on the ignition and explosion of gaseous mixtures, in which principles of fundamental importance were established. His thermo-electric couple inaugurated a new period in the measurement of high temperatures. One of the pioneers of micro-metallurgy, he was among the first to introduce exact methods into the science of industrial silicates. Prof. le Chatelier was elected a foreign member of the Royal Society in 1913, and allotted the distinction of its Davy medal in 1916, in respect of his eminence as a chemist.

Sir RICHARD GARTON was educated at Owens College, Manchester, and the University of Marburg. As honorary secretary of the British Empire Cancer Campaign he has carried out work of widespread importance.

Prof. MAX VON LAUE, Nobel laureate, 1915, was born at Pfaffendorf, near Coblentz. His studies were conducted at the Universities of Strasbourg, Munich and Berlin. In 1912 he occupied a chair in the University of Zurich, and was afterwards at Frankfort. Since 1919 he has been professor of theoretical physics in the University of Berlin. Prof. Max von Laue was allotted the Nobel prize in physics for 1915, for his discovery of the diffraction of Röntgen rays in crystals.

Prof. SEWARD, Master of Downing College, Cambridge, professor of botany in and vice-chancellor of the University, was educated at Lancaster Grammar School and St. John's College, Cambridge. The Royal Society awarded Prof. Seward a Royal Medal last year for his fruitful studies in palæobotany, which have proved of direct stratigraphical value to geologists, enabling the principles and facts of one science to aid, and even solve, the problems of another.

Societies and Academies.

PARIS.

Academy of Sciences, August 30.—**Bigourdan**: The regularity of the diurnal movement and the possibility of verifying it by means of observatory clocks (see also NATURE, September 18, p. 425).—Boris **Delaunay**: The theory of parallelohedra.—G. **Polya**: The linear functional operations exchangeable with the derivation and the zeros of the sums of exponentials.—Mlle. N. **Bary**: The analytical representation of a class of continuous functions.—A. **Kovanko**: The integration of suites of functions capable of summation.—Kyrille **Popoff**: The convergence of series and celestial mechanics.—**Krawtchouk**: The method of N. Kriloff for the approximate integration of the equations of mathematical physics.—N. **Bogoliouboff** and N. **Kriloff**: The justification of Rayleigh's principle by the order of the error committed at the *n*th approximation.—Jacques **Bourcart**: An attempt at the morphological interpretation of the Bouches de Cattaro.—Lucien **Daniel**: Researches on the grafting of garlic and cabbage.—Antonin **Němec**: Chemical methods for determining if agricultural soils are in need of nitrogenous or potash manures. Details of the analytical methods and limits of nitrate and potash suitable for sugar beet, barley, and oats.—Raymond **Hamet**: The inversion of the normal action of adrenaline.—E. **Ducloux** and Mlle. G. **Cordier**: The virus of sheep scab treated with various aldehydes.

CAPE TOWN.

Royal Society of South Africa, August 18.—L. P. **Bosman**: The nature of the co-enzyme of lipase. The lipase extract (from sheep's pancreas) is dialysed against distilled water and the lipolytic actions of the dialysate and the 'inside' liquid on ethyl butyrate are studied. The inside liquid loses approximately 50 per cent. of its hydrolytic power. The dialysate, while having no hydrolytic power, when coupled with the inside liquid, restores the lipolytic power of the original extract. The dialysate was investigated and the so-called co-enzyme was found to be inorganic salts.—W. **Rose** and J. **Hewitt**: Description of a new species of Xenopus from the Cape Flats. The new species, *Xenopus gilli*, differs from *X. laevis* in that tentacles are not apparent and that there is in the mouth an organ which is either a posteriorly attached tongue or a deflated air-sac.—J. H. **Power**: Notes on the habits and life histories of South African Anura with descriptions of the tadpoles.—C. von **Bonde**: The vascular system of the Plagiostomi, with special reference to the common dogfish (*Squalus acutipinnis*, Regan). The author has previously worked out the morphology of the vascular system of the South African dogfish *S. acutipinnis* and it is now compared with the structure typical of the Plagiostomi in general. The absence of vascular loops round the gill-arches together with the absence of a precardiac extension of the dorsal aorta presents an interesting feature. The arterial circulation of the cephalic region also shows a distinctive difference from the normal distribution of the carotid arteries in the Plagiostomi.—Neville S. **Pillans**: The African genera and species of Restionaceae.—H. G. **Fourcade**: A new method of aerial surveying.

ROME.

Royal National Academy of the Lincei: Communications received during the holidays.—T. **Levi-Civita**: Einsteinian motions in second approximation.—Ferruccio **Zambonini** and S. **Restaino**: Double sulphates of the rare earth and alkali metals (vi.). Cerous potassium sulphates. In addition to the double salts already described, this system forms the compound, $Ce_2(SO_4)_3$, 4·5 K_2SO_4, which is stable in the presence of solutions containing from about 5 per cent. to 1·2 per cent. of potassium sulphate.—G. **Bruni** and A. **Ferrari**: Crystalline structure of certain bivalent chlorides. Anhydrous magnesium, manganous and cadmium chlorides are found to be of rhombohedric structure with the respective axial ratios, 2·45, 2·34, and 2·20. Zinc chloride appears to exhibit a rhombohedric or hexagonal structure, the dimensions of its structure indicating its structural similarity to magnesium chloride.—Silvio **Minetti**: Investigation of the singularity of $f(z)=\sum_{n=0}^{n=\infty} a_n z^n$, where $a_n=g(n)$ for n a positive integer with $g(n)$ wholly transcendental.—Mauro **Picone**: The isolated singularity of harmonic functions in two or more variables.—Oscar **Zariski**: Conformable representation of the area bounded by a lemniscate on a circle.—Luigi **Fantappié**: The polydromy of linear analytic functionals.—A. M. **Bedarida**: A new rectilinear congruency.—Harry **Levy**: Einsteinian motions of a disgregate medium with spherical symmetry.—Arnaldo **Belluigi**: Evaluation of the damping in seismographic pendulums.—Rita **Brunetti**: Theory of the polarisation of independent X-rays.—G. **Natta** and A. **Reina**: Oxides and hydroxides of cobalt: Crystalline structure of cobaltous oxide and hydroxide. The results of X-ray analysis show that cobaltous oxide belongs crystallographically to the monometric system and has an elementary cell of side a 4·22 Å.U. of the sodium chloride type, containing four molecules. The precipitated and crystalline forms of cobaltous hydroxides are structurally identical and are of the uniaxial rhombohedric type.—Raoul **Poggi** and Angiolo **Polverini**: Destruction of filter-paper by alternate oxidising agents applied to quantitative analysis.—Adolfo **Quilico**: Röntgenographic investigation of metallic hydrides: copper hydrides. The so-called hydrides obtained by reducing cupric oxide by means of hydrogen prove to be either pure copper or copper containing occluded hydrogen in proportion insufficient to modify appreciably the crystal lattice. The products formed in the reaction between hypophosphorous acid and copper sulphate vary with the temperature employed and consist either of amorphous copper containing occluded hydrogen or of a mixture of this with cuprous oxide.—C. **Sandonnini**: Heats of mixing of water with acetic acid and with isopropyl alcohol.—Emanuale **Quercigh**: The nature of stibiobismuthinite. This mineral, found in Nacozari, Mexico, consists of an isomorphous mixture of bismuthinite and antimonite, with or without inclusions of sulphur.—C. **Acqua**: The virus of the polyhedry of the silkworm in relation to modern theories on the filterable virus.

Official Publications Received.

Canada. Department of Mines: Geological Survey. Memoir 148, No. 129 Geological Series: Geology and Mineral Deposits of Windermere Map-area, British Columbia. By J. F. Walker. (No. 2088.) Pp. 69. 20 cents. Summary Report, 1924, Part C. (No. 2091.) Pp. 268C. (Ottawa: F. A. Acland.)

Education Committee for the County Borough of Brighton. Technical College, Richmond Terrace, Brighton. Day Courses, Session 1926–27. Pp. 79+9 plates. Evening Courses, Session 1926–27. Pp. 48. (Brighton.)

Almanach České Akademie věd a umění. Ročník 35. Pp. 240. (Praze.)

Académie Tchèque des Sciences (Česká Akademie věd a umění). Bulletin International: Résumés des travaux présentés. Classe des sciences mathématiques, naturelles et de la médecine. 23e année (1923). Pp. 5+266. 25e année (1925). Pp. iv+385. (Prague.)

Premier Congrès International pour la Protection de la Nature, Faune et Flore, Sites et Monuments Naturels (Paris, 31 mai–2 juin, 1923). Rapports, Vœux, Réalisations. Pp. viii+388. (Paris: Paul Lechevalier. Instituts scientifiques de Buitenzorg: "'sLands Plantentuin." Treubia: Recueil de travaux zoologiques, hydrobiologiques et océanographiques. Vol. 6, Supplément, Avril 1926: The Bloodsucking Arthropods of the Dutch East Indian Archipelago. vii: The Tabanids of the Dutch East Indian Archipelago (including those of some neighbouring Countries) By Dr. J. H. Schuurmans Stekhoven, Jr. Pp. 551+18 plates. Vol. 8, Supplément, Juillet: Die Jugendstadien der malayischen Thysanopteren. Von H. Priesner. Pp. iii+264+16 Tafeln. (Buitenzorg: Archipel Drukkerij.)

Ceylon Administration Reports for 1925. Part 4: Education, Science and Art (D). Administration Report of the Director of Agriculture for 1925. Pp. D60. (Colombo: Government Record Office.) 1.25 rupees.

Bureau of Education, India. Education in India in 1924–25. Pp. iii+59. (Calcutta: Government of India Central Publication Branch.) 1.6 rupees; 2s.

Memoirs of the Department of Agriculture in India. Entomological Series, Vol. 9, No. 5: Experiments on the Transmission of Rinderpest by Means of Insects. By S. K. Sen. Pp. ii+59-185. (Calcutta: Government of India Central Publication Branch.) 2.4 rupees; 4s. 2d.

The Hundred and Fourth Report of the Commissioners of Crown Lands, dated 29th June 1926. Pp. 36. (London: H.M. Stationery Office.) 4s. net.

The Indian Zoological Memoirs on Indian Animal Types. 1: Pheretima (The Common Indian Earthworm). By Prof. Karm Narayan Bahl. Pp. v+72. (Lucknow: The University.) 1.8 rupees.

Cambridge Observatory. Annual Report of the Observatory Syndicate, 1925 May 19–1926 May 18. Pp. 3. (Cambridge.)

The Journal of the American Chemical Society. Vol. 48, No. 8-a; Golden Jubilee Number, August 20, 1926: A Half-Century of Chemistry in America, 1876–1926; an Historical Review commemorating the Fiftieth Anniversary of the American Chemical Society. Edited by Charles A. Browne. Pp. xiv+254. (Easton, Pa.: American Chemical Society.)

South African Sugar Association. Proceedings of the Fourth Annual Congress held at Durban on April 12th to 16th, 1926. Pp. 109. (Durban: South African Sugar Association.)

Union of South Africa: Department of Agriculture. Science Bulletin No. 48 (Division of Chemistry Series No. 66): Fumigation with Hydrocyanic Acid Gas; Concentration and Distribution as influenced by Fumigation Procedure. By B. J. Smit and Dr. T. J. Naude. Pp. 23. Science Bulletin No. 49: Experiments in Veld Management, First Report. By R. R. Staples. Pp. 35. (Pretoria: Government Printing and Stationery Office.) 3d. each.

Geofysiske Publikasjoner utgitt av det Norske Videnskaps-Akademi i Oslo. Vol. 4, No. 7: Résultats des mesures photogrammétriques des Aurores boréales observées dans la Norvège méridionale de 1911 à 1922. Par Carl Størmer. Pp. 108+48 planches. (Oslo: A. W. Broggers Boktrykkeri A/S.) 12 kr.

D. Kgl. Danske Vidensk. Selsk. Skrifter, naturvidensk. og mathem. Afd., 8 Række, 11, 1: La surface de la planète Jupiter 1919–1924. Par C. Luplau Janssen. Pp. 88+7 planches. (København: Andr. Fred. Høst and Søn.) 10 kr.

The East London College (University of London). Calendar, Session 1926–1927. Pp. 184. (London: East London College.)

Ministry of Agriculture and Fisheries: Standing Committee on River Pollution. River Pollution and Fisheries: a Non-Technical Report on the Work during 1925 of the Standing Committee on River Pollution appointed in 1921. Pp. 33. (London: H.M. Stationery Office.) 6d. net.

The British Mycological Society. Transactions, Vol. 11, Parts 1 and 2, August 26th. Edited by Carleton Rea and J. Ramsbottom. Pp. 168+6 plates. (London: Cambridge University Press.) 15s. net.

University of London, University College: Faculty of Medical Sciences. University Centre for Preliminary and Intermediate Medical Studies. Courses for Dental Students, Session 1926–1927. Pp. vi+227-262+10. (London: University College.)

Journal of the Marine Biological Association of the United Kingdom. New Series, Vol. 14, No. 2, August. Pp. 239-555. (Plymouth: Marine Biological Association.) 10s. net.

Conseil Permanent International pour l'Exploration de la Mer. Bulletin hydrographique pour l'année 1925. Pp. 49. Bulletin hydrographique: Appendice supplémentaire d'observations de surface anglaises pour la période 1915–1923. Pp. 64. Bulletin hydrographique: Appendice 1 et 2 pour les années 1923 et 1924. Pp. 20. Rapports et procès-verbaux des réunions, Vol. 40. Rapport Atlantique 1925 (Travaux du Comité du Plateau continental Atlantique) (Atlantic Slope Committee). Pp. 60. (Copenhague: Andr. Fred. Høst et fils.)

Transactions of the Royal Society of Canada. Third Series, Vol. 20, Section 4. On some Minerals from the Ruby Mining District of Mogok, Upper Burma. By Frank D. Adams and R. P. D. Graham. Pp. 113-136. (Ottawa: Royal Society of Canada.)

Aeronautical Research Committee: Reports and Memoranda. No. 1104 (Ae. 211): Further Experiments on the Relation between Skin Friction and Heat Transmission. By Miss Dorothy Marshall. Work performed for the Engineering Research Board of the Department of Scientific and Industrial Research. (D.1. Special Technical Questions, 132.—T. 2082.) Pp. 19+12 plates. 1s. net. No. 1012 (M. 35): Some Comparative Fatigue Tests in special relation to the Impressed Conditions of Test. By H. J. Gough and H. J. Tapsell. Work performed for the Engineering Board of the Department of Scientific and Industrial Research. (M.C. 79, 157, 167, 167A.) Pp. 21. 1s. net. No. 1021 (E. 19): The Effect of Metallic Sols in delaying Detonation in Internal Combustion Engines. By Ft.-Lieut. C. J. Sims, assisted by Dr. E. W. J. Mardles. (I.C.E. 516.) Pp. 11. 6d. net. No. 1013 (E. 18): Report on Dopes and Detonation. By Prof. H. L. Callendar, assisted by Capt. R. O. King and Flying Officer C. J. Sims. (B. 4. Engines 55.—T. 2151, I.C.E. 508.) Pp. 54+13 plates. 2s. net. No. 1022 (M. 38): An Experiment to determine if Slip can be detected during the Unloading Portion of a Cycle of repeated Tensile Stresses. By H. J. Gough, S. J. Wright and Dr. D. Hanson. Work performed for the Engineering Research Board of the Department of Scientific and Industrial Research. (B. 1.a. Metals, 46.—T. 2165.) Pp. 6+3 plates. 6d. net. (London: H.M. Stationery Office.)

Government of India: Department of Industries and Labour, Public Works Branch. Irrigation in India: Review for 1924–25. Pp. 37. (Simla: Government of India Press.)

International Hydrographic Bureau. Special Publication No. 13: Tide Predicting Machines. Pp. 110+34 plates. (Monaco.) 0.50 Swiss fr.

Denkschriften der Schweizerischen Naturforschenden Gesellschaft: Mémoires de la Société Helvétique des Sciences naturelles. Band 62: Vol. 62. Pp. viii+344. (Zürich: Schweizerischen Naturforschenden Gesellschaft.)

Prospectus of University Courses in the Municipal College of Technology, Manchester. Session 1926-27. Pp. 296. (Manchester.)

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 78. The Blattidae of French Guiana. By Morgan Hebard. Pp. 135-244+plates 12-17. (Philadelphia, Pa.)

R. Osservatorio Astrofisico di Catania. Annuario 1926. Pp. 39. Catalogo Astrofotografico Internazionale 1900·0. Zona di Catania fra le declinazioni +46° e +55°. Vol. 2, Parte 2ª: Declinaz. da +47° a +49°, ascens. retta da 3h a 6h. (Fascicolo N. 10.) Pp. viii+48. L' Attività del sole nell' anno 1925. Per G. A. Favaro. Pp. 16. (Catania: R. Osservatorio Astrofisico.)

Proceedings of the Imperial Academy. Vol. 2, No. 6, June. Pp. xix-xx+241-298. (Ueno Park, Tokyo.)

Annals of the (Mededelingen van het) Transvaal Museum. Vol. 11, Part 4: Some Changes in Nomenclature, New Records of Migrants and New Forms of S. African Birds, by Austin Roberts; Descriptions of some S. African Birds' Eggs, by Austin Roberts; Some new S. African Mammals and some Changes in Nomenclature, by Austin Roberts; The Dolichopodid Genus *Diaphorus* in South Africa, by C. Howard Curran; The Ethiopian *Cerceris* species, by Dr. H. Brauns; The Sphegidae of South Africa, Part 7, by Dr. George Arnold. Pp. 217-376+plates 40-44. (Pretoria: Transvaal Museum.)

Proceedings of the Indian Association for the Cultivation of Science. Conducted by Prof. C. V. Raman. Vol. 10, Part 1. Pp. 96+4 plates. (Calcutta.) 3 rupees; 4*s.*

The Indian Forest Records. Entomology Series, Vol. 12, Part 10: On some Indian Coleoptera. Part i: Description of a New Species of Fornax from India (Melasidae, Col.), by E. Fleutiaux; Part ii: (*a*) Description of the Early Stages of Fornax gardneri Fleut. (Melasidae, Col.), (*b*) Description of the Larva of Atractocerus emarginatus Cast. (Lymexylonidae, Col.), by J. C. M. Gardner. Pp. 271-282+1 plate. (Calcutta: Government of India Central Publication Branch.) 4 annas; 5*d.*

The Scientific Proceedings of the Royal Dublin Society. Vol. 18 (N.S.), No. 27: Studies on Peat. Part i: The Thermal Decomposition of Peat under Reduced Pressure. By Dr. Joseph Reilly and Gerald Pyne. Pp. 329-341. 1*s.* Vol. 18 (N.S.), No. 28: Velocity of Formation of 3·5 Dimethylpyrazole-4-Diazonium Chloride. By Dr. Joseph Reilly and Honorah E. Bastible. Pp. 343-349. 6*d.* (Dublin: Royal Dublin Society; London: Williams and Norgate, Ltd.)

Papers from the Geological Department, Glasgow University. Vol. 8 (Quarto papers from 1924 to 1925). Pp. iii+164+6 plates. Vol. 9, 1925. Pp. iii+149. (Glasgow: Jackson, Wylie and Co.)

International Hydrographic Bureau. Special Publication No. 14: Echo Sounding, iv. Pp. 28+20 plates. (Monaco.) 50 Swiss centimes.

Report of the Government Chemist upon the Work of the Government Laboratory for the Year ending 31st March 1926 (with Appendices). Pp. 37. (London: H.M. Stationery Office.) 1*s.* 6*d.* net.

Apia Observatory, Samoa. Report for 1923. Pp. 73. (Wellington, N.Z.: W. A. G. Skinner.)

The Journal of the Institution of Petroleum Technologists. Decennial Index, Volume 1 to 10, 1914 to 1924. Compiled by George Sell. Pp. 116. (London.) 7*s.* 6*d.*

Svenska Hydrografisk-Biologiska Kommissionens Fyrskeppsundersökning år 1925. Pp. 43. (Goteborg: Elanders Boktryckeri A.-B.)

Field Museum of Natural History. Anthropology, Memoirs, Vol. 1, No. 1: Report on the Excavation of the "A" Cemetery at Kish, Mesopotamia, Part 1. By Ernest Mackay. (Field Museum—Oxford University Joint Expedition.) Pp. 63+20 plates. Report Series, Vol. 6, No. 5: Annual Report of the Director to the Board of Trustees for the Year 1925. (Publication 235.) Pp. 385-525+plates 63-79. (Chicago, Ill.)

Proceedings of the American Philosophical Society held at Philadelphia for Promoting Useful Knowledge. Vol. 65, No. 1. Pp. xxxii+67+4 plates. (Philadelphia, Pa.)

Cornell University: Agricultural Experiment Station. Memoir 92: The Flora of the Cayuga Lake Basin, New York; Vascular Plants. By Karl M. Wiegand and Arthur J. Eames. Pp. 491. (Ithaca, N.Y.)

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 525: A Unicontrol High-Frequency Radio Direction Finder. By F. W. Dunmore. Pp. 23-35. (Washington, D.C.: Government Printing Office.)

Diary of Societies.

SATURDAY, OCTOBER 2.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South Midland District) (at Icknield Hall, Letchworth), at 11 A.M.—G. T. Hill and others: Discussion on Letchworth, its Ideals and Municipal Undertakings.

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch) (at 90 Deansgate, Manchester), at 4.—S. G. Smith: Notes on Foundry Practice.

ELECTRICAL ASSOCIATION FOR WOMEN.—Visit to All-Electric Farm of Mr. Borlase Matthews, Greater Felcourt, East Grinstead.

MONDAY, OCTOBER 4.

SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—Capt. W. J. Liberty: The History of Artificial Lighting.

INSTITUTION OF AUTOMOBILE ENGINEERS (The College, Loughborough) (Loughborough Graduates' Centre), at 7.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—Dr. E. K. Rideal: Recent Advances in Catalysis.

INSTITUTION OF THE RUBBER INDUSTRY (London Section) (at Engineers' Club, Coventry Street, W.), at 8.—Dr. E. A. Hauser: The Problem of Rubber Latex Concentration and the Industrial Application of Concentrated Latices.

TUESDAY, OCTOBER 5.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at Caxton Hall, Westminster), at 7.—A. H. Barker: Panel Heating.

INSTITUTE OF METALS (North-East Coast Local Section) (at Armstrong College, Newcastle-on-Tyne), at 7.30.—Dr. C. J. Smithells: Preparation and Metallography of Metal Filaments.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Automobile Club), at 8.—H. K. Thomas: The Debt of the Country to the Automobile (Presidential Address).

WEDNESDAY, OCTOBER 6.

INSTITUTION OF SANITARY ENGINEERS (at Caxton Hall, Westminster), at 6.30—G. B. Chilvers: Housing Problems, with special reference to Subsidies and Rural Needs.

INSTITUTION OF AUTOMOBILE ENGINEERS (Western Centre) (at Merchant Venturers' Technical College, Bristol), at 6.45.—H. K. Thomas: The Debt of the Country to the Automobile (Presidential Address).

INSTITUTION OF THE RUBBER INDUSTRY (Birmingham Section) (at Grand Hotel, Birmingham), at 7.—Dr. E. A. Hauser: What is Rubber?

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (at 20 Trongate, Glasgow), at 7.15.—The Functions and Scope of our Society—Discussion opened by Chairman.—Demonstration of Lighting.—Q. Moore, Jun.: Notes on the Testing of Disinfectants by the Rideal-Walker Method.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—A. Chaston Chapman: On the Presence of Compounds of Arsenic in Marine Crustaceans and Shell Fish.—A. R. Tankard and D. G. T. Bagnall: The Examination of Fish for Formaldehyde.—K. Sandved: Potentiometric Titration of Tin with Potassium Bromate.—R. R. T. Young: The Determination of Nicotine in Tobacco.

THURSDAY, OCTOBER 7.

HOSPITAL FOR SICK CHILDREN (Great Ormond Street), at 4.—Dr. Cockayne: Rickets as it is seen to-day.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 7.30.—L. S. Gullivan: Informal Illustrated Lecture on Architecture for Workers in the Building Trades:—The Job.

SOCIETY OF CHEMICAL INDUSTRY (Bristol Section) (in Chemical Department, Bristol University), at 7.30.—F. H. Carr: Insulin and its Manufacture.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 8.30.—The Master of Sempill: Aero Engine Fuels of To-day and To-morrow.

FRIDAY, OCTOBER 8.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—N. J. Griffin: A Survey of Modern Airless Injection Oil Engines.

SATURDAY, OCTOBER 9.

BIOCHEMICAL SOCIETY (at Cambridge).

PUBLIC LECTURES.

SUNDAY, OCTOBER 3.

GUILDHOUSE (Eccleston Square, S.W.1), at 3.30.—Sir Richard Gregory: The Worth of Science.

MONDAY, OCTOBER 4.

UNIVERSITY COLLEGE, at 5.—R. J. Lythgoe: The Special Senses. (Succeeding Lectures on October 6, 11, 13, 18, 20, 25, and 27.)

WEDNESDAY, OCTOBER 6.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 6.—G. Wood: Calculating Machines.

UNIVERSITY COLLEGE, at 7.—A. H. Barker: The Engineering Plant of University College Hospital.

THURSDAY, OCTOBER 7.

BEDFORD COLLEGE FOR WOMEN, at 2.—Prof. Wilson: Introduction to Physics.

UNIVERSITY COLLEGE, at 2.30.—Sir Flinders Petrie: Influences of Egyptian Art.—At 5.15.—Dr. T. G. Pinches: Recent Discoveries in Babylonia. (Succeeding Lectures on October 14 and 21.)

KING'S COLLEGE, STRAND, at 5.—Dr. C. Da Fano: Histology of Nerve Tissues and Paths of Conduction in the Central Nervous System. (Succeeding Lectures on October 14, 21, 28, November 4, 11, 18, 25, December 2 and 9.)—At 5.30.—Prof. E. V. Appleton: Wireless Telegraphy. (Succeeding Lectures on October 14 and 21.)

FRIDAY, OCTOBER 8.

UNIVERSITY COLLEGE, at 5.—R. K. Cannan: Biological Oxidation-Reduction. (Succeeding Lectures on October 15, 22, 29, November 5, 12, 19, and 26.)

SATURDAY, OCTOBER 9.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Mrs. Robert Aitken: Life in a Red Indian Family.

SUNDAY, OCTOBER 10.

GUILDHOUSE (Eccleston Square, S.W.1), at 3.30.—Dr. Bernard Hollander: Sound and Unsound Mind.

CONGRESSES.

OCTOBER 13 TO 26.

GERMAN SOCIETY FOR THE STUDY OF DISEASES OF DIGESTION AND METABOLISM (at Berlin).

OCTOBER 25 TO 28.

ITALIAN CONGRESS OF SURGERY (at Padua).