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The Education Estimates.

THE Estimates for Civil Services for the year ending March 31, 1923, have been issued, and it is expected that Class IV., which deals with Education, Science, and Art, will be discussed in Parliament almost immediately after the Easter recess. While it is now clear that the drastic cuts recommended by the Geddes Committee will not be made, the Estimates in this class still show a reduction of 7,979,154*l.* for Great Britain—Ireland being omitted from this calculation. We propose to examine three items in which economies are indicated.

First, the estimate for the Ordinary Services of the Board of Education shows a reduction of 4,898,970*l.* on the corresponding estimate for the year 1921–22, which means a cut of rather more than 10 per cent. Next, the estimate of the grant in aid of Universities and Colleges for the year 1922–23 is 300,000*l.*[1] less than the sum granted to these institutions for the year 1921–22, which means a cut of 20 per cent. And, thirdly, the estimate for Scientific and Industrial Research is reduced by 118,486*l.*—a cut of 28 per cent.

It will be observed that the cuts for higher education and research are proportionately much greater than for the Ordinary Services of the Board of Education, and it would seem that this is the considered policy of the framers of the Estimates. A closer examination of the estimate for the Ordinary Services of the Board of Education seems to confirm this opinion. Here we find that the proposed reduction in the grants to local education authorities for elementary education amounts to 1,916,307*l.* on 36,900,000*l.*, which works out as a cut of about 5 per cent.; whereas the proposed reduction of grants to local education authorities for *higher* education amounts to 954,920*l.* on 6,647,920*l.*—a cut of more than 14 per cent.

If further confirmation were needed it is to be found in the treatment of technical colleges and the grant towards students' fees. The grant to the former is to be reduced from 50,000*l.* to 40,000*l.*—a cut of 20 per cent.; while the students' fees grant, from which scholarships, studentships, and exhibitions tenable at the universities are drawn, is to be reduced from 15,000*l.* to 12,600*l.*

Obviously these facts point to the conclusion that higher education and research are bearing a greater proportion of the proposed reductions in the Education Vote than the remaining educational services. Such a discrimination requires further consideration. At the outset we may say that we have no fault to find with the rejection of the Geddes proposals regarding the salaries of school teachers. In our opinion there was ample justification for refusing to adopt proposals of that character. Rather are we concerned to point out that the proposals regarding higher education and research, if carried into effect, will, in the long run, be most injurious to education and the development of our national life. In the debate on the Consolidated Fund Bill in the House of Commons on March 28, Mr. Asquith warned the Government of "the extreme and criminal inexpediency at this time of cutting down the Education Estimates." He then proceeded to ask "Was there ever a moment in our history when it would be more suicidal to cut down the facilities which were not by any means ample enough for this great national purpose of securing the best intellectual life for the boys and girls who were most fitted to profit by it?" Far from the facilities being ample enough, we understand that at the present time 20,000 children, well qualified for higher education, are excluded from secondary schools for lack of accommodation. Yet at this particular juncture the Education Estimates, as we have indicated above, show a reduction of more than 14 per cent. in the grants to local education authorities for higher education.

While the attack upon secondary education is bad, that upon the universities is worse. A cut of 20 per cent. will have far-reaching effects. Already one university is proposing to reduce its staff, and others are preparing to follow suit. This will mean impaired efficiency and the sacrifice of future developments. A temporary and trivial economic gain will cripple the universities for many years and inflict irremediable hardships upon many deserving students. We cannot understand

[1] The proportion of the decrease for Great Britain is estimated at 247,000*l.*

how a Minister of Education can agree to a reduction of 300,000*l.* to the universities when in the debate just referred to he stated that the universities "were making contributions to learning and science exceeding in quality and amount that ever given before," and further that "it was within his knowledge that there was work proceeding in the laboratories of this country which, if the hopes of scientific men engaged upon it were realised, would repay the country over and over again for the cost." Mr. Fisher must surely know that such a reduction in the grant cannot be made without serious consequences. The sum may be small in comparison with the Education Vote as a whole, but it is most certainly large in comparison with the funds at the disposal of the universities.

The President of the National Union of Teachers in his address to the Annual Conference on April 17 was at pains to point out that money spent on scientific and technical education was productive expenditure which would become the very source of national income. And he is right. He insisted that more money was required to enlarge our control over the resources of nature. "We shall want," he says, "more money to build and equip our technical schools and colleges. We shall want more money to train our scientists and technicians, for we could not float a world trade on scientific ignorance and technical inefficiency." Again he is right. Yet the Government is proposing to reduce its grants for such purposes!

Already thoughtful men and women are realising that the hope of the future in commercial life, as well as in intellectual life, lies largely with our universities and colleges, and that any action which will prejudice their development will mean a national loss. While we hold to the same opinion we are not prepared to say that the educational system of this country is run on sound economic lines or that the system itself from a purely educational point of view is beyond criticism. Any one with inside knowledge would have no lack of material for criticism. Our point is that the proposed economies in higher education and research are specious economies which in the near future will entail losses out of all proportion to the slight temporary gain they effect. On the other hand, we believe it would not be a difficult matter to discover ways of economising which would not entail such serious consequences as those proposed. We can only hope that Parliament will show a real appreciation of the inevitable consequences of the proposed drastic cuts, and that proper means will be taken to prevent so great a calamity to higher education and research.

Studies in Symbiosis.

Tier und Pflanze in intrazellularer Symbiose. By Prof. P. Buchner. Pp. xi+462+Tafel 2. (Berlin: Gebrüder Borntraeger, 1921.) 114 mk.

THE extent and significance of symbiosis are matters of general interest. The delicate adjustments that enable yeasts to interpenetrate the tissues of insects, algae those of corals, and bacteria those of cuttlefish, resulting in mutual advantages to both partners in each association, form an evolutionary topic of no little importance. But the subject assumes practical and economic value when it is realised that the nutrition of our domestic ruminant animals is carried out not solely by their own enzymes and tissues, but is due partially to the activity of symbiotic bacteria (and probably to Protozoa also) which live within the cattle. So great has been the increase of our knowledge of these associations in the last fifteen years, that the large volume under review does not cover the whole ground, but deals only with those animals in which the invading micro-organisms take up positions within certain cells of the other partner. The no less interesting cases of symbiosis in which the invader lies in the cavity of its partner's body (as in cattle) are, with one exception, deliberately omitted.

Accustomed as we are to think of each being as working out its own salvation and that of its race, the thought of deep-seated infection of diverse animals by myriads of alien microscopic yeasts or bacteria which invade even the very germ cells and are conveyed to children's children, has in it something repulsive. Such cases, we are inclined to conclude, are exceptional. The bulk of life stands on its own ground. Symbiosis is at best a secondary phenomenon of the struggle for subsistence. It is not even a safe compromise. Co-operation may mean litigation. Mutual benefit gives place only too easily to one-sided benefit or to mutual harm. The "symbiote" becomes a parasite. Requiring such a delicately adjusted balance, symbiosis, we argue, can never have been an evolutionary factor of real and widespread significance. In opposition to the entrance of such foreign corpuscles, the body would exert all its antigens as against foreign proteids or as it does against the entrance of pathogenic spores. The struggle would lead to the survival of those forms which repelled the invaders or which tolerated their presence whilst maintaining an easy mastery.

The facts of biology, however, imperfectly known as they are and still more imperfectly apprehended in their full significance, show that the more carefully animal life is studied, the more numerous and intimate are the cases of symbiosis that investigation discloses.

Many of the blood-sucking flies, probably all, are cases of symbiosis. The whole vast order of sucking insects known as Hemiptera—the green fly, scale insect, body louse—is another. The ant and the death-watch beetle, the cockroach and the leaf-miner are examples of other orders that show the same or similar associations.

The first section of Dr. Buchner's book deals with marine plant-animals, and provides a welcome and critical summary of our knowledge of the algal associations in Protozoa, Coelenterates and Turbellaria. The second, and perhaps the most valuable, part of the work gives a full, illustrated discussion of symbiosis in insects, with especial reference to the transmission of the bacteria or yeasts to the egg and the "infection" of the embryo. This aspect of insect physiology has been neglected by English entomologists, and its significance is as yet scarcely grasped. Some indication of the importance of insect symbiosis may be gathered from the fact that Peklo has shown the symbiotic organism of green-fly to be an Azotobacter modified by residence in the tissues of the insect. The only important omission in this part of the work is that of the recent discovery of a symbiotic organism in the tsetse-fly.

Native Life in the Highlands of Assam.

The Angami Nagas, with some Notes on Neighbouring Tribes. By J. H. Hutton. Pp. xv+480. (London: Macmillan and Co., Ltd., 1921.) 40s. net.

MR. HUTTON'S excellent monograph on the Angamis is a more than welcome accession to the series of monographs dealing with the Naga and other indigenous tribes now under the control of the Government of Assam. The volume is a very valuable contribution to the ethnological literature of the Naga Hills, and reflects great credit both upon the author, who has made full use of his opportunities, and upon the Government under the auspices of which it has been published. Ethnologists, local administrators and many others will feel grateful to the authorities for their praiseworthy encouragement of the scientific study of the natives for whose welfare they are responsible. Such detailed study is not only of value from the ethnological point of view, but has also a practical bearing upon the administration of native affairs. Accurate knowledge of the habits, customs, beliefs and culture-environment in general of primitive peoples promotes sympathetic and equitable treatment and control, and prevents those misunderstandings and unintentional acts of injustice which are due to ignorance of the native point of view, ethics, and social organisation.

The present monograph, while it deals in detail with the various phases and features of the life of the Angamis, has the merit of being brightly written and interspersed with touches of humour. It is "readable" as well as instructive.

Mr. Hutton, during several years of close contact with Naga tribes, has developed a *sympathetic* interest in them which has gone far towards winning their confidence. Much of the information which he has gleaned could have been acquired only by breaking down those barriers of reserve and distrust which are too often interposed between the representatives of

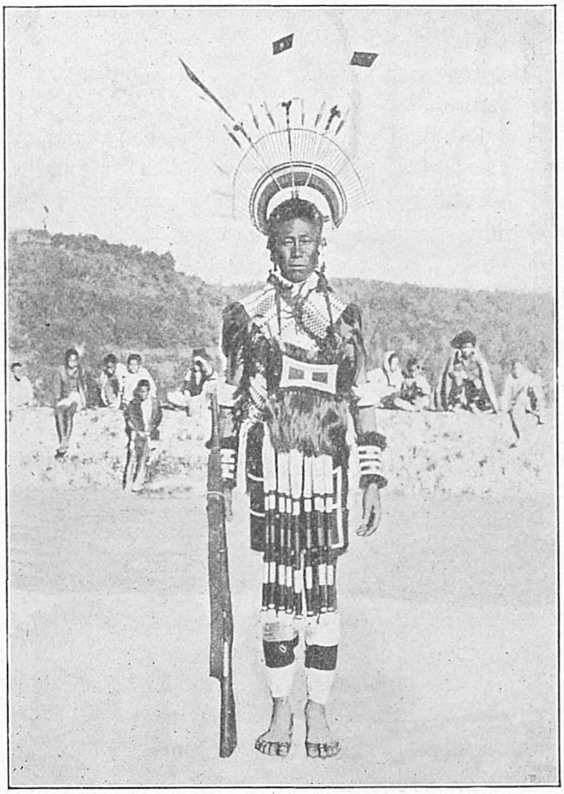

FIG. 1.—Viswema youth in ceremonial dress. From "The Angami Nagas."

government and the governed. The facts which he records have been collected mostly at first hand, being the results of his own observations. Where he depends upon the data collected by his predecessors in the field, he has endeavoured to check off their statements and, so far as possible, to verify or correct them. Many of the practices recorded by Butler, Woodthorpe, Davis, Peal, and other pioneer observers are no longer followed, and must be accepted at second hand or studied through the imperfect memory of the "oldest inhabitant." The time-honoured practice of head-hunting is rapidly becoming extinct in the administered area, and the passing of this prominent and absorbing feature in Naga culture involves the atrophy of many other cultural items and the modification or abolition of many status-grades in Naga society. Even those striking and elaborate ornaments (Figs. 1 and 2), which were formerly guarantees of prowess on the war-path, have, to a great extent, now lost their significance, and may be worn by those who have not earned them under the rules of the old *régime*. While recognising that changes are inevitable and, no doubt, even desirable, the ethnologist views with concern the supplanting of traditional customs by "civilisation," at any rate before they have been studied and recorded in detail. Similar regrets are felt by the naturalist when some interesting zoological

FIG. 2.—Mozema youth in ceremonial dress. From "The Angami Nagas."

type becomes extinct and is no longer available for research into its life-habits. Mr. Hutton's careful record has done much towards minimising the mourning over obsolescent customs. How rapid are the culture-metamorphoses which are being effected in the Naga Hills is well reflected by the author's statement that a considerable portion of his MS. was "typed by an Angami"! Truly, there is no time to lose, and it is to be hoped that he will continue his researches without interruption.

There is much to be said in praise of the Angami, whom Mr. Hutton describes as intelligent, self-reliant, honest, good-humoured, and devoted to their families. While they may be declared swashbucklers and exaggerators, they are, nevertheless, fairly truthful. Underlying these characteristics there run a vein of sadness and a considerable fear of death. Their villages, built for defensive purposes on the high ground, testify to the inter-tribal feuds, vendettas, and head-hunting raids which have hitherto retarded progress and rendered the life of every man, woman, and child somewhat precarious.

The Angamis are prominent as agriculturists, and in this industry they are ahead of the neighbouring tribes, inasmuch as they practise, for rice-growing, a very elaborate and striking system of terrace-cultivation (Fig. 3) involving complex irrigation methods. Their irrigation channels extend sometimes for miles, and water-rights are jealously guarded. This terracing of the hill-sides reminds one of that of the Bontoc-Igorots of the Philippine Islands, and it contrasts with the crude and wasteful system of *jhuming* so prevalent among Naga agriculturists, including the Angamis themselves.

These natives are skilled in several manufacturing processes, in weaving, iron-working, etc., and exhibit great artistic feeling in decorating their weapons and houses and in making their often elaborate personal ornaments. But, in spite of skill and ability to progress, severe restrictions upon culture-advancement are imposed by the complex and inexorable system of magico-religious *gennas*, or prohibitions, which play a very important part in the Angami social ritual, and exercise a retarding effect upon the prosecution of industries. The various kinds of *gennas* and their application and social significance are dealt with very fully by the author. He explains the distinction between *kenna*, which is a prohibition laid upon an individual unit of the community, and *penna*, one which involves the whole community and relates chiefly to non-working days; the latter are very numerous. Further, there is *nanü*—which embraces *any* prohibition and the whole of the active ceremonies connected with it. It is impossible in a review to deal with these social restrictions, but their dominating influence upon the whole life of the natives is very far-reaching, and their detailed study of prime importance.

The religious beliefs are vague and ill defined. There is belief in the souls of the dead and, it would seem, of the living also, and these often take the form of butterflies, as in Burma and in the Greek legend of Psyche. The reality of dreams and their value in divination are also recognised. Omens and divination to a considerable extent regulate procedure. Certain major and minor deities or spirits (*terhoma*) of greater and lesser power exist and are propitiated, and sometimes even defied, but their exact nature is but little understood. The chief of these is Kepenopfü, variously referred to as male or female, who is the reputed creator of living things and whose abode is in the sky. Animatism prevails, and were-tigers and were-leopards are a feature in the popular beliefs. With all these matters Mr. Hutton deals interestingly and in some detail, though he wisely assumes a cautious attitude in describing the native beliefs in view of the uncertainty of the material.

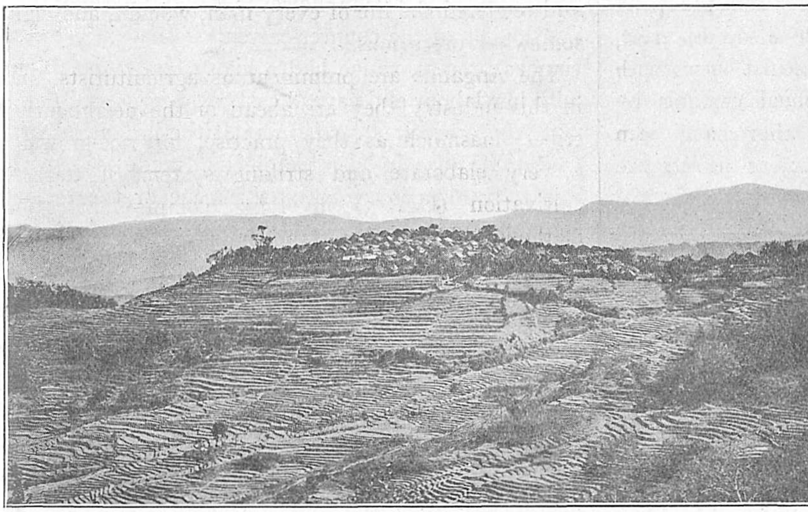

FIG. 3.—Viswema village showing terraced fields. From "The Angami Nagas."

The arts, industries, amusements, and general domestic life, the laws and customs and other culture-phenomena all receive adequate attention, and a number of traditions, legends, and songs are recounted. An important chapter deals with the Angami language, which belongs to the Tibeto-Burman group. There are also several valuable appendices concerned with special points, including a series of anthropometric measurements. It is to be hoped that the Stone Age of the Naga Hills may be the object of further researches. Our knowledge of it is mainly, almost exclusively, derived from stone celts which are locally believed to be thunderbolts, and are valued as such by the natives. One assumes that other types of stone implements, which may be revealed by careful search, must have been associated with the celts. They should throw light upon the archæology of the region, a subject which as yet remains obscure.

A few words of criticism are called for. Some of Mr. Hutton's descriptions are by no means clear. For instance, on p. 68 mention is made of a "trumpet" upon which military bugle-calls are reproduced, but which is not "blown with a loose lip." If this is so, the instrument should not be described as a "trumpet," and one wonders how bugle-calls can be imitated without the "loose-lip" method of sound-production. Again, on p. 93, we learn that "millet and Job's tears . . . are . . . used for making rice beer," but these ingredients are not referred to in the description of the brewing of this staple drink, and one remains uninformed as to their function in the process. On p. 94 the reasons given for the food-*genna* to women are far from clear, and require further elucidation to show the connection of ideas. In a future edition of this excellent book it will be well if all native words and place-names are accented throughout, so as to assist the uninitiated in their correct pronunciation. This should be a general rule in all works of this nature. The illustrations are mostly good, several are very good, and they are well placed in reference to the text, but references to particular figures should appear in the letterpress. Three useful maps are added.

Mr. Hutton's enthusiasm and industry in recording the details of native life in the Naga Hills are evidenced not only in his book upon the Angamis, but also in his more recently published work on the Sema Nagas. These books are so full of information in regard to this important ethnological region that one thirsts for more, and can only hope that other Naga tribes (the Aos, Rengmas, Konyaks, etc.) may be described in a similar manner. "The Angami Nagas" may well serve as a model for further monographs. We congratulate Mr. Hutton and his readers upon a valuable and enlightening piece of work.

HENRY BALFOUR.

The Manufacture of Explosives.

Ministry of Munitions and Department of Scientific and Industrial Research: Technical Records of Explosives Supply, 1915–1918. No. 1: *Recovery of Sulphuric and Nitric Acids from Acids used in the Manufacture of Explosives: Denitration and Absorption*. Pp. viii + 56. 12*s*. 6*d*. net. No. 2: *Manufacture of Trinitrotoluene* (TNT) *and its Intermediate Products*. Pp. viii + 116. 17*s*. 6*d*. net. No. 3: *Sulphuric Acid Concentration*. Pp. vi + 91. 12*s*. net. No. 4: *The Theory and Practice of Acid Mixing*. Pp. vi + 93. 12*s*. net. (London: H.M. Stationery Office, 1920–1921.)

THE first four of the series of publications dealing with the technical records of explosives supply now to hand form a valuable addition to the literature of technical chemistry. The work of preparing the information was begun by Mr. W. Macnab under the Ministry of Munitions, and thanks are due to the Department of Scientific and Industrial Research for arranging for his retention to complete it.

Denitration.—The first volume deals with the recovery of the nitric and sulphuric acids from the waste acid produced in the nitration of toluene and glycerine. Not only is the proportion of waste acid a large one—650 tons for 100 tons of trinitrotoluene produced—but the efficient recovery of the sulphuric acid in a condition suitable for concentration, and of the nitrogen oxy-acids as nitric acid, constitutes one of the principal economic factors of the manufacture.

The chemical reactions involved in denitration have been the subject of discussion both earlier and as a result of experience in war factories, and the position is summed up in the introduction to this volume. It may briefly be said that by considering the behaviour of nitrosylsulphuric acid when it acts on nitric acid, and when it breaks down on dilution with water, a fairly coherent explanation is afforded of what goes on during the progress of waste acids down a denitrating tower as they meet an ascending current of steam.

The treatment of the subject of the absorption of the nitrous fumes coming from the towers to form 55 per cent. nitric acid is of importance at the present time, when this problem confronts any manufacturer proposing to make nitric acid by the catalytic oxidation of ammonia. The experience recorded is that a 90 per cent. conversion of nitrogen peroxide to nitric acid can be secured with a ratio of free tower space to rate of passage of nitrogen peroxide, which is less than a tenth of that in large towers erected for the same purpose in connection with the oxidation of ammonia. The relative effectiveness of the small towers with the most advantageous conditions of concentration and velocity of gases and free space, temperature, and concentration of nitric acid, is clearly indicated, and forms a basis for modification of the present practice of installing immense absorption towers which are obviously inefficient and very costly.

Full detailed drawings are given of the plant for the processes of denitration, absorption, and storage of acids, and its applicability to the manufacture of organic nitro-bodies should make the report of interest and importance to a wider field than that of the explosive manufacturer alone.

Trinitrotoluene Manufacture.—No. 2 of this series gives the history of processes for making trinitrotoluene and for its purification, and describes plant and manufacturing methods. An account is given of the experimental work at the Research Department, Woolwich, which established the conditions necessary for nitration, the advantage of the extraction of waste acids ("detoluation") by mononitrotoluene, itself to be nitrated later, and the benefits of a cyclic system of nitration in stages in order to conserve acids. These features were embodied in the processes followed in the large factories erected for making trinitrotoluene, an important variation, however, being the elaboration at Oldbury of the counter-current method into a continuous process, which had a high capacity combined with low labour and capital cost.

In the process as carried out at the largest factory, Queen's Ferry, mononitrotoluene, made separately either by nitrating gas-works toluene or the toluene contained in Borneo petroleum, was used to detoluate waste acids which had themselves been detoluated by once-used mononitrotoluene, brought up to nearly dinitrotoluene in the last-mentioned operation, and this dinitrotoluene was then nitrated to trinitrotoluene.

The next process, that of freeing the crude trinitrotoluene from acids, underwent some elaboration, for in addition to agitation of the molten trinitrotoluene by hot water it was found efficacious to chill it by pelleting it in cold water, and to use weakly basic hydrolysable salts for the hot washing; a continuous system of hot washing was also developed.

But although it became possible latterly to push the process of nitration until nearly all the dinitrotoluene had been converted into trinitrotoluene, there remained about 4 per cent. of its unsymmetrical isomerides resulting from the nitration of the meta-nitrotoluene. While the crude trinitrotoluene, after having been washed and dried, could be used in large quantities for making the bulk of the amatol for filling shell, there were certain purposes for which a purer product was demanded, when, for example, the ammonium nitrate was not free from pyridine and thiocyanate, or when it was necessary to avoid the low melting-point eutectics formed by the isomerides. Purified trinitrotoluene was prepared at first by crystallisation from, or by washing with, organic solvents, and large factories were erected for these purposes. Later, a process was adapted from the French, safer from the point of view of fire-risk, and characterised by treating the crude trinitrotoluene with sodium sulphite solution which under suitable conditions selectively dissolves out the other isomerides, leaving the pure symmetrical trinitrotoluene and any dinitrotoluene that has escaped further nitration. As this process was one which could readily be embodied in the scheme of manufacture, it was carried out in the trinitrotoluene factory.

The plant at Queen's Ferry, which in every detail is stamped with the genius of Mr. K. B. Quinan, is described in this volume in all relevant particulars as to the main features of the manufacture. The reproductions of the working drawings, the diagrams and flow-sheets, the detailed sketches of parts and of special devices, and the examples of methods of statistical control, constitute a body of information of a unique character. The description forms a permanent record of these matters in a connected narrative, but again its usefulness is by no means confined to the explosives manufacturer, since many of the methods used and devices for overcoming difficulties are subject-matter for numerous projects in chemical engineering.

Concentration of Sulphuric Acid.—In the third volume will be found a useful study of the thermal conditions obtaining in the Gaillard tower system. The methods used before the war in this country for concentrating the sulphuric acid of 70 per cent. strength resulting from processes of nitration were for the most part the Kessler and the cascade systems, both of which are operated with comparatively small units. Excellent results both as regards efficiency and low cost of working were obtained with the large Gaillard towers erected in the large explosives factories such as Queen's Ferry and Gretna. The feature of these towers is the conversion of the weak acid into a spray, which in falling by gravity down a tower of about 50 ft. in height, meets ascending hot gases from a producer, and so becomes concentrated to a strength of 92-95 per cent. sulphuric acid. As the fuel consumption, weight of dilute acid, and weight of concentrated acid can be measured with fair accuracy, the opportunity is taken to calculate the efficiency of the plant from a knowledge of the various thermal data available, including those of Porter for sulphuric acid and oleum. The various factors are considered in detail which will repay the study of technical students, and a satisfactory heat balance is made out in which the heat imported into the system is contrasted with that which is lost by water evaporating, by radiation, and by being carried away in the hot acids. As the last-mentioned source of loss amounts to nearly a quarter of the heat put into the system, its recovery on counter-current lines by suitable constructional modifications would appear to be worth attempting.

A short study follows of the Gilchrist concentrating plant, which worked on a process analogous to that of the Kessler plant, but with a high capacity.

It had been a disadvantage in all the varieties of concentrating plant mentioned that the gases finally discharged into the air carried with them a mist of dilute sulphuric acid in water, involving a certain loss of acid and considerable inconvenience to those working in the neighbourhood. It was also objectionable in explosives factories where many large-scale operations have to be conducted in an acid-free atmosphere. Accordingly it was determined to precipitate this mist electrically by the Cottrell electrostatic process, of which full details are given and also a description of all the electrical parts and their mode of maintenance. As about 3 per cent. of the acid fed into the concentrating plant was recovered in the Cottrell precipitating plant, it will be seen that besides the advantages mentioned, a useful addition to the yield of acid was obtained.

Acid Mixing.—In No. 4 of this series is described the working of that important section of a nitration factory in which the acids are adjusted as regards their quantity and composition. In such a factory as Queen's Ferry, where 700 tons of trinitrotoluene a week could be made, the magnitude of the problems of production, handling, and conveyance of acids may be judged from the vast quantities—about 43,000 gallons—of nitric and sulphuric acids occurring in many stages of dilution. It is essential to secure that the various acids are in balance for controlling the cycle of production and recovery in manufacture. An example for a given output of explosive is worked out, and a diagrammatic acid balance figured, which includes a set of factors by which the quantities of acid at various stages must be modified to compensate for variations in working of the units composing the acids cycle. In this way the proper quantity of mixed nitrating acids of a definite composition and the economical utilisation of spent acids are kept under strict control.

As variations in dilution and in strength of the concentrated sulphuric and nitric acid inevitably creep in, calculations must be made of the adjustments necessary to bring the contents of the large mixing vessels to the desired composition. The methods for doing this are explained, and it is of interest to note that the presentment of the necessary data in the form of graphs was abandoned in favour of a series of simple tables by means of which the necessary additions for obtaining a correct mixing could be found.

A description is given in detail of the plant for storing and mixing these acids, and this completes the account of the manufacture of trinitrotoluene contained in vol. 2.

Apart from its value as an exposition of scientific method applied to the control of acid mixing for a nitration process on the largest scale, there will be found other subject-matter, such as descriptions of the mechanical details, methods of controlling undue rise of temperature, prevention of wear of parts, and methods of distribution of acids by pipes, which will be found to have a wide interest among those concerned with the erection of plant.

It is clear that the publication of the data which have accrued in the operation of these factories will form a permanent record of the application of scientific method to problems of chemical industry, as well as affording typical examples for the use of students as well as of manufacturers. It is to be regretted that Queen's Ferry factory, which embodies so much original work in plant construction, is now for disposal, but it is understood that while there is yet time the Disposals Board have acquiesced in an arrangement for students to study the plant. A course of this kind with Mr. Macnab's volumes as text-books should prove a very valuable means of instruction.

Popular Expositions of Relativity.

Relativity and the Universe: A Popular Introduction into Einstein's Theory of Space and Time. By Dr. Harry Schmidt. Authorised Translation by Dr. Karl Wichmann. Pp. xiii+136. (London: Methuen and Co., Ltd., 1921.) 5*s.* net.

The Ideas of Einstein's Theory: A Theory of Relativity in Simple Language. By Prof. J. H. Thirring. Translated by R. A. B. Russell. Pp. xv+167. (London: Methuen and Co., Ltd., 1921.) 5*s.* net.

An Introduction to the Theory of Relativity. By L. Bolton. Pp. xi+177. (London: Methuen and Co., Ltd., 1921.) 5*s.* net.

Relativity and Gravitation. Edited by J. Malcolm Bird. Pp. xiv+245. (London: Methuen and Co., Ltd., 1921.) 8*s.* 6*d.* net.

The Rudiments of Relativity: Lectures delivered under the Auspices of the University College, Johannesburg, Scientific Society. By Prof. J. P. Dalton. Pp. vi+105. (London: Wheldon and Wesley, Ltd., 1921.) 5*s.* net.

Die Einsteinsche Gravitationstheorie: Versuch einer allgemein verstandlichen Darstellung der Theorie. Von Prof. G. Mie. Pp. iv+67. (Leipzig: S. Hirzel, 1921.) 7 mk.

HERE are six accounts of the Relativity theory designed for the general reader. The first four hail from Messrs. Methuen, who had the enterprise to secure an English translation of Einstein's own popular exposition, and have also recently published a translation of Weyl's "Space, Time and Matter." The fifth is published in Johannesburg by the Council of Education, Witwatersrand. The last comes from the pen of an eminent German professor of physics.

In surveying such a collection it is appropriate to quote from the last named. "We cannot penetrate into the thought-world of a symphony by reading a description of it, be it by the most distinguished musical critic. The symphony must be heard. The more we analyse it note by note, and the more deeply we understand the relations of the notes, the more do we come into the real meaning of the work."

That is the feeling which emerges after going one after another through many attempts to describe this new theory without asking the reader that he should first equip himself for the act of appreciation by an intimate study of the technique and terminology of geometry, of the significance of Newton's theory of gravitation and his system of mechanics both as an explanation of known phenomena and as forming the whole basis of the further development of physical science. But even granting these prime requisites, the reader is desired, on the strength of the reading of a few simple pages, to readjust the whole of his outlook on the world to an degree even greater than that required for one brought up in a classical school of art to comprehend the strivings of the moderns to find a new mode of expression for the thoughts of a new age.

This much is certain, that there is no short-cut to an understanding of Einstein's achievement. What is the most that we can expect from these many attempts to supply the public with some answer to their inquiries for light on this latest achievement of the imagination and intellect in co-operation? We may legitimately ask for some presentation of the historical setting. But even here we are faced with a great difficulty in providing an account which is free on the one hand from technical difficulties and on the other from misleading vagueness. For the precise statement of the actual achievements of Newton is in itself a matter requiring so much detail that the majority of our university students would not show up well in an examination on this subject. They are content with a parrot-like learning of the conventional language in which the laws of motion are expressed, and a false facility in doing problems without any reference to their physical significance. Meanwhile the Newtonian conceptions of space and time are absorbed as if they were strictly obvious, whereas the mere fact of the existence of Newton's definitions of absolute space and time shows that after all his investigations he found himself bound to postulate something which his reason and conscience could not justify. Newton's absolute space, like Euclid's axiom of parallels, were last confessions of remaining mysteries rather than preliminary statements of the obvious.

Yet it is not possible to appreciate the bearing of the relativity theory without appreciating first the point at which the classical mechanics is unsatisfactory. For it is perhaps the greatest merit of Einstein's work that it gives us something which is more satisfactory just at this point. Einstein has met the greatest of all objections both to Newtonian mechanics and to Euclidean geometry. He has satisfied the logicians, and it so appears that, beginning with this sole end in view, he has found the explanation of the outstanding discrepancy with observation.

After the historic setting the most important element in an exposition of this theory is an analysis of the nature of measurement and of exact observation. The new element in the general theory of relativity is directly concerned with this. Einstein insists on the fact that the use of co-ordinates to distinguish between events is a piece of mathematical machinery; that the physical facts are there, and are the same, whatever descriptive method we may employ. On the other hand, measurement is simply a particular part of physical observation. On this point much more exact thinking is needed. The expositions of relativity, on the other hand, almost without exception encourage more than usually loose thinking. The strictest logical analysis cannot be avoided.

But after all the test of a popular exposition is whether it is really illuminating to the amateur reader. The reviewer is not entitled to pass hasty judgment. Nor is he entitled to compare these books on the score of their strict accuracy in detail. For the success of the author's attempt is relative to the previous knowledge and habit of thought of the reader.

One or two words of reference to the particular features of these publications may, however, be made.

Dr. Schmidt's account is colloquial and entertaining, and shows that the author feels the story of physical science to be part of the wonder book of the universe. Dr. Thirring is more severe and academic; but at the same time is lucid and free from exaggerations and misleading illustrations. Mr. Bolton's essay is interesting as the expansion of the 3000-word essay which won the prize offered by the *Scientific American*. Mr. Bolton remarks in his preface that the general drift of the theory was a greater obstacle to an understanding of the subject than the details of the advanced mathematical work, and he has written the book with a lively recollection of his own troubles. The fourth of Messrs. Methuen's publications is the most interesting. It is a collection of the best portions of the essays sent in for the *Scientific American* prize. This book will give hours of interesting reading from a multitude of points of view.

Dr. Dalton's Lectures in Johannesburg have been reproduced attractively and are very readable, while Prof. Gustav Mie gives us the point of view of one who has himself contributed a good deal to the discussion of fundamental physical theories.

The Induction Motor.

The Induction Motor and other Alternating Current Motors. By B. A. Behrend. Second edition, revised and enlarged. Pp. xxiii+272. (New York and London: McGraw-Hill Book Company, Inc., 1921.) 24*s.* net.

A FULL discussion is given in this book of the practical theory of the induction motor and of several of the main types of alternating current motors. The author also gives a historical account of the invention of the induction motor and of the development of its theory. He attributes the invention to Nikola Tesla in 1888. In England it is generally attributed to Ferraris, who certainly made an induction motor, the rotating part of which was a solid copper cylinder, in the autumn of 1885. In this connection also, Baily has some claim to be called the inventor, as he showed a disc revolving in a rotating magnetic field to the Physical Society of London in June 1879. Tesla and the Westinghouse Co., however, were the first to make a motor similar to those used to-day. They had great difficulties to contend with, as the standard frequency of alternating current supply in America in 1888 was 135.

In 1895 the author first developed his theory of the induction motor. He showed that in an ideal motor the locus of the extremity of a vector representing a phase current is a circle, and that from this circle the engineer can foretell the working of the machine. This circle diagram has proved of the greatest value to the designer and is in world-wide use, although it is known that in consequence of certain assumptions made in the course of the proof it is only an approximation. An immense amount of ingenuity has been expended in trying to make it more accurate, but we are very doubtful of the value of these corrected diagrams. Very often the authors unwittingly introduce new assumptions—for instance, that all the vectors lie in one plane—which may introduce appreciable errors into their results.

There are two parts in an induction motor, the stator or fixed part containing the windings carrying the polyphase currents which produce the rotating magnetic field, and the rotor, which is rotated by this field and from which mechanical power is taken from a pulley on its shaft. The induced alternating currents in the rotor are quite distinct, and have a different frequency from the alternating currents in the stator. The mutual inductance coefficients between the stator and rotor windings are not constants, and the inductances of the windings are only approximately constant. The problem is therefore difficult, and great credit is due to the author for discovering that the speed, torque and efficiency at all loads can be found very simply by constructing a certain circle and drawing various lines.

Theory shows that the torque developed when switching one of these motors into circuit is greatly increased by increasing the resistance of the rotating circuits. Many inventions have been devised, so that the resistance of the rotor circuits automatically diminishes as the speed increases, thus securing high initial torque with economic working. It is interesting to learn that in the rotors of the two-phase motors used in the U.S. battleship *New Mexico* there are two windings. The outer is made of a high-resistance alloy and the inner has low resistance. The outer winding produces the initial torque, but the inner produces the greater torque at normal speed.

The author defines the leakage factor of a motor as $L_1L_2/M^2 - 1$, where L_1, L_2 are the inductances of a stator and rotor winding respectively and M is the mutual inductance between them. We much prefer Behn-Eschenburg's definition, namely, $1 - M^2/L_1L_2$. The latter is always a fraction lying in value between 0 and 1. The former varies between 0 and infinity. We also think it better to talk about motors being "in cascade" rather than "in concatenation." We regard this book as an important contribution to the practical theory of alternating current machinery.

A. RUSSELL.

Our Bookshelf.

Memoirs of the Geological Survey. Special Reports on the Mineral Resources of Great Britain. Vol. xxiii.: *Lead and Zinc Ores in the Pre-Carboniferous Rocks of West Shropshire and North Wales.* Part 1, West Shropshire. By B. Smith. Part 2, North Wales. By H. Dewey and B. Smith. Pp. iv+95. (Southampton: Ordnance Survey Office; London: E. Stanford, Ltd., 1922.) 3s. net.

REPORTS on the lead and zinc ores of Scotland, of Cornwall, Devon and Somerset, of the Lake District, and of the carboniferous rocks of North Wales have already appeared, and the three remaining volumes of the series, dealing with British lead and zinc ores in the remainder of the country, are promised shortly. It is of the utmost importance in the interests of economic geology that this work should be done now, before it is too late; but unfortunately it is becoming only too clear that the interest is a purely academic one, and that the industry of lead and zinc mining in Britain is in a moribund condition. It is obviously impossible that our relatively small deposits, some of which have probably been worked for 2000 years, can compete in the world's markets against the vast masses of mineral, the development of which is of quite recent date, which are to be found in the United States, Australasia, Burma, etc., and it must be regretfully admitted that it is impossible to bolster up an industry that has to contend with such crushing disadvantages, both natural and artificial. For reasons that are well known to all students of mineral deposits, our veins of lead ore were richer and more easily worked at the outcrops than they are to-day; we are far indeed from the days of Pliny, according to whom lead was found in Britain near the surface of the ground in such abundance that it was found necessary to limit strictly the output.

The volume before us describes the occurrences of lead and zinc in two districts, which have probably been thus grouped together on account of their marked geological similarity, the ores in both occupying fault fissures in the older rocks of Cambrian, Ordovician and Silurian age. The individual mines are described accurately and minutely, and the description is in many cases supplemented by sections taken from the actual mine plans. It is only to be regretted that more attention has not been paid to the introductory chapters dealing with the districts as a whole, particularly as regards the statistical portion. No summary of district statistics is given for North Wales, and that for Shropshire is indicated only by means of a small graph, which shows the general features of its rise and fall, but from which it is impossible to obtain exact figures.

H. L.

Elementary Chemical Microscopy. By Prof. E. M. Chamot. Second edition, partly rewritten and enlarged. Pp. xvi+479. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1921.) 25s. net.

THE first edition of this work was reviewed at some length in NATURE in 1915 (vol. 96, p. 84) shortly after its appearance. The subject of chemical microscopy, however, received a great impetus during the war, many new applications revealing themselves in the special war industries, which resulted in a more extensive use of the microscope in applied chemistry than at any time during the last quarter of a century. Hence, a new edition of this book was found necessary in America, and it is somewhat disappointing to find that practically no new methods or processes, and but little new apparatus, are described. The lack of photomicrographs of typical microscope fields of characteristic crystals produced in the tests described is still very obvious, but the author on the one hand promises a second book to make good this deficiency, and on the other states that this present book is primarily intended as a text-book (especially for the students of Cornell University), and not as a book of reference, and that the method of instruction in the Cornell course is intentionally one which leads to the best results when the student is encouraged to discover for himself (under guidance) the characteristic morphology of the materials studied.

The same more or less antiquated crystallography is retained, in which such terms as "optical elasticity," "hemihedral," and "tetartohedral" constantly occur, and the confusion between trigonal and hexagonal crystals is so complete that the former term is not even mentioned.

This second edition is, however, an improvement, for several obscure portions of the first edition have been rewritten, and some of the inadequate practical details have been amplified. The chapter on the ultramicroscope stands out, as before, as one of the best in the book, and the later apparatus of Zsigmondy is here described. Moreover, the book is clearly printed in good-sized type, and the illustrations, although only the reproductions of line drawings, are unusually good for this class of figure. A. E. H. T.

(1) *Photo-Engraving Primer: Concise Instructions for Apprentice Engravers or for those seeking simple yet practical knowledge of Line and Half-Tone Engraving.* By S. H. Horgan. Pp. xvi + 100. (London: P. Lund, Humphries and Co., Ltd., 1921.) 5*s.* net.

(2) *Byepaths of Colour Photography.* By O. Reg. Edited and with an Introduction by William Gamble. Pp. xii + 116 + xiii-xx. (London: P. Lund, Humphries and Co., Ltd., 1921.) 5*s.* net.

BOTH these volumes are by "practical men," and they are characterised to the full, if we may say so, by the advantages and the disadvantages that might be expected to result from this fact. Each has a critical and, to a certain extent, supplementary introduction by Mr. W. Gamble, so that the reader may feel fully assured that he is in safe hands. (1) Mr. Horgan goes clearly and concisely over the subject as he has practised it, and as he is a man of great and prolonged experience, his instructions cannot fail to be of value to the student, whether or not he has arrived at the stage of workman. But it is not a treatise on the subject. The author leaves theory quite on one side, though here and there he justifies his directions by a shrewd statement of the trouble likely to follow variations of them. Perhaps the chief matter to notice is that Mr. Horgan uses collodion, while in this country gelatine plates have largely replaced it.

(2) Mr. Reg clearly describes his own system in which he uses a one-exposure camera, with one reflector and one compensator, and plates specially sensitised. He gives full details as to the making of the camera, formulæ for sensitising the plates, and instructions for the general procedure. Rather more than half the volume is devoted to throwing what he calls "side-lights" on certain notions of previous inventors. Here he is not always lucid, and his excursions into theory are not always fortunate. But he has been a diligent searcher with regard to the methods of other workers in this field, and gives many useful dates and references to patents, with illustrations of apparatus. He calls his volume "byepaths," and in this sense it is both useful and interesting. C. J.

Forestry for Woodmen. By C. O. Hanson. Second edition. Pp. 238 + 13 plates. (Oxford: At the Clarendon Press, 1921.) 6*s.* 6*d.* net.

DURING the ten years that have elapsed since the first edition of this book was published, much progress in the art of forestry has been made in this country. The necessity of having within our shores an ample store of growing timber to meet the possible emergency of war, is now admitted by statesmen. The Forestry Commission established in 1919 has been busily engaged in acquiring land for new plantations and in re-afforesting the extensive areas which were denuded of timber during the war. Municipalities are awakening to the useful work of covering their water-catchment areas with trees, as evidenced by the new scheme of the Glasgow Corporation, which, if carried out, will create around Loch Katrine a magnificent forest, such as that owned by Liverpool at Vyrnwy in Wales.

The interest in forestry is increasing, and there is a demand for elementary instruction on the subject. This has been met by the publication of the second edition of this useful manual. It is well adapted for the purpose, being cheap in price, handy in form, and simple in language. Scarcely any change has been made in the original text, but two chapters have been added. One deals with the Forestry Act of 1919 and the Forestry Commission, and gives a summary of recent developments. The other new chapter treats briefly the afforestation of waste land, and gives a sketch of the survey necessary before any planting scheme can be decided upon. The book is brought up to date by the intercalation of a new paragraph here and there, and it may be recommended to landowners, as well as to agricultural students and forestry apprentices, as a satisfactory guide to elementary forestry. The index is, however, incomplete, and should be enlarged to double its present size in a new edition.

Problemi di Filosofia Botanica. By Antonino Borzi. Pp. 344. (Roma: G. Bardi, 1920.) 60 lire.

THE introduction of this posthumous work contains a short historical sketch of vegetable biology, as foreshadowed by the elder Agardh, Delpino (to whose memory the book is dedicated), Haeckel, and others. The scope of the book itself is best indicated by the chapter headings: I. General conceptions and limits of vegetable ecology; II. Ecological principle of vegetable organisation; III. Ecological principles of vegetable associations; IV. Ecology of dissemination; V. Aerophylactic function in the vegetable kingdom; VI. Hydrophylactic function in the vegetable kingdom; VII. Form and evolution of the earliest vegetable life. VIII. Ecological conception of the evolution of the vegetable kingdom.

The author, a specialist on Cyanophyceæ, sums up very ably in chap. vii. his observations on the evolution of that group, and describes their extraordinary adaptability to varying ecological conditions. Continuous vegetative reproduction means a progressive development, from which no return to an earlier stage ever occurs; but development of the sexual function arrests such indefinite evolution and lays the foundation of constant characters. "Mutation" occurs before the development of sex. The polyphyletic origin exemplified in Cyanophyceæ is also manifested in the scheme of the entire vegetable kingdom.

The view generally held, that subaqueous life represents the primitive condition of terrestrial vegetation is regarded as unproved. Hydrophytes and aerophytes are probably two distinct stocks, the former representing primitive vegetation, the latter originating as Vascular Cryptogams at the period of land-emergence. That Bryophytes may possibly be survivals of a transitional stage between Hydrophytes and Aerophytes is not sufficiently clear. These views are set forth in detail.

40 *Blätter der Karte des Deutschen Reiches* 1 : 100,000 *ausgewählt für Unterrichtszwecke.* Erläuterungen bearbeitet von Dr. W. Behrmann. Veröffenlicht von der Gesellschaft für Erdkunde zu Berlin. Zweite Auflage. Size 17 in. × 15 in. Handbook, Pp. 62. (Berlin: R. Eisenschmidt, 1921.) Germany, 60 marks; England, 180 marks.

The portfolio of forty maps under notice consists of reprints of German surveys on the scale of 1 to 100,000. The first edition, published some nine years ago, was essentially the same except for three sheets, Metz, Gebweiler, and Oltingen, which have been omitted since the regions they cover are now outside German territory. Three other sheets have been substituted. The collection has been made for educational purposes, and with this end in view illustrates as many types of land forms and geographical features as possible within the limits of the country. The sheets, which are in black and white, are finely printed and leave no ground for criticism as regards reproduction. Surface features of relief are shown by hachures only. This method, excellent as it may be for a general impression, gives no absolute information and precision of detail. It has also the disadvantage of making the map so dark on the steeper slopes that other symbols, and particularly the names, are almost illegible. In fact, if these sheets have any great fault, it is one common to most German maps, namely, the attempt to show more than the scale will allow. In spite of this, however, the collection should prove extremely useful, and might well be imitated for the British Isles by the Ordnance Survey. A pamphlet giving a description of the sheets accompanies the portfolio.

Physical Map of England and Wales, 1 : 1,000,000. Size $34\frac{1}{2}$ in. × 26 in. (Southampton: Ordnance Survey Office, 1922.) 2*s.* (Not less than 20 copies for educational purposes, 1*s.* each.)

The Ordnance Survey has produced a beautifully printed map which leaves little to be desired in the way of cartographical skill and excellence in reproduction. Surface relief is shown by layer colouring in green and brown. The contours are at 200, 400, 800, 1200, and 2000 feet. Rivers, lakes, and water names are in blue; other names are in black. No submarine relief is shown. The addition of this would improve the map for educational purposes. Some criticism may be offered with regard to the names. These are comparatively few in number; this is certainly an advantage, but a few more names of physical features might have been inserted. The fine black type used for these names does not obscure the map, and we miss such names as Charnwood Forest, Solway Plain, Fenland, Forest Ridges, or Aire Gap. The system on which the town names, printed in heavy black, have been selected is not very apparent. Such towns as Oldham, Sunderland, Gainsboro', Yarmouth, and Goole, to mention only a few large places, are omitted while many relatively unimportant names are to be found. The nearest towns to Manchester to be found on the map are Buxton, Liverpool, and Northwich, while in other less populated parts of the country the names are more crowded. No administrative names and no communications are marked. The low price is noteworthy.

Contribution à l'Étude de la Flore du Katangar. Par E. de Wildeman (Comité Spécial du Katanga). Pp. viii + cxliv + 264. (Bruxelles: D. Reynaert, 1921.) n.p.

The large district of Katanga forms the south-eastern corner of that part of Africa which is now under Belgian rule. It is governed by the Comité Special du Katanga, under the auspices of which this account of the vegetation of the country has been prepared and published. Four districts are recognised in considering the flora, namely, the Kasai, the middle Katanga or Upper Congo, the district of the great lakes, or the Tanganyika region, which forms the eastern limit, and the Upper Katanga district. A sketch is given of the botanical geography of the two last-mentioned districts; and Dr. de Wildeman dissents from Scott Elliot's view that the Tanganyika basin forms botanically merely a part of the great western Congo-Niger area, but regards it as an area with very special characters.

The Upper Katanga is described in greater detail, and some features of its vegetation are illustrated by a number of photographic reproductions. Dr. de Wildeman insists on the importance of the conservation of the forests; the number of useful species at present known is not great, but forestry investigations will probably reveal others. A large portion of the volume is occupied with a systematic enumeration of the flowering plants already known from the area; these number about 1900, but probably represent less than half the actual flora. A map of the whole district, indicating its relation to surrounding districts, would have been a useful addition.

Technique des Pétroles. By R. Courau. Pp. 406 + 19 Plates. (Paris: Octave Doin, 1921.) Price 16 francs.

Practically every phase of petroleum technology is covered by this volume, and as a general text-book it will be of considerable utility. Much of the subject matter is treated somewhat summarily, particularly in the geological section; in fact this suffers from undue brevity when contrasted with the engineering and chemical aspects of the science.

The arrangement of the text is systematic, and it is primarily divided into two books, the first dealing with the geology and economic development of petroleum, and the second with its chemical and physical properties, methods of refining, storage, and transport. Unlike many books of this description, there is no overcrowding with tables of constants, statistics, etc., and space is therefore available for a consideration of certain technical operations which either receive scanty treatment or are omitted altogether from similar publications elsewhere. We should have preferred, however, the inclusion of the figures in the text rather than in their less convenient form of plates at the end of the book, while the omission of a detailed index is also rather unfortunate. Apart from this and the fact that the present rate of exchange makes the book an extremely cheap purchase in this country, it is well worth reading, if only to obtain the French view of current oilfield development and refinery technique.

H. B. Milner.

Letters to the Editor.

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

Discoveries in Tropical Medicine.

IT is a matter for regret that the obituary notice of a well-known medical man should be used to put forward a statement of his share in the progress of knowledge which is misleading. It is necessary to correct such a statement when it is conspicuous and likely to be accepted as truthful. In a brief biography of the late Sir Patrick Manson in the *Times* of April 10, it is stated that "modern tropical medicine" was born when he suggested that the *Filaria sanguinis hominis*—discovered some years previously by Dr. Timothy Lewis in persons afflicted with elephantiasis —"is taken from one person to another by mosquitoes." On the ground that this was the first suggestion as to the carriage of disease-germs by mosquitoes, *and was well founded*, the chief merit in the later discoveries of the part played by those insects in the transmission of malaria and of yellow fever is attributed by the *Times* to Sir Patrick Manson.

This, however, is a misapprehension, the propagation of which must do injustice and falsify history. The fact is that Manson's "suggestion" that the Filaria of elephantiasis is actually carried by mosquitoes from the blood of one person to that of another remains to this day a "suggestion." It has not been established as a fact.

Another important misconception enunciated in the same article is that no suggestion as to the mode of entry of the malaria parasite into the blood of human beings was made until Manson, fourteen years after their discovery by Laveran, "suggested" mosquitoes as the carriers. The fact, on the contrary, is that Laveran himself had stated this to be a possible and not improbable mode of transmission, and that the notion was long ago prevalent in India. The man who actually "discovered" the fact of the carriage of malaria germs by a mosquito and the particular species (*Anopheles maculipennis*) so concerned, as well as important facts as to the multiplication of the malarial parasite in the gnat's body, is Sir Ronald Ross.

Finally, the *Times* states that General Sir David Bruce is a disciple of Sir Patrick Manson. This is a peculiarly unfortunate assertion, for it makes it necessary to state the fact, well known to their colleagues, that Bruce, so far from being a disciple of Manson, disapproved of his suggestions and of his methods. The man of genius who discovered and finally abolished Malta fever, who by laborious years of work in Africa gave us solid and absolutely new knowledge of the Tsetze fly and Trypanosome diseases, nagana and sleeping-sickness—not to mention his war work in conjunction with pupils and colleagues on tetanus and on trench fever—was not in any way, directly or indirectly, influenced by or associated with Sir Patrick Manson. The attempt to associate the discoveries of Bruce with the Manson legend is a mere assertion regardless of fact and of the pain which it must cause to the friends of both.

E. RAY LANKESTER.

April 17.

Atmospheric Refraction.

IN NATURE of August 11, 1921, p. 745, appeared my letter in which I criticised a result stated by Mr. Mallock in NATURE of June 9, p. 456; and also a further brief letter by Mr. Mallock. Further letters have appeared by Dr. Ball (January 5, p. 8) and Instr. Commander Baker, R.N. (January 5, p. 8, and January 26, p. 105). In his second letter Mr. Mallock says that "the pressure gradient near the ground, and the density and refractive-index gradients also, decrease linearly at such a rate that if the linear relation continues to hold, the pressure and density would be zero and the refractive index unity at height H." This statement is incorrect as regards the density and refractive-index gradients, except in the special case when the temperature gradient is zero.

The relation between density and refractive index, $\mu - 1 = K\rho$, where K is constant ($= 222 \cdot 16$ for sodium line D), shows that $d\mu/dh = K d\rho/dh$, and so it is only necessary to consider the density gradient. Using suffixes $_1$, $_0$ to indicate values at sea level and at the upper limit of the atmosphere, the height H of the homogeneous atmosphere is given by $\int_1^0 \rho g dh = \rho_1 g_1 H = p_1$. Hence $p_1/H = \rho_1 g_1$, and by the ordinary mechanical law of equilibrium this is equal to $-(dp/dh)_1$, proving Mr. Mallock's statement as regards the pressure gradient.

Now if the absolute temperature near the level considered (sea level) is given by $t = t_1(1 - \alpha h)$, then $p = Ct\rho = Ct_1(1 - \alpha h)\rho$, which differentiated logarithmically gives for $h = 0$, $(d\rho/dh)_1 = -\rho_1(1 - H\alpha)/H$. This result agrees with Mr. Mallock's only when $\alpha = 0$, that is, when the temperature gradient is zero.

The curvature $1/\sigma$ of a ray inclined at an angle ϕ to the vertical is derived from $\mu r \sin\phi = \text{constant}$, $d\psi = d\phi + \sin\phi ds/r$, whereby $1/\sigma = d\psi/ds = -K \sin\phi d\rho/dh = (1 - H\alpha)\sin\phi \,.\, K\rho/H = (1 - H\alpha)\sin\phi(\mu - 1)/H$, a result applicable to any point of the ray if H is understood to mean the height of the homogeneous atmosphere, of density ρ at the point, above the point. Here again agreement with Mr. Mallock is obtained if $\alpha = 0$ and $\phi = 90°$, *i.e.* for a horizontal ray.

Introducing the temperature gradient $\beta = t_1\alpha$, we see that $H\alpha = C\beta/g_1 = 29 \cdot 28\beta g_{45}/g$. Also $(\mu - 1)/H$ varies as Bg/t^2, B being the barometer reduced reading. Hence

$$\frac{1}{\sigma} = 3 \cdot 665 \times 10^{-5} \frac{B}{760} \cdot \frac{g}{g_{45}}(1 + at)^{-2}\left(1 - 29 \cdot 28\beta' \frac{g_{45}}{g}\right)\sin\phi,$$

where $a = 1/273$, β' is fall of temperature t per metre, and σ is in kilometres. No mention has been made of humidity for the reason that its action is chiefly to modify the temperature gradient, which has been allowed for.

If we multiply $1/\sigma$ by the earth's mean radius, 6371 km., we obtain $2k$, according to the Indian definition of coefficient of refraction k; or k, according to the continental definition. The result is to change the numerical factor in $1/\sigma$ into $0 \cdot 2335$. This agrees well with Jordan's formula quoted by Dr. Ball, which I had not previously seen and which, I believe, has never been used by surveyors. For B = 760 mm. and latitude 45° we can write

$$\sigma = 27285\,(1 + at)^2(1 - 29 \cdot 28\beta')^{-1} \operatorname{cosec}\phi \text{ kilometres.}$$

The following table gives values of the radius of curvature σ in miles of a horizontal ray at level B = 760 mm., and the coefficient of refraction as defined in India.

Gradient. Degrees Centigrade per metre.	σ in miles.		k (Indian).	
	$t=0°$	$t=10°$	$t=0°$	$t=10°$
0·000 (isothermal) .	16,980	18,220	0·117	0·109
0·006 (average) .	20,600	22,100	0·096	0·090
0·010 (adiabatic) .	24,000	25,760	0·082	0·077
0·03414 . . .	infinite		zero	

Mr. Mallock's value, 14,900 geographical miles = 17,150 miles, agrees nearly with the isothermal value for $t=0°$. (In my former letter I had not recognised that Mr. Mallock's result was in nautical miles.) The result is too small as a usual value, because he takes the temperature gradient as zero and the surface temperature to be freezing point. Dr. Ball's explanation is incorrect as pointed out by Commander Baker (January 26); and further in that he states in his second paragraph that the difficulty is not to be got over by any consideration of temperature gradient.

Commander Baker, in his letter (January 5) has arrived at a similar result, for a horizontal ray, as I have. The temperature gradient, however, of 1° C. per 200 feet, which he says will give my results, is in error; it should be per 600 feet.

In the second paragraph of this letter, Commander Baker says that neither Mr. Mallock nor I give an adequate presentation of the facts, in that the assumption is made that the ray is circular. I do not think that this deduction can be made rightly from my former letter of August 11. I may say at once that I entirely agree that the ray is not in general circular, especially when the ray is close to the earth or sea surface. However, in cases met with in land surveys (excepting rays which continue very close to the ground) one may *compute the refraction practically* by the use of a coefficient of refraction which represents the curvature at height $(2h_a+h_b)/3$, as stated in my letter. The use of different coefficients of refraction for different heights essentially involves the idea of a ray of varying curvature except in the case of a truly horizontal ray.

Now work on the diurnal change of refraction on inclined rays shows up the importance of the varying conditions of temperature gradient in the layers near the earth. I have not yet been able to reduce the case of rays, which lie mostly or largely in these lower layers, to a formula, though I think there is fair hope of doing so in some cases. Extreme cases, in which there is obvious and varying mirage, will not be amenable to treatment: but I think a ray, 20 feet above the surface, probably will. But I gather that Commander Baker is chiefly interested in rays over the sea, at a height of 30 feet or less. In the Survey of India such cases naturally do not arise, and I have not had any observations of this kind to consider. However, in my Professional Paper No. 14 (Survey of India) I have given some deductions as regards dip of the horizon (*vide* pp. 96-100), arriving at the formula

Dip in seconds from point at height $h=$

$$56{\cdot}33(h'-15{\cdot}13\Delta t')^{\frac{1}{2}}$$

where $\Delta t'=\mathrm{F}\Delta t$, $h'=h(1-0{\cdot}2204\mathrm{F})/0{\cdot}7796$, $\mathrm{F}=519{\cdot}4/t$, $t+\Delta t$ and t being the absolute temperatures at levels of observer and sea respectively. This formula is based on $\cos(\text{dip})=(1+h/r)^{-1}\mu_0/\mu$ which involves only the terminal values of μ.

I have tabulated the corresponding dip in Tab. LIII. *loc. cit.* for various values of h' and $\Delta t'$, and I should be very interested to hear from Commander Baker or others to what extent my formula represents the facts of observations. J. DE GRAAFF HUNTER.

Survey of India, Dehra Dun, U.P., India, March 2.

I AGREE with Dr. Hunter that my letter of January 5 contained a numerical error when I stated that a temperature gradient of 1° C. per 200 feet would give a ray curvature corresponding to the refraction coefficient given in his letter of August 11, 1921.

Dr. Hunter also takes me to task for my comment that both he and Mr. Mallock assume the refracted ray to be circular. I think I have a certain amount of justification for this, as in his letter of August 11 he speaks of the curvature of the ray "tacitly assumed to be circular," although later it is true that he states that the coefficient of refraction has different values at different heights.

It was rather in connection with the formulæ upon which the nautical tables for the dip of the sea horizon are based that I take exception to any assumption that adequate results can be obtained unless variations of curvature are considered.

As stated in my letter of January 5, it is impossible to draw a circle which touches the surface of the sea and also becomes horizontal at a height of say 30 feet above the sea, and unless consideration is given to a form of ray path that can satisfy these conditions it is impossible to get a zero value for the dip.

Dr. Hunter quotes from his Professional Paper No. 14 (Survey of India) a formula which he has set out there from which the dip is to be evaluated, and asks to what extent this formula represents the facts of observations. I have, unfortunately, no data of measurement of the dip made in connection with the temperatures of the sea level and at the bridge, but on theoretical grounds I cannot admit that this formula is correct. It will be seen that the dip becomes zero whenever $h'=15{\cdot}13\Delta t'$, which is equivalent to saying that, if the temperature rises uniformly 1° F. per 15 feet, the dip is zero at all heights. Consider now what will happen to a ray of light which starts off from the surface of the sea tangentially. In an atmosphere of uniform refractive index that ray would proceed in a straight line and ultimately depart from the earth entirely. With a refractive index that diminishes with height the ray will be bent towards the earth, and if the rate of diminution is great enough that ray will at some point become horizontal and the dip will be zero. Let us say that this point is at a height of 30 feet above the sea. Dr. Hunter's formula requires that the temperature should be 2° more at 30 feet than at sea level, and if the rise of temperature is uniform in this 30 feet his formula also requires that the dip should be zero, and therefore the ray horizontal, at all heights below 30 feet. This is obviously a fallacy, for if the ray was always horizontal it would never reach the height of 30 feet at all.

The fact is that in an atmosphere where the layers of uniform refractive index are spheres concentric with the earth, the dip can only be zero, if at all, at one height. Below that height the dip will be positive with a maximum value at some lower level; above that height no ray tangential to the earth's surface can be seen at all, and the depression or elevation of the sea horizon requires an entirely different explanation.

The equation upon which Dr. Hunter's formula is based brings out this point quite clearly. This equation is

$$\mathrm{Cos}\ (\text{dip}) = \mu_0 r/\mu(r+h).$$

In an atmosphere in which $\mu(r+h)$ is, at some height, less than $\mu_0 r$ the dip becomes imaginary, for its cosine is greater than unity. The dip could only be zero for all heights for an atmosphere in which $\mu(r+h)$ is constant, and in such case a ray once horizontal would remain horizontal for a complete circuit of the earth. THOS. Y. BAKER.

Admiralty Research Laboratory,
Teddington, Middlesex, April 6.

Memory.

MEMORY is the power to learn, to grow mentally in response to functional activity, to profit from experience, and so to become intelligent. It has its counterpart in the power to develop physically in response to use. Its evolution occurred especially among the higher animals, and was accompanied by a general retrogression of instinct. Nevertheless, at least four new instincts were evolved, each of which incites to learning, and without which little or no intelligence could develop, no matter how great the capacity to learn.

(1) The parental instinct incites to the protection and training of offspring. It wanes when offspring are fit to fend for themselves.

(2) The instinct of sport impels the individual to develop both body and mind in exactly the right directions. Thus the kid climbs and butts, and the kitten stalks and pounces. This instinct wanes as the individual reaches maturity and ability to battle for existence. It lingers longest in human beings who remain capable of some mental development even to old age. But the character of human sport gradually changes from those contests of strength and endurance which developed the boy to those which merely maintain physical development, or else are pure contests of skill and wit. Thus the mature man ceases to wrestle, and amuses himself instead with golf, bowls, cards, and the like.

(3) The instinct of imitation incites the individual to learn (from the examples furnished by his companions) how to act and what to think. It often works in combination with play (for much play is mimicry), and wanes in the individual even more swiftly and in a greater degree than the latter. While it persists in strength the individual is termed "plastic." It is best developed in man, who learns through imitation not only such habitual actions as walking and speaking a language, but also the habits of thought, the general outlooks on life, the ambitions, and the emotional convictions as to what is true and right that distinguish the community (or section of it) in which he is reared, savage or civilised, Christian or Mohammedan, Catholic or Protestant, lowly or exalted, and so on. In this way he fits himself for life in that particular environment. Thus, mainly, is fashioned what is termed his "character," his general mental disposition. As the twig is bent, so the tree grows. Hence the importance of good homes, companions, and schools. As this instinct wanes the character sets. The same kind of things are no longer learned, at any rate to the same extent and with equal facility. Compare language as learned by a child and by an adult. It follows that the traits created by imitation tend to be very stable, for they are not afterwards displaced by others of the same kind. The boy becomes the father of the man.

(4) The instinct of curiosity impels the individual to seek for, and learn from, evidence. Unlike imitation, it persists with relatively little diminution even to old age. To it (and to labour) the individual owes the main part of his mental development after childhood, his intelligence, his reason. It creates, not sentimental, but intellectual convictions. Since it persists during life, the ideas acquired through it tend to be unstable—apt to be displaced by others which seem founded on superior evidence.

(5) Apart from instinct, man, especially civilised man, has invented labour, to which he is impelled by the intelligence created through his memory, and from which he learns to become yet more intelligent, efficient, and laborious. Thus, as indicated by Prof. Goodrich, in the mental, as in the physical, world each stage of development furnishes the basis for the next until full development is achieved. Labour commonly lacks the pleasure and interest which accompany the instinctive activities. Thus, while men never delegate the latter (*e.g.* eating, sporting, and love-making) to others, they often delegate the labours to which they are prompted by intelligence. Like play and imitation, but unlike curiosity, labour tends to create habitual "physical" dexterities—which are really mental, for the (subconscious) mind co-ordinates the muscles. On the other hand, the intellectual traits created by labour resemble those created by curiosity.

We are concerned especially with the products of imitation and curiosity. All the rest of the "make-up" of man's mind is relatively simple and obvious. His instincts, few in number and definite in character, are identical in kind for all men. At most this man or this race may have this instinct or that (*e.g.* the sexual or parental) more or less developed than this or that other. Again, all men except idiots are eminently educable. They differ in capacities for learning, but yet more in the way in which the capacity is used. Apart from play and labour, the results of which are glaringly obvious, men learn only through imitation and curiosity; and accordingly as they acquire more through the one than through the other, their characters are shaped and the fates of nations decided. Here must the parent and the pedagogue learn or be impotent. Here must the man of science labour, or charlatans and fanatics will for ever dominate the body politic.

The mental traits created by imitation and curiosity differ sharply. Not only are convictions derived from example very stable, but they are tinged with emotion, and even passion. The reverse is the case with those derived from evidence. Compare moral and religious convictions, which belong to the former category, with business and scientific beliefs, which belong to the latter. A religious and ethical system may conflict daily with common sense (*i.e.* evidence), and yet persist for a hundred generations. But the knowledge and ideas acquired through curiosity change in every man with every year. When men believed on grounds of faith (*i.e.* through imitation) that the world was flat they burned dissentients; to-day, when they believe on grounds of fact (*i.e.* on grounds of evidence) that it is round, they are contemptuously indifferent. Every missionary knows the ease with which the children of non-Christians may be trained to his beliefs and ideals, and the difficulty and danger of trying to convert adults. A child who is taught that honesty is right will for ever hold that opinion; an adult taught that honesty is the best policy may easily change. If there be such things as absolute right and wrong, the human mind is incapable of knowing them; for the conscience, chameleon-like, is a product of imitation. Thus at different times and places everything, from promiscuous sexual intercourse to rigid abstention from all intercourse, has been held holy, or permissible, or damnable, and conscience has pricked men correspondingly.

The traits created by imitativeness—habitual emotions and ways of acting—resemble closely the instinctive emotions and actions. Thus men and horses walk, men and ants are social, men and bees defend their communities; but while the men have learned, the others have not. The love of a human mother for her baby is instinctive, that for her mature offspring is habitual; yet the one passes insensibly into the other. Did we not know that the children of Mohammedans could be trained to other beliefs and ideals we might think the fanaticism of the adults instinctive. So closely do habitual actions and emotions resemble their instinctive prototypes that they are often thus described—as when a woman shrinks from untruth or a caterpillar, or when a boy dodges a blow. Habits are, in fact, pseudo-instincts; they have the same function; they are substitutes. Unlike real instincts, they are not infallibly useful, but, on the whole, they are superior, for they fit the individual to his particular environment, and, since they may change in future generations otherwise than by slow processes of natural selection, may be improved more rapidly.

On the other hand, the traits created by curiosity bear no resemblance to instincts. They are intellectual, not emotional. In the little child the two instincts work hand in hand, but in the adult they are often opposed; for the traits derived from imitation (faith, right belief, and morality, as we term them in ourselves; bias, prejudice, fanaticism, and superstition, as we call them in others) may prevent the development of those traits which curiosity should bestow—as is best seen among savages, creatures of custom and emotion, who, following from age to age in the ancestral footsteps, add little to their command over nature. Among modern civilised peoples the ecclesiastical mind is especially a product of imitation, the scientific mind of curiosity. Consider how unlike they are, and how different all societies trained mainly through imitation (*e.g.* medieval Christians and modern Mohammedans) are from those trained through curiosity (*e.g.* ancient Greeks and the more "enlightened moderns").

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Walaeus and the Circulation of the Blood.

IT has been my good fortune to come across two epistles written by Johannes Walaeus (1604–1649), professor of medicine in the University of Leyden in the year 1640. The two epistles occur at the end of Bartholini's "Anatomy," published by Nich. Culpeper, Gent., and Abdiah Cole, Doctor of Physick: printed (in English) by Peter Cole; London, 1665.

Walaeus was greatly interested in the discovery of the circulation of the blood by Harvey, and in order to confirm it performed a large number of experiments on dogs, cats, rabbits, and monkeys. Having arrived at the conclusion already reached by Harvey, that the blood does not move itself, but is driven, he asks the questions "How is it driven?" and "What is the mechanism?" The answer is given in these two epistles written by Johannes Walaeus to his friend Bartholini, the professor of anatomy at the University of Copenhagen, and is as follows:—

"And that the Blood is driven by the *Vena Cava* into *the right Earlet of the Heart*, I have manifestly seen in the dissection of live Creatures: for in all motions of the Heart, the first beginning of Motion is so or no, because the Cava was knit to the Earlet [*i.e.* Auricle] and the Heart, we cut the Heart and the Earlet quite off in living Dogs, at the *Vena Cava*, and we observed, that even then the *Vena Cava* did a very little pulse, and at every time did send forth a little Blood. And therefore the *Vena Cava* hath certain fleshy fibres, for the most part about the Heart, which elsewhere you shall not find in *Vena Cava*. Now the motion of the *Vena Cava* is most evident near the Heart."

Writing in 1913 Sir James Mackenzie says: "Until very recent times no definite remains of the sinus venosus had been found. Keith and Clark have described a small node of tissue—the sino-auricular node—at the mouth of the superior vena cava. This tissue consists of fine, delicate, pale fibres faintly striated." In the same year Dr. (now Sir Thomas) Lewis tells us that "the wave of contraction starts in a small and newly discovered mass of tissue the sino-auricular node, which lies embedded in the upper and anterior end of the sulcus terminalis."

On the subject of auricular fibrillation Walaeus is also very interesting for he tells us that "the Impulse into both Earlets and into both Ventricles happens at one and the same moment of time; save in Creatures ready to die, in which we have observed that both Earlets, and both Ventricles do not pulse at one and the same time. But when the Blood is thus driven into the Ventricles of the Heart, the Heart hath no motion evident to the Eye, but putting our Finger upon the Heart we perceive something to enter into the Heart, and that the Heart becomes fuller, which also Harvey hath observed. Yea, we have observed that the Earlet hath pulsed seventy, sometimes an hundred pulses before any motion of the Heart followed." Somewhat similar observations had, however, already been made by Harvey ("De motu cordis et sanguinis," 1628, Chapter IV.).

G. ARBOUR STEPHENS,
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April 2.

Transcription of Russian Names.

SOME 35 years ago I made in the columns of NATURE the proposal to adopt for the transcription of Russian names a few letters from the Bohemian alphabet. My letter was submitted to the authority of the editor of the Journal of the Chemical Society (for I was at that time Abstractor of that Journal for Russian literature), but he did not agree with my proposal, though later he accepted it for the Journal.

I beg to repeat my old proposal; for a great part of Russian scientific life is concentrated in Prague, and the Bohemian mode of transcription has, moreover, been accepted by philologists and by many geographers. Bohemian is now the State-tongue of an independent State. It is necessary to introduce only the following few letters: č = tch, ď = dj, ě = ye, ch = kh, ň = nj, š = sh, ť = tj, and ž = zh (joli); á = long a, and if you add the Bohemian ř which has two pronounciations: rž and rš, you can pronounce also all Bohemian names.

The following comparison between the old and new mode of spelling shows that the latter has also the advantage of a great economy in printing:

Tchitcherine (12)	= Čičerin (7)
Zhemtchuzhnyj (13)	= Žemčužnyj (9)
Mendeleeff	= Mendělějev
Konj (4)	= Koň (3)
Tatjana (8)	= Taťána (6)
Pushkine (8)	= Puškin (6)
Djadja (6)	= Ďáda (4)
Metchnikoff (11)	= Měčnikov (8).

BOHUSLAV BRAUNER.

Chemical Laboratory,
Bohemian University, Prague,
March 9.

Evolutionary Faith and Modern Doubts.[1]

By W. BATESON, F.R.S.

I VISIT Canada for the first time in delightful circumstances. After a period of dangerous isolation, intercourse between the centres of scientific development is once more beginning, and I am grateful to the American Association for this splendid opportunity of renewing friendship with my western colleagues in genetics, and of coming into even a temporary partnership in the great enterprise which they have carried through with such extraordinary success.

In all that relates to the theme which I am about to consider we have been passing through a period of amazing activity and fruitful research. Coming here after a week in close communion with the wonders of Columbia University, I may seem behind the times in asking you to devote an hour to the old topic of evolution. But though that subject is no longer in the forefront of debate, I believe it is never very far from the threshold of our minds, and it is with pleasure that I find it appearing in conspicuous places in several parts of the programme of this meeting.

Standing before the American Association, it is not unfit that I should begin with a personal reminiscence. In 1883 I first came to the United States to study the development of Balanoglossus at the Johns Hopkins summer laboratory, then at Hampton, Virginia. This creature had lately been found there in an easily accessible place. With a magnanimity that on looking back I realise was superb, Prof. W. K. Brooks had given me permission to investigate it, thereby handing over to a young stranger one of the prizes which in this age of more highly developed patriotism, most teachers would keep for themselves and their own students. At that time one morphological laboratory was in purpose and aim very much like another. Morphology was studied because it was the material believed to be most favourable for the elucidation of the problems of evolution, and we all thought that in embryology the quintessence of morphological truth was most palpably presented. Therefore every aspiring zoologist was an embryologist, and the one topic of professional conversation was evolution. It had been so in our Cambridge school, and it was so at Hampton.

I wonder if there is now a single place where the academic problems of morphology which we discussed with such avidity can now arouse a moment's concern. There were of course men who saw a little further, notably Brooks himself. He was at that time writing a book on heredity, and, to me at least, the notion on which he used to expatiate, that there was a special physiology of heredity capable of independent study, came as a new idea. But no organised attack on that problem was begun, nor had any one an inkling of how to set about it. So we went on talking about evolution. That is barely 40 years ago; to-day we feel silence to be the safer course.

Systematists still discuss the limits of specific distinction in a spirit which I fear is often rather scholastic than progressive, but in the other centres of biological research a score of concrete and immediate problems have replaced evolution.

Discussions of evolution came to an end primarily because it was obvious that no progress was being made. Morphology having been explored in its minutest corners, we turned elsewhere. Variation and heredity, the two components of the evolutionary path, were next tried. The geneticist is the successor of the morphologist. We became geneticists in the conviction that there at least must evolutionary wisdom be found. We got on fast. So soon as a critical study of variation was undertaken, evidence came in as to the way in which varieties do actually arise in descent. The unacceptable doctrine of the secular transformation of masses by the accumulation of impalpable changes became not only unlikely but gratuitous. An examination in the field of the interrelations of pairs of well-characterised but closely allied "species" next proved, almost wherever such an inquiry could be instituted, that neither could both have been gradually evolved by natural selection from a common intermediate progenitor, nor either from the other by such a process. Scarcely ever where such pairs co-exist in nature, or occupy conterminous areas do we find an intermediate normal population as the theory demands. The ignorance of common facts bearing on this part of the inquiry which prevailed among evolutionists was, as one looks back, astonishing and inexplicable. It had been decreed that when varieties of a species co-exist in nature, they must be connected by all intergradations, and it was an article of faith of almost equal validity that the intermediate form must be statistically the majority, and the extremes comparatively rare. The plant breeder might declare that he had varieties of Primula or some other plant, lately constituted, uniform in every varietal character and breeding strictly true in those respects, or the entomologist might state that a polymorphic species of a beetle or of a moth fell obviously into definite types, but the evolutionary philosopher knew better. To him such statements merely showed that the reporter was a bad observer, and not improbably a destroyer of inconvenient material. Systematists had sound information, but no one consulted them on such matters or cared to hear what they might have to say. The evolutionist of the 'eighties was perfectly certain that species were a figment of the systematist's mind, not worthy of enlightened attention.

Then came the Mendelian clue. We saw the varieties arising. Segregation maintained their identity. The discontinuity of variation was recognised in abundance. Plenty of the Mendelian combinations would in nature pass the scrutiny of even an exacting systematist and be given "specific rank." In the light of such facts the origin of species was no doubt a similar phenomenon. All was clear ahead. But soon, though knowledge advanced at a great rate, and though whole ranges of phenomena which had seemed capricious and disorderly fell rapidly into a co-ordinated system, less and less was heard about evolution in genetical circles, and now the topic is dropped. When students of other

[1] Address delivered before the American Association for the Advancement of Science at Toronto on December 28, 1921.

sciences ask us what is now currently believed about the origin of species we have no clear answer to give. Faith has given place to agnosticism for reasons which on such an occasion as this we may profitably consider.

Where precisely has the difficulty arisen? Though the reasons for our reticence are many and present themselves in various forms, they are in essence one; that as we have come to know more of living things and their properties, we have become more and more impressed with the inapplicability of the evidence to these questions of origin. There is no apparatus which can be brought to bear on them which promises any immediate solution.

In the period I am thinking of, it was in the characteristics and behaviour of animals and plants in their more familiar phases, namely, the zygotic phases, that attention centred. Genetical research has revealed the world of gametes from which the zygotes—the products of fertilisation—are constructed. What has been there witnessed is of such extraordinary novelty and so entirely unexpected that in the presence of the new discoveries we would fain desist from speculation for while. We see long courses of analysis to be travelled through and for some time to come that will be a sufficient occupation. The evolutionary systems of the eighteenth and nineteenth centuries were attempts to elucidate the order seen prevailing in this world of zygotes and to explain it in simpler terms of cause and effect: we now perceive that that order rests on and is determined by another equally significant and equally in need of "explanation." But if we for the present drop evolutionary speculation it is in no spirit of despair. What has been learned about the gametes and their natural history constitutes progress upon which we shall never have to go back. The analysis has gone deeper than the most sanguine could have hoped.

We have turned still another bend in the track and behind the gametes we see the chromosomes, for the doubts—which I trust may be pardoned in one who had never seen the marvels of cytology, save as through a glass darkly—cannot, as regards the main thesis of the Drosophila workers, be any longer maintained. The arguments of Morgan and his colleagues, and especially the demonstrations of Bridges, must allay all scepticism as to the direct association of particular chromosomes with particular features of the zygote. The transferable characters borne by the gametes have been successfully referred to the visible details of nuclear configuration.

The traces of order in variation and heredity which so lately seemed paradoxical curiosities have led step by step to this beautiful discovery. I come at this Christmas season to lay my respectful homage before the stars that have arisen in the west. What wonder if we hold our breath? When we knew nothing of all this the words came freely. How easy it all used to look! What glorious assumptions went without rebuke. Regardless of the obvious consideration that "modification by descent" must be a chemical process, and that of the principles governing that chemistry, science had neither hint, nor surmise, nor even an empirical observation of its working, professed men of science offered positive opinions very confidently on these nebulous topics which would now scarcely pass muster in a newspaper or a sermon. It is a wholesome sign of return to sense that these debates have been suspended.

Biological science has returned to its rightful place, investigation of the structure and properties of the concrete and visible world. We cannot see how the differentiation into species came about. Variation of many kinds, often considerable, we daily witness, but no origin of species. Distinguishing what is known from what may be believed, we have absolute certainty that new forms of life, new orders and new species have arisen on the earth. That is proved by the palæontological record. In a spirit of paradox even this has been questioned. It has been asked how do you *know* for example that there were no mammals in palæozoic times? May there not have been mammals somewhere on the earth though no vestige of them has come down to us? We may feel confident there were no mammals then, but are we sure? In very ancient rocks most of the great orders of animals are represented. The absence of the others might by no great stress of imagination be ascribed to accidental circumstances.

Happily, however, there is one example of which we can be sure. There were no Angiosperms—that is to say, "higher plants" with protected seeds—in the carboniferous epoch. Of that age we have abundant remains of a world-wide and rich flora. The Angiosperms are cosmopolitan. By their means of dispersal they must immediately have become so. Their remains are very readily preserved. If they had been in existence on the earth in carboniferous times they must have been present with the carboniferous plants, and must have been preserved with them. Hence we may be sure that they did appear on the earth since those times. We are not certain, using certain in the strict sense, that the Angiosperms are the lineal descendants of the carboniferous plants, but it is very much easier to believe that they are than that they are not.

Where is the difficulty? If the Angiosperms came from the carboniferous flora why may we not believe the old comfortable theory in the old way? Well so we may, if by belief we mean faith, the substance, the foundation of things hoped for, the evidence of things not seen. In dim outline evolution is evident enough. From the facts it is a conclusion which inevitably follows. But that particular and essential bit of the theory of evolution which is concerned with the origin and nature of *species* remains utterly mysterious. We no longer feel as we used to do, that the process of variation, now contemporaneously occurring, is the beginning of a work which needs merely the element of time for its completion; for even time cannot complete that which has not yet begun. The conclusion in which we were brought up, that species are a product of a summation of variations, ignored the chief attribute of species, that the product of their crosses is frequently sterile in greater or less degree. Huxley very early in the debate pointed out this grave defect in the evidence, but before breeding researches had been made on a large scale no one felt the objection to be serious. Extended work might be trusted to supply the deficiency. It has not done so, and the significance of the negative evidence can no longer be denied.

When Darwin discussed the problem of inter-specific sterility in the "Origin of Species" this aspect of the matter seems to have escaped him.[1] He is at great pains to prove that inter-specific crosses are *not always* sterile, and he shows that crosses between forms which pass for distinct species may produce hybrids which range from complete fertility to complete sterility. The fertile hybrids he claims in support of his argument. If species arose from a common origin, clearly they should not always give sterile hybrids. So Darwin is concerned to prove that such hybrids are by no means always sterile, which to us is a commonplace of every-day experience. If species have a common origin, where did they pick up the ingredients which produce this sexual incompatibility? Almost certainly it is a variation in which something has been added. We have come to see that variations can very commonly—I do not say always—be distinguished as positive and negative. The validity of this distinction has been doubted, especially by the Drosophila workers. Nevertheless in application to a very large range of characters, I am satisfied that the distinction holds, and that in analysis it is a useful aid. Now we have no difficulty in finding evidence of variation by loss. Examples abound, but variations by addition are rarities, even if there are any which must be so accounted. The variations to which inter-specific sterility is due are obviously variations in which something is apparently added to the stock of ingredients. It is one of the common experiences of the breeder that when a hybrid is partially sterile, and from it any fertile offspring can be obtained, the sterility, once lost, disappears. This has been the history of many, perhaps most of our cultivated plants of hybrid origin.

The production of an indubitably sterile hybrid from completely fertile parents which have arisen under critical observation from a single common origin is the event for which we wait. Until this event is witnessed, our knowledge of evolution is incomplete in a vital respect. From time to time a record of such an observation is published, but none has yet survived criticism. Meanwhile, though our faith in evolution stands unshaken, we have no acceptable account of the origin of "species."

Curiously enough, it is at the same point that the validity of the claim of natural selection as the main directing force was most questionable. The survival of the fittest was a plausible account of evolution in broad outline, but failed in application to specific difference. The Darwinian philosophy convinced us that every species must "make good" in nature if it is to survive, but no one could tell how the differences—often very sharply fixed—which we recognise as specific, do in fact enable the species to make good. The claims of natural selection as the chief factor in the determination of species have consequently been discredited.

I pass to another part of the problem, where again, though extraordinary progress in knowledge has been made, a new and formidable difficulty has been encountered. Of variations we know a great deal more than we did. Almost all that we have seen are variations in which we recognize that elements have been lost. In addressing the British Association in 1914 I dwelt on evidence of this class. The developments of the last seven years, which are memorable as having provided in regard to one animal, the fly Drosophila, the most comprehensive mass of genetic observation yet collected, serve rather to emphasise than to weaken the considerations to which I then referred. Even in Drosophila, where hundreds of genetically distinct factors have been identified, very few new dominants, that is to say positive additions, have been seen, and I am assured that none of them are of a class which could be expected to be viable under natural conditions.

If we try to trace back the origin of our domesticated animals and plants, we can scarcely ever point to a single wild species as the probable progenitor. Almost every naturalist who has dealt with these questions in recent years has had recourse to theories of multiple origin, because our modern races have positive characteristics which we cannot find in any existing species, and which combinations of the existing species seem unable to provide. To produce our domesticated races it seems that ingredients must have been added. To invoke the hypothetical existence of lost species provides a poor escape from this difficulty, and we are left with the conviction that some part of the chain of reasoning is missing. The weight of this objection will be most felt by those who have most experience in practical breeding. I cannot, for instance, imagine a round seed being formed on a wrinkled variety of pea except by crossing. Such seeds, which look round, sometimes appear, but this is a superficial appearance, and either these seeds are seen to have the starch of wrinkled seeds or can be proved to be the produce of stray pollen. Nor can I imagine a fern-leaved Primula producing a palm-leaf, or a star-shaped flower producing the old type of *sinensis* flower. And so on through long series of forms which we have watched for twenty years.

Analysis has revealed hosts of transferable characters. Their combinations suffice to supply in abundance series of types which might pass for new species, and certainly would be so classed if they were met with in nature. Yet, critically tested, we find that they are not distinct species, and we have no reason to suppose that any accumulations of characters of the same order would culminate in the production of distinct species. Specific difference therefore must be regarded as probably attaching to the base upon which these transferables are implanted, of which we know absolutely nothing at all. Nothing that we have witnessed in the contemporary world can colourably be interpreted as providing the sort of evidence required.

Twenty years ago, de Vries made what looked like a promising attempt to supply this so far as Oenothera was concerned. In the light of modern experiments, especially those of Renner, the interest attaching to the polymorphism of Oenothera has greatly developed, but in application to that phenomenon the theory of mutation falls. We see novel forms appearing, but they are no new species of Oenothera, nor are the parents which produce them pure or homozygous forms. Renner's identification of the several complexes allocated to the male and female sides of the several types is a wonderful and significant piece of analysis introducing us to new genetical conceptions. The Oenotheras illustrate in

[1] He refers to it, however, in "Animals and Plants," chap. xix., and adduces the sterility which he observed in several of his illegitimately raised plants of Lythrum, arguing that this sterility, arising from the crossing of co-derivatives, is comparable with that produced by the intercrossing of true species. The details are given in "Forms of Flowers," chap. v. Without more evidence the genetical nature of these plants cannot be conjectured with much confidence, but it is highly improbable that the parallel really holds.

the most striking fashion how crude and inadequate are the suppositions which we entertained before the world of gametes was revealed. The appearance of the plant tells us little or nothing of these things. In Mendelism, we learnt to appreciate the implication of the fact that the organism is a double structure, containing ingredients derived from the mother and from the father respectively. We have now to admit the further conception that between the male and female sides of the same plant these ingredients may be quite differently apportioned, and that the genetical composition of each may be so distinct that the systematist might without extravagance recognise them as distinct specifically. If then our plant may by appropriate treatment be made to give off two distinct forms, why is not that phenomenon a true instance of Darwin's origin of species? In Darwin's time it must have been acclaimed as supplying all and more than he ever hoped to see. We know that that is not the true interpretation for that which comes out is no new creation.

Only those who are keeping up with these new developments can appreciate fully their vast significance or anticipate the next step. That is the province of the geneticist. Nevertheless, I am convinced that biology would gain greatly by some co-operation among workers in the several branches. I had expected that genetics would provide at once common ground for the systematist and the laboratory worker. This hope has been disappointed. Each still keeps apart. Systematic literature grows precisely as if the genetical discoveries had never been made, and the geneticists more and more withdraw each into his special "claim"—a most lamentable result. Both are to blame. If we cannot persuade the systematists to come to us, at least we can go to them. They too have built up a vast edifice of knowledge which they are willing to share with us, and which we greatly need. They too have never lost that longing for the truth about evolution which to men of my date is the salt of biology, the impulse which made us biologists. It is from them that the raw materials for our researches are to be drawn, which alone can give catholicity and breadth to our studies. We and the systematists have to devise a common language.

Both we and the systematists have everything to gain by a closer alliance. Of course we must specialise, but I suggest to educationists that, in biology at least, specialisation begins too early. In England certainly, harm is done by a system of examinations discouraging to that taste for field natural history and collecting, spontaneous in so many young people. How it may be on this side, I cannot say, but with us attainments of that kind are seldom rewarded, and are too often despised as trivial in comparison with the stereotyped biology which can be learned from text-books. Nevertheless, given the aptitude, a very wide acquaintance with nature and the diversity of living things may be acquired before the age at which more intensive study must be begun, and is the best preparation for research in any of the branches of biology.

The separation between the laboratory men and the systematists already imperils the work, I might almost say the sanity, of both. The systematists will feel the ground fall from beneath their feet, when they learn and realise what genetics has accomplished, and we, close students of specially chosen examples, may find our eyes dazzled and blinded when we look up from our work-tables to contemplate the brilliant vision of the natural world in its boundless complexity.

I have put before you very frankly the considerations which have made us agnostic as to the actual mode and processes of evolution. When such confessions are made the enemies of science see their chance. If we cannot declare here and now how species arose, they will obligingly offer us the solutions with which obscurantism is satisfied. Let us then proclaim in precise and unmistakable language that our faith in evolution is unshaken. Every available line of argument converges on this inevitable conclusion. The obscurantist has nothing to suggest which is worth a moment's attention. The difficulties which weigh upon the professional biologist need not trouble the layman. Our doubts are not as to the reality or truth of evolution, but as to the origin of *species*, a technical, almost domestic, problem. Any day that mystery may be solved. The discoveries of the last twenty-five years enable us for the first time to discuss these questions intelligently and on a basis of fact. That synthesis will follow on an analysis, we do not and cannot doubt.

Alternating-Current Mineral Separation.[1]

By PROF. S. J. TRUSCOTT, Imperial College (Royal School of Mines), South Kensington.

INVESTIGATION of the possible use of alternating current in magnetic separation, either in the direction of obtaining a rotary field by polyphase currents, or otherwise, has hitherto not resulted in any useful discovery. Recently, however, Mr. W. M. Mordey, past president of the Institution of Electrical Engineers, by arranging poles energised by two-phase currents to follow one another across the stream, has succeeded in driving iron minerals and iron compounds in that direction. This effect is not one of ordinary magnetic attraction and repulsion, but apparently a display of "hysteretic repulsion," a repulsion consequent upon the magnetism residual after each alternation, and made continuous by the moving field contributed by polyphase current.

A laminated alternating-current magnet behaves towards magnetite or iron-filings much like a direct-current magnet, in that tufts of these materials form at the poles, from which lines of force radiate. On the other hand, towards such a feebly magnetic mineral as hæmatite no attraction appears to be exercised but a decided repulsion is witnessed, for example, when a dish containing powdered hæmatite is laid upon an upturned pole. This repulsion is continuous when the dish spans a number of poles and these are energised by polyphase current. Similar repulsion of magnetite occurs at a lower excitation or when the dish is lifted sensibly off the poles.

[1] W. M. Mordey, Transactions South African Institute of Electrical Engineers, December 1921.

From the foregoing it seems probable that ordinary magnetic attraction and hysteretic repulsion determine between them the behaviour of particles in the field of an alternating-current magnet. Of these two factors the former is fairly understood; it remains to indicate one or two points concerning the latter. Hysteretic repulsion is low and attraction relatively high when the frequency of alternation is low, and *vice versa*; Mr. Mordey found that, with an increase of frequency from 25 to 75 periods, the speed at which the material was repelled increased approximately as the square of the increase in frequency. At higher frequencies, however, repulsion appears to be again inactive; Mr. Mordey, for example, found that both at 150 periods and at 350, repulsion was not manifest but attraction, even hæmatite remaining over the poles. He used relatively low inductions, 560 to 2000, these being more proper to alternating current than the higher inductions associated with direct current in ordinary magnetic separation.

The continuous repulsion of the ferriferous particles across the stream is forceful and unhesitating, whether these particles be dry or borne in water; it is assisted by an upward repulsion which frees them from entanglement with associated gangue, and gives them power to climb an inclination or even the sides of the container. At the same time, however, these particles, and particularly those of magnetite, tend to be held strongly in the plane of their movement, so that unless the field be properly adjusted transverse walls or banks form such as hinder the escape of gangue.

To make use of this discovery Mr. Mordey has in mind a shallow inclined launder down which the material would flow in the condition of an ore-pulp. With poles running the length of this launder the ferriferous particles would be driven to one side, to be collected separately at the bottom, the gangue particles keeping a straight path.

It is interesting that only iron minerals have so far been found capable of making the transverse movement, such moderately magnetic minerals as ilmenite and wolframite not moving; it is also of interest that, though magnetite moves more strongly, hæmatite can hardly be said to be outclassed; further, a small contamination with iron oxide causes other minerals to move, wolframite and cassiterite, for instance.

Obviously, therefore, though magnetic susceptibility is doubtless involved it does not enter unfettered; as already stated, it is associated with hysteretic repulsion. That the repulsion may be due to eddy currents set up in the particles appears to be excluded by the fact that the conductivity of hæmatite is not high enough to permit any pronounced development of such currents; moreover, particles of metallic aluminium, the conductivity of which is very high, are not repelled.

It is to be hoped that this process of magnetic separation may so develop that deposits, such as that at Dunderland, Norway, which contain much hæmatite in addition to magnetite, and others consisting largely of granular hæmatite, may be successfully treated. In view of the many deposits coming within these descriptions, and of the fact that the present means of magnetic separation, good as they are for dry work, fail entirely to separate feebly-magnetic minerals from a water-borne pulp, any endeavours to realise this hope will be viewed by all with the greatest sympathy and interest. The ordinary magnetic concentration of magnetite is not an expensive treatment, but the treatment outlined by Mr. Mordey, being simplicity itself, would cost still less.

Obituary.

PROF. J. C. BRANNER.

PROF. JOHN CASPER BRANNER, president emeritus of Stanford University, California, died at Palo Alto, California, on March 1, in his seventy-second year. He was a geologist of stimulating activity, and was attracted to Brazil as a young man in 1874 through his master at Cornell, C. F. Hartt. In 1875 he succeeded Hartt as director of the Imperial Geological Commission in Brazil, and, on the establishment of the republic, continued his observations in that country on various expeditions from time to time. In 1885 he was appointed professor of geology in Indiana University, and in 1892 to the similar post in the newly founded Stanford University. He won a considerable position as an economic botanist, and his geological papers cover a wide and practical field. His "Outlines of the Geology of Brazil," the second edition of which was published in the Bulletin of the Geological Society of America as recently as 1920, has been noticed in NATURE, vol. 106, p. 58. This very useful summary includes a geological map of the whole country on the scale of 1 : 5,000,000.

Many European geologists will remember Branner at the International Geological Congress in Zürich in 1894, and all who met him must have been won by his strong personality and his equally strong and manly presence. It is characteristic of his outlook that in his most recent treatise he hopes that his work may be of service to the Brazilian people, "to whom I am strongly attached, and in whose welfare I am deeply interested."

We owe some of the facts and dates in the foregoing notice to an appreciative article by Dr. David Starr Jordan in *Science* for March 31, and to an obituary notice in the *American Journal of Science* for April.

DR. ANDREW MCWILLIAM, C.B.E.

THE death of Dr. Andrew McWilliam, which occurred on April 5, came as a shock to a large circle of friends and former pupils, and deprives the steel world of a metallurgist of great knowledge and wide experience. A native of Galloway, Dr. McWilliam was educated at Allan Glen's School, Glasgow, and at the Royal School of Mines, of which he became an Associate. On leaving South Kensington, he entered the Sheffield Technical School, afterwards incorporated with the University of Sheffield, but later he left to take up in succession several outside posts. Returning to Sheffield, he was first appointed lecturer, and then assistant professor, in metallurgy, and began that long association with Dr. Arnold in the development of the University as a centre of metallurgical education and research. Besides the work of training chemists and managers for the steel industry of the city, the two collaborators published numerous papers containing important contributions to metallurgy, and were always ready to assist local manufacturers by advice, by conducting special investigations, and when necessary by defending their patent rights against attacks.

In 1911 Dr. McWilliam left for India to become government inspector of steels in that country, and held that responsible position for six years. He then entered the Tata Iron and Steel works and for a year did excellent service in the technical reorganisation of the steel departments. On his return to Sheffield he took up a consulting practice, for which he was peculiarly qualified from his intimate knowledge of the manufacture and properties of steels of high quality. As an active member of technical societies, he could always be counted on to illuminate a discussion by drawing on his stores of experience and by his shrewd criticism and ready wit. His good literary style is seen to advantage in the well-known work "Modern Foundry Practice," which he wrote in collaboration with Dr. Longmuir. Of fine presence and genial manner, he was a popular figure in the city of his adoption, and enjoyed the esteem and affection of his friends and colleagues, among whom were so many who owed to him a part of their metallurgical training.

WE learn from the *British Medical Journal* of the death on March 26 of Dr. W. Ainslie Hollis at the great age of eighty-two years. Dr. Hollis was educated at Cambridge and St. Bartholomew's Hospital, receiving his M.D. in 1871. He was elected a Fellow of the Royal College of Physicians of London in 1876. Most of his life was spent at Brighton, where he set up in private practice; but his activities led him more to literary and scientific pursuits, during the course of which he made a fine collection of British macro-lepidoptera. He was president of the Brighton and Sussex Medico-Chirurgical Society and of the Brighton Natural History and Philosophical Society, and in 1913 he served as president on the occasion of the Brighton meeting of the British Medical Association. Dr. Hollis was the author of numerous contributions to medical journals on disseminated fibrosis of the kidney, the duration of life in infective endocarditis and other topics.

THE death is announced, in his sixty-third year, of Dr. Henry Edgerton Chapin, who was professor of biology in Ohio University from 1891 to 1900. He then removed to New York to teach biology and physiography in the high schools there. He was the author of many scientific monographs, and collaborated in writing Chapin and Rettger's "Elementary Zoology and Guide."

WE much regret to announce the death on April 21, in his seventy-third year, of Sir Alfred Bray Kempe, F.R.S., treasurer of the Royal Society from 1898 to 1919.

WE regret to record the death on April 19, at seventy years of age, of Sir Alfred Pearce Gould, K.C.V.O., late vice-chancellor of the University of London, and president of the Medical Society of London and of the Röntgen Society.

Current Topics and Events.

AT the meeting of the London Mathematical Society to be held on May 11, at 5 P.M., in the rooms of the Royal Astronomical Society, Burlington House, Prof. G. H. Hardy will deliver a lecture on "The Elements of the Analytic Theory of Numbers." Members of other scientific societies will be welcome.

THE Institute of Physics, of which Sir J. J. Thomson is president, is arranging for the delivery of a course of public lectures with the view of indicating the growing importance and place which physics now holds in industry and manufacture. The first of these lectures was delivered by Prof. A. Barr of Glasgow, on Wednesday, April 26, in the Hall of the Institution of Civil Engineers.

RAI BAHADUR SARAT CHANDRA ROY is carrying on with a considerable measure of success his new quarterly journal of anthropology, entitled *Man in India*. The third number contains two important articles by Mr. T. C. Hodson, the author of works on the Nagas and other Assamese tribes, on exogamy in India and free marriage, which merit the attention of anthropologists, besides shorter notes on the Kharwars and Khasis and on Indian palæoliths. The journal, which is published at Church Road, Ranchi, deserves encouragement.

A JOHN SCOTT medal and certificate, with a premium of 160*l*., has been awarded by the Board of Directors of City Trusts, United States of America, to each of the following: Dr. William Duane, for "his researches in radio-activity and the physics of radium and of X-rays"; Prof. R. A. Fessenden, for "his invention of a reception scheme for continuous wave telegraphy and telephony"; Mr. Elwood Haynes, for "his discoveries in connection with stainless steel, stellite, chrome-iron, etc."; and Dr. T. B. Osborne, for "his researches on the constitution of the vegetable proteins."

THE annual meeting of the Iron and Steel Institute will be held on May 4-5 at the house of the Institution of Civil Engineers. On the first day of the meeting, the new president, Mr. Francis Samuelson, will deliver his presidential address, and the Bessemer Medal will be presented to Prof. Kotaro Honda. The remainder of the meeting will be devoted to the discussion of some thirteen papers by various workers on the constitution, properties, and manufacture of iron and steel. The annual dinner of the Institute will be held on May 4 at 7.30 P.M. at the Connaught Rooms, Great Queen Street, W.C., and the autumn meeting will be held in London on September 5-7 next.

MR. JOHN PLACE, 16 The Avenue, Beckenham, Kent, directs our attention to a phenomenon known to the guides at the Solfatara of Pozzuoli near Naples, but not, as he believes, satisfactorily explained. When a lighted torch of brushwood or tarred string is introduced into, or merely waved near any of the crevices from which gases emanate, the emanation appears to be greatly increased and "smoke and steam issue from the spot where the torch is waved," and even from fissures at a considerable distance. We suggest that the burning of the torch provides nuclei for condensation of vapour; for clouds gathering in a volcanic crater have been traced, in some cases at least, to atmospheric vapour influenced by the fine ejecta from the vent.

THE issue of the index numbers of the physics and electrical engineering sections of *Science Abstracts* completes volume 24 of each. The physics section extends to more than 900 pages, 800 of which are occupied by 2000 abstracts, while the electrical engineering section of 650 pages devotes 600 pages to nearly 1200 abstracts. Both volumes are rather larger than pre-war issues, while the number of abstracts is approximately the same. The increase of length of the abstracts is scarcely justified by any increase in the intrinsic importance of the matter abstracted. The greater average length of the electrical engineering as compared with the physics abstracts is due mainly to the number of descriptions of power plants and installations. *Science Abstracts* continues to be one of the most valuable and time-saving publications issued in this country; without it, research in physics and electrical engineering would be seriously hampered and progress retarded.

THE issue of *Science* of March 31 contains an account of the opening of the Norman Bridge Physics Laboratory of the Californian Institute of Technology at Pasadena, South California. The laboratory and equipment have been provided by Dr. Norman Bridge with the object of furthering work of the highest type in the mathematical and physical sciences and their applications. In the opinion of Dr. Millikan no subject furnishes a better training in accurate observation, honest and dispassionate treatment of data, and logical deduction of consequences, while the classics are gradually disappearing as the foundation of the American educational system. The physics laboratory, of which Prof. Millikan has been appointed director, and the Gates Chemical Laboratory with Dr. Noyes as director, are to receive 7000*l.* per annum for five years from the Carnegie Corporation, and will thus be able to co-operate with the Mount Wilson Observatory in a joint investigation of the constitution of matter and the nature of radiation.

IN a paper read at a recent meeting of the Royal Colonial Institute, Mr. J. M'Whae, Agent-General for Victoria, dwelt on the importance of white settlement of the "heart of Australia," an area of over half a million square miles lying approximately within a circle of 400 miles radius, the circumference of which passes through Sydney, Melbourne, and Adelaide. This area at present contains only 3,300,000 inhabitants, although it comprises as great an area as France, Germany, Denmark, Switzerland, Holland, and Belgium together. He admitted, however, that the problem is not merely one of attracting population but depends also on the provision of a sufficiency of water. Artesian wells number over 5000, and there are in addition many shallow bores in the Riverina. In Victoria to-day 14,000,000 acres out of 56,000,000 acres are being artificially irrigated. The Murray river valley offers the greatest opportunities and considerable areas of arid land have been reclaimed. The greater part of the "heart of Australia" must, however, depend on artesian water, and to what extent this supply is inexhaustible remains to be seen.

THE annual report of the Smithsonian Institution of Washington for 1919 is a volume of nearly six hundred pages, of which the greater part is composed, as is customary, of noteworthy contributions to science which were made known during that year. In all, twenty-eight such publications are included. Sir Ernest Rutherford's article, "Radium and the Electron," which appeared in the Jubilee issue of NATURE of November 6, 1919, and Sir Arthur Keith's presidential address at the Bournemouth meeting to Section H (Anthropology) of the British Association on "The Differentiation of Mankind into Racial Types," from NATURE of November 13, 1919, are reprinted. There are also two translations, "On the Extinction of the Mammoth," by H. Neuville, which is taken from *L'Anthropologie* of July 1919, and "A Great Chemist: Sir William Ramsay," by Ch. Moureu, from *Revue Scientifique* of October 1919. Some of the remaining papers are reprinted from American journals and a few are original. The volume forms a valuable record of notable announcements in the world of science for the year 1919.

WE have received from Messrs. Harbutt's Plasticine, Ltd., of Bathampton, an inexpensive outfit for mounting insects and other natural history objects. The apparatus is very simple and consists of "thymo-plas," which is plasticine impregnated with a strong preservative, slides of celluloid, and binding strips of gummed paper. In using this method, a narrow strip of "thymo-plas" is used to form a cell of the desired shape on the centre of a celluloid slide: the object to be mounted is then transferred to the cavity thus formed and a second slide of celluloid is pressed down on top. The opposite ends of the two superposed slides are securely bound together with strips of gummed paper, and the mount is then complete. The paper strips also serve as labels upon which the necessary data relating to the specimen may be recorded. Any one who tries this method will find no difficulty in carrying it out; groups of insect eggs *in situ* on leaves or twigs, coccids, larval tubes, cocoons, pupæ, etc., can all be well exhibited when mounted in this way. The method can also be applied to samples of seeds, fibres, small shells, and many other objects. In so far as adult insects are concerned the specimens are not so well displayed as when pinned and set, but on the other hand, they are secure against damage, and the "thymo-plas" method should be valuable for teaching purposes when specimens must of necessity be handled frequently. Collections mounted in this manner can be stored in microscope slide cabinets with undivided trays. By way of advertisement it is stated that "thymo-plas" is "adopted by Prof. Lefroy as the standard method for use in the Entomological Department, Royal College of Science, London." The price of the outfit is 3*s.* and 6*s.* according to size.

Two catalogues of second-hand works of science, each of exceptional interest, have recently reached us, namely, Sotheran's Catalogue of Science and Technology, No. 3, and Heffer's Catalogue (No. 210) of Scientific Books and Publications of Learned Societies. In the former list many works from the libraries of the late Profs. Carey Foster, J. Perry, and P. Duhem are offered for sale. In the latter a prominent feature is sets of scientific journals. The catalogues are obtainable free of charge from their respective publishers—H. Sotheran and Co., 140 Strand, W.C.2, and W. Heffer and Sons, Ltd., Cambridge.

Our Astronomical Column.

The April Meteors, 1922.—Mr. W. F. Denning writes that what appears to have been the most brilliant and abundant shower of Lyrids observed during the present century was witnessed by Miss A. Grace Cook and Mr. J. P. M. Prentice, of Stowmarket, on the night following April 21. Miss Cook, watching the sky up to 13 hours G.M.T., observed 30 Lyrids, and a number of others must have escaped observation while the paths of the brighter meteors were being recorded. Eight of the meteors seen were brilliant, six of them being estimated as equivalent to, or surpassing, the lustre of Jupiter. The maximum of the display apparently occurred in the two hours preceding midnight; the meteors moved swiftly, leaving trails. The brightest object appeared at 11 h. 12 m. G.M.T., and it left a conspicuous streak which remained visible for twenty seconds. Mr. Prentice also watched the progress of the shower, and saw many brilliant meteors, though the sky was partly clouded at times.

At Bristol the sky was overcast during the whole night, and no meteors could be seen.

Eccentricity of Double-Star Orbits.—Prof. H. N. Russell shows (*Pop. Ast.*, March) that it is possible to deduce average eccentricities, by statistical methods, even in the case of those long-period systems in which only a very small portion of the orbit has been described. All that is necessary is to note the angle between the tangent and the radius-vector, and compare the observed distribution of angles with that resulting from different assumed values of eccentricity. From observations of 750 pairs he deduces a mean eccentricity slightly greater than 0·6, about the same as that given by stars the orbits of which have been determined. This is an important result from the cosmogonic point of view, as the orbits now considered must be very large, and the periods measured by millenniums.

Progressive Latitude Changes.—The reported change of the latitude of the International Station at Ukiah, California, at the rate of a foot a year, recently attracted considerable notice. Prof. F. Schlesinger devotes an article to the subject in *Astr. Journ.*, 798. He notes that Cohn's proper motions (depending on the Auwers system) are used for the latitude stars at the International stations, and that they differ systematically from those of Boss. The following list shows the apparent annual change of latitude of the six stations—(1) using Cohn's system and (2) using Boss's: Mizusawa, Long. $-141°$ (1), $+0·0008''$ (2), $-0·0079''$; Tschardjui, Long. $-63°$ (1), $+0·0110''$ (2), $+0·0023''$; Carloforte, Long. $-8°$ (1), $+0·0053''$ (2), $-0·0034''$; Gaithersburg, Long. $+77°$ (1), $+0·0103''$ (2), $+0·0016''$; Cincinnati, Long. $+84°$ (1), $+0·0099''$ (2), $+0·0012''$; Ukiah, Long. $+123°$ (1), $+0·0106''$ (2), $+0·0019''$. It will be seen that the systematic northward shift resulting from Cohn's values vanishes when Boss's are used. If we ascribe the changes to a motion of the pole, the indicated motion is 5 inches per annum towards North America. We may, however, consider that at Mizusawa, which is in a volcanic region, there is an actual surface shift of 10 inches per annum southward; the shifts at the other stations are small enough to be regarded as accidental. Prof. Schlesinger urges that observations at the second, fourth, and fifth stations, which were dropped during the war, should be resumed, at least temporarily.

Effective Temperatures of Stars.—Various methods used to obtain stellar temperatures give different results, yet it is interesting to note that the divergences are not great; indeed, for stars of classes G, K, and M, stars of comparatively low temperature, the agreement is fairly close. The cause of these disagreements lies probably in the fact that each observer has limited himself to a portion of the spectrum only, which may not necessarily contain the observed maximum spectral energy. Dr. W. W. Coblentz, in the Proceedings of the National Academy of Sciences (U.S.A.) (vol. 8, No. 3, p. 49), gives the results of his inquiry into the effective temperatures of 16 stars as estimated from the energy distribution in the complete spectrum.

By means of screens of red and yellow glass, quartz, and water he found it possible to obtain the radiation intensity in the spectrum in consecutive portions from $0·3\mu$ to 10μ. In addition to an interesting table giving a comparison of the total radiation from stars having closely the same visual magnitude but of very different spectral class, Dr. Coblentz sums up his results in another table, comparing his stellar temperatures with values previously obtained by other workers. As the values he has deduced will prove very useful for reference they are here reproduced, commencing with the hottest stars and passing through the various stellar types, taking class Go as standard.

Star.	Spectrum Type.	Temp.
ϵ Orionis	Bo	13,000° K
β Orionis	B8p	10,000
α Lyræ	Ao	8,000
α Can. Maj.	Ao	8,000
α Cygni	A2	9,000
α Aquilæ	A5	8,000
α Can. Min.	F5	6,000
α Aurigæ	Go	6,000
α Bootis	Ko	4,000
β Geminorum	Ko	5,500
α Tauri	K5	3,500
α Orionis	Ma	3,000
α Scorpii	Ma p	3,000
β Androm.	Ma	4,000
μ Geminorum	Ma	3,500
β Pegasi	Mb	3,000

Research Items.

The Dispersion of Flies by Flight.—A definite knowledge of this subject is of importance in measures of control or repression. It is also of significance in the study of the spread of fly-borne diseases. Messrs. Bishopp and Laake (*Journ. Agric. Research*, xxi. No. 10, Aug. 15, 1921) have conducted an extensive series of observations with several species of common flies, using an estimated total number of 234,000 specimens in the experiments. These were marked by being liberated into bags containing finely powdered red chalk or paint pigment, and afterwards allowed to escape. In order to ascertain the distance of dissemination, baited fly-traps were set at measured distances, in different directions, from the point of liberation. The experiments carried out show that under rural and urban conditions flies have marked powers of diffusion; similar results obtain for both the sexes, although in very different proportions in different species. The common house fly, *Musca domestica*, was recaptured at a distance of more than 13 miles from the point of liberation, *Chrysomya macellaria* 15 miles, and *Phormia regina* nearly 11 miles. The fact that many favourable feeding and breeding grounds were passed over by the flies appears to indicate that, in so far as the above three species are concerned, very evident migratory habits are noticeable. The authors conclude that, under natural conditions, the influence of moderate winds on dissemination is not of great importance. The speed of flight is evidently considerable; thus *Phormia regina* was recovered about 11 miles away in less than 48 hours after release, and *Musca domestica* travelled over 6 miles in less than 24 hours. The stimuli affecting dispersion appear to be so blended and mixed as to make it impossible to judge their relative importance.

The Ascent of Sap.—Sir J. C. Bose informs us that he has carried out a series of investigations at the Bose Institute, Calcutta, which affords a complete explanation of the phenomenon of the ascent of sap, and its diverse manifestations. The following is a short summary of the results: (1) It is shown that the ascent of sap is a process of physiological activity dependent on the pulsation of living cells inasmuch as it is arrested by the action of poison, either in entire plants or in cut shoots. (2) The active pulsating cells are not confined to the root, but are continued throughout the stem. It has been ascertained that in the stem of Dicotyledons, these cells constitute the cortical layer which abuts upon the endodermis. (3) The velocity of the ascent has been determined by three independent methods, which give concordant results. The ascent takes place in plants even in the complete absence of transpiration. In "varnished" plants this velocity has been found sometimes to be as high as 70 metres per hour. (4) The cellular pulsations have been investigated and their characteristics determined from automatic records; they consist of alternate contractions and expansions. (5) The direction of propulsion is determined by the phase differences of the adjacent cells. The velocity increases with the wave length of the propagated impulse. This wave length is determined experimentally from definite points of electric maxima and minima. Enhancement of velocity is associated with corresponding increase in the wave length. (6) The enhanced rate of ascent is also attended by the increase of amplitude and frequency of cellular pulsations. (7) Ascent of sap depends upon cellular pulsation in tall trees as well as in herbaceous plants. There is, however, in the former the special adaptation of the woody tissue which serves as a reservoir to meet the excessive demand for water in the season of active transpiration. When this reservoir is more or less depleted, the phenomenon of "negative pressure" is manifested.

Norwegian Explorations in Spitsbergen.—In 1917 the Norwegian Government decided to undertake the systematic survey and exploration of the western part of the mainland of Spitsbergen between Ice Fjord and the South Cape. This was in continuance of previous Norwegian work under the auspices of the Prince of Monaco on the west coast between the north of Spitsbergen and Ice Fjord. The work was to include geological exploration and hydrographical survey in coastal waters, where this was incomplete. In "Revue de Geographie Annuelle," Tome ix., Fascicules iv.-v., 1922, Mr. A. Hoel gives a full account of the surveys made in 1919, 1920, and 1921, when he was in charge, and a summary of the whole work, which is now virtually completed after five summers in the field. Only a few small gaps in the survey between Horn Sound and the South Cape remain to be filled in. Altogether some 4800 sq. kilometres of land surface have been surveyed. The most striking geological results are the proof of the Ordovician age of the Hecla Hook beds of the west coast, and the discovery that beds ranging from Carboniferous to Tertiary ages form the greater part of the coastal region south of Horn Sound where the Hecla Hook beds were supposed to predominate as they do farther north. The botanical researches, of which some important results have already been published, promise to be of great interest.

Tertiary Fossils of Peru.—We have received a copy of "Illustrations of the Tertiary Fossils of Peru," by H. Woods, T. Wayland Vaughan, and J. A. Cushman. It consists of twenty-four plates of fossils and their explanations, without any indication of the source of issue or the possibility of accompanying text. We understand, however, that they are intended to illustrate a forthcoming work on the "Geology of N.W. Peru," by Dr. T. O. Bosworth. The first twenty plates deal with Mollusca, and for these Mr. Woods is responsible, Mr. Vaughan answering for three of Corals, and Mr. Cushman for the one of Foraminifera. This separate issue will be very welcome to palæontological students, who will at once recognise the wonderful similarity of these Peruvian fossils to those of our British Oligocene and Eocene; indeed one, *Venericardia planicosta*, is said to be identical, while there is a Clavilithes, which the author, doubtless on good grounds, cites as a new species, but which one might be forgiven for mistaking for *C. longævus*. Mr. T. A. Brock, the draughtsman of the plates, is to be congratulated on his beautiful figures, which have been most admirably reproduced: we have seen nothing better.

Records of Palæontological Research.—It is well from time to time to emphasise the value of the simple paper-bound guides to the British Museum collections as means of keeping the student in touch with the developments of research. The tenth edition of "A Guide to the Fossil Reptiles, Amphibians, and Fishes" has just appeared, with 8 plates and 117 text-figures, price 2*s*. (1922). Here will be found the Downtonian ostracoderms of Lanarkshire, the problematic Palæospondylus, Ichthyosaurus from Lyme Regis, clothed in a habit drawn from German specimens, and Tritylodon, placed clearly with the theriodonts. One of the plates shows the immense proportions of the hind limb and tail of the Cetiosaurus discovered by A. L. Leeds near Peterborough.

THE LIMBS OF TRILOBITES.—Those zoologists and palæontologists who have been fortunate enough to look through P. E. Raymond's recent monograph on the trilobites (see NATURE, vol. 108, p. 481) will be glad to note Dr. C. D. Walcott's additions, comments, and suggestions as to limb-structure, in his recent paper on the Cambrian Neolenus (Smithsonian Misc. Coll., vol. 67, No. 7, 1921). The author proposes to put forward the results of further investigations into the organisation of trilobites "in the course of two or three years," so that our anticipations when directing attention to the stimulating nature of Raymond's paper were evidently correct.

GEOLOGY FOR TOWNSMEN.—The Geological Survey of Great Britain has done great service to those who dwell or work in London by issuing a memoir by H. Dewey and C. C. A. Bromehead on "The Geology of South London" (Ordnance Survey, Southampton, 1921, price 3*s.* 6*d.*). This describes the country covered by the recent colour-printed map, showing superficial deposits, Sheet 270, on the scale of 1 : 63,360. Starting from the gravels of Ealing, Hyde Park, and Millwall on the north, we can realise, as in a series of pictures, the broad exposures of London clay south of the Thames, supporting at Wimbledon outliers of Glacial gravel; and in the south we reach the chalk at Sutton, and rise to the unspoiled uplands of Banstead Downs and Sanderstead. The geological colouring well marks out the old valley, widening quickly on the clay, by which the railways now reach Croydon from the south. The memoir contains a view of the area in 1794, looking across London from the north, and another of Richmond at about the same date. The sources of these should have been mentioned; they appear to be from separately published plates. A city and suburban map, of equal interest, but of a very different nature, is the Johannesburg Sheet (52) of the Geological Survey of South Africa. The scale is near 1 : 150,000. With the attached longitudinal section, it is an admirable exposition of the geological relations of the Witwatersrand system, and the moderate price of 5*s.* includes a memoir by C. T. Mellor and A. L. Du Toit (Pretoria, 1921). The area covers the whole historic mining district, and extends across the dolomite to the reappearance of the Rand rocks at Heidelberg.

ELECTRIFICATION OF PHOSPHORUS SMOKE NUCLEI.—With reference to a note on electrical precipitation which appeared in NATURE of March 23, p. 388, we have received a paper by J. J. Dowling and C. J. Haughey (Proceedings of the Royal Irish Academy, vol. 36, Section A, No. 3) on the electrification of phosphorus smoke nuclei. The authors' experiments indicate that the nuclei in the smoke of phosphorus slowly oxidising in air acquire charges in an electric field, that the charges depend on the strength of the field, and that they vary in whole multiples of the electron. Charges from one to twenty-five electrons were observed. They also indicate that when large numbers of particles, of nearly equal sizes and charged equally, are exposed to the same electric field, the particles may be dragged through a comparatively narrow channel in the air, and may carry the air in this channel along with them. The mobilities of particles in fumes exposed to electric fields may, therefore, exceed considerably what might be expected for the limiting velocity according to Stokes's law applied to isolated particles (as in the well-known experiments of Millikan). This effect is obviously of importance in precipitation apparatus, and careful quantitative experiments of this kind should be of assistance in the design of such apparatus.

A NEW SCIENCE MICROSCOPE.—We have received from Mr. C. Baker of 244 High Holborn, W.C.1, an example of his new Science Microscope which has been specially designed to meet the requirements in science schools (Fig. 1). The stand is a single casting with a foot of the horse-shoe type but with a posterior limb which gives complete stability. A large square stage, 4·2 in. ×4·2 in. is provided with mirror below, with plain and concave surfaces. The coarse adjustment, of the diagonal rack and pinion type, gives a motion slow enough to enable the user to focus with comfort a $\frac{1}{6}$-in. objective—actually we found that even a $\frac{1}{12}$-in. objective could be used without difficulty. A combination 1 in. and $\frac{1}{2}$ in. objective was supplied and both powers were found to give excellent definition and flat field. The instrument is well finished, rigid in all parts and strongly built, and should prove a very serviceable one capable of withstanding rough usage. For the stand alone the price is 4*l.* 10*s.*, or with a No. 3 eyepiece and combination 1 in., $\frac{1}{2}$ in. and $\frac{1}{4}$ in. objective, 6*l.* 17*s.* 6*d.* In this particular instrument, the objective thread did not seem to be exactly the R.M.S. standard size, for we were unable satisfactorily to attach a Zeiss, a Leitz and four Swift lenses, which themselves were completely interchangeable on their respective instruments.

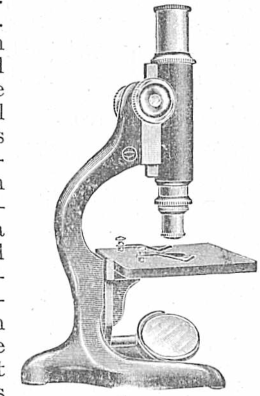

FIG. 1.

THERMOMETERS FOR MEASURING ROCK TEMPERATURES.—An interesting new type of thermometer has recently been designed and constructed by Messrs. Negretti and Zambra, for the purpose of measuring the surface temperature of rocks, sand, or other materials. Since the difficulty in design lies in securing that the bulb shall take up accurately the temperature of the surface, whatever the other attendant circumstances may be, the new features of the instrument mentioned are associated with the bulb end of the thermometer. The other end of the thermometer is simply supported so that the stem, which is about 15 cm. long, lies parallel to the surface and about 0·5 cm. from it. At the bulb end the stem is curved so that the bulb (of rather larger size than in a clinical thermometer) lies along and almost touching the surface. Actual contact is effected by a thin flat copper plate lying on the surface and attached to the bulb, which itself is copper-plated on the outside. The under surface of the plate is roughened, and its relatively large surface (it is about 1 cm. wide) quickly takes up the temperature of the rock by conduction and radiation, and conducts the heat rapidly to the glass bulb. The upper surface of the plate, and the plated surface of the bulb, are polished to prevent radiation to or from the surrounding objects. The bulb is further insulated by a polished reflector which covers it almost entirely, and prevents radiation while also reducing conduction of heat by air currents. The reflector is gilt in order that it shall not become tarnished. The mass of the bulb is small, so that it possesses little thermal capacity and scarcely disturbs the condition of temperature existing before placing the bulb on the rock; the thermal inertia is also small for the same reason. The makers state that on holding the bulb near to the side of the radiator with the polished surface facing the radiator, the thermometer shows no change of reading, but on turning it round so that the flat copper plate faces the radiator, the column at once begins to move.

The Aryan Problem.

ON March 28, Mr. Harold Peake made a communication to the Royal Anthropological Institute on the subject of Bronze Swords and the Aryan Problem. He began by describing a type of sword, with a long tang cast to fit the hand, the Type II. of Naue, which is believed to have originated in the Danube basin. He showed how the butt of the blade had passed from a depressed semicircle through various forms to that of a flattened oval, and how its convex outline had then gradually become concave; he then divided the swords into a progressive series of seven types. He explained how the first of these had developed from a dagger, while the last had been found in the Hallstatt cemetery, where iron weapons had been the rule.

Mr. Peake next considered the distribution of the series, showing that type A was of Hungarian origin; type B ranged thence northwards to Denmark; type D was found in Greece and Egypt and in certain regions of Italy; type E ranged across France, England, and Ireland; type F was absent from Hungary and was confined to the mountain region of central Europe; while type G, the Hallstatt type, was also absent from the Hungarian plain but widely distributed to the west and north.

It was suggested that the Egyptian specimens were relics of the Ek-wesh, who invaded Egypt in 1220 B.C., and that those from Greece had been introduced by the Achæan invaders, who were, Mr. Peake thought, only a few wandering heroes, of Thraco-Phrygian origin, who made themselves masters of city states in Greece. This gave an approximate date to type D of 1250–1150 B.C., while type G could not be earlier than 1000–900 B.C.; he suggested that type A was evolved after 1400 B.C.

It was argued that the distribution of these swords must be referred rather to invasion than to trade, and it was suggested that peoples emerging from the Hungarian plain and adjoining mountain regions had passed thence, in 1350 to Denmark, in 1250 to Greece and Italy, and in 1150 to France and Britain.

Mr. Peake then discussed the absence of types F and G from Hungary, and showed evidence of the departure of some of these people through the Dukla pass, across Galicia and Podolia to the Koban. He showed how they learnt the use of iron from tribes on the southern slopes of the Caucasus and suggested their return to Hungary with their new weapons. Some of these invaded Greece as Dorians, while others pressed up the Save to the iron-fields and to Hallstatt for the salt-mines; they destroyed the lake-dwellings in the mountain zone, whence refugees fled down the Rhine to Holstein, to the east of England and to Ireland, while others passed through the Belfort gap into France and thence down the Rhone, Loire, and Seine. Other invaders crossed the Predel pass into Italy, destroyed the *terra-mara* culture of the Po Valley, and settled north of the Apennines near Bologna, introducing the Villanova culture, while others again passed by the old route into France, and followed the refugees down the Rhone and Loire but not down the Seine.

Thus there were two movements of peoples allied but in some ways distinct. The first waves had bronze swords and included the refugees from the lake-dwellings of the mountain zone; the second wave had iron swords and were the Dorians, Villanova, and Hallstatt peoples.

Turning to the linguistic side, Mr. Peake sketched in outline the Aryan hypothesis and referred to a paper published in 1891 by Sir John Rhys. In this paper it was suggested that two waves of similar people had dispersed from central Europe, westward and southward, the first speaking Q and the second P tongues. To the first belonged Gaelic, Erse, Latin, and Ionic Greek, to the second Welsh, Osco-Umbrian, and Greek. Sir John Rhys had suggested that the second wave consisted of non-Aryan people, probably from the Swiss lake-dwellings, who had learnt Aryan speech from their subjects.

Mr. Peake pointed out that Sir John's theory had not been well received, especially in Germany, and that certain of his conclusions could not be accepted. The Ionic dialect of Herodotus was not an archaic form, though perhaps Thraco-Phrygian might represent the Q form of Greek speech. Again, evidence was against the Swiss lake-dwellers being the conquering labialisers. Still archæology showed evidence of two dispersals, and it might be that Sir John's theory was correct in the main though erroneous in some of its details.

The case was tested in Italy, where Mr. Peake showed that the bronze swords were confined to a definite region, mainly around Fucino, while the Villanova culture centred chiefly north of the Apennines. He exhibited a map of the Latin or Q dialects, which coincided very nearly with the distribution of the bronze swords, except in one or two particulars, and to account for these he related a story told by Dionysius of Halicarnassus how the Aborigines dwelt in this area, but one night the Sabines, a P people, issuing from Amiternum, dislodged some of them, who eventually marched towards Rome and settled there.

Mr. Peake suggested that the Italian test seemed to prove that so far as this peninsula was concerned the archæological and philological evidences agreed. In Greece the first wave consisted of a few heroes only, the second wave was the only true invasion; here, as would be expected, we had only P speech. In France both waves covered the same ground, except that in the valley of the Seine the latter was lacking. It was in this valley that we had the best evidence of Q speech in Gaul, the river Sequana and the tribe Sequani. He maintained, therefore, that the equations all round were as clear as could be expected, and that the main features of Sir John Rhys' hypothesis were justified.

British swords for 25 years and that he agreed with
Mr. Parker Brewis said that he had been studying the typological scheme proposed by Mr. Peake. He was also prepared to accept the dates, though type G lasted in Britain to a much later date. Mr. E. C. R. Armstrong also agreed with the typology and chronology, but said that the philologists of Dublin would not accept the view that the Q people had ever settled in England.

After some remarks by Mr. Parkyn, Mr. Peake replied that his chronology referred to central Europe and not to Britain, and that he was well aware of the views of the Dublin philologists. He was prepared to admit, at any rate for the sake of argument, that there was no linguistic evidence for the early presence of Q people in England, but that such negative evidence was not conclusive in the light of the positive evidence he had adduced. At the request of the chairman, Dr. A. C. Haddon, he then outlined his views on the racial affinities of the people he had been discussing, and on the original dispersion of the Aryan people.

Woollen and Worsted Research.

THE annual report of the Council of the British Research Association for the Woollen and Worsted Industries for the year 1921 gives details of the progress which the Association is making, and includes some lines of its future activities. The Association is now in its fourth year, though it is only during the past year that its building and equipment have been sufficiently completed to furnish the research staff with reasonable facilities for extensive development of its work. The main activities of the Association during the year have resulted from the work of the research, education, and sheep-breeding committees of the Council of the Association, on which expert advisory members are co-opted.

As the publications of the Association are circulated to its members only, and to certain allied associations and institutions, it is difficult to estimate the actual extent of the work of the Association. One interim report has, however, been published dealing with faults caused by oils, effect of light on oil stains, photomicrographic work on raw wool, standard conditions for measuring wool fibre diameters, cross-sections of wool fibre, polarity of the worsted sliver, construction and control of the humidity room, and the effect of oil stains on dyeing. Two reports including observations on the elasticity and setting of wool by time, heat, and moisture, and work on the dyeing and burldyeing of union cloths have also been published. In view of its importance in the textile industry, it is surprising to find that the effect of light on the oils themselves does not appear to have been studied.

Reports are also in preparation on the fastness of dye-stuffs on woollen material, the sorption of neutral soap by wool and its bearing on scouring and milling processes, and on the methods of estimation and analysis of soap in cloth and yarn. In addition the research committee has sketched out a bold and comprehensive programme of research. The programme includes problems presenting themselves in most sections of the textile trade, and of its allied branches. The committee has obviously attempted to avoid "the short-sighted policy of confining research organisations to the search for results of immediate commercial value," and if results in some only of the branches named in the programme are forthcoming in future years, the Association should render help of the greatest value to the industry.

The education committee of the Association has been active in its efforts to co-ordinate textile educational work. As a result of a joint meeting with the Board of Education, the National Wool (and Allied) Textile Industrial Council, and the City and Guilds of London Institute, a Joint Advisory Education Committee has now been formed, which will assist the Board of Education and the City and Guilds of London Institute in textile educational matters. The education committee of the Association has itself drawn up syllabuses of textile courses, and has secured the provision of some research fellowships for textile work.

Coal Resources of South Africa.

UNDER the title "Recent Additions to our Knowledge of the South African Coalfields," Dr. E. T. Mellor has contributed a paper to the Transactions of the Geological Society of South Africa, vol. 25, which supplies a much-needed summary of the coal resources of South Africa.

The Witbank or Middleburg coalfield is the most important, and owing to the fact that it is comparatively readily accessible to the main line of the Transvaal-Delagoa Bay railway, it has been more extensively worked and more thoroughly prospected than any of the others. It is comparatively free from disturbances of any great importance, and the continuity of the seams has now been fairly well proved for a length of some 45 miles. There are five and in places six seams, the two most important being the No. 2 Seam, averaging 16 to 20 feet in thickness, and the No. 4 seam, averaging 24 feet, and in places reaching a thickness of 27 feet. All these coals are somewhat variable in character, there being some areas, fortunately quite extensive, in which the coal is of good quality with a relatively low ash, whilst in others the ash is much higher, owing, according to the author, to certain conditions that prevailed at the time of its deposition. In one block of 7000 acres, a tonnage of over 214 million tons has been proved, and the whole field is estimated as being capable of yielding at least 1000 million tons of coal of an evaporative power of 12·5 or over.

The Komatipoort coalfield has disappointed the expectations that were at one time formed of it and, in Dr. Mellor's words, "its prospects as a coalfield must be regarded as very doubtful."

In Swaziland recent boring operations have proved the existence of several seams, mostly thin, of coal of high quality, though the total tonnage likely to be developed does not at present appear to be very considerable.

In the Waterberg district several seams of good coal have recently been discovered, but owing to the distance from any line of railway, this field cannot be looked upon as of any value in the immediate future.

The Natal coalfield differs in many respects from that in the Witbank district; the coal seams are thinner, rarely exceeding 5 feet, and they have been broken up and greatly affected by intrusions of dolerite. Moreover, they lie relatively deep, and for these reasons are gassy and present greater working difficulties than the coal of the Transvaal field. The quality of the coal is good, but the prevailing impression as to the available quantity appears to be greatly exaggerated. It is now estimated that the best Natal coal is likely to be exhausted in another 40 or 50 years.

These statements show that the Witbank coalfield must be looked upon as the main source of South African coal supplies, and this field presents numerous advantages, amongst them being the shallowness of the seams and the ease with which they can be worked. South Africa may therefore be reasonably expected to become a formidable competitor in the world's coal markets, and to develop an important coal export trade. Coal is also likely to play an important part in the development of local industries, amongst which iron manufacture will probably be one of the most important. The main obstacles at present are the inadequacy of railway transport to the coast and the want of proper shipping facilities. It is obvious that both of these difficulties can easily be overcome, and when they are, South Africa will be ready to take full advantage of this additional source of wealth.

H. L.

A National Council for Mental Hygiene.

A GENERAL meeting will be held at 5 o'clock on Thursday, May 4, in the rooms of the Royal Society of Medicine, Wimpole Street, in order to decide on the constitution, officers, etc., of the new National Council for Mental Hygiene. The provisional committee consists of Sir Courtauld Thomson (chairman), Sir Norman Moore, Sir Charles Sherrington, Sir John Goodwin, Sir George Newman, Sir Walter Fletcher, Dr. C. H. Bond, Dr. Bedford Pierce, Prof. George Robertson, Dr. C. S. Myers, Dr. G. Ainsworth, Dr. Helen Boyle, Dr. Edwin Bramwell, Dr. Farquhar Buzzard, Sir Maurice Craig, Lord Dawson of Penn, Sir Horatio Donkin, Prof. Elliot Smith, Dr. Edwin Goodall, Dr. Henry Head, Dr. Crichton Miller, Sir Frederick Mott, Dr. W. H. R. Rivers, Sir Humphry Rolleston, Dr. T. A. Ross, Dr. Tredgold, and Dr. W. Worth.

A letter, signed by Sir Courtauld Thomson, appeared in the *Times* of March 29 which describes the purposes for which the new Council is being established. It will co-ordinate and encourage the work of the various existing societies which are "engaged in promoting the study of mental disorders, the welfare of the insane, the problems of industrial psychology and the various aspects of mental deficiency"; it will also aim at establishing psychological clinics in general hospitals for the early treatment of mental disturbance, and at improving the education of the medical student in normal and abnormal psychology. In addition, it will attempt to lessen the popular ignorance at present prevailing in regard to the nature and prevention of mental illness, which results in an enormous amount of needless unhappiness and wastage of energy.

Such National Councils have been and are being formed in various countries on the Continent, moulded largely according to the pattern of the well-known United States National Committee for Mental Hygiene, which has done so much to raise the standard of the care and treatment of mental disorders in America, and to remove the widespread prejudice of the public towards these diseases. In America it has given birth to smaller Societies for Mental Hygiene in the various States and to an important Canadian Committee. Ample work awaits the formation of a National Council in Great Britain, and we extend to it the cordial welcome which it merits.

University and Educational Intelligence.

CAMBRIDGE.—The Report of the Financial Board on the expenditure of the current academic year points out that, despite the Emergency Grant of 30,000*l*., the University depleted its balances by 3975*l*. during the past academic year; and it is anticipated that there will be a further deficit of 7650*l*. in the current year. The Report of the Royal Commission has not come any too soon unless Cambridge is to increase its fees or to cut down its activities.

Mr. H. G. Carter has been appointed Curator of the Herbarium.

The Linacre Lecture will be delivered on Saturday, May 6, at 5.15 P.M., by Sir Humphry Rolleston, on the subject of "Medical Aspects of Old Age."

LONDON.—The following are among the Public Lectures to be given at University College during the present term:—"Atoms, Molecules and Chemistry," three lectures by Sir J. J. Thomson; "Insects and Disease," four lectures by Sir Arthur Shipley; "Recent Discoveries in Egypt," by Prof. Flinders Petrie; and "The Expansion of European Civilisation," four lectures, by Prof. W. R. Shepherd, of Columbia University. A copy of the full programme may be obtained by sending a stamped addressed envelope to the Secretary, University College, London, W.C.1.

IT is announced by the Royal Academy of Belgium that a prize of 1000 francs has been established, which will be awarded biennially, under the name of the Prix O. van Ertborn, for the best work on geology.

PROF. E. MELLANBY will deliver the Oliver Sharpey lectures at the Royal College of Physicians of London on Tuesday, May 2, and Thursday, May 4, at 5 o'clock. The subject of the lectures will be "Some Common Defects of Diet and their Pathological Significance."

THE Ramsay Memorial Trustees will, at the end of June, consider applications for two Ramsay Memorial Fellowships for chemical research. One of the Fellowships will be limited to candidates educated in Glasgow. The value of the Fellowships will be 250*l*. per annum, to which may be added a grant for expenses not exceeding 50*l*. per annum. Full particulars as to the conditions of the award are obtainable from Dr. Walter W. Seton, Secretary, Ramsay Memorial Fellowships Trust, University College, London, W.C.1.

NEW regulations have recently been made by the Trustees of the Beit Memorial Fellowships for Medical Research. The date of the election of Fellows has been changed from December to July, so that Fellows may commence work on October 1, instead of January 1, in each year. In future there will be three classes of fellowships, namely, (1) junior fellowships, 350*l*. per annum. Not more than six junior fellowships will be awarded annually. The usual tenure of a junior fellowship is for three years. (2) Fourth-year fellowships, 400*l*. per annum. On the recommendation of the advisory board, a junior fellowship may be extended for a further period of one year. (3) Senior fellowships, 600*l*. per annum. A limited number of senior fellowships may be awarded. The usual tenure of a senior fellowship is for three years. No change will be made in the emolument of any fellowship held at the date of coming into force of these amended regulations on May 1, 1922. All correspondence of candidates and fellows should be addressed to the Hon. Secretary, Beit Memorial Fellowships, 35 Clarges Street, Piccadilly, W.1.

THE annual report for the session 1920–21 of University College, London, contains some interesting facts which may well be placed on record. The total number of students enrolled for full time courses was 2408, of which 1506 were men; in addition there were more than 700 attending part time courses. In the full time courses, arts and science claim about equal numbers. During the year, donations to the College amounted to a little more than 3000*l*., a total which includes sums of 1500*l*. from the Carnegie United Kingdom Trust for the school of librarianship; 500*l*. from the Worshipful Company of Drapers, an annual grant to the biometric laboratory which will continue until 1924; and a grant of 250*l*. from the Chadwick Trustees for the departments of municipal engineering and hygiene. The London County Council made a capital grant of 5000*l*. towards the cost of the completion and equipment of the department of engineering. As in past years, the College has taken an active share in the promotion of adult education by the provision of free public lectures by men of note. In all, some seventy lectures and courses were given and it is estimated that more than 8000 persons attended.

Calendar of Industrial Pioneers.

April 27, 1885. Joseph d'Aguilar Samuda died.—Entering into partnership with his brother Jacob, Samuda built marine engines, laid down railways worked on the atmospheric principle, and became an eminent builder of iron steamships and armoured men of war. In his works in the Isle of Dogs he introduced labour-saving machinery, and with Reed, Woolley, Scott Russell, and others he helped to found the Institution of Naval Architects.

April 27, 1891. Loftus Perkins died.—Known for his bold experiment of fitting the yacht *Anthracite* with an engine supplied with steam at 500 lbs. pressure, and for his invention of the "arktos" cold chamber refrigerating apparatus, Perkins was the son of the inventor Angier March Perkins, and the grandson of Jacob Perkins, who came to England from America in 1827 and in 1828 constructed what was probably the first triple compound steam engine.

April 28, 1865.—Sir Samuel Cunard died.—The founder in 1839 of the famous British and North American Royal Mail Steam Packet Company, Cunard was a native of Nova Scotia. His first transatlantic liners were built on the Clyde, while the first passage was made in 1840 by the *Britannia*, a wooden vessel of 1154 tons and 740 horse power, which took 14 days 8 hours to cross. Iron steamers were introduced in 1855, and the paddle wheel abandoned for the screw in the early 'sixties.

April 28, 1914. Robert Kaye Gray died.—After passing through University College, London, Gray became an assistant to Charles Bright, subsequently superintended the laying of many important submarine cables for foreign governments, and became the head of the Telegraph Works Company at Silvertown. He assisted in founding the National Physical Laboratory and served as President of the Institution of Electrical Engineers.

May 1, 1895. John Newton died.—Graduating from the United States Military Academy in 1842, Newton was employed on engineering duties and saw active service during the Civil War. He was afterwards responsible for the improvement of New York harbour, and during the removal of the notoriously dangerous rocks at Hell Gate solved many new problems.

May 2, 1857. Frederick Scott Archer died.—The discoverer of the collodion process in photography, Scott started life as a silversmith and then became a sculptor. It was while trying to obtain pictures of his work that he made his noteworthy discovery.

May 3, 1888. Sir Charles Tilston Bright died.—A most eminent telegraph engineer, Bright in 1847 at the age of fifteen, through Cooke, entered the Electric Telegraph Company, and in 1856 with Brett and Cyrus Field initiated the movement for an Atlantic Submarine Cable. Appointed engineer to the Atlantic Cable Company he was on board the U.S.S. *Niagara*, which jointly with H.M.S. *Agamemnon* laid the first cable from Valentia to Newfoundland, and in 1858 he was knighted. Bright afterwards carried out important cable work in the Mediterranean, in the Persian Gulf, and in the West Indies. One of the original members of the Institution of Electrical Engineers, he served as president of the society in 1886–87.

May 3, 1909. Thomas Aldridge Weston died.—The inventor of many things, Weston was known all the world over for his differential pulley block and lifting tackle, a simple contrivance of great usefulness. Born in Birmingham in 1832 he was for a time associated with the firm of Tangye, but his later years were spent with the Brown Hoisting Machinery Company of Cleveland, Ohio. He died in New York.

E. C. S.

Societies and Academies.

LONDON.

Optical Society, April 6.—Sir Frank Dyson, president, in the chair.—H. H. **Emsley** and E. F. **Fincham**: Diffraction haloes in normal and glaucomatous eyes. Every normal eye, under appropriate conditions, sees diffraction rings or haloes encircling bright sources of light. Similar haloes are seen by eyes in certain abnormal pathological conditions, particularly in the case of eyes suffering from glaucoma. Tests are specified by means of which the different phenomena in the two cases may be identified.—E. W. **Taylor**: The effect of changes of surface curvature at the focus of an astronomical object glass. The balancing of the components of a large object glass is difficult, and the effect at the focus of a similar alteration of curvature at each of the four surfaces is different. If the effect of an alteration at each surface is known, the one most suitable may be chosen, having regard to the nature of the aberration to be overcome.

PARIS.

Academy of Sciences, March 27.—M. Emile Bertin in the chair.—The president announced the death of M. Louis Ranvier, member of the section of Anatomy and Zoology.—E. **Goursat**: A classical theory of Cauchy. Comments on two recent communications by M. Mittag-Leffler.—H. **le Chatelier**: The manufacture of soda with ammonia. A discussion by a graphical method of the bearing of some experiments of M. Toporescu (see below) on the ammonia soda process.—C. **Richet**, Eudoxie **Bachrach**, and H. **Cardot**: Studies on the lactic fermentation. Memory in micro-organisms. Culture of the lactic bacillus is made for one day in a medium containing traces of three poisons (arsenate, cadmium, copper) and then seven successive daily inoculations are cultivated on normal media. The strain of organism thus produced is sensitive to the action of each poison. The authors conclude that when two cultures of micro-organisms of the same species have lived, even for a short time, in slightly different media, they are different from each other.—C. **Lallemand**: The parabolic wage. The system of wage payment described, which has been tested in practice over a period of 34 years, is based on a formula $S = S_0 + kT^2$, where S_0 is the minimum wage, T the work done, S the actual wage paid, and k a constant. It is in effect a compromise between payment by time and by results. It has been applied in the "Service du Nivellement général de la France" since 1888, with the result that while the wage increased in four years from 6·30 francs to 12·25 francs, the cost per kilometre decreased from 40 to 33 francs.—P. **Montel**: A theorem of algebra.—G. **Giraud**: Non-linear partial differential equations of the second order of elliptic type.—P. **Lévy**: The *rôle* of the law of Gauss in the theory of errors.—E. **Cartan**: Generalised conformal space and the optical universe.—A. **Planiol**: Study of the friction losses in internal combustion motors. Experiments were carried out on a specially constructed 30 H.P. gas engine by three methods differing in principle. The results showed that the resisting couple of the motor due to friction was a linear function of the mean pressure shown by the indicator diagram. The constants obtained were shown to apply to another (35 H.P.) gas engine, and hence it is found possible to calculate the field of an internal combustion engine without taking indicator diagrams.—H. **Roussilhe**: The applications of aerial photography and the photo-restitution apparatus.—H. **Chaumat**: A new wattmeter.—O. **Liévin**: The kinetic study of alkaline solutions of iodine. In alkaline solutions, iodine is transformed into iodate by different reactions depending on the degree of alkalinity.—E. **Toporescu**: The preparation of sodium bicarbonate. An experimental study of the reaction $NaCl + NH_4HCO_3 = NaHCO_3 + NH_4Cl$. The solubilities of the salts at 15° C. were taken first singly, then in pairs, and finally omitting one constituent only. The results are plotted on the square diagram due to M. H. le Chatelier (see above).—A. **Mailhe**: The catalytic decomposition of oleic acid. The vapour of oleic acid passed over copper-aluminium pellets contained in a copper tube maintained at 600°-650° C. gives a gas rich in olefines (10 per cent.) and an acid liquid. The hydrocarbons, freed from acids, commenced to distil at 40° C. (amylene) and contained about 50 per cent. of olefines. These were removed by hydrogenation over nickel at 180°-200° C., and hexane, heptane, benzine, toluene, metaxylene, and nonane were identified in the resulting hydrocarbon mixture.—A. **Schoep**: Stasite, a new mineral, dimorphous with dewindite. This was obtained from a chalcolite from Kasolo (Katanga, Belgian Congo), and analyses led to the formula $4PbO \cdot 8UO_3 \cdot 3P_2O_5 \cdot 12H_2O$, which is identical with the composition of dewindite, from which, however, the new mineral differs in its density, colour, and the form of its crystals. Its radioactivity is a little less than that of dewindite.—L. **Blaringhem**: Abnormal heredity of the colour of the embryos of a variety of pea, *Pisum sativum*. Certain strains of pea, like hordeum and flax, present striking irregularities in the transmission of discontinuous characters.—H. **Ricome**: The elongation of roots.—M. **Molliard**: A new acid fermentation produced by *Sterigmatocystis nigra*. The products can be made to vary by changing the constituents of the culture fluid. If the nitrogen is deficient *d*-glucosic acid is the main acid produced; if the phosphates are reduced, then citric and oxalic acids preponderate.—J. **Pellegrin**: A new blind fish from the fresh waters of western Africa. This belongs to a new genus named Typhlosynbranchus by the author. The character of the branchial apparatus places it in the family of Synbranchus.—A. **Lécaillon**: The characters of a male hybrid arising from the union of a male duck (*Dafila acuta*) and female wild duck (*Anas Boschas*).—P. **Cristol**: Zinc and cancer. The proportions of zinc in various forms of cancerous tumours have been estimated. The preliminary results show that the high proportion of zinc found in cancerous tumours is a function of the proliferation and the cellular and nuclear activity.—J. **Mawas**: The limphoid tissue of the middle intestine of the Myxinoides and its morphological signification.—C. **Bourguignon**: The treatment of contraction by electrical stimulation of the non-contracted muscles in the lesions of the pyramidal bundle and in the secondary contraction of peripheral facial paralysis. Evolution of the chronaxy in the course of the treatment.—C. **Levaditi** and A. N. **Martin**: The preventive and curative action in syphilis of the acetyl derivative of oxyaminophenylarsinic acid (sodium salt). This salt has been shown to be stable, very soluble, rich in arsenic and relatively slightly toxic, and has been used with effect in the cure by injection of experimental syphilis of the rabbit. The present experiments deal with administration by the mouth and not by injection, and it was proved that this salt would cure experimental syphilis rapidly in the rabbit and the ape. Two cases in man were successfully cured in the same way, and its preventive action was also shown on the human subject.

Official Publications Received.

The Journal of the Royal Anthropological Institute of Great Britain and Ireland. Vol. 51, July to December 1921. Pp. xii+289-462+13+27. (London: Royal Anthropological Institute.) 15*s*. net.

Transactions of the Geological Society of South Africa. Vol. 24: Containing the Papers read during 1921. Pp. iv+252+13 plates. (Johannesburg: Geological Society of South Africa.) 42*s*.

Madras Fisheries Department. Administration Report for the Year 1920–21. (Report No. 1 of 1922. Madras Fisheries Bulletin, Vol. 15.) Pp. 44. (Madras: Government Press.) 4 annas.

Proceedings of the Indian Association for the Cultivation of Science. Vol. 7, Parts 1 and 2. Pp. 59. (Calcutta.) 4 rupees; 6*s*.

The South African Journal of Science. Vol. 18, Nos. 1 and 2: Comprising the Report of the South African Association for the Advancement of Science, 1921, Durban. Pp. xxxviii + 200. (Johannesburg.) 15*s*.

Canada. Department of Mines: Mines Branch. Summary Report of Investigations made by the Mines Branch during the Calendar Year ending December 31, 1920. Pp. 87. (Ottawa: F. A. Acland.)

Reports of the Department of Conservation and Development, State of New Jersey. Annual Report for the Year ending June 30, 1921: Department of Conservation and Development, Administering Geology, Soils, Water Resources, Forestry, Forest Fire Service, State Museum, Testing Laboratory, State Parks, Land Registry. Pp. 105. (Trenton, N.J.)

Sudan Government. Wellcome Tropical Research Laboratories, Khartoum. Report of the Government Chemist for the Year 1921. (Chemical Section: Publication No. 22.) Pp. 38. (Khartoum.)

Jahrbuch der Geologischen Staatsanstalt. Jahrgang 1921, 71 Band. 1 und 2 Heft. Pp. 100. 3 und 4 Heft. Pp. vii+101-224. (Wien: Geologischen Staatsanstalt.)

Verhandlungen der Geologischen Staatsanstalt. Jahrgang 1921. Nr. 1 bis 12 (Schluss). (Wien: Geologischen Staatsanstalt.)

Diary of Societies.

FRIDAY, APRIL 28.

ZOOLOGICAL SOCIETY OF LONDON, at 4.—Anniversary Meeting.
ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—F. G. Royal-Dawson: The Need of an All-India Gauge Policy.
PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—T. Smith: The Position of Best Focus in the Presence of Spherical Aberration.—F. Twyman and J. Perry: The Determination of the Absolute Stress-variation of Refractive Index.—C. J. Smith: An Experimental Comparison of the Viscous Properties of (*a*) Carbon Dioxide and Nitrous Oxide, and (*b*) Nitrogen and Carbon Monoxide.—F. Twyman: Demonstration of the Optical Sonometer.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration of Museum Specimens illustrating the Forms of Inguinal Hernia.
ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 5.—Sir Robert Jones: Presidential Address.
INSTITUTION OF AERONAUTICAL ENGINEERS (at Engineers' Club, Coventry Street, W.1), at 6.—Capt. Sayers: Some Unsettled Problems of Aeroplane Design.
INSTITUTE OF MARINE ENGINEERS, at 6.—Annual Meeting.
INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Prof. E. G. Coker and Dr. K. C. Chakko: An Account of some Experiments on the Action of Cutting Tools.
JUNIOR INSTITUTION OF ENGINEERS, at 8.—Capt. H. Whittaker: Some Notes on the Utilisation of Water Power.
ROYAL SOCIETY OF MEDICINE (Epidemiology Section), at 8.—Dr. F. Dittmar: Outbreaks of Enteric Fever associated with Carrier Cases.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. A. Harden: Vitamin Problems.

MONDAY, MAY 1.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—Annual Meeting.
INSTITUTE OF ACTUARIES, at 5.—E. H. Brown: The Valuation of Endowment Assurances by Select Tables.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. Shattock: Demonstration of Museum Specimens illustrating Sarcoma.
SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—Dr. C. V. Drysdale: The Testing of Small Electrical Plant.
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Annual General Meeting.
ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street, W.C.1), at 8.—Miss M. MacFarlane: Prof. Alexander's Theory of Values.
ROYAL SOCIETY OF ARTS, at 8.—F. F. Renwick: Modern Aspects of Photography (1) (Cobb Lectures).
SOCIETY OF CHEMICAL INDUSTRY (at Chemical Society), at 8.
ROYAL SOCIETY OF MEDICINE (Tropical Diseases and Parasitology Section), at 8.30.—Annual General Meeting.

TUESDAY, MAY 2.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Arthur Keith: Anthropological Problems of the British Empire. Series II.: Racial Problems of Africa (2).
ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Prof. E. Mellanby: Some Common Defects of Diet and their Pathological Significance (Oliver Sharpey Lectures) (1).
INSTITUTION OF CIVIL ENGINEERS (Extra Meeting), at 6.—Sir John A. F. Aspinall: Some Post-War Problems of Transport (James Forrest Lecture).
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.
RÖNTGEN SOCIETY (at Institution of Electrical Engineers), at 8.15.

WEDNESDAY, MAY 3.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—C. S. Franklin: Short Wave Directional Wireless.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—J. L. Lizius and N. Evers: Studies in the Titration of Acids and Bases.—C. Ainsworth Mitchell: Graphites and other Pencil Pigments.—Dr. J. C. Drummond: The Sulphuric Acid Reaction for Liver Oils and its Significance.—W. Singleton and H. Williams: Inadequacy of "A.R." Test for Alkalies in Calcium Carbonate.

ROYAL SOCIETY OF ARTS, at 8.—N. Heaton: The Production of Titanium Oxide, and its Use as a Paint Material.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

INSTITUTE OF METALS (at Institution of Mechanical Engineers), at 8.—Sir Ernest Rutherford: The Relation of the Elements (May Lecture).

THURSDAY, MAY 4.

IRON AND STEEL INSTITUTE (at Institution of Civil Engineers), at 10.30 A.M.—F. Samuelson: Presidential Address.—F. Clements: British Siemens Furnace Practice.—D. E. Roberts: Notes on Blast Furnace Filling.—Prof. H. C. H. Carpenter and Miss C. F. Elam: Effect of Oxidising Gases at Low Pressures on Heated Iron.—C. R. Austin: Hydrogen Decarburisation of Carbon Steels, with Notes on Related Phenomena.—E. W. Ehn: Influence of Dissolved Oxides on Carburising and Hardening Qualities of Steel.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. E. H. Barton: A Syntonic Hypothesis of Colour Vision.

ROYAL SOCIETY, at 4.30.—*Probable Papers.*—Dr. C. Shearer: The Heat Production and Oxidation Processes of the Echinoderm Egg during Fertilisation and Early Development.—Dr. H. Hartridge and R. A. Peters: Interfacial Tension and Hydrogen Ion Concentration.—W. Cramer, A. H. Drew, and J. C. Mottram: Blood-platelets and their Behaviour in "Vitamin A" Deficiency, and after "Radiation," and their Relation to Bacterial Infections.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Prof. E. Mellanby: Some Common Defects of Diet and their Pathological Significance (Oliver Sharpey Lectures) (2).

LINNEAN SOCIETY OF LONDON, at 5.—Prof. Lloyd Williams: The Life-history of Laminaria and Chorda.

INSTITUTION OF LOCOMOTIVE ENGINEERS (at Engineers' Club, Coventry Street, W.1), at 7.15.—J. A. Hookham: Comparison between Superheated and Non-superheated Tank Engines.

CHEMICAL SOCIETY, at 8.—I. E. Balaban and F. L. Pyman: Bromo-derivatives of Glyoxaline.—E. P. Perman: The Properties of Ammonium Nitrate. Part IV. The Reciprocal Salt-pair $NH_4NO_3 + NaCl \rightleftarrows NH_4Cl + NaNO_3$.—Prof. E. C. C. Baly and H. M. Duncan: The Reactivity of Ammonia.—Prof. E. C. C. Baly, Prof. I. M. Heilbron, and D. P. Hudson: Photocatalysis. Part II. The Photosynthesis of Nitrogen Compounds from Nitrates and Carbon Dioxide.

CIVIC EDUCATION LEAGUE (at Belgravia Hotel, Grosvenor Gardens, S.W.1), at 8.15.—W. de la Mare: Character.

FRIDAY, MAY 5.

IRON AND STEEL INSTITUTE (at Institution of Civil Engineers), at 10.30 A.M.—D. Selby-Bigge: Recent Developments in Power Production.—A. Westgren and G. Phragmen: X-ray Studies on the Crystal Structure of Steel.—N. T. Belaiew: The Inner Structure of the Pearlite Grain.—J. H. Whiteley: Formation of Globular Pearlite.—A. F. Hallimond: Delayed Crystallisation in the Carbon Steels: the Formation of Pearlite, Troostite, and Martensite.—K. Honda: The Constitutional Diagram of the Iron-Carbon System based on Recent Investigations.—K. Honda and T. Kikuta: The Stepped A1 Transformation in Carbon Steel during Rapid Cooling.—N. Yamada: The Heat of Transformation of Austenite to Martensite, and of Martensite to Pearlite.

ROYAL SOCIETY OF ARTS (Dominions and Colonies and Indian Sections), at 4.30.—Prof. W. H. Eccles: Imperial Wireless Communication.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 5.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration of Museum Specimens illustrating Umbilical and Diaphragmatic Hernia.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 7.—R. P. Howgrave-Graham: Electrically Oscillatory Discharges.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—Failures.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. M. Grabham: Biological Studies in Madeira.

SATURDAY, MAY 6.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. D. H. MacGregor: Industrial Relationships (2). The Problem of Structure.

PUBLIC LECTURES.

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

FRIDAY, APRIL 28.

BEDFORD COLLEGE, at 5.15.—Prof. E. Claparède: L'Intelligence et la Volonté (1). (In French.)

KING'S COLLEGE, at 5.50.—Dr. J. Hjort: Biological Aspects of Oceanography (1).

MONDAY, MAY 1.

BEDFORD COLLEGE, at 5.15.—Prof. E. Claparède: L'Intelligence et la Volonté (2). (In French.)

KING'S COLLEGE, at 5.30.—Dr. J. Hjort: Biological Aspects of Oceanography (2).

TUESDAY, MAY 2.

UNIVERSITY COLLEGE, at 5.—Sir Arthur Shipley: Insects and Disease (1).

BEDFORD COLLEGE, at 5.15.—Prof. E. Claparède: L'Intelligence et la Volonté (3). (In French.)

KING'S COLLEGE, at 5.30.—Dr. J. Hjort: Biological Aspects of Oceanography (3).—Prof. H. Wildon Carr: The Principle and Method of Hegel (1). The Real and the Rational.

WEDNESDAY, MAY 3.

ROYAL SOCIETY OF MEDICINE, at 5.—Prof. C. Winkler: The Human Neo-Cerebellum.

UNIVERSITY COLLEGE, at 5.15.—Dr. D. H. Scott: The Early History of the Land Flora (2).

THURSDAY, MAY 4.

ST. MARY'S HOSPITAL (Institute of Pathology and Research), at 5.—Sir Archibald E. Garrod: More Inborn Errors of Metabolism.

ROYAL SOCIETY OF ARTS, at 5.15.—Sir Lawrence Weaver: Rural Re-Settlement and its Relation to Public Health (1) (Chadwick Lecture).

FRIDAY, MAY 5.

UNIVERSITY COLLEGE, at 5.—Prof. T. Borenius: The Re-discovery of the Primitives (Admission by Invitation only);—at 5.30.—Prof. W. R. Shepherd: The Expansion of European Civilisation (1).

KING'S COLLEGE, at 5.30.—Dr. J. Hjort: Biological Aspects of Oceanography (4).—R. F. Young: The University of Prague.

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