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The Imperial Conference and Natural Resources.

AMONG the problems being discussed at the Imperial Conference, now being held in London, one of the most important is the development of the natural resources of the British Empire, and this is a question which can no longer be approached on old-fashioned empirical lines. On the contrary, a successful solution can be expected only if the whole matter is put on a rigidly scientific basis.

The first need is for a scientific survey of each area of the Empire as a possible home of man. The result of such a survey would be a store of definite knowledge as to (1) the various raw materials (food and other) to be expected from each area, and (2) the extent to which any area at present contributes its proper share of such raw materials.

Two facts must, however, be faced before entering on any such survey for any part of the Empire. One is that the Empire is, politically and economically, oceanic. We depend on the ocean not only for strategic security, but also for economic and commercial prosperity; and our consciousness of this has tended or tempted towards excessive dependence, in the form of neglect of the tiny, but vital, home supplies, until we no longer attempt to grow bread enough for our needs during even a quarter of the year. Indeed, Mr. Churchill's famous motor park is still a wilderness of hulks cumbering some of the best wheat land in England; and across the Middlesex border from Slough a housing authority thought that the best "brick earth" in Middlesex was a good foundation for brick cottages. We may agree entirely that "working men had as much right as any one else to the best land in the parish," and yet question the suitability of "brick earth" for any house-sites and resent its being alienated from its proper work of providing food by intensive culture.

Space forbids detailed treatment of the homeland, but the fundamental factors must be kept in mind. In the first place, we ought to add 8,000,000 acres to our arable area, and put 250,000 men on them; then, in any emergency, we could guarantee four-fifths of the adequate minimum of wholesome and nourishing food for all our people. Then literally some millions of our people never taste a drop of fresh English milk; and the way to increase and cheapen the supply is to increase our arable area. Denmark is so small and so highly specialised that it scarcely gives a fair comparison. But in 1913 even Germany produced 485 lb. of "bread" per head of population (against our 90 lb.), and so had only 25 per cent. of her farm area under grass (against our 60 per cent.), and was able to rear one head of cattle to the acre, while we reared only one to three acres.

Lastly, our method of raising meat is appallingly wasteful. It takes 48 lb. of cereals fit for human use to raise one pound of beef; even the pig, by far the most economical converter, consumes 3,000,000 tons of "human" food to produce 250,000 tons of pork, ham, and bacon. The saving of time and money and ships, if we imported the meat instead of the food for cattle, would almost pay our whole unemployment dole; and even the bacon, equal in quality to that for which we paid Denmark about 30,000,000*l.* last year, could be imported from our own tropical dominions, for tropical bacon is as "firm" as English bacon, if the pigs are given coconut in their food.

The British Empire, unlike other big empires, is an epitome of the world, so that we have naturally a climatic base for classifying natural regions; and we can distinguish half-a-dozen broad types. Each of them has its appropriate products, and should be encouraged to produce these; and the various areas, being scattered over the whole world, have complementary seasons. Of these broad types the most important are the temperate, the Trade-wind, and the monsoon.

The temperate type, as seen in Canada, has marine margins and continental interior; and these marine margins, whether dominated by snow, as in the east, or by rain, as in the west, are specially timber areas and should grow and market forest products. In 1922, Canada produced very nearly 3,000,000 cords of pulpwood and more than 1,000,000 tons of newsprint; and yet just before the War we were importing from Germany more than twice as much wood-pulp as we imported from Canada, and more than ten times as much paper.

The cleared forest is not suited either by soil or by climate to the growing of grain, but makes admirable pasture; and exports should be in small, solid, and imperishable form, *e.g.* butter and cheese. Canada and New Zealand already send us 80 per cent. of all our imported cheese, and Canada alone could supply all our needs. Off each margin, a cold sea current is exceedingly favourable to fishing, and on each margin orchard trees flourish almost as well as forest trees. Fish, fruit, forest, and dairy products are, therefore, natural exports. The dry continental interior is natural grassland with early summer rain, which is just as favourable to grain-growing as the perennial rain of the margin is to forest. Canada is now the largest producer of wheat in the world—capable of producing 400,000,000 bushels a year.

Our Trade-wind areas are partly insular and partly continental. The islands already produce the finest sugar and coffee in the world, and have almost unlimited possibilities in the way of raising fruit and tobacco. They could easily produce all the sugar and all the coffee that we need, and yet, in 1913, 90 per cent. of our sugar and 85 per cent. of our coffee came from outside the Empire.

The continental part of the Trade-wind region is mainly savana, capable of producing almost unlimited supplies of cattle and maize and tobacco, and in several areas already raising large quantities of cotton, to which the *slow* changes of Trade-wind climate are very favourable, as they are also to tobacco. For example, Nyasaland raises excellent "Egyptian" cotton on its heavy soil, and equally good tobacco on its light soil. If every native on this African savana was guaranteed a supply of "Salisbury White" maize, and was excused his hut tax if he planted a certain area under cotton, the British Empire would become the greatest producer of maize in the world, and in two years the African savana would be sending us 2,000,000 bales of cotton.

This question of cotton, however, is more important in the monsoon region. India already rules the market of the world for jute, tea, oil-seeds, and rice; and her population is of a very different type from that in Africa. India is, therefore, the only area where there can be an *immediate* increase of any product which requires a great deal of labour; but, unfortunately, India, like Nigeria, being a monsoon area, gets its heat before its rain—which greatly handicaps the quality of many crops, especially cotton. In the meantime, India raises the worst cotton in the world, so far as length of staple is concerned, and very nearly the worst in the world for yield per acre (85 lb.). But wherever cotton can be grown entirely by irrigation, as in the north-west, or where the rain comes before the heat, as in the extreme south-east, there could be a very great increase of "calico" cotton—our greatest need; and India is not troubled, as Nigeria is, with a short growing-season, which involves the natives in the necessity of providing all food crops before thinking of growing cotton.

These scattered examples may illustrate the sort of lines on which a geographical survey of the Empire would proceed. Such a survey has been already roughly made, and its results may be summarised as follows:—The Empire can produce: (1) all the wheat and oats, maize and rice, that we need, and most of the barley; (2) all the tea, coffee, cocoa, sugar, and oil-seeds (margarine); (3) all the beef, mutton, pig, and rabbit products that we need, and most of the leather; (4) all the wool, rubber, jute, and sisal, and fully half the cotton; and (5) all the most important constructional and industrial timber. In some of these cases, the Empire is already absolutely supreme; *e.g.* tea, cocoa, wool, rubber, and palm oil. All of them could be produced without a raising of price, probably with an actual lowering of it; and it is obvious that an adequate minimum of all should be produced. Only in this way can we get rid of a foreign monopoly, as in cotton, and foreign control, as in maize and meat.

L. W. LYDE.

Aitken's Scientific Papers.

Collected Scientific Papers of John Aitken, LL.D., F.R.S. Edited for the Royal Society of Edinburgh (with Introductory Memoir) by Dr. C. G. Knott. Pp. xxi+591. (Cambridge: At the University Press, 1923.) 30*s*. net.

THE late Dr. John Aitken bequeathed to the Royal Society of Edinburgh a sum of 1000*l*. to be expended in issuing a reprint of his more important scientific papers. The work of editing the collection was assigned by the Society to its General Secretary, the late Dr. C. G. Knott, and the present volume is the result.

Aitken's contributions to science and to its literature extend over half a century, and include about a hundred papers contributed to various societies and periodicals. The subjects ranged over a remarkably wide field. Safety-valves on steam boilers, colour vision, glaciers, thermometer screens, colours in the sky and sea, are only a few of the subjects dealt with beyond the main work which occupied his attention for more than forty years. The selection here presented consists of thirty-eight of the more important papers, and has been made with great care. The volume, which includes a brief account of Aitken's life and work, meets a real need, for in recent years the Royal Society of Edinburgh has had to reprint some of Aitken's papers more than once.

The most notable contribution made to science by Aitken was his study of dust in the atmosphere and of the physical phenomena to which it gives rise. This forms the subject of no fewer than fourteen of the collected papers. He was drawn to the inquiry from consideration of the phenomena accompanying changes of state and especially of the acceleration of such changes in the presence of "free surfaces." In his first paper, on "Dust, Fog, and Clouds," he states his main conclusion.

"Molecules of vapour do not combine with each other and form a particle of fog or mist; but a free surface must be present for them to condense upon. The vapour accordingly condenses on the dust suspended in the air, because the dust particles form free surfaces at which the condensation can take place at a higher temperature than when they are not present. Where there is abundance of dust there is abundance of free surfaces, and the visible condensed vapour forms a dense cloud: but when there are no dust particles present there are no free surfaces, and no vapour is condensed into its visible form, but remains in a supersaturated vaporous condition till the circulation brings it into contact with the free surfaces of the sides of the receiver, where it is condensed."

Aitken was not the first to reach this conclusion, for he had been anticipated by Coulier, whose results had been published five years earlier. But of the absolute independence of Aitken's work there can be no doubt, and his more extensive researches opened out the field of inquiry in such a manner that his name will always be associated with the subject. He proceeded in later papers to develop it further, to describe ingenious apparatus devised for counting the number of dust particles (or rather, condensation nuclei) in unit volume of air, and to state the results of a large number of observations, in widely different conditions, on the "dustiness" of air in houses, towns, open country, and seashore, and on mountain heights.

The present writer heard Aitken giving some of these papers to the Royal Society of Edinburgh, and had the privilege of working at the subject under his guidance. One was at first struck with the confidence with which Aitken stated his results, but there was always the note of reservation when a possible alternative was presented. Looking back on these early days, and in the light of later work, it can be seen that although his results seemed straightforward and their interpretation obvious, Aitken was troubled by the fear that something more lay behind them. This is evident from his guarded language in speaking of the arrangements for filtering dust out of a sample of air and his insistence on the readiness with which condensation takes place in the presence of alkaline salts and sulphur compounds. The fuller knowledge came later with Wilson's experiments on the condensation of supersaturated vapour upon the ions in a gas; and evidence, collected together in Dr. Simpson's recent Royal Institution lecture (NATURE Supplement, April 14), has accumulated to show that condensation at or near normal pressure takes place only on the hygroscopic dust particles. In another direction, too, Aitken's work has been supplemented. His explanation of the production of fog, especially the smoky fog of towns, was insufficient inasmuch as it (necessarily at that time) took no account of those temperature inversions at comparatively low altitudes which prevent the lateral or vertical escape of smoke-laden foggy air. But he was more nearly correct in his deduction that—

"We must remind those who are crying for more perfect combustion in our furnaces and grates that combustion, however perfect, will not remove or diminish fogs. It will, however, make them cleaner, take away their pea-soupy character, but will not make them less frequent, less sulphurous, less persistent, or less dense."

Aitken's next contribution of importance was his paper "On Dew" (1885), in which he showed that deposits of dew are produced by the condensation of water vapour rising from the soil, and that the dewdrops on grass are formed from water exuded from the pores of the leaves when the overlying air is already saturated. His excursion into the dynamics of travelling cyclones and anticyclones forms a less fruitful but not less interesting portion of his work. By an experimental arrangement of the ingenious kind that might be expected from him, he sought to demonstrate the flow of air into a region of low pressure. Inside, and near the lower end of, a vertical metal tube, three gas jets were lit and the lines of flow of air into the updraught in the tube were then studied. The spiral motion was represented as being due to non-uniform distribution of velocity in the horizontal plane through the lower end of the tube. His theory was that anticyclonic areas supplied descending and therefore heated air to cyclonic areas, and also supplied "the cyclone with part of the tangential force necessary for producing the spiral circulation so well known in cyclones." Further, that—

"the upper winds, circling from the anticyclones, and to the cyclones, by moving more quickly, and by moving at an angle across the lower air, tend to prevent the latter rising, even although it be the lighter. The effect of this . . . is to drive the hot moist air lying near the earth's surface to the circumference of the anticyclone where it is picked up by the cyclone, and as the spirally moving cyclonic winds also tend to prevent the lower air rising, the hot moist air is swept into the front of the low-pressure area . . . and it is drawn into the centre of the depression and . . . forms the core of the cyclone."

Sir Napier Shaw has pointed out, however, that the difficulty lies in deciding whether or how far any experiment such as Aitken's really reproduces the natural conditions on the larger scale. To begin with, that portion of the atmosphere within a cyclonic area has no resemblance to a vertical column the height of which is a dozen times its diameter; its axis is most probably not vertical; it is not provided with a constant heat supply at its base; its core is almost certainly not a mass of warm moist air; and the distribution of temperature is not symmetrical about its "centre." Lastly, the whole system moves in a field of force the characteristics of which are not altogether simple. Thus, although Aitken's experiment forms an ingenious illustration of eddy motion in a fluid, his theory of cyclonic motion has not done much to advance the subject, except that it has stirred up the interest of others in the matter. Recent years have brought additional information, but the end is not yet; nor will that be reached without more extensive exploration and study of the first six or eight kilometres of the atmosphere lying over and within cyclonic areas. This, perhaps, is the greatest need of the meteorology of to-day.

Notice must be taken of the admirable sketch of Aitken's work, drawn up by the late Dr. C. G. Knott. He shows Aitken as a typical example of the private scientific inquirer—a class to whom British science owes much. With ample private means, he pursued his inquiries in his own time and in his own way, happy in freedom from those distractions which seem inseparable from the occupation of official position. He did his work because he loved it; he sought for the truth because it was "something true and good for ever, not the mere outcome of craft or expediency."

Dr. Knott's editorial work has been done with care and discrimination. But a melancholy interest attaches to it, for the date of his *imprimatur* shows it to have been the last piece of work in a long and useful life.

A. C. M.

A Zoological Tribute.

Bydragen tot de Dierkunde. Uitgegeven door Het Koninklijk Zoologisch Genootschap Natura Artis Magistra te Amsterdam. Feestnummer uitgegeven bij gelegenheid van den 70sten geboortedag van Dr. Max Weber, oud Hoogleeraar in de Zoologie aan de gemeente Universiteit te Amsterdam. Pp. 342. (Leyden: J. Brill, 1922.) 25 guilders (*2l. 1s. 8d.*).

TOWARDS the end of last year the Royal Zoological Society Natura Artis Magistra of Amsterdam issued the twenty-second number of its publication, "Bydragen tot de Dierkunde" (Contributions to Zoology), on the occasion of the seventieth birthday of Prof. Max Weber. To this large volume no less than forty-four zoologists have contributed papers on various subjects, and all thus unite, each in his own way, "to weave a small leaflet into the wreath which his adorers, friends, and pupils offer him on this festivity."

As the table of contents itself includes a considerable number of papers, it is easy to understand that we cannot possibly give a summary of each contribution in particular, for such an account would exceed the limits of the space available in NATURE. We must therefore content ourselves with mentioning those of special interest, first to the distinguished zoologist to whom the collection is dedicated, and next from the point of view of science.

No more sincere admiration of Weber's investigations of the fauna of the Dutch East Indies, and his endeavours to establish scientific collaboration between the colonies and the motherland, can be expressed than is done by Koningsberger in his partly historical, partly modern, consideration of biological research work in Dutch Asiatic colonies. The zoogeographical problems of this archipelago, which have occupied Weber's interest since his first explorations in those regions, now nearly forty years ago, furnish the reason for Hugo Merton's contribution, a paper "Zur Zoogeographie der Aru- und Keiinseln," resuming the results of his own scientific expedition in this interesting eastern region which shows such relationship to Australian fauna.

The connexion with the fauna of British India, studied several years ago by the scientific staff of the Indian Museum at Calcutta, induced Annandale to choose as his subject a discussion of the "Marine Element in the Fauna of the Ganges." The biology of such intermediate territories between normal fresh-water and real sea-water has always been a fairly difficult subject for comparison in different areas, and this may be partly attributed to the lack of agreement in the use of the expression "brackish water."

An attempt to suggest some unanimity has been made here by Redeke: "Zur Biologie der niederländischen Brackwassertypen." Following Einar Naumann's investigations of the food-salts of the aquatic organisms, Redeke based his division of the conditions of life in brackish water on so-called chlorine spectra. These pages should be of special interest to several British zoologists. The most important divisions are:

Fresh water, up to 100 milligrams per litre.
Oligohalin (slightly brackish), 100 to 1000 milligrams per litre.
Mesohalin (brackish), 1000 to 10,000 milligrams per litre.
Polyhalin (very brackish), more than 10,000 milligrams per litre.

Several species are mentioned that are typical for each salinity. I hope British zoologists will adopt these divisions also—or propose better ones.

As the volume is dedicated to the greatest living Dutch zoologist, we are not astonished to meet a number of papers which are more or less in close relation to Weber's own fields of investigation. Thus his friend, L. F. de Beaufort, gives "Some Remarks on the Anatomy of the Melano-tæniinæ," those remarkable fresh-water fishes of Australia and part of the neighbouring archipelago. A fine Röntgen photograph shows their peculiar skull form, with the characteristic protruding mouth caused by the shape and position of the præmaxillæ.

H. C. Delsman opens here a series of studies on the development of larval fish of the Java Sea and surrounding waters, carried out in the laboratory for marine investigations at Batavia. This branch of science may have a successful future for purely scientific as well as for economic purposes, as hitherto it has been very little studied in tropical seas.

The director of the Zoological Garden at Amsterdam, C. Kerbert, contributes from his rich collection and his long experience a survey of what we know about pregnancy, birth, adolescence, and lifetime of *Hippopotamus amphibius*, observed in the different zoological gardens of Europe.

Only a short time before his death, Kükenthal drew up the results of his study of a fœtus of the Greenland Right Whale, "Die Brustflosse des Groenlandswales, *Balæna mysticetus* L." The study of these largest of mammals is a territory on which Weber and Kükenthal often met, and more than once has been the subject of sharp controversy as well as of sincere appreciation.

We now pass to those papers which are more distantly related to Weber's personality or to his own scientific work, and as such can only be regarded as the outcome of the focus of the authors' immediate interest. They fall into two chief groups: systematic and anatomical-phylogenetical. De Meyere on Javanese agromyzines; Döderlein on the genus Calliaster; de Man on marine nematodes; Eigenmann, Metzelaar, Clark, Nelly de Rooy, and Horst; indeed, they are not the least of zoologists who work as "mere" systematists. An admirable paper on "Repeated changing of Body-forms in the Course of the Phylogeny of Teleosteans" has been contributed by Abel. Here again we are astonished at the author's "biological" treatment of a subject so dead as the palæontology and phylogeny of extinct fishes.

Dollo, in his own way of discussing matters, gives a survey of some of the remarks and opposition offered against his theory of evolution, dealing here with the secondary nectonic life of Pristis and Ceratoptera and the rolling back of the curled shells of fossil tetrabranchous cephalopods. According to Dollo, these instances are but secondary adaptations accomplished along another way.

Finally, we wish to direct attention to Dubois' paper on the question whether the brains of domesticated dogs have increased in volume in comparison with those of wild races of dogs and foxes. He has worked out accurately the results of his measurements and weighings, and concludes that, contrary to the usual opinion that domestic animals should have increased in brain weight, tame dogs at least are provided with smaller brains than their wild congeners.

From the fourteen contributions to this work written in the English language reference can be made only to that of R. F. Scharff "On the Origin of the West Indian Fauna"—a complicated problem.

The volume is attractively illustrated, the first full-page being a fine portrait of Weber. Paper, print, and illustrations are fully up to the usual standard of the publications of the firm of E. J. Brill, of Leyden.

W. G. N. VAN DER SLEEN.

American Chemical Monographs.

(1) *The Origin of Spectra.* By P. D. Foote and F. L. Mohler. (American Chemical Society Monograph Series.) Pp. 250. (New York: The Chemical Catalog Co. Inc., 1922.) 4.50 dollars net.

(2) *The Properties of Electrically Conducting Systems: Including Electrolytes and Metals.* By Prof. Charles A. Kraus. (American Chemical Society Monograph Series.) Pp. 415. (New York: The Chemical Catalog Co. Inc., 1922.) 4.50 dollars.

(3) *Glue and Gelatin.* By Jerome Alexander. (American Chemical Society Monograph Series.) Pp. 236. (New York: The Chemical Catalog Co. Inc., 1923.) 3 dollars.

(4) *Catalytic Action.* By K. George Falk. Pp. 172. (New York: The Chemical Catalog Co. Inc., 1922.) 2.50 dollars.

(1) THE monograph on "The Origin of Spectra" has been well written by highly qualified authors. The subject is not an easy one to handle, especially in view of the fact that the mathematics involved in the quantum theory of spectra is so difficult that only those who have specialised in advanced mathematics can hope to follow it. The utmost that can be done, therefore, in presenting the subjects to chemists is to try to give to them a clear picture of the general nature of the problems and of the solutions which have been found for them, without attempting to display the intermediate stages of the work.

Under these conditions, it is no serious reflection upon the authors of this monograph to say that Prof. Bohr has achieved a greater measure of success in the difficult, if not almost hopeless, task of explaining his theories to readers who are unable to understand the arguments on which they are based. This monograph is, however, much more experimental in character than Bohr's "The Theory of Spectra and Atomic Constitution," and is liberally provided with photographic reproductions of spectra of the most diverse types; indeed, in the matter of successful illustration this book may be compared with the publications of Prof. R. W. Wood, some of whose photographs are reproduced in the present volume.

As a general conclusion it may be said that the authors of the monograph have rendered a valuable service to chemists by bringing together so much information in reference to spectroscopy; but that they have probably overrated the mathematical and physical equipment of their readers. The result is that even a physical chemist, with a keen interest in spectroscopy, is likely on reading this book to feel that he is being carried—no doubt by highly competent swimmers—into rather deep water, where he is only occasionally allowed to touch bottom, or to exercise his own limited powers of swimming.

(2) Prof. Kraus deals with a subject with which physical chemists are much more familiar. His book professes to cover the properties of electrically conducting systems in general; but, in actual fact, metallic conductivity and gaseous conductivity occupy so small a portion of the volume that the monograph is really concerned only with liquid electrolytes, although it contains a final chapter on "The Properties of Metallic Substances."

Earlier writers on electrolytic conductivity, especially those of the German school, have erred in paying attention almost exclusively to aqueous electrolytes. This inevitably leads to a distorted view of the phenomena, since properties which are quite exceptional are accepted as normal if they happen to exist in aqueous solutions. Prof. Kraus, as a distinguished research-worker in the field of non-aqueous solutions, is particularly well qualified to give a broader view of the phenomena. His presentation of the subject, therefore, leaves the reader with the feeling that, under the guidance of the author, he has surveyed the whole width of the field, instead of being conveyed across it on a narrow stream of conductivity-water with such high banks that the greater part of the field is shut out from his view.

(3) Mr. Alexander's book on "Glue and Gelatin" is, in the opinion of the reviewer, of a much lower standard than the two preceding volumes. The author has already written a book on "Colloid Chemistry," but is not well known to English readers. From the book itself it is difficult to know whether the author is a colloid-chemist who has taken an interest in the manufacture of glue, or a glue-chemist who has taken an interest in the theory of colloids. In any case the monograph lays itself open to criticism by the fact that it is neither a complete technical handbook nor a satisfactory theoretical treatise.

It is indeed difficult to picture the mental attitude of the author of a technical work who finds it necessary to warn his readers of the importance of possessing "minds flexible enough to fit all the facts of Nature"; or of the writer of a book on glue who proceeds to inform his readers that "the decimal in the atomic weight of hydrogen 1·008 represents electrons." Although the work contains a considerable amount of information, as well as many quotations from papers to which references are given, it is very badly put together. In this case at least the American Chemical Society has made itself responsible for a work which ought to have undergone drastic revision before being issued.

(4) Dr. Falk's book on "Catalytic Action" has not been written under the authority of the American Chemical Society, although it is issued by the same publishers, and it differs in style from the monographs reviewed above only in the absence of the Society's imprint and general introduction. Dr. Falk has recently published a book on "Chemical Reactions" in which he lays stress on the formation of intermediate addition-compounds; he represents these by enclosing the formulæ of the reacting substances in large square brackets, similar to those used by Werner to represent co-ordinated complexes. The present volume is in the main an interpretation of the phenomena of catalysis on the basis of this theory.

The theory itself lacks the preciseness of Werner's theory of co-ordination, and does not lead to any marked simplification of the task of explaining the phenomena of catalysis. In this respect it is indeed less helpful than the crudely mechanical theories of adsorption which have so clearly proved their utility in recent years, and are described in the tenth chapter of this monograph. The author states in his preface that he has not attempted to cover the whole field of catalytic reactions, but has discussed only sufficient cases to illustrate his own particular point of view. Since this point of view is not especially helpful, the ordinary student would probably be well advised to use a text-book written from a less specialised aspect; but research-workers on catalysis may well find fresh inspiration in a novel way of looking at familiar facts.

Characters and History of the Ferns.

The Ferns (Filicales) Treated Comparatively with a View to their Natural Classification. By Prof. F. O. Bower. Vol. 1: *Analytical Examination of the Criteria of Comparison.* Pp. x+359. (Cambridge: At the University Press, 1923.) 30*s*. net.

THE publication of the present volume is of peculiar interest to all who seek to understand the inter-relationships of living organisms. Consisting, as it does, of some 360 pages of beautifully produced and liberally illustrated matter, this book is indeed a literary effort of which both author and publishers may well be proud.

It has been Prof. Bower's intention to present not only a reasoned statement of the relative value of the criteria on which the systematic grouping of the ferns must for long be based, but also to indicate for them probable relationships with other primitive phyla, and thus to render the comparative study of their phylesis contributory to still wider views on the descent of land-living organisms. The present volume deals primarily with the criteria of systematic comparison themselves. Presenting as it does for the first time in the history of the literature of plant-systematics a fully co-ordinated and closely reasoned statement on the values ascribed to the characters considered, it forms a conspicuous landmark in the progress of systematic thought and writing.

On the criteria drawn from the widest study of external form, cellular segmentation, leaf venation, the vascular system of the shoot, dermal appendages, the position and structure of the sorus, indusial protections, the characters of the sporangia and spores, spore-output, the morphology of the prothallus, the position and structure of the sexual organs, and the embryology of the sporophyte, the author's rebuilding of the systematics of the ferns in the second volume will largely rest. It is not too much to say that in this book Prof. Bower has valiantly endeavoured to formulate anew standards of phyletic comparison whereby a new and more reasonable order will arise out of the chaos to which fern-systematics had been reduced. A chapter is devoted to each criterion considered, and a comprehensive and carefully chosen bibliography is in each case appended, chosen with the author's full knowledge of the literature of his subject.

Varied as are the ways whereby we arrive at our conclusions, our most absorbing interest, and indeed our ultimate aim in the study of living organisms, lie in the determination of their inter-relationships. It is safe to assert that for the past generation the only method open for a reasonable understanding of the phylesis of any group of organisms has been the morphological method. This Prof. Bower has followed with admirable persistency and foresight throughout a lifetime of active research. That the results have fully justified the means cannot for a moment be doubted. To arrive at a reasonable grouping of the ferns from the comparative study of their characters of form, structure, and reproduction has been the avowed aim of the author for many years. That the meaning of the characters themselves expressed in form and structure still escapes us will be readily granted. For many who have not followed his phyletic method, the absence of a final interpretation of structural characters may seem cause for delay in the acceptance of the relative value of the characters discussed, and indeed of any wide application of the conceptions of the relative primitiveness or advancedness at which the author has arrived. Instinctively, one revolts against the idea that hairs must be the expressions of relatively primitive characters, while scales, on the other hand, are indicative of advance, even though the author has conducted with consummate skill a special pleading of the case, supported on broad grounds by the illuminating evidence of fossil-history. That primitive ferns were dominantly hairy is universally accepted on the fossil evidence itself, but that hairiness in a living organism—which on other grounds is considered advanced—may be viewed as a relatively primitive character seems unjustifiable, especially in the absence of any intimate understanding of the meaning of either hairiness or scaliness in any living fern.

The case is similar, and indeed must be so, with all the characters concerned, considered as they are by the author on the broad basis of structural comparison alone. It is so, for example, in the consideration of the vascular system of the axis, the venation of the leaf, and the gametophytic generations; for although we are now in possession of the fullest knowledge of the distribution and structure of vascular tracts and of the organisation of the sexual generation of many ferns, we still know nothing of the meaning of conductive tissue in the ontogeny of any organism, or of the true values to be assigned to the gametophytes of any fern which may figure in a systematic discussion.

In the hands of a less skilful writer and pleader the conceptions of "biological probability" which underlie the author's treatment of structural characters might seem less alluring than they do in the pages of this volume. The weakness of the morphological method lies indeed in its inherent inability to explain the characters considered. It must always be so, until a closer co-operation has been secured and persistently maintained between morphological and physiological investigators. Its strength lies in the knowledge that for long it must remain the sole avenue to wide generalisations on phyletic relationships. To its weaknesses and to the tentativeness of the conclusions secured by morphological study alone, the author of this work is as fully alive as is any student of phylogeny who would arrive, at some distant period, by physiological inquiry at a reasonable understanding of any life-process.

The very doubts and fears which the consideration of this book must naturally arouse for those who have not employed the author's methods are, however, integral parts of its purpose. We are on the eve of new departures in morphological inquiry, in which a closer alliance between the pure physiologist and the morphologist will be secured. It is good, then, to have this treatise at this time providing the sum of knowledge in a branch of biological science so admirably condensed, and the philosophy which has grown with it so skilfully and so clearly presented. The day of the formal morphologist is past: the day of the causal morphologist is already with us. It may yet be possible to present a work in which a chapter on "the habit and habitat of ferns" will form a satisfying conclusion to the treatise as a whole, for these are the expressions of the sum of the characters with which the author has dealt so ably.

Whatever will be the fate of the classification which the second volume of this treatise is to provide, the present volume will stand as a classic in the presentation of the thought and work of a school of investigators who for a generation have made history in biological inquiry. The pages of this book should be read and re-read by every student of descent, and its matter will be undoubtedly considered as a statement of structural fact which has seldom been surpassed in the literature of the natural sciences for clarity and just judgment.

J. McL. T.

Our Bookshelf.

Contributions to Embryology. Vol. 14, Nos. 65-71. (Publication No. 277.) Pp. iii+162+15 plates. (Washington: Carnegie Institution, 1922.) 3.50 dollars.

AMONG noteworthy papers on the development of the circulatory system by E. D. Congdon, H. H. Woollard, Florence R. Sabin, and others, this volume contains an important contribution by Charles A. Doan to the solution of the problem of the bone-marrow circulation. His method of investigation was general injection, under a pressure of 130 mm. of mercury, with an Indian-ink solution, of the vascular system of about forty pigeons. By this means he claims to have brought to light the existence of an extensive capillary plexus connecting the branches of the sinusoidal, venous elements, arranged in tufts, which probably form the active, functioning vascular bed of the bone-marrow.

It is suggested that the normal state of these blood-channels, which must be studied in hypoplastic marrows, is one of collapse. This view the author correlates with his conclusion that the vascular system of the bone-marrow is a closed system, and with Drinker's discriminating statement that red cells are apparently found outside the blood-stream, and enter the moving current as a result of growth pressure, but that their extravascular origin is not implied by this presentation of the facts. It is clear that the capillary system described would add to the endothelium of the larger vessels the amount represented in a close and extensive network throughout the marrow. In the light of this, Sabin's work on the origin of blood-cells in the chick embryo is reviewed. The *venous sinusoids* of the author's text are the *venous capillaries* of most other writers. There is much to recommend the new term. Another point of interest is the author's description of the relation between the vessels of the marrow and those of the periosteum, and of the compact tissue of the diaphysis.

Die Vegetation der Erde. Herausgegeben von Prof. A. Engler und Prof. O. Drude. XV.: *Die Pflanzenwelt der bolivischen Anden und ihres östlichen Vorlandes.* Von Prof. Dr. Th. Herzog. Pp. viii+258. (Leipzig: W. Engelmann, 1923.) 27,000 marks.

THE first part of the work under notice deals with the physical geography of Bolivia, a country comprising both high Andean tableland and moist tropical forests. This is preceded by a short account of the various botanical expeditions to Bolivia, one of the most important being that of Weddell, which led to the publication of his classical "Chloris Andina." Dr. Herzog has made two expeditions himself, and the book before us is largely based on his own extensive travels and observations.

The second part is divided into chapters dealing with the several groups and families of plants which comprise the flora. The characteristics of the formations are described and a brief account of the different ecological regions found on the west and east sides of the Cordillera and in the high Andes is also given.

In the third and largest part, the types of vegetation and the history of the flora are more fully dealt with, and throughout the book there are numerous good text figures showing the different types of vegetation from the low lands of the Gran Chaco, the eastern edge of the Cordillera, the Savanna region of Santa Cruz de la Sierra, and the vast high Andean region which has so remarkable a flora. There is also a useful short chapter on the cultivated plants of Bolivia, and three vegetation maps and plans conclude the volume. Throughout the book the author indicates the affinities of the flora to the floras of adjacent and distant countries.

(1) *A Text-Book of Dental Anatomy and Physiology.* By John Humphreys and A. W. Wellings. Pp. viii+323. (London: E. Arnold and Co., 1923.) 16*s*. net.
(2) *A Manual of Human Anatomy for Dental Students.* By R. Bramble Green. Pp. xi+263. (London: Benn Bros., Ltd., 1923.) 18*s*. net.

Within its necessary limitations, each of these books is admirable. Half of (1) is devoted to comparative dental anatomy, being a well-written and straightforward account of an intricate subject which may be expected to contribute considerably to the education as well as the instruction of dental students. If it fails at all it is when too great a desire for the brief and definite leads to such statements as that "the adoption of the erect attitude led to the perfecting of the hand, that marvellous piece of mechanism by which man's progress became assured, and in consequence of this came the increase in cranial capacity and intellectual development." Such a statement, moreover, does not represent current views. The less general matter is excellent.

(2) Mr. Green has filled a gap in the series of textbooks. His account of the salient features of human anatomy is well arranged and well illustrated, and he has shown great discretion in necessary omissions. The ligaments called "alar or check" in the text are marked "accessory" in the corresponding figure; but mistakes are few.

Die Pfeilgifte: nach eigenen toxikologischen und ethnologischen Untersuchungen. Von L. Lewin. Pp. xi+517. (Leipzig: J. A. Barth, 1923.) Grundzahl: 13 marks.

Dr. Lewin's monograph on arrow poisons is one which neither students of toxicology nor those who are interested in primitive science and methods of warfare and the chase can afford to neglect. Its comprehensiveness and careful attention to minute detail are such that it is not surprising to learn that it is the product of some thirty years' study and research. In an introductory chapter he surveys briefly the early use of poisoned weapons, which were well known to the ancients and may, the author thinks, go back so far as late palæolithic times, if, that is, his explanation of certain grooves in Magdalenian bone implements is correct. He then goes on to describe in detail the various forms of poison, both animal and vegetable, in use in all parts of the world, including Europe in early historic times. Not only does he deal with their preparation, but he also considers their chemical composition and gives the result of experimental observations of their effects and the length of time in which these effects are produced. Special attention has been given to the well-known Upas or Ipoh poison of the Indonesian area and the curare of South America, and in both cases interesting accounts of these poisons are quoted from early travellers.

A Naturalist in Hindustan. By R. W. G. Hingston. Pp. 292+10 plates. (London: H. F. and G. Witherby, 1923.) 16*s*. net.

Imbued with the spirit of Fabre, and possessing much of his ingenuity and accuracy, Major Hingston gives a fascinating account of some of the ants, spiders, and dung-burying beetles that he has watched and subjected to various experiments in a small patch of jungle in the Fyzabad district. Of the many good things that he sets before us perhaps the most interesting are his observations on the power of communication with one another that is possessed by ants, and on their sense of direction. That an individual Phidole ant having found treasure afield is able on returning to the nest to send forth direct to the treasure and unescorted an army of its fellows, compels our wonder. The author, however, shows convincingly by reference to other species how in all probability this amazing faculty has been evolved from very simple and perfectly intelligible beginnings:—guidance of one follower by actual touch along the whole route is the starting point; progress towards the complex phenomenon exhibited by Phidole depended on successive refinements of the olfactory sense. That sense of direction is possessed seems proven by the experiments cited; but "it is quite inexplicable to us."

La Chimie et l'industrie. Numéro spécial, mai 1923. (Congrès Exposition des combustibles liquides.) Pp. 852+xcii. (Paris: 49 rue des Mathurins, 1923.) n.p.

La Société de Chimie Industrielle organised in the month of October 1922 an International Congress on Liquid Fuels, which appears to have fulfilled the objects of the Society. A very large number of scientific and practical problems, due for solution, were discussed by the members of the Congress. The results of their labours are seen in the 800 pages of this volume, which in effect becomes a text-book illustrative of current procedure in the winning and in the utilisation of liquid fuels. Much is said of the prospect of future supplies, but little can be known with certainty in view of the doubtful duration of the yield of known wells and the unknown possibility of the discovery of further oil fields. So small an area of the world has yet been surveyed, and so little is known of the origin of the various oils, that the time is not yet ripe for the formation of broad policies. A watchful, waiting attitude is the only scientific one.

Letters to the Editor.

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

Correlation of Upper Air Variables.

I DO not see that Prof. Mahalanobis (NATURE, September 1, p. 323) has given any good reason for the statement that the correlation coefficients that I have obtained from the English balloon ascents are to be taken as the upper limit of what is possible, excepting that Capt. Douglas working on a different system in one specific instance has obtained a lower value. I freely admit they may be wrong; unless one has a very large sample one always has to reckon with the casual error of a correlation coefficient, but there seems no reason why I should not equally well accept Dr. Chapman's conclusion that they are too low.

Taking Prof. Mahalanobis's equation (1) (Memoirs of the Indian Meteorological Department, vol. xxiv., pt. ii., p. 12), transposing it somewhat, and rearranging, we get the following expression for the correction for the observational errors:

$$\frac{s_a}{s_b}\left\{r_{ax}r_{x_1y_1} - r_{ay}\right\} + \frac{s_b}{s_y}\left\{r_{by}r_{x_1y_1} - r_{bx}\right\}$$
$$+\tfrac{1}{2}\left\{\frac{s_a{}^2}{s_b{}^2}r_{x_1y_1} + \frac{s_b{}^2}{s_y{}^2}r_{x_1y_1} - 2r_{ab}\frac{s_as_b}{s_xs_y}\right\}$$
$$-\tfrac{1}{2}r_{x_1y_1}\left\{r_{ax}\frac{s_a}{s_x} - r_{by}\frac{s_b}{s_y}\right\}^2$$

where x and y denote the true departures from the mean, x_1 and y_1 the observed departures, and a and b the errors.

Let us take the special case of the correlation between pressure and temperature at a fixed height between 4 and 8 kilometres. Here $r_{x_1y_1}$ is equal to 0·85 and the ratios s_a/s_x and s_b/s_y are known to have a value of about 1/5.

Substituting approximate numerical values the correction is

$$0{\cdot}20(0{\cdot}85r_{ax} + 0{\cdot}85r_{by} - r_{ay} - r_{bx}) + 0{\cdot}04(0{\cdot}85 - r_{ab}) - 0{\cdot}02(r_{ax} - r_{by})^2.$$

Owing to its comparatively high numerical coefficient the first bracket is the important one, and a negative correction requires that r_{ax} and r_{by} should be negative and r_{ay} and r_{bx} positive. I can see no reason why the correlation values should be anything but casual; they will certainly be small. Moreover, x and y are positively and highly correlated and therefore r_{ax} and r_{ay} are likely to have the same sign; so are r_{bx} and r_{by}, hence it does not seem likely that the term can supply a large correction either positive or negative.

In the second bracket the coefficient r_{ab} is certainly positive for the special case where a and b refer to the errors of temperature and pressure at about 6 kilometres height. This is apparent because y_1 is calculated by Lagrange's formula and a positive value of (a) increases the value of y_1 and therefore increases (b), but the casual error of y_1 due to faulty calibration or incorrect working up will prevent the correlation between a and b being as high as 0·85 and the term will be positive. The third bracket is the square of a small quantity multiplied by 0·02 and is insignificant. Thus it appears probable that on the whole the computed correlation coefficients are somewhat too low.

There can be no reasonable doubt that the correlation between certain variables in the upper air is very high, and any theory of the genesis of cyclones and anticyclones to be satisfactory must account for such correlation.

I should like to add that I have never thought that the seat of atmospheric disturbances was in the stratosphere, but, since upper air observations have been available, have held that the winds of the general circulation in the upper part of the troposphere are responsible for the formation and maintenance of cyclones. This fits in satisfactorily with the known variations of temperature.

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Greek Orthography in Scientific Names.

IT is difficult, as correspondents in NATURE have noted, to preserve orthography in scientific names derived from the Greek. A good example of the confusion which has been allowed to become inevitable occurs in the similarity of the generic title of two very dissimilar shrubs. *Chionanthus Virginica* has been named from χιών—snow—because of the masses of white blossom it bears at midsummer; while *Chimonanthus fragrans*, flowering in midwinter, ought to be written *Cheimonanthus*, from χειμών, winter. To each of these Greek generic names a Latin adjective has been tacked, which serves to distinguish the species, but may offend the scholar.

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X-Rays and Crystal Symmetry.

IT has long been recognised that angular measurements do not always carry one beyond a determination of the system, and that other methods of investigation are needed if the crystal is to be assigned to its class of symmetry. But different methods do not always give the same result, so that some principle of discrimination has to be adopted. In the past the principle universally applied has been that of greatest common measure, the crystal being correspondingly relegated to the highest class, the symmetry of which is common to the various symmetries observed (in most cases this leads to the lower of two observed symmetries, since the symmetry of one is generally wholly contained in that of the other). It must be noted that all class assignments are provisional and liable to modification (necessarily in the direction of lower symmetry) as new evidence is forthcoming.

The above symmetry has hitherto always been regarded as the true symmetry of the internal structure. This view has been somewhat questioned by E. T. Wherry (*Amer. J. Sci.*, 1922, vol. 4, p. 237) and repudiated by R. W. G. Wyckoff (*ibid.* vol. 3, p. 177; vol. 4, p. 469). It is much to be regretted that considerations of space prevent any discussion of Wherry's paper, for it is in many ways suggestive. The issue raised by Wyckoff is, however, more clearly defined. As a result of a renewed X-ray examination of sal-ammoniac he finds that there is no possible model which will simultaneously satisfy Tschermak's symmetry, deduced from surface studies, and the X-ray data (a model can be found to agree with either of two higher symmetries, the ambiguity arising from an impossibility of placing the hydrogen atoms on account of their small scattering power). This leads to an entirely new definition of symmetry, as being that of the constituent parts (the atoms) as revealed by X-rays. The evidence of such surface phenomena as face development, etch figures, and the like, is discussed and finally dismissed as untrustworthy—apparently on the sole ground that some crystals are known to exhibit different geometrical symmetries when grown or dissolved under different conditions.

An examination of Wyckoff's and Tschermak's papers would seem to leave no doubt concerning an actual clash between the two symmetries, but as Wyckoff's explanation is quite unacceptable I would discuss it here and add a few suggestions, which may contribute towards an eventual solution to a problem of great complexity.

The question, whether symmetry of structure (there is no other real symmetry) can be deduced from surface observations, revolves round the following typical case, in which observations on etch figures can well be omitted, for dissolution is the inverse of growth. Among the faces exhibited by a certain orthorhombic substance are those of a right tetrahedron, sometimes but not always accompanied by those of the correlative left tetrahedron. In the former case the symmetry appears to be holoaxial, the crystal belonging to the category of enantiomorphous figures; while in the latter case the symmetry is apparently holohedral, and the crystal is identical with its mirror image. Even in the case of such apparently ambiguous evidence the crystallographer believes he can determine the correct symmetry of structure.

In any crystal having the lower symmetry, similar directions occur in sets of four, geometrically expressible as normals to a tetrahedron. This offers a simple structural interpretation of the observed fact that if the conditions at the surface are suitable for the appearance of one facet, the other three are simultaneously developed. In other words, the structure is controlling the surface. But the conditions may simultaneously be favourable for a revealment by the structure of another set of morphogenetic directions—with the production of the left tetrahedron. The definitive choice of the lower symmetry is still seen to afford a simple correlation between structure and surface. Now consider the implication of the selection of the higher symmetry, demanding the structural subsistence of similar directions in groups of eight instead of four. The simultaneous appearance of the two tetrahedra is accounted for, but not the occasional development of the right tetrahedron alone (or alternatively of a left tetrahedron alone, if this ever occurred). There is no longer any simple explanation for a tetrahedral development, as opposed to a development of four facets at one end of the crystal (hemimorphic), or of three facets at one end and the fourth at the other. The possibility of correlating form and structure vanishes just as utterly as if the crystal were bounded by an irregular or curved surface.

Now the above substance, like thousands of others, shows no trace of curvature but obeys Haüy's Laws of Symmetry and of Simple Multiple Intercepts. Some crystals are, however, known which are partly bounded by plane and partly by curved faces, and the question naturally arises whether such curved boundaries admit of a simple structural interpretation. Fortunately, the invention of the two-circle goniometer permits of the exact exploration of a curved surface, and a recent observation in the Oxford laboratory may now be put on record. A substance closely allied to the one already discussed, in addition to plane facets of negligible symmetry import, exhibits large curved tracts arranged tetrahedrally. Moreover, there are two kinds of crystal, the curved tetrahedron of one being the mirror image of that of the other. If the crystals were mixed together, they could be separated by hand. It is evident that the apparently irregular boundary of certain crystals is being reduced to the same rule of law and order as is obeyed by the plane-faced crystals of the text-books.

Such results as the foregoing are held by a growing body of X-ray workers to have no exact structural implication, being contaminated, as it were, by the non-crystalline influence of the surrounding fusion, solution, or vapour. It therefore seems desirable to press the argument home into the structure. Exactly seventy-five years ago a young crystallographer was examining a problem that had long vexed several Academies of Science. The problem had in fact been pronounced insoluble only three years previously, but the tiny tetrahedral facets, occasionally observed in certain crops of crystals and not in others (a fact I know from experience), proved sodium ammonium "racemate" to be an impostor, being in fact a conglomerate of *d*- and *l*-tartrates. In this way Pasteur showed there is something of unimpeachable integrity on the surface of a crystal: something which when properly interpreted can be made to found a new province of a science dealing with liquids and vapours.

But this is not all. A later (as also an earlier, but forgotten) advance in the classification of crystals led to the recognition that out of thirty-two classes of crystal symmetry, there are eleven enantiomorphous classes: namely, the asymmetric class of the anorthic system, the tartaric acid class of the monoclinic, the Pasteur class of the orthorhombic, and two classes in each of the rhombohedral, hexagonal, tetragonal and cubic systems. It follows indubitably that every substance which is optically active in solution belongs to one of those classes. Happily, the most important systems statistically are the first three mentioned, and a recent count has shown that some 420 structures (an isomorphous group being regarded as one structure), representing 93 per cent. of optically active substances on the crystallographic record, are thus definitely known as to their class of symmetry. There are possibly two thousand more, lying indetermined in the specimen cupboards of the chemist for want of a crystallographer on the staff to examine them. (Parenthetically, I would point out that Shearer's rule could well be tested by an X-ray examination of those substances, which in solution have a truly asymmetric configuration. If, for example, the anorthic tetrahydrated acid strontium tartrate were found to contain more than one molecule to the unit of structure—or seignette salt more than four—the rule would be infringed.)

Unfortunately the Pasteur generalisation is not applicable to all crystals, so that a careful examination of the surface, eked out by a determination of certain physical properties, is still demanded for the great majority of substances, namely, those inactive in solution and, owing to a certain limitation, those which are only active in the crystalline condition.

The above will, perhaps, be sufficient to show that surface studies lead towards a real knowledge of crystal symmetry, provided they are interpreted by the principle of greatest common measure. In individual cases the knowledge may not be complete at the outset (every determination being in a sense provisional). It may have to be modified with accretion of evidence, in which connexion it is a highly significant fact that whenever there has been such a modification in the past, as a result of a study of such structure properties as pyro-electricity or optical activity, the modification has always been towards a lower symmetry, *i.e.* towards a symmetry which experience proves might equally well have been offered (if only on one occasion) by the surface, if the crystal had been grown or dissolved under a greater variety of conditions. On the other hand, the symmetry demanded by the X-ray work on sal-ammoniac is higher than that of the crystallographer. It is, therefore, not the crystal symmetry (the complete physico-chemical symmetry on which crystallography and its offshoot stereochemistry are based) but a pseudo-symmetry—a phenomenon with which the crystallographer is familiar in other connexions. It may accordingly well be termed X-ray symmetry, in order to distinguish it from other pseudo-symmetries.

Now, whatever may be the true cause of this X-ray symmetry, the explanation given by X-ray workers is singularly unconvincing. So far from harmonising a previously organised body of fact and interpretation of proven worth with the new results, the explanation relies wholly on the data obtained from the X-ray tube, and discounts the value of surface evidence, almost on principle—for however ambiguous surface evidence may be in certain crystals, it cannot be fairly held to apply to sal-ammoniac, in which plane faces of growth, the run of their striations, and the orientation of etch figures all demand the same class of symmetry. It is surely obvious that the real explanation must take equal cognisance of all well-established facts, including those collected by the aid of the goniometer, microscope, polarimeter, and, last but not least, the test-tube, all such facts being apparently equally precious in this province of crystal symmetry. The problem is to evaluate the results from all these instruments without unduly elevating or depressing this or that section. My own view is that the ultimate solution awaits the discovery of a new method, which shall tell us as much about the chemical aspect of crystal structure as the X-ray method does about its physical side. Thus warned, a reader will not expect too much from the following paragraphs.

As a preliminary, it seems necessary to clear up a widespread misapprehension concerning the results of X-ray investigation. It has not infrequently been stated that the recent work on organic compounds has proved the existence of the molecule in the crystalline condition. I do not know how this misapprehension arises, for a perusal of Sir William Bragg's original paper, in this domain, shows that the molecule is assumed as a working hypothesis. The real position is that the X-ray method can scarcely ever be expected to prove molecular structure. It is now generally accepted that the origin of X-rays (as also the seat of their diffraction) lies near the nucleus, and not in the few peripheral valency electrons which provide an occupation for the chemist. The X-ray method has the defect of its qualities: in revealing the atomic positions in a crystal, it ignores the molecular aspect completely. In the case of naphthalene the method reveals the presence in the crystal of pockets, each containing a mass of material having the composition $C_{20}H_{16}$ (if anything, then, in this case it reveals polymerised molecules). The interpretation naturally takes a molecular form, because any other would be chemically absurd; but so far as anything of the nature of chemical "bonds" is concerned (or of a union of certain atoms into a molecule) it is, relatively, a waste of time to appeal to the X-ray bulb. The proper appeal is to the test-tube.

A similar remark applies to the typical inorganic case of sodium nitrate. The crystal model of the X-ray analyst allows an interpretation of a structure, which has been electrically resolved into sodium and nitrate ions. But it might also be interpreted as a fine mixture of sodium, nitrogen, and oxgyen, or even as an ionised sodium nitrite plus oxygen, in which the latter strives after geometrical symmetry and succeeds. There can of course be little doubt that we are dealing with the first alternative, because it is possible to crystallise a solution to dryness, and redissolve the salt without any appreciable evolution of nitrogen or formation of nitrite. It may be added that although ionisation of a crystal salt into electrolytic parts is extremely probable, it has not yet been proved by the X-ray method (Debye and Scherrer's work on lithium fluoride being generally held, in particular by W. L. Bragg, to be inconclusive).

In this purely atomic reaction of molecular matter to X-rays (proved to the hilt by the pioneering work of Barkla and later by Moseley) there would seem to lie a possibility of obtaining a higher symmetry than by the physico-chemical method of surface studies. The rôle played by the physicist's atom in his statement of symmetry is that of a sphere. This may be true so far as X-rays are concerned, but scarcely of the crystal, for valency forces must be taken into account. The question therefore arises whether the replacement of a sphere by a humped surface (or, alternatively stated, whether a consideration of the movements of valency electrons) will serve to degrade the symmetry, not merely of the individual atoms (as it must) but also of the structure as a whole (as it might). If this is found to be the case there is an obvious explanation of a pseudo-symmetry, obtainable by the X-ray method.

An examination of this problem shows that no lowering of symmetry can result from single valencies (I have, then, no explanation to offer for sal-ammoniac), but with the double bond (the double sharing of electrons), which first becomes possible with a divalent atom, the symmetry may, indeed, be degraded, always provided that the atom occupies a "specialised" position in the structure, *i.e.* a position in which it may be the seat of centro-symmetry or intercepted by a plane or axis of symmetry. In a crystal of sodium nitrate, for example, we have probably to deal with Na^+ and NO_3^-. If the oxygen be monovalent, or divalent with the double bond lying in the basal plane of the crystal, the symmetry is still that of the atomic crystal of the physicist; but if the double bonds be arranged in a manner suggested many years ago, without any reference to X-rays, by J. E. Marsh and myself (J. Chem. Soc., 1913, vol. 103, p. 845), the NO_3^- group acquires the symmetry of quartz, and so does the crystal as a whole (the new "space group" or point system being: Fedorov, 46 *s*; Schoenflies, D_3^7). Such a crystal would be indistinguishable by the X-ray method from the atomic crystal of the physicist, but would presumably betray its lower symmetry, when allowed to grow or dissolve in its solution. A similar theoretical possibility holds, of course, with the calcite group, the extra electron given up by Ca^{++} making up the corresponding deficiency in an atom of carbon as compared with an atom of nitrogen.

The real state of affairs is evidently not as described above, for the symmetry of the calcite group and of sodium nitrate is not that of the quartz class. It does not necessarily follow, however, that the crystal is exactly as it has been left by X-ray workers. It may be a "racemic" substance, consisting of alternate basal strata of *d*- and *l*-carbonate or -nitrate groups, interlaminated by charged calcium or sodium atoms. Examination of the new model shows such a crystal to have both the correct symmetry and the same space group as the purely atomic model (Fedorov 47 *h*, Schoenflies D_{3d}^6), but with a crystallographic vertical translation equal to twice the old value. From the X-ray point of view, however, the vertical translation would be as before, for X-rays would scarcely appreciate the fact that they are dealing with enantiomorphous groups of valency electrons. The case is not analogous to racemic acid, for there is no enantiomorphism of the grossly material nuclei or inner swarms of electrons.

It need scarcely be added that the optically active sodium chlorate (or bromate) follows the above scheme and is in agreement with recent X-ray atomic models. The instantaneous racemisation on dissolution may well be attributed to the delicate nature of a purely electronic type of enantiomorphism.

The above suggestions are possibly open to the objection that they are too elusive to be put to an experimental test. This leads me to suggest material for future investigation, which may help towards a decision. The rhombohedral dithionates of calcium, strontium, and lead are usually quoted as having four molecules of water of crystallisation, thus, PbS_2O_6, $4H_2O$. If this is really true, it would seem to follow that the crystal unit must contain six, if not twelve or even twenty-four, molecules of the salt, and that no successful elucidation is to be expected with present-day X-ray technique. But a rhombohedral crystal with four instead of three or six molecules of water almost amounts to a contradiction in terms, and the early analyses of these salts (ignition to an anhydrous sulphate) are perhaps not conclusive. A particularly simple crystal structure is consistent with a hexahydrated salt; in fact any eventual proof of a four-unit cell would determine the water content as securely as a chemical analysis. It is therefore conceivable that the structure is modelled on the calcite pattern (four molecules to the Bragg unit) according to the following scheme :

$$\ldots [6H_2O]Pb^{++} \ldots O_3S^{-}\text{——}^{-}SO_3 \ldots [6H_2O]Pb^{++} \ldots$$

and that we shall have an X-ray pseudo-symmetry, the atomic assemblage appearing to have the symmetry of calcite, while the crystal structure has the symmetry of quartz (the crystals are optically active, but not the solution). The rhombohedral (or hexagonal ?) anhydrous potassium salt may, perhaps, follow similar lines, but the crystallography is somewhat obscure.

No good purpose would be served by following out the consequences of a deformation of the RO_3 group into lower systems of crystallisation. Nor need the case of an RO_4 group be discussed, as it does not seem to offer any likelihood of pseudo-symmetry.

As previously indicated there is no such possibility of pseudo-symmetry as the above, when no atom, ion, or molecule occupies a specialised position in the structure. None is therefore to be expected in any of the 420 optically active structures previously mentioned. In theory, then, we have here another possible way of testing the above suggestions, but practical considerations, unfortunately, rule out any likelihood that the X-ray analyst will be able to determine any kind of symmetry in such complicated compounds in the present generation. In Astbury's recent investigation of tartaric acid the symmetry had, perforce, to be assumed.

The only other possibility that has occurred to me is that the arrangement of the internal electrons (as opposed to the chemical electrons) may affect crystal symmetry ; but as it is difficult to see how this could have any physico-chemical manifestation at the crystal surface, it has not been further examined.

In conclusion, it will be realised that the work on sal-ammoniac may represent a turning point in the history of the X-ray method, for no matter whether X-ray symmetry be held to be a pseudo-symmetry or a true symmetry, the practical consequences are the same. As emphasised by Wyckoff, the X-ray analyst must henceforth look upon crystal symmetry with suspicion, and not be led astray at the outset of his interpretation. Unfortunately, this leaves him in the air so far as symmetry is concerned, and implies a revision of many past models. The symmetry of calcite, for example, from the X-ray point of view is not necessarily the symmetry of Haüy. To the crystallographer it will remain so, until such time as new evidence shall demand a lower symmetry.

The following summary may be useful. Each crystal has a definite symmetry—that of a structure of a physico-chemical order of complexity. At the present time the only way to determine this symmetry is to study the surface or make use of such a generalisation as the Pasteur principle, which has established itself on a permanent foundation. Any higher symmetries are pseudo-symmetries, and have their origin in a suppression of certain determinants. A notable example is X-ray symmetry, for it is compulsorily based on an atomic conception of crystal structure, and not on the molecular basis demanded by a wealth of chemical facts. An attempt is made to bridge the gulf between X-ray symmetry and crystal symmetry, but it is felt that the real solution is not yet in sight, owing mainly to the lack of a general chemical method of investigating crystal structure *in situ*.

T. V. BARKER.

University Museum, Oxford,
September 8.

Some Curious Numerical Relations.

IN the course of a series of computations it was noticed that the ratio of the numerical values of the following pairs of quantities is in each case an integral power of ten. This curious relation is so surprisingly exact that it seems worthy of record :

$$(h/2\pi)^2 = 1{\cdot}08806 \times 10^{-54} \text{ erg}^2 \text{ sec.}^2$$
$$e^3/K_0 = 1{\cdot}08804 \times 10^{-28} \text{ erg cm. es.}$$

$$e = 4{\cdot}774 \times 10^{-10} \text{ es.}$$
$$h/k = 4{\cdot}777 \times 10^{-11} \text{ sec. deg.}$$

$$m_0 = 8{\cdot}9991 \times 10^{-28} \text{ gm.}$$
$$c^2 = 8{\cdot}9916 \times 10^{20} \text{ cm.}^2 \text{ sec.}^{-2}$$

$$r_1 = 5{\cdot}30507 \times 10^{-9} \text{ cm.}$$
$$e/m_0 = 5{\cdot}30500 \times 10^{17} \text{ es. gm.}^{-1}$$

The symbol *es* has been used to denote the electrostatic unit of charge, r_1 the radius of the first Bohr ring in hydrogen, K_0 the dielectric constant of a vacuum, k the gas constant per molecule; the other symbols have their usual significance. The values that served as the basis of the computation were those just given for e, e/m_0, and c, and the following: h, $6{\cdot}554 \times 10^{-27}$ erg sec.; the faraday, $2{\cdot}89365 \times 10^{14}$ es. per equivalent; the volume of one gram-molecule of ideal gas at 0° C. and one standard atmosphere, 22411·5 cm.^{3} per mole; and 0° C., 273·1° K.

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Lichens and their Action on the Glass and Leadings of Church Windows.

I HAVE read with great interest the paper by Dr. Ethel Mellor in NATURE of August 25 and I should like to refer to one or two points.

The paper gives the general impression that the decay of ancient stained glass is produced by the action of lichens. This has frequently been suggested, but surely the reverse is the case—the decay of the glass is not due to the presence of lichens but the undoubted growth of lichens on it is due to, and subsequent to, the glass being decayed.

The immediate cause of decay and the formation of the characteristic pit holes is surely due to chemical and physical decomposition, and it is only when the glass is in an advanced state of decay that the lichens find in the disintegrated glass accumulated in the pits a soil suitable for their growth. (For details I would refer to an article in NATURE of May 2, 1907.)

One finds, in fact, that the degree and character of the corrosion is determined by the chemical composition of the glass. The statement that the glass of the twelfth to the fifteenth century shows a slower rate of alteration than that used later needs some modification. The glass of the twelfth century was of good quality and shows little decay, but there was steady deterioration from the thirteenth to the beginning of the fifteenth century; the glass of this latter period shows the most pronounced decay. After this time the composition of the glass in general steadily improved.

The point I would particularly challenge, however, is the suggestion that windows should be treated with a liquid mastic to prevent the growth of lichens. I am not quite sure if this is intended to apply to new or old windows. If the latter, surely the remedy is a thousand times worse than the disease. If the former, I suggest that the proper way to prevent the growth of lichens is to prevent the decay of the glass which enables them to gain a foothold. That can be done only by ensuring that glass of a composition which ensures durability is used in new windows. As a matter of fact the glass used nowadays as a rule leaves little to be desired in this respect.

One further point occurs to me. I have made many analyses of medieval stained glass and I invariably find phosphates as a constituent—particularly in glass of the fourteenth century. As the glass decays this would presumably be deposited as calcium phosphate in the corrosion pits. Would this encourage the subsequent growth of lichens and account in some measure for the prolific flora described by Dr. Mellor? NOËL HEATON.

81 Queen Victoria Street, E.C.4,
August 29.

THE article referred to by Mr. Noël Heaton describes the results of "one of several possible lines of research"; it shows that lichens accelerate the chemical change of the glass and lead, and exert a mechanical action on the altered glass.

Certain species of lichen are found only on unaltered glass; they do not persist, and on disappearing leave a roughened surface conformable to their own shape. On deeply corroded glass, lichen débris, not the plant, is the more frequent. Lichen physiology is a controversial subject, but the probability is that neither the calcium phosphate nor the "soil" mentioned by Mr. Heaton accounts for the flora.

References to the presence of three species of lichen on the windows of two churches are made by Fries and Nylander, and reproduced by a few lichenologues; there has been, to my knowledge, no scientific investigation of the lichen flora on church windows or of its relation to the deterioration of glass until three years ago when the research was undertaken at the Sorbonne. I cannot therefore appreciate Mr. Heaton's statement that it "has frequently been suggested" that "the decay of ancient stained glass is produced by the action of lichens." I am, however, open to correction if Mr. Heaton will give the authority for his statement.

The only modification I can make with regard to the glass of the twelfth to the fifteenth centuries is that certain glass of the twelfth century is immune, but is this not to some extent true of the glass of each century? It is reassuring to be told that "the glass used nowadays as a rule leaves little to be desired" as regards durability, when one knows that certain stained glass of so recent a date as the second half of the nineteenth century shows an advanced state of corrosion. In this case lichens have apparently played no part.

The quality of the glass is undoubtedly a factor of great importance in ensuring its durability, but it cannot prevent the growth of lichens, as some of these plants find a suitable substratum on the smooth unaltered surface of the glass. The application of a liquid mastic to exclude the lichen spores is intended for those windows difficult of access for cleaning purposes. What can be the objection to its use on old glass and not on new? The suggestion is not my own; it finds favour with one who has more than forty years' experience in the art of stained glass, medieval and modern, and has the keenest appreciation of æsthetic value.

It may be mentioned that the destructive effect of lichens on their substratum is remarkably evident on the marble statues at Versailles,—some eighteen months ago it was decided to arrest the corrosion by cleaning the marble and then treating it with a mastic.

Does Mr. Heaton use the word "disease" in its popular or pathological sense? It is to my mind as wrongly used in connexion with the corroded glass as it would be if applied to the weathering and disintegration of rocks.

Through the courtesy of Mr. J. A. Knowles, of York, I have had access to Mr. Knowles's own work and once more read Mr. Noël Heaton's papers on the composition and decay of glass. I see no inconsistency between these papers and my article in NATURE of August 25. E. MELLOR.

University College, Reading.
September 15.

Painted Pebbles from the North-East Coast of Scotland.

THE statement that Azilian painted pebbles do not occur further north than Basle was made by me in a review appearing in NATURE, August 25, p. 276. It has been challenged and the so-called painted pebbles found by Sir F. Tress Barry on the N.E. coast of Scotland recalled. These interesting objects cannot, however, be referred to the Azilian culture, and this for two reasons, namely:

(1) They were found in connexion with and in the precincts of Broch buildings, admittedly from their archæological and faunal content of much later date. It has been suggested that the Broch had been constructed on an older Azilian settlement, but this idea is vetoed by,

(2) When the actual objects are seen and handled it is found they in no respect resemble the Azilian painted pebbles. Prof. H. Breuil, of Paris—previously a partisan of the early age for these objects—at once rejected the Azilian date on seeing the specimens. I may add that I also came to the same conclusion when I saw and handled the stones.

However, it need not be added that the above in no way detracts from the interest of these queer objects from the Broch, and the problem of their meaning and object still remains unsolved.

M. C. B.

Science and Progress in Australia.[1]

By Sir DAVID ORME MASSON, K.B.E., F.R.S., Professor of Chemistry, University of Melbourne.

AN underlying motive of all international conferences is to contribute something towards that mutual understanding—that sympathy—which alone can preserve the peace of nations; but each has also its own specific work to do. The task of the Pan-Pacific Science Congress is to discuss those scientific problems which are of special interest in the Pacific area, to direct attention to them and to lay plans for future research. It is hoped that all the participating countries may benefit; but I think there are two good reasons why Australia may look to profit most. In the first place it is here that the Congress meets and here, therefore, that its deliberations will attract most attention from the public and those higher authorities that have it in their power to aid or discourage any co-operative ventures for the public good. In the second place, Australia, in respect to scientific effort, has more to learn from the older and greater nations—from the Mother Country, from America, from Japan, from Holland—than they have to learn from her.

This island continent is as large as the United States but has a population only about one-twentieth as great. It is a continent of huge distances and vast empty spaces, held by a people of nearly pure British stock, who would not run two persons to the square mile if evenly distributed over its surface. Collected on and near its coastal fringe, they have done much to open up the resources of the land and have learnt much about its difficulties. To carry on the work towards complete development, overcoming obstacles and gradually increasing the area of settlement, is the proud ambition voiced in the nation's motto "Advance Australia." Progress, full utilisation of the great land we occupy, is a duty we owe to ourselves; but clearly our obligation is even more binding as trustees for the world, present and future.

Many things are needed to ensure successful progress—the triumphant fulfilment of Australia's destiny. Statesmanship of course; but as to that we may have faith and confidence. Man-power—a vast increase of population; and towards that end even now the efforts of our rulers here and in Britain are turned, utilising and directing hither the migration wave from an overcrowded land where food is scarce: a movement which has arisen since the War and recalls the greater hunger migrations that went to make history when the world was young. But apart from these there is a need as pressing, as fundamental, though I think it is not so generally recognised of the people. That is the need of science.

Science is nothing more nor less than the knowledge and understanding of Nature's laws. To a law of Nature there can be no exception. The apparently abnormal is seen to be normal when the laws at work are better understood. There is no happening in the Universe except in conformity with natural law. No human act can successfully run counter to it. Any such attempt is foredoomed to failure. Man cannot "fight Nature"; he can but utilise its law-governed processes, profiting by the result. There is, indeed, no true distinction between what we call "artificial" (man-made) and "natural" (Nature-made). An artificial ruby is either not a ruby at all, and therefore misnamed, or it is the outcome of Nature's edict that certain substances, raised to a certain temperature, will fuse, and, on cooling, will crystallise in a certain manner. All that the artificer has done is to gather the right materials and to adjust the environment to the necessary temperatures; and, for this last purpose, he has but utilised Nature's infallible laws of chemical combination and of energy. His ruby is, in truth, as much a natural product as those man finds ready-made in the earth. Let me cite a more important case. Sir Ernest Rutherford is commonly said to have *caused* the *artificial* disintegration of certain of the lighter atoms, such as those of nitrogen, and their partial transmutation into hydrogen atoms. He is said to have done this by bombarding them with swiftly moving alpha-particles emitted by radio-active material. The facts are true, but the common mode of stating them is misleading. Not Rutherford, but Nature, did the work; not Rutherford, but Nature, caused the result. Neither the work nor the result was new. What Rutherford did was to arrange the environment so as to render detection of the phenomena possible; then to observe and then to interpret Nature's deeds. Radium and other radio-active matter have been shooting out swift-moving alpha-particles, and these have been bombarding other atoms and causing occasional transmutations, since time was young; only we did not know of it until recently. Rutherford's discovery is one of the most important events in the history of science, and none but a man with genius such as his for searching Nature's secrets could have made it. We owe to him many other discoveries of first-rate importance and surpassing interest; but even he can do no more than study Nature, follow out her processes, and elucidate her laws.

In more obviously utilitarian fields the same story must be told. The sheep-breeder who gradually and patiently improves the quality or the quantity of his wool and thus raises the value of his flock is not the main agent in the process. He merely acts as Nature's henchman and her immutable laws of heredity do the rest. So it is with the cultivator of improved varieties of wheat—rust-resisting or what not—or of varieties of beet that provide a greatly enhanced yield of sugar.

Is all this a mere truism? I think not; for there are many signs that mankind at large does not yet realise that everything that happens in this universe is the result of the working of natural laws and that the best that man can do is to study them and turn the knowledge of them to his profit. One is tempted here to ask the old question: how many utterly futile man-made laws have been passed by parliaments, foredoomed to become dead letters or to be rescinded, because they tried to run counter to the complex and incompletely understood natural laws of economics or social science?

But, if the principle I have enunciated be a truism,

[1] From the presidential address delivered to the Second Pan-Pacific Science Congress at Melbourne on August 13.

so much the better; for so much the more readily will it be conceded that a nation's progress is dependent on its *understanding* of Nature's laws. This is science; and so much more readily will Australia realise that science is as essential as statesmanship and man-power if she is to achieve greatness.

Science, of course, is too vast a study for any but those who give their lives to it to make much headway, and even these rarely can specialise in more than one of its many branches. Nature, it is true, is one and indivisible, but her work is infinite. The more we learn of her the more we realise her unity, but the more we are forced for our own sakes to subdivide and classify science. The most learned in any branch are at best but amateurs in any other. A nation, therefore, needing science, must make liberal provision for the highest training in all its branches, and must, moreover, see to it that the resulting skill and knowledge are fully utilised for the public good.

Nature being infinite, it stands to reason that what man already knows of her—the science of to-day—is but a fraction of what man may come to know—the science of the future. Yet this small fraction is in itself stupendous. In modern times, since man learnt how best to seek new knowledge, all the great nations of the earth have contributed, and as science grew its rate of growth became accelerated. Now not a day passes without additions to every branch. Scientific education, then, must be equipped to deal adequately with all this accumulated mass of knowledge; but the universities, if equipped to do no more, will fail in their task of training competent men of science to serve their country's needs, and that country will fail in its duty to the world—the duty of contributing by research to the growth of natural knowledge. The science of to-day cannot be divorced from the science of to-morrow; the power to make new knowledge is both the final test and the reward of a scientific education.

The familiar distinction between "pure research" and "applied research" is justified in this—that, while there is no real difference in the methods employed and one may require as much skill and knowledge as the other, the aims from first to last are essentially different. The aim of any pure research is nothing more nor less than to add something new to natural knowledge in a chosen field. The investigator's reward is the joy of discovery. The aim of any applied research is to solve a particular problem, the successful solution of which promises results of direct utility to man and is therefore of marketable value. It may be that the investigator himself does not reap this tangible reward; it may even be that he is content to let it go to others; but in any case his task is that of the treasure-seeker. If he find that the expected treasure does not lie where he hoped to find it, he may follow up any other likely clue to its whereabouts, but may not turn aside tempted by mere glimpses of an unknown land. It is true that exploration there might possibly lead to valuable discoveries, but that is mere conjecture: his immediate task is to unearth the treasure he went out to seek.

Such definitely utilitarian research should require but little advocacy, for it should appeal strongly, even to the unscientific. Any one can understand something of the valuable results that would follow from the discovery of a new and successful treatment of a disease rife among men or flocks and herds, of a method of eradicating a vegetable pest or a parasite destructive of cultivated crops, of an improved process of ore treatment or of metallurgical work, or of the utilisation of some waste product of a manufacture. But not everybody can realise that all such discoveries have their foundation in pure research, that the successful quest of the obviously useful is merely the last stage of an intricate series of scientific investigations, to which many workers have contributed—mostly working with the sole object of adding something to natural knowledge. Those acquainted with the history of scientific discovery and invention know that this is true. They know, moreover, that no genuine new knowledge can properly be stigmatised as useless or "merely academic," however remote from utility it may at first appear; for, sooner or later, it will be found as an essential link in the chain of truths that leads to a valuable conclusion.

When, in 1895, Sir William Ramsay separated small quantities of a gas from the rare mineral cleveite and identified its spectrum with that of Lockyer and Frankland's constituent of the sun's atmosphere, helium, the discovery was full of academic interest but certainly did not promise to be useful. On the purely scientific side the expectations have been far more than realised, for this helium element, since its discovery in terrestrial matter, has been linked up with all that earlier and later knowledge that has culminated in the proof of the electrical constitution of material atoms, or the fundamental identity of matter and electricity—probably the most far-reaching scientific advance within our memory. But, on the utilitarian side, what could offer less promise of practical application than a gaseous element, not only scarce and costly but also absolutely inert and incapable of forming chemical compounds? Yet it was this very inactivity that soon found for it an important use and market value. For, next to hydrogen, helium is by far the lightest of all gases; and, being inert and therefore totally incombustible, it is a safe gas with which to inflate balloons and airships, while hydrogen emphatically is not. The scarcity of supply was overcome when research showed it to be present in small proportions in several natural gas springs in America, and methods were devised for separating it from its companion gases in a pure state. In parenthesis it may be said that the solution of this problem of its separation, were we to follow it out in detail, would itself be seen to have been rendered possible by a chain of earlier pure researches on the physics of the gaseous state. When war ended in 1918, large quantities of pure helium, compressed in drums, were ready in America for shipment to Europe, to be used in war balloons and air-ships. This was but twenty-three years after Ramsay's "academic" discovery of the apparently useless element in terrestrial minerals and half a century after the first observation of it as a line in the spectrum of the sun's chromosphere. The armistice came too soon for it to play its destined part in war; but the ideal inflater of lighter-than-air vessels still meets a want in times of peace, and helium is now being prepared and stored in quantity in the United States, where I understand the use of any other gas for this purpose is prohibited by law.

Such examples of the complete dependence of practical science on pure research, and of the utter falseness of the idea that any genuine contribution to natural knowledge can be inherently and permanently devoid of utility, could be multiplied indefinitely. Any nation, therefore, which aims at progress must for its own sake foster to the utmost of its ability scientific education and both pure and applied research. If further reason and, perhaps, a higher reason be wanted, no civilised nation stands alone: each owes a duty to the others to do its share in the work that is essential for the world's intellectual and material—aye, and moral—progress—the making of new knowledge of Nature's eternal truths. Nothing but extreme poverty or youthful irresponsibility could excuse a nation which, shirking this sacred duty, elected selfishly to profit only by foreign-made science; and nothing is more certain than that it would profit not at all, for it would fail through sheer inability to understand.

That, of course, is far from being the case with Australia. Young though our nation is, it is not so very poor and it certainly is not irresponsible. To make progress for itself and for the world is Australia's just ambition, and it has done much already to prove that it does partly recognise the importance and the power of science. Each State has its University, and each University seeks, within its somewhat narrow means, to excel on its science side. We have our Royal Societies and others of more specialised type, our more popular Australasian Association for the Advancement of Science, and, of more recent birth but, we hope, with a great future before it, the Australian National Research Council, with important international connexions. Each State Government maintains its own scientific activities, particularly in connexion with agriculture and mining. The Government of the Commonwealth does much for public health and for meteorology; and quite recently it has undertaken to build, equip, and maintain a Solar Physics Observatory—a very important contribution to international research. Our Governments, indeed, both Federal and State, have given many proofs that they appreciate the value of international co-operation in scientific work. But democratic governments can never go very far ahead of public opinion; and our Australian people have given no sign as yet of a general understanding of what science can do for them or of an urgent desire to put it to the test.

Here, as elsewhere, there was some war-time awakening to the potency of applied research. It resulted, in 1915, in the adoption by the Commonwealth Government of an ambitious scheme for the formation of an Institute of Science and Industry, with a statutory constitution and with ample means for carrying out investigations over the wide field of Australia's primary and secondary industries. Pending the passing of the necessary Act of Parliament, the scheme was nursed for some four years by a body of voluntary workers, who tried to make up in enthusiasm what they lacked in financial means to success. That Institute now has its statutory constitution, its powers, its director and its office staff, but it has never yet been given the promised means to build the laboratories or appoint the skilled investigators essential to its proper work. War-time awakening was but temporary. It happens that I have a personal knowledge of the history of that adventure and of the difficulties put in its way by unlooked-for opposition and growing indifference in Parliament and elsewhere. That experience has convinced me that the Australian public is still largely blind to its own interests and its duty. Time and education will bring improvement. All that has yet been done is but a beginning, holding out hope of greater achievement in the future. For real progress, Australia needs a great deal more science, even as she needs more men and women.

Let me cite briefly a few of those typical scientific problems of a practical kind which have interested the Commonwealth Institute. Few of them are peculiar to Australia. Most have their counterpart in other countries, and there is none in which we cannot benefit from the experience of one or more of the countries in the Pacific area.

The settlement of people on the land, the spread of pastoral industry and of agriculture, are seriously hampered by the aggressive character of many vegetable pests of foreign origin. One of these, the prickly pear, is estimated to be now in occupation of some 24 million acres of Australian soil, mainly in Queensland, and to be spreading at the rate of one million acres a year. Australia, indeed, owns a much larger area under prickly pear than its total area under cultivation; and there are parts of Queensland so densely covered with this pest that surveys wanted for a railway extension scheme could not be carried through it. Destruction by mechanical means or by poisons has been found too costly for general use; but the biological method of attack holds out more hope. This is based on the fact that the prickly pear, as well as other pests, has been introduced without those natural enemies, insect or fungoid, which keep it in check in its native haunts. By importing them we might eventually re-establish the balance of Nature. Obviously, no such action can be taken without proof that it is free from risk to crops or pasture; and this means prolonged research by experts. Some definite progress has already been made in this direction, but much more work is wanted.

The cattle industry is beset by many ailments, which in the aggregate cost Australia millions of pounds per annum. The cattle tick, with the related tick-fever, is responsible for untold damage, direct and indirect. Similarly, in sheep country the blow-fly pest causes enormous loss, especially in some seasons. All these and many other ills are, or should be, curable; and real success with any one of them would recoup Australia for all it is likely to spend on science; but nothing can be hoped for without extensive and systematically organised research.

In quite another field large progress has already been made, which, however, should but serve as a stimulus to further work. I refer to the increase of our harvests and the extension of the area available for cultivation by the selection and breeding of new varieties of plants better adapted to local conditions. Agricultural experts tell us that an increase of one bushel per acre in the average yield of wheat would represent a gain of 2,200,000*l.*, while any considerable extension of the wheat belt in average breadth by the introduction of more drought-resistant varieties would enormously increase the nation's wealth.

Our forests, so uniquely Australian, offer problems which cry loudly for systematic scientific work, far too little attention having been paid to some of them in the past. The admirable pioneer labours of von Mueller and of Baker and Smith have opened up an almost limitless field in the investigation of the characters and the chemistry of our forest trees. Closely related is the practical problem of the development of forest-product industries. Those who have to do with the timber industry know how much remains to be done in the systematic study of the character of the timbers, their exact classification, and the methods of seasoning and of preservation. All this is apart from, though related to, the problem of forestry proper; that is, the development of a complete organisation, scientifically controlled, for the care and upkeep of the forests, which—though wantonly destroyed in the past—may still be one of the nation's great assets.

The thorough investigation of Australian clays, with the view of the development of a ceramic industry employing native material, is another example of what may be done by applied science in the future; and here again some noted advance has already been made by the Commonwealth Institute, though it has been compelled to restrict its field of work.

There are tasks ahead, however, of perhaps more fundamental importance than any of these in connexion with the development of our country's resources and the settlement of population—tasks, moreover, called for by our obligation to contribute in our own area to man's knowledge of the earth on which he lives. I refer to the need of much more extensive, detailed, and systematically organised topographical and geological surveys than any as yet provided for. Such work would seem to require a definite scheme of co-operation between the Federal and State Governments and the institution of permanent scientific services.

In Papua and still more in the Mandate Territory of New Guinea there is urgent need for systematic scientific work, both for utilitarian reasons and because the unknown, wherever it exists, cries loudly for intelligent investigation. There are not many parts of this earth's surface that remain to-day so unexplored as does much of the interior of New Guinea, or which hold out so much promise of reward to the topographer, the geologist, the chemist, the botanist, the zoologist, and the anthropologist. The services of all these are needed as regular adjuncts to the civil administration. The work should not be left to the casual efforts of individual enthusiasts or of occasional scientific expeditions, often privately financed and undertaken more in the spirit of adventure than of true research. It needs highly trained men and systematic organisation. Most pressing of all is the need of skilled ethnological work—the study of the natives, their beliefs, thoughts, languages, customs, and mode of life, while yet it is possible; for it can be but a little while before they become sophisticated—I had almost said degraded—by contact with white man.

Australia has voluntarily undertaken a difficult task and a great responsibility in New Guinea and the adjacent islands. Its position there is that of a public trustee. Surely its most urgent duty is to make full provision for the scientific study of the land itself, its inhabitants and all that it contains. How else can it hope to succeed? How else to discharge its obligation fully to mankind? Pioneering work has been done in the past by specialists, some of them leaders of the highest repute; but the time has surely come for systematic, co-operative, and government-supported effort.

There is, then, reason to hope that the public demand for science in Australia will grow—that it has a great future before it. In building up that future on the foundations already laid, the Australian people must look for guidance and example to the greater and older nations of the earth. In this, as in all things, we turn first to that Mother Country which we still call Home. There the Royal Society, pioneer among national academies of science, has taught and practised the true gospel of the pursuit of natural knowledge for 260 years, and many younger research associations have gained world-wide repute. There also the cause of applied science has gained steadily in recent times, and is now represented by a powerful Department of Scientific and Industrial Research and by such highly endowed institutions as the National Physical Laboratory. We look also to America, where the organisation and endowment of scientific work are now on a scale that arouses universal admiration, not unmixed with envy. There Federal and State authorities, great manufacturing firms and wealthy citizens, seem to vie with one another in promoting education and research, knowing that thus the greatness of their country will be yet increased. We look to Japan—that wonderland which, in so short a span of years, has made for itself in science, as in all ways, an honoured place among the great nations. We look to Holland, ancient centre of learning and of maritime discovery, famous in the history of the Pacific, and to its splendid colonies in our tropic seas; for both Motherland and colonies are known throughout the world for what they have done and are doing for science.

Science and the Agricultural Crisis.[1]

By Dr. CHARLES CROWTHER.

It is generally recognised that the primary causes of the present difficulties of British agriculture are strictly economic in character, and not due to any gross and general failure to apply present-day scientific knowledge to the technique of farming, although the great disparity which exists between the average production of the country and that secured by the more competent farmers on soils of the most diverse natural fertility suggests that with a higher general level of technique and education the intensity of the crisis might have been sensibly reduced. Whether it be a case of the "sick devil" or not, the agricultural com-

[1] From the presidential address delivered to Section M (Agriculture) of the British Association at Liverpool on September 13.

munity is at present in a more receptive mood towards scientific advice than at any time I can recall in some twenty years' advisory experience, and I believe the moment to be opportune for a forward movement in agricultural education, which, if wisely developed, may remove the last vestiges of opposition and establish education and research firmly in their rightful places in our agricultural organisation.

Our agricultural educational system may be likened to a pyramid with research at the apex, elementary education and general advisory work at the base, with intermediate education, higher education, and higher advisory work occupying the intervening parts. Our pyramid has grown within the last thirty years from a very modest structure of low elevation into an imposing edifice, which perhaps appeals to the mind's eye more through its height than its spread, the upward growth having taken place at a proportionately greater rate than the expansion of the base. The essential need of the moment appears to be a broadening of the base with the view of greater stability and a more effective transmission of the results of the activities of the upper portions to the maximum basal area over which they can beneficially react.

For the purposes of my survey it will be convenient to follow the customary classification of our work into research, advisory work, and teaching. Of these three divisions I propose to deal but very briefly with the first, that of research, since the potentialities of research for the advancement of agriculture are too patent to require exposition, the ultimate object of all agricultural research being the acquisition of knowledge which will enable the farmer to comprehend his task more fully and to wield a more intelligent control over the varied factors which govern both crop production and animal production.

Agricultural progress must be dependent upon research, and no phase of our agricultural educational system is so full of great promise for the future as the comprehensive research organisation, covering practically every field of agricultural research, which has been brought into existence during the past twelve years, and developed upon lines which ensure an attractive career to a large number of the most capable research workers coming out of our universities. In praising the research institute scheme, I am not unmindful of the needs of the independent research worker and the spare-time research work of teaching staffs—the type of research work to which we owe so much in Great Britain—and it is with some anxiety that I have watched the distribution by the Ministry of Agriculture of the modest resources available for the support of this class of work. I trust that my fears are groundless, but I am afraid of a tendency to deflect such resources towards the work of the research institutes, a tendency which in common fairness to the independent worker should be most strenuously resisted. With a sufficiently liberal conception of the class of work which can be effectively carried through by the independent worker, there should be no difficulty in allocating these moneys to the purposes for which they are intended.

In suggesting that, in proportion to the means available, agricultural research is perhaps more adequately provided for at the moment than other branches of agricultural educational activity, nothing is further from my mind than to imply that greater resources could not be effectively absorbed in this direction. I am guided by the feeling that a due measure of proportion should be maintained between research and the organisation behind it designed to translate the findings of research into economic practice, and to secure that each advance of knowledge shall be made known quickly and effectively throughout the industry.

It is chiefly in the latter direction that agricultural science can make an immediate and effective contribution to the alleviation of the present crisis, since agricultural research in the main does not lend itself to the "speeding-up" necessary for quick action. The same applies also to formal educational work, which must necessarily exert its influence on the industry but slowly.

The one line of approach along which agricultural science can make its influence felt quickly is that of *advisory work*, which consists in the skilful application of existing knowledge to the solution of practical problems, or at most the carrying out of investigations of a simple type, with the view of securing guidance as to the solution of the problem in time for effective action to be taken.

The root difficulty of agricultural educational propaganda in the past has been to secure a sufficiently intimate and widespread contact with the farmer, and for this purpose no agency at our command is so valuable as advisory work, since it ensures a contact with the individual farmer which is both direct and sympathetic, originating, indeed, in most cases out of a direct request for help. The difficulties in the way of extending advisory work greatly I shall turn to presently, but I wish first of all to outline some of the more immediately helpful forms of advisory work which have fallen within the scope of my own personal experience.

I will deal first with soil advisory work, being actuated by the conviction that soil investigation is the most fundamental of all forms of agricultural research. Soil factors dominate the growth of crops from germination to maturity, and must influence the utilisation of the crops by the animal, which is their ultimate destiny. In stressing the importance of soil advisory work I am not unmindful of the fact that, despite the enormous volume of investigation relating to soils which has been carried out, the task of the soil adviser still remains a very difficult one, and except in a few directions, and over a comparatively small area of the country, the interpretation of soil analytical data is rarely clear. It is a sobering thought, indeed, to recall the abounding optimism with which soil analysis was entered upon some eighty years ago, and contrast the hopes then held with the realities of soil advisory work as we find them to-day.

The initial mistake—so common throughout a large part of our agricultural investigational work of the past—lay in a failure to visualise the complexity of the problem, even with due regard to then existing knowledge. The problem was approached as if the soil were to be regarded solely as a reservoir of plant food, the capabilities of which for crop production should therefore admit of complete diagnosis by chemical analysis. The conception is fascinating in its simplicity, and has dominated the greater part of our soil work down to the present time, repeated endeavours being made by variation in the methods and intensity of the analytical attack to improve the persistently low degree of correlation between analytical data and crop results. Parallel with this at a later date was developed the mechanical conception, which found the major part of the explanation of the differentiation of fertility in the physical properties of the soil particles, while still later soil biology has asserted its claim to provide the "simple solution." The work of recent years, however, so brilliantly led in Great Britain by Sir John Russell and his colleagues, leaves us with no excuse for such restricted conceptions of soil fertility, which must now be regarded as the index of the equilibrium established by the mutual interactions of a highly complex series of factors, the variation of any one of which may affect the interplay of the whole, with consequent effect upon the rate or character of plant growth.

The problem of fertility being so complex, one might perhaps be inclined to despair of attaining anything really effective in soil advisory work, which must necessarily be dependent upon rapid and somewhat superficial examination. Such apparently is the view held by the Ministry of Agriculture, if one may judge by the conspicuous neglect of chemical and physical science in recent extensions of advisory facilities.

My own conception, however, of the present possibilities of soil advisory work is more optimistic, and, from experience covering the most diverse parts of the country, I am confident that an extension of facilities for soil advisory work would be of immediate and progressively increasing benefit to the farmer. The real difficulty at the moment is that for large tracts of the country we lack the necessary data to enable us to determine what is the "average soil" for each particular area, and until provision is made for specific soil work in these areas, which comprise the whole of the great agricultural areas of the Midlands, our advisory work relating to this raw material of crop production must of necessity remain superficial, and only too frequently ineffective.

In no direction has the need for extended soil advisory work become more evident in recent years than in the revelation of the extent to which large areas of our soils have become depleted of lime. Cases come almost daily to our notice in which this lack of lime is clearly the chemical "limiting factor," and the annual waste due to unremunerative expenditure on fertilisers on such land must indeed be very great. In many cases, fortunately, the depletion has been detected at a stage at which it is still economically remediable, but in others, unfortunately, this is no longer the case, and unless soil-survey facilities be greatly extended, it is certain that large areas of our land must steadily fall into the latter category, with the inevitable development in the near future of a problem of such magnitude as will require national action for its solution. It is worthy of note also that this problem will probably be accentuated rather than diminished as a greater proportion of our arable land reverts to grass.

A further direction in which great scope remains for the work of the soil adviser is in the economic manuring of crops. Inadequate and improper manuring is still widely prevalent, and the annual wastage of resources thereby incurred must represent a very large sum. A considerable part of this wastage is due to the widespread use of proprietary compound manures, more often than not compounded without any special reference to the soils upon which they are to be used, or even without intelligent adaptation to the special needs of the crops for which they are supplied. It is not uncommon, indeed, to find mixtures of identical composition offered for the most diverse crops. In far too many cases also the prices charged are extravagantly disproportionate to the intrinsic value of the ingredients of the mixture, and in all these various ways costs of crop production are made higher than they need be.

Passing on from soil and manuring, we come to the sphere of seed and sowing problems, presenting obviously abundant scope for advisory work. The need for good and pure seed is axiomatic. Seed must not only be good, however, but it must also be of the right kind, sown under proper conditions and at the most suitable time, and the value of advisory guidance on these points has always been recognised, especially with reference to the choice between different varieties of each particular crop. The variety tests carried out on the various college farms and elsewhere have always proved helpful in this respect in so far as they serve to demonstrate the general characteristics of the different varieties. Whether they have been equally successful in measuring the cropping capacities of the different varieties is more than doubtful, owing to their restriction to single, or at most double, plots of a kind. This has been recognised in the more elaborate schemes devised for the purpose by the National Institute of Agricultural Botany, which it is to be hoped may furnish a practical scheme for more accurate quantitative field tests in the future.

Given good seed, the improvement of crop possible through seed selection is perhaps not in general so striking as that frequently obtainable by manuring, but it may nevertheless be substantial, especially with crops such as barley, where improvement of quality may have a special value. There is also a rapidly extending field for seed advisory work in connexion with the laying down of land to grass for varying periods.

During the growth of the crop, advisory work is largely restricted to the domain of diseases and insect pests, the ravages of which take incalculable toll of our crops. I believe science can make no more directly effective contribution towards the removal of at least the technical difficulties of the farmer than the elaboration of effective preventive measures against pests and diseases.

I must pass on, finally, to the utilisation of crop products as food for animals, the line of work with which my own personal interests and activities have always been most closely associated. Looking back over twenty years of advisory activity, I realise that the position of the adviser in animal nutrition is infinitely stronger to-day than when I first assumed the rôle.

With all the newer knowledge at his command, the adviser in nutrition can now approach his work with far greater confidence, and evidence of the increasing practical value of his work is rapidly accumulating. This is particularly the case with advisory work in milk production, a branch of feeding which lends itself more readily than most to carefully regulated rationing, owing to the ease with which the amount of product can be determined. Much success has also been met with in advisory work in pig-feeding, and to a less extent in the feeding of cattle, the lower degree of success in the latter case being due not so much to an inferior capability of the adviser to help as to the difficulty of dispelling the tradition that beef production represents the supreme accomplishment of the British farmer, as to which there is nothing left for him to learn. The work already accomplished represents, however, but the very beginnings of economy in the feeding of live-stock, and wasteful feeding of both home-grown and purchased feeding-stuffs for lack of the necessary advisory guidance is still far too widely prevalent.

Such are only a few of the aspects of advisory work, which, if extended more widely, might exercise a very profound effect upon the economy of the industry. Such extension implies, however, greatly increased resources in men and money and more efficient means of bringing the advisory facilities to the notice of the farmer.

I am inclined, indeed, to think that a more efficient propaganda is perhaps the first need of the situation, for one finds in all parts of the country an astonishingly large number of farmers who are totally unaware of the existence of advisory facilities of any kind. A more extensive propaganda will be useless, however, unless accompanied by increased provision for advice, since the present resources are already more than fully taxed by the relatively moderate volume of calls for assistance that now arise. Most of our counties have, at present, only one agricultural adviser—some, indeed, have none —and yet this slender organisation represents in large measure the base of contact with the industry upon which the whole pyramid of our advisory and educational work rests. It is here where I see the most immediately profitable outlet for any further moneys that may be available for agricultural education in the near future.

I have already alluded to the chemical gaps in our specialised advisory organisation, and I might also have indicated the similar and even less comprehensible inadequacy in the provision for specialist advice in economics; but these are relatively small matters compared with the paucity of the less highly specialised but scientifically trained advisers of the county organiser type, whose business it should be to secure the confidence of the individual farmer by personal contact, and to render him assistance either directly in the simpler problems or, in more complex cases, with the help of the specialist staff standing behind the county staff, whereby a more widespread and real appreciation of the practical value of agricultural education and research than now prevails might quickly be developed.

A great extension of advisory work, such as I suggest, must necessarily involve heavy expenditure, and further, an exceptional measure of care in the selection of men, since in the direct approach to the farmer personal qualities may in the first instance count for more than technical proficiency. Furthermore, if the full measure of success is to be achieved, it is essential that a more closely organised and intimate contact should be established between the various units of the advisory organisation, from the research station through the scientific adviser, to the practical adviser. Our present organisation is too indefinite and too widely permissive in this respect and calls urgently for consideration by all concerned, both county authorities and advisory and research workers, with the view of more effective co-ordination and co-operative effort.

I have laid great stress upon the potentialities of advisory work as a contribution to the alleviation of the present crisis, but I cannot close without some reference to the far greater contribution to the future prosperity of British agriculture which we can make through our educational system, if wisely pursued, in the training of the farmers of the future.

The existing facilities for organised agricultural education—at least so far as universities and colleges are concerned—are adequate to deal with the numbers of students presenting themselves. There is indeed at the moment a considerable excess output of the class of student who is either unwilling or unable to take up practical farming and must needs have a salaried post.

Of more immediate concern is our comparative failure to secure for our educational courses more than a small fraction of the sons of farmers, upon whom the future of the industry will largely rest. I have testified to the greatly awakened interest in agricultural education which has been displayed among farmers in recent years, but it is yet far from having developed into a conviction that such education is to be regarded as a vitally essential part of the farmer's training. One must perhaps be content with gradual advance towards this goal by internal development, although the possibilities of more rapid advance by external pressure should not be overlooked. The enlightened landowner might exert an influence more potent perhaps than any other in filling our colleges with farmers' sons, if in letting his farms—at any rate so far as young applicants are concerned—he showed his faith in agricultural education by giving preference where possible to men who have received adequate instruction in the principles of agriculture in addition to practical experience. So long as the private ownership of land continues, the landowner will have it in his power to render in this respect the most powerful aid to the progress of agricultural education, and by action along these lines might exert more good in one year than is attainable by many weary years of propaganda.

Whatever the character of our land-tenure system of the future, it is certain that sooner or later some guarantee of efficiency for the productive occupation of land will be demanded from the would-be farmer. We cannot continue indefinitely, on one hand, to proclaim that the land is our greatest national asset, to be maintained with the help of, and in the interests of the State in a highly efficient state of productivity, while, on the other hand, the use of the land is left open to all, regardless of fitness for its effective use. This vision of farming reduced to the status of medicine and law as a close profession regulated by an entrance examination, may perhaps be stigmatised as a horrible nightmare; but some movement in that direction I believe to be inevitable, and, with nationalisation of the land, it might well come more speedily than one would venture to contemplate. None will question, at any rate, that, should such a day arrive, education in the principles underlying the calling will loom as largely as practical training in determining the standards of admission to the use of the land.

The Structure of the Great Rift Valley.

By Prof. J. W. GREGORY, F.R.S.

THE explanation that the lake chains of East Africa lie in a system of tectonic valleys which are a continuation of the basin of the Red Sea was due to Suess (1891) in his contribution to the geological results of Teleki's expedition. Suess regarded the Great Rift Valley as made by a sudden rupture of the crust of the earth owing to contraction, as preceded by no upheaval, its age as Pliocene and Pleistocene, and the height of the land beside it as due to an uplift[1] in consequence of the rupture; and he considered that as the East African Rift Valley is bounded by block mountains and not by parallel horsts, it is different in structure from that of the Rhine. The present writer, after a visit in 1892–3 to the highest part of the Rift Valley, supported Suess's view of its formation by earth-movements due to lateral tension, but he considered that the valley had a much longer and more complex history than Suess recognised; for the Rift Valley was made by faulting repeated at intervals from at least the Oligocene to the Pleistocene, it was initiated by an uplift of a broad arch in the Upper Cretaceous, and the infall of the top of that arch was probably a consequence of the foundering of the floor of the Indian Ocean.

The Great Rift Valley in its course from Syria to Mozambique varies greatly in structure. In some places it consists of a single trench, and at others of several branches. Its structure is geographically most complex in Tanganyika Territory, where it was studied with especial care when that area was part of German East Africa. A valuable discussion of the combined topographic, geological, and geodetic researches in that region has now been prepared by Prof. Krenkel, of the University of Leipzig.[2] He shows that between the Congo and the eastern coast of Africa three great tectonic belts are now well established. That nearest the coast forms the eastern front of the main African plateau. As it is the oldest, and in the most exposed position, its structures have been obscured by denudation. Hence the determination that this mountain rampart was formed by faulting required close examination of its geology. The evidence available shows that the central part of Tanganyika Territory is traversed by a zone of fractures, which extends from Lake Nyasa to the plateau front west of Mombasa. This eastern zone consists in places of a series of step faults, but includes, as in Uluguru, some rift valleys.

The second belt is the continuation of the main trunk of the Great Rift Valley southward from Kenya Colony. It includes Lake Magadi, and forks at Lake Natron; one branch goes south-westward, and includes Lake Eyasi, and disappears near the town of Tabora. The main trunk continues southward; it is repeatedly deflected south-westward by faults parallel to those of the eastern fracture belt; it becomes indefinite after passing Kilimatinde on the railway from Dar-es-Salam to Tanganyika. There is some evidence of the extension of this fracture belt through the Ruaha valley to Lake Nyasa. The only gap still uncertain in the course of the Great Rift Valley is from the lower part of the Ruaha to near Kilimatinde.

The westernmost tectonic belt follows the western branch of the Rift Valley, and includes the Albert Nyanza and Lake Tanganyika. It forks near its southern end: one branch breaks into splinters on the southern coast of Tanganyika; the longer branch goes south-eastward past Lake Rukwa, joins the main trunk at the Ruaha valley, and continues through Lake Nyasa to south of the Zambezi, where it has been traced by Teale and Wilson. The evidence of the tectonic origin of the valley is especially clear around Lake Tanganyika, the coasts of which show complex series of faults, fault blocks, and secondary rift valleys. Many of the faults are quite modern, as some of them have dislocated recent conglomerates and have tilted some of the lake beaches. The walls of this valley, from the features noted in the original graphical description of it by Burton, are young, and, as Prof. Krenkel holds, the westernmost of the three tectonic belts is probably the youngest.

Between Suess's simple theory that the Rift Valley was formed from a single series of fractures in the uppermost Kainozoic and my more complex classification with its three different series of fractures separated by four volcanic periods, Prof. Krenkel adopts an intermediate position. He accepts two periods of faulting and three of volcanic activity for the Nyasa basin; so that his sequence of events is nearly as long as mine; but he regards all the volcanic rocks as Miocene or later. The evidence on which I referred the lava of the plains near Nairobi to the Upper Cretaceous was admittedly scanty; but that age fitted in best with the general history of that part of the world. Later a promising clue to the age of the earlier volcanic eruptions was offered by Dr. Oswald's work on the Victoria Nyanza; but the volcanic pebbles he collected in the pre-Miocene conglomerates cannot be certainly identified. It is to be hoped that some visitor to that area will make a further collection of the volcanic pebbles from these conglomerates, so that their position in the East African volcanic sequence may be determined.

The view that the Kapitian lava plains are Pliocene has been held persistently; but that view has now been conclusively disproved by fossils collected by Mr. Sikes from beds deposited in depressions in the surface of these lavas. The fossils have been identified by Mr. R. B. Newton as Pliocene, so that the lavas themselves must be Miocene or older. Their Cretaceous age

[1] [In 1891 he referred to the uprise as an *Aufwölbung*; later as an *Aufwulstung*.]

[2] Die Bruchzonen Ostafrikas: Tektonik, Vulkanismus, Erdbeben und Schwereanomalien. Von Prof. E. Krenkel. Pp. viii+184. (Berlin: Gebrüder Borntraeger, 1922.) 7s. 4d.

has recently been supported by the work of E. O. Teale and W. Campbell Smith from the Zambezi. Some lavas which these authors correlate with the Kapitian are shown to be Cretaceous; they remark (*Geol. Mag.*, May 1923, p. 228), " . . . the close similarity between the specimens from the Lupata Gorge just described, and the Kapitian phonolites, seems to afford very striking confirmation of Prof. Gregory's view that the latter are of Cretaceous age."

This evidence establishes the suggested date for the beginning of the East African part of the Rift Valley by fixing the age of the oldest associated lavas as Cretaceous. That the Rift Valley faults had begun by the Oligocene has now received further confirmation from the Gulf of Suez. In a lecture to the Royal Geographical Society in 1921 (*Geog. Journ.* vol. lviii. pp. 267-271) Dr. Hume threw doubt on the fault origin of the Gulf of Suez, and attributed it to folding. This conclusion would have been difficult to reconcile with the successive maps of the area issued by the Geological Survey of Egypt had not that Survey also published a diagram of one of its folds (Petrol. Research Bull. No. 6, 1920, before p. 1). The structure represented is what in ordinary geological nomenclature is termed a fault. In answer to Dr. Hume's view that the Gulf of Suez was formed by folding, it is only necessary to refer to the two last publications on the area by the Survey of which he is director. The valuable account of the geology of the Gulf of Suez in No. 10 of the Petroleum Research Bulletins, by Messrs. Moon and Sadek, includes two sections which illustrate the structure of the Gulf. The essential parts of these sections are here reproduced (Figs. 1 and 2). They both represent the Gulf of Suez as in a typical fault-formed valley. The second figure (after Pl. IX. D) is especially instructive, as it shows that the faults which formed the Gulf of Suez were post-Eocene and pre-Miocene. It therefore shows that the conclusion that the Rift Valley faulting began in the Oligocene, which was first based on evidence from Lake Nyasa, holds for the Gulf of Suez. A further Petroleum Research Bulletin, No. 12, has just been issued, in which part of the eastern shore of the Gulf of Suez is described. The authors, Messrs. Moon and Sadek, conclude that the position of the shore is determined by " a very important fault," and they show that the faults in this area were in part pre-Miocene and partly post-Miocene. One of the sections, Pl. I. D-H, shows a series of vertical and steeply inclined fracture planes which are marked as faults and not as folds.

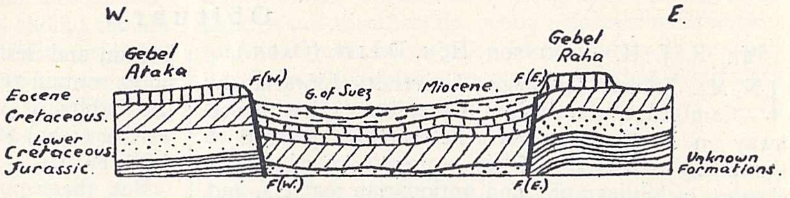

FIG. 1.—The structure of the Rift Valley of the Gulf of Suez according to the Egyptian Survey. From Petroleum Research Bull. No. 10. (Cairo, 1921.)

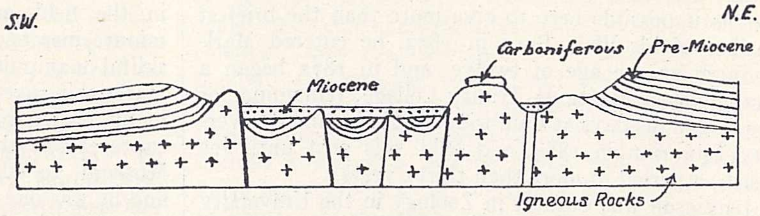

FIG. 2.—Another section by the Egyptian Survey of the valley of the Gulf of Suez. From Petroleum Research Bull. No. 10. (Cairo, 1921.)

Suess's view that the Great Rift Valley is tectonic in origin has been supported by an overwhelming balance of opinion; but his view that it was a sudden rupture due to the contraction of the crust has been less widely adopted than the writer's hypothesis that it was due to a series of infalls along an upraised belt. That preliminary uplift has been accepted under various names—arch, anticline, or mountain ridge along the axis of the valley—and it is consistent with the gravity survey by Kohlschütter, of the results of which an excellent summary is given by Prof. Krenkel. Tanganyika Territory is under three different conditions. Along the coast gravity is in excess. The central area, along the south-western branch from the Great Rift Valley through Lake Eyasi to Tabora, includes a broad basin, with gravity less than the normal. Along the western branch of the Rift Valley is a long narrow band in which the gravity is also less than normal; Krenkel describes it as a *Dichterinne* or density-trough.

The majority of recent authors have adopted the view that the Great Rift Valley was due to lateral tension. That the faults which bound the valley might be due to compression has been several times suggested. The occurrence of reverse faults in the older rocks beside the Great Rift Valley appeared to support this possibility. This view was suggested by Uhlig in 1907, but he has abandoned it. An overthrust fault—which has since been rejected—was described from German East Africa, but Suess remarked that he knew of no other anywhere along the Great Rift Valley system. Dr. Hume inserted a reversed fault on the western shore of the Gulf of Suez. His section was reissued last year " slightly altered " (Petroleum Research Bulletin, Geological Survey Egypt, No. 10, Pl. VIII. Fig. 2); but the only noticeable modification, except in colouring, is that the fault is no longer drawn as a reverse fault.

The main advocate of the compression theory is Mr. E. J. Wayland, the director of the Geological Survey of Uganda, for the Great Rift Valley near the Albert Nyanza (*Geog. Journ.* vol. lviii., 1921, pp. 344-359). The suggestion is more probable for that area than for those places where the Rift Valley is associated with immense lava fields, and in Unyoro it has some abnormal features. Mr. Wayland's view is based on general considerations, and he does not appear to have seen any reversed fault along the Rift Valley. All the numerous faults that have been recognised in the Great Rift Valley series are normal. Any reversed faulting that may be found will probably prove to be exceptional. The geographical and geological features of the mountains beside the Great Rift Valley resemble those of normally faulted block-mountains, and not those of fold mountains due to corrugation of the crust by compression. The topography along the Great Rift Valley agrees with that of areas torn by tension clefts rather than with mountains raised by compression; for all the faults known are normal; beside the valley rise many block-mountains and horsts, and it is associated with vast lava fields. In mountains due to compression, on the other hand, the faulting is reversed; volcanic action is rare except for isolated volcanic groups some distance from the main chain, or where it is cut across by later faults. The mountains, moreover, occur in long sinuous chains and sheaves of chains which gradually dwindle in height through parallel foothills. That the Rift Valleys are due to tension is emphatically asserted by Prof. Krenkel. The fracture zones of East Africa, he says, are zones in which the crust has been torn asunder (*Zerreissungszonen der Kruste*, p. 169).

Recent evidence, therefore, from the Zambezi and the Gulf of Suez, Mr. Sikes's fossils from the Kapiti Plains, and Prof. Krenkel's valuable monograph, combine to confirm the conclusions that the Great Rift Valley was initiated by an upbulging of the crust; that its fractures were connected with vast volcanic eruptions which began in East Africa in the late Cretaceous, and were contemporary with the Deccan Traps of India; and that one set of the fractures that made the Rift Valley happened in the Oligocene. These conclusions render it probable that the African Rift Valleys are due to the secondary consequences of the movements that made the basin of the Indian Ocean.

Obituary.

Mr. F. J. H. Jenkinson, Hon. D.Litt. (Oxon.).

In Mr. Francis Jenkinson, University Librarian at Cambridge, who died on September 21, has passed away one of the most versatile and distinguished of Cambridge scholars. Of his profound knowledge of classics, of bibliography and antiquarian matters, and of music, this is not the place to write. This notice must be restricted to his activities in natural science, in one branch of which, entomology, he was an expert. Nor is it possible here to give more than the briefest outline of his life. Born in 1853, he entered Marlborough at the age of twelve, and in 1872 began a distinguished career at Trinity College, remaining for the rest of his days at Cambridge. He became University Librarian in 1889, and held this post until his death, a period of more than thirty years.

Jenkinson was Curator in Zoology in the University Museum for a few months in 1878 (the same year in which he gained his Fellowship at Trinity by his classical attainments). He was the second occupant of this position, the first having been Mr. J. F. Bullar, and during his tenure he worked chiefly at insects. The same curatorship was afterwards filled (in 1890) by the late Dr. David Sharp. But though Jenkinson's official connexion with the Museum of Zoology was short, he was its valued helper to the end.

From boyhood a keen naturalist, and especially a lepidopterist, Jenkinson was much associated in early years with his lifelong friend Mr. Edward Meyrick, as a student of the smallest and most delicate forms. Some time after the coming to Cambridge of Dr. Sharp, with whom he formed a lasting friendship, Jenkinson turned his attention to Diptera. These were henceforth his special study until the last, and it is as a dipterist that he will be remembered in entomological circles.

It is true of Jenkinson's entomological side, as perhaps of all his interests, that his published works are little in comparison with the greatness of his knowledge. His writings comprise some twenty-seven short notes and papers, contributed to the *Entomologist's Monthly Magazine* between 1886 and 1922. The first four, up to 1900, deal with Lepidoptera, the remainder almost entirely with Diptera. In his longest paper (1908) he recorded a number of fungus-gnats new to Britain and described one new to science. The short notes contain records of captures and observations of the habits of various flies. His last entomological writing (1922) was an obituary notice of his old friend A. B. Farn.

But these publications are only a small part of Jenkinson's dipterological work. None could be more generous than he in aiding other workers. He had a wonderful faculty for distinguishing obscure species in the field, and very great deftness in capturing minute insects, even without a net. He was a very skilful manipulator, and collected a vast amount of material in several parts of Great Britain, but especially in his own garden at Cambridge. The pick of these captures was always at the disposal of the University Museum, to which he gave hundreds of specimens, and he was one of the makers of the Cambridge collection of British Diptera, now one of the largest extant. The national collection at South Kensington has also been enriched by many of his specimens. His miscellaneous captures in other orders were frequently interesting: a minute Copeognathe found in a house at Crowborough, and described by Dr. Enderlein in 1922 as a new genus and species (*Pteroxanium*), is the first Psocid (*sens. lat.*) with scale-covered wings to be discovered in Great Britain, the forms related to it being tropical.

Jenkinson's faculties for observing were extended to plants, birds, and even, at one time, to mollusca. He applied his classical and bibliographical knowledge also to entomological matters. The former was often called into play in questions relating to scientific names. What he wrote of Farn was true also of himself: "he disliked slovenliness" and "was the most scholarly of naturalists." As Librarian he was always sympathetic to the needs of entomology, and contributed to the result that the University Library and departmental libraries together now contain a body of entomological literature (especially periodicals) probably unsurpassed in any centre in Great Britain outside London. In person he was tall but of almost fragile build, and he was always hindered by poor health. The kindest-hearted of men, his personality exercised a singular charm over his many friends. H. S.

Current Topics and Events.

THE report of the Broadcasting Committee appointed on April 24 by Sir William Joynson-Hicks, then Postmaster-General, has now been issued, together with a statement from the present head of the Post Office, Sir Laming Worthington Evans. The committee had to consider: (*a*) Broadcasting in all its aspects; (*b*) the contracts and licences which have been or may be granted; (*c*) the action which should be taken upon the determination of the existing licence of the Broadcasting Company; (*d*) uses to which broadcasting may be put; and (*e*) the restrictions which may need to be placed upon its user or development. The Committee states that broadcasting is of value for instruction and entertainment and has great potentialities, and it is recommended that a Broadcasting Board should be established by statute to advise the Postmaster-General, though broadcasting services should remain in the hands of non-Government bodies working under Government licence. The revenue required to maintain broadcasting services is to come mainly from the receiving licence fee. The Committee considers that the existing fee of 10*s*. a year is sufficient for the present, and that three-quarters of the receipts might go to meet the costs of broadcasting. As regards licences, a uniform and simple type of licence obtainable without formalities and with practically no limitations on the apparatus is suggested for all users. Extension of broadcasting hours and of the wave-lengths in use (350-425 metres) so as to cover the range 300-500 metres, excluding the band 440-460 metres, is also recommended. The Committee considers the immediate application of its scheme desirable, and suggests that the British Broadcasting Company's licence be continued and extended on a modified basis. No recommendation is made on the subject of the protection of British apparatus against foreign competition, the Committee stating that the matter should be dealt with by Parliament.

ARISING out of our recent article on "Inventors and Patents" (NATURE, September 8, p. 349), it has been brought to our notice that the interest of patentees and inventors has been made the special aim of the Institute of Patentees (Incorporated). This association was founded in the year 1919, and within a short space of time enrolled some twelve hundred members. It has set up a body of technical advisers to assist the inventor and prevent him from wasting money on useless propositions. In the case, however, of those inventions which contain germs of value, even though the inventions are but crudely presented, the Institute advises their originators as to the best method of developing their productions. To a certain extent, the Institute also acts as a clearing-house, at the same time aiming at submitting to manufacturers such inventions only as have reasonable commercial prospects. In favourable cases, assistance will be given in the direction of obtaining capital for the exploitation of inventions. In order to reduce considerably the huge expense generally involved in the settlement of disputes proceeding from inventions, a Court of Arbitration has been constituted to which contentious questions may be remitted. At the present time, the Institute is concentrating its efforts on securing an Empire patent, whereby the cost of protecting an invention throughout the British Empire may be materially reduced. At the general meeting in March of this year, the chairman in his presidential address announced that the Institute was recognised by the Board of Trade, and that certain inquiries addressed to that Department were referred immediately to the Institute. It is stated that the Institute is in no way a trading or profit-making concern, for the members of its various advisory and other committees give their services gratuitously. Two classes of members are enrolled. An annual subscription of two guineas secures full membership, while associate-membership for the annual subscription of one guinea is reserved for the genuinely poor inventor. Further particulars are obtainable from the organising secretary at 44 Russell Street, London, W.C.1.

BEFORE the War, Capt. C. W. R. Knight, as a photographer of birds and their nests, was already in the front rank. Being a practised climber, he did not confine his attention to species that build near the ground, and more recently he has specialised and taken the kinematograph as well as the ordinary camera "into the tree-tops" with most successful results. On Monday last, at the Polytechnic Hall, in Regent Street, Capt. Knight used a number of his films and some lantern slides to illustrate to a specially invited audience a lecture which will be repeated daily for the benefit of the public for several weeks to come. There is no need at the present time to emphasise the usefulness of films as records of fact (in contradistinction to portrayals of fiction) where motion has to be illustrated, or the advantage of having them verbally described. Capt. Knight was able to show the climbing of woodpeckers, the rapid flight of birds of prey when catching food for their young, the plucking of the victim, its partition among the nestlings of tender age, the throwing of it whole to them to scramble for when they were older. He also showed special records of young birds exercising their wings and getting into training for flying, as well as their hesitation before they could make up their minds to launch themselves for the first time in the air. Many points of incidental interest were mentioned by the lecturer. The finding of a swift in the nest of a hobby was used as an argument in favour of the latter bird being the swiftest of our hawks. Stress was laid upon the amount of vegetable food eaten by the greater spotted woodpecker; the writer has known of this bird taking coconut intended for tits, but Capt. Knight described the extraction of kernels from hazel-nuts fixed in the crevices of bark, after the fashion of the nuthatch. Owls were dealt with, as was the daily life of a rookery, while the rearing of young herons was considered in detail. All who are interested in British wild life should go to Capt. Knight's lecture, for they will thus add to their knowledge besides gaining a great deal of enjoyment.

According to the latest estimates (given in the *Times* for September 28 and 29), the loss of property in Tokyo and Yokohama due to the earthquake of September 1 is somewhat less than was at first supposed. In Yokohama, about three-fourths of the houses (including those of greatest value) were destroyed; those which remain are apparently but a fringe of small dwellings. It was on the flat levels, intersected by canals, in which the business and shopping quarters were situated, that the destruction was greatest; but on the Bluff, where the foreign merchants lived, there was also much damage done, many of the houses having fallen into the valley below. In Tokyo, out of about 335,000 houses destroyed, only 11 per cent. collapsed under the earthquake shock; the remainder were burned. It was again in the densely crowded riverside districts that the worst of the destruction took place. It has been suggested that Yokohama should be rebuilt in a safer district, but the site of the city is obviously determined by the harbour, which has not been materially damaged. Moreover, though there is no absolutely safe area in such a seismic zone, the safest for many years to come, and perhaps for several centuries, may be the epicentral area of the recent shock.

We are glad to note that British firms are adopting more and more the principle, on the lines of many American firms, of helping their clients in every possible way—and indirectly the general public as well—by the issue of thoroughly scientific literature written by experts. A good example of this is a recent publication, "Water Treatment," by Messrs. Brunner, Mond and Co., Ltd., the well-known chemical manufacturers of Northwich, Cheshire. This booklet, which is a production of the firm's research staff, and may be obtained free of charge by writing to the above address, gives a most lucid and concise explanation of the whole principles underlying the hardness and treatment of water, especially for boiler feed purposes, and should prove invaluable to engineers and all others in charge of boiler plant. It is divided into fourteen sections, and particularly good are those devoted to the cause of hardness, the soda ash and lime treatment, and the choice and method of operation of softening plant in general. Also of great interest are the sections dealing with the more difficult aspects of water treatment, about which the average chemist is none too clearly informed, such as the presence of free carbon dioxide and sodium bicarbonate, acids, whether mineral or of the peaty acid variety, oil, and especially the removal of the last traces of magnesium, for which the use of alumino-ferric is recommended.

In 1905 the Meteorological Office was able for the first time to make some provision for the regular investigation of the upper air over the British Isles. Investigation had previously been carried out privately, in some cases with the assistance of the British Association and of the Royal Meteorological Society. Mr. W. H. Dines, who had taken a leading part in the practical development of the investigation, agreed to supervise the work for a nominal fee and to provide, free of charge, the facilities which his residence afforded for work with kites and balloons. After 1913 Mr. Dines removed to Benson in Oxfordshire, and for the past ten years he has continued there the upper-air work which he had carried out so successfully at Pyrton Hill on the Chilterns and at Oxshott in Surrey. Largely as a result of these investigations, England has gained a position in the forefront of the investigation of the upper atmosphere. At the end of June 1922, Mr. Dines retired from active supervision of the work, although he continued generously to give facilities for investigation to be carried on at Benson. Mr. Dines's experience indicated that open country north-west of Oxford was the most suitable place for a permanent observatory, but financial reasons made this impossible; it was accordingly arranged to utilise Kew Observatory, where the disadvantage of position would be to some extent compensated by proximity to the central office and contact with other branches of meteorological work. The transfer will probably be made in a few days. The Observatory at Benson will then be closed. The regular daily reports in connexion with forecasting will be made at the wireless station at Leafield by the courtesy of the Postmaster-General, while the upper-air investigation will be continued at Kew Observatory.

Great activity continues to prevail on the question of the cause and incidence of cancer. The Ministry of Health has recently issued a circular (No. 426) in which the views of a committee of experts are set forth. The circular deals with the characteristic features and natural course of the disease, the extent of cancer mortality and its increase, the proclivity to cancer, chronic irritation as a determining factor in the appearance of the disease, and the diagnosis and the treatment of cancer. The statements made are in harmony with the results of modern scientific inquiry, and the circular should help to counteract a great deal of irrelevant matter which the public has been invited to accept from quacks, cranks and well-meaning persons who do not possess the requisite knowledge. Local health authorities are encouraged to deal with the cancer problem in the best interests of the community.

Die Naturwissenschaften for August 31 contains two articles by Arrhenius and by Freundlich on the life and work of Wilhelm Ostwald, who reached the age of seventy on September 2, as recorded in our issue of August 25, p. 289.

A review of the adhesives industries appears in the *Chemical Trade Journal* for September 14. The properties, composition, extraction, and sterilisation of animal glues are concisely described. Vegetable glues (*e.g.* from starch), waterproof glues, and various forms of adhesives (*e.g.* sodium silicate adhesives, adhesives from cellulose waste, liquid glues, etc.) are all treated. A solution of glue in acetic acid is the basis of "seccotine."

A REVIEW of the dye-stuffs industry of Great Britain, by Prof. G. T. Morgan, is published in *Chemistry and Industry* for September 14. In this the progress made during and since the War in the manufacture of intermediates and dyes is discussed in great detail, and the article gives a reasoned account of the present position and future prospects of one of the most important British industrial undertakings.

THE autumn conference of the Textile Institute will be held at Leicester on October 18-19. The first day of the meeting will be spent at the Exhibition of Textile Machinery and Textile Fabrics which is being held in Leicester on October 10-20. On the second day, Mr. P. E. King, of the University of Leeds, will present a paper on "Artificial Silks," and later the annual Mather lecture will be delivered by Prof. J. F. Thorpe, who will take as his subject "The Application of Dyes to Fibres and Fabrics." The remainder of the meeting will be devoted to visits to works in the neighbourhood of interest to members of the conference.

THE first paper-mill for producing printing paper and pasteboard from hydrophytes or water-plants on a large scale was started on September 15 in Grossenhain, Saxony. The hydrophytes (Typha, Phragmites, etc.) are made into pulp by a cheap new process of the German Hydrophyte Co., and are said to yield a good material for paper and pasteboard. The reeds grow wild in shallow waters and their removal is desirable in the interests of fishing; in Germany, therefore, as in other countries, large amounts of the raw material are to be had freely. It has been calculated that in Germany alone one million tons of dry reed material can be gathered, thus freeing for other purposes a like quantity of wood up to now used for manufacturing wood pulp and cellulose. Several further works for producing paper pulp from reeds are to be erected in Germany as well as in other countries. It is stated that the same process may also be used for bamboo and similar tropical plants.

THE Gilbert White Fellowship offers an attractive programme for the present session ending January 1924. Meetings and expeditions have been arranged for most Saturdays during the winter; noteworthy events are lectures by Dame Helen Gwynne-Vaughan on "The Mechanism of Inheritance" on November 3 and by Mr. F. R. S. Balfour on "Trees and Flowers of the North-West Pacific Coast" on December 1. The Ramble Section of the Selborne Society has also issued a programme of its fixtures for the next few months (price 6d.). Numerous "rambles" of historic and literary interest are included, mostly in London and its museums. Lectures have been arranged apart from the rambles and among them are "Among the Himalayas," by Mr. F. W. Hodgkinson, on October 31; "Japan, Past, Present and Future," by Prof. Wilden-Hart, on November 7; "In Neptune's Kingdom," by Mr. F. Martin Duncan, on November 14; "Animal Disguises and Camouflage," by Mr. Wilfred Mark Webb, on November 29; and "Nature at Home," by Mr. M. A. Phillips, on December 12. Correspondence relating to the rambles, other than applications for tickets, should be sent to Mr. P. J. Ashton, 72 High Street, Bromley, Kent.

A SPECIAL volume of the *Zeitschrift für Kristallographie*, comprising no less than 640 pages and numerous illustrations and plates, has been published as a testimonial to the magnificent life-work in crystallography of the founder and first editor (for over fifty volumes) of the *Zeitschrift*—Prof. P. von Groth. It consists of contributory memoirs on their most recent original researches by thirty-two authors of repute, mostly well-known contributors to the *Zeitschrift* for many years and old friends of Prof. von Groth. The two British contributors are Dr. Tutton and Mr. Barlow, the former of whom sends a thirty-five-page paper on the completion of his many years' work on the sulphates, selenates, and double salts, in the results of which Prof. von Groth had taken a very deep interest, while the latter sends a paper on the division of space in enantiomorphous polyhedra. The universal character of this remarkable birthday present—for it commemorates the eightieth birthday of Prof. von Groth, which occurred on June 23—will be apparent from the mere mention of the names of a few of the contributors from other lands. First should be mentioned Prof. Niggli of Zurich, who now acts as editor and to whom the greatest credit is due for the organisation of such a memorable testimonial to the great crystallographer; then we have memoirs from Prof. Jaeger of Groningen, M. H. Ungemach of Paris, A. Hadding of Lund, C. Leiss of Berlin, J. Beckenkamp of Würzburg, G. Aminoff of Stockholm, F. Zambonini of Turin, H. Tertsch of Vienna, F. Rinne of Leipzig, C. Viola of Parma, E. Artini of Milan, R. Scharizer of Graz, and others equally famous from almost all the greatest European centres of learning. The value of these papers alone is a noteworthy testimony to the great esteem and affection in which the recipient is held, and their publication as a common dedication at a time like the present should prove a valuable aid to international peace and goodwill. The volume is dedicated to one of the greatest of modern men of science, one of the kindliest of men, who ever gave the impulse of his encouragement and approbation to those striving sincerely and earnestly to advance the subject which he had so much at heart.

MESSRS. LONGMANS AND CO. have many science books in their new list of announcements. Among them are "The Action of Alcohol on Man," by Prof. E. H. Starling, with contributions on alcohol as a medicine, by Dr. R. Hutchison; alcohol and its relations to problems in mental disorders, by Sir Frederick W. Mott, and alcohol and mortality, by Prof. Raymond Pearl; and "Galvanomagnetic and Thermomagnetic Effects: The Hall and Allied Phenomena," by Prof. L. L. Campbell (in Monographs on Physics).

THE autumn announcement list of Messrs. Methuen and Co., Ltd., contains many books of scientific interest. Among them we notice "The Principle of Relativity," by Profs. A. Einstein, H. A. Lorentz,

H. Minkowski, A. Sommerfeld, and H. Weyl, translated by Drs. G. B. Jeffery and W. Perrett, consisting of a selection of the more important scientific papers in which the theory of relativity was originally expounded; a new and revised edition of "The Foundations of Einstein's Theory of Gravitation," by Prof. E. Freundlich, translated by H. L. Brose; "Einstein's Theory of Relativity," by Prof. Max Born, translated by H. L. Brose (the book aims at giving a lucid historical account of Einstein's Theory of Relativity); "The Chemical Elements," by F. H. Loring, dealing with recent developments in connexion with the chemical elements along lines which include electron binding processes in atomic structure, in radiation phenomena, and in electromagnetic reactions (the quantum theory and the stationary states of the Bohr atom are illustrated by analogy); "Radioactivity," by Prof. K. Fajans, translated by T. S. Wheeler and W. G. King; "Crystals and the Fine-Structure of Matter," by Prof. F. Rinne, translated by W. S. Stiles (the book presents a comprehensive survey of the fine-structure of matter as elucidated by the study of crystals); "Practical Mathematical Analysis," by Prof. H. von Sanden, translated by Dr. H. Levy; "The Mechanism and Physiology of Sex Determination," by Prof. R. Goldschmidt, translated by Prof. W. J. Dakin, presenting in concise form a review of the most modern knowledge of the mechanism and physiology of sex determination, and in particular of the theories of Goldschmidt; a translation, by J. G. A. Skerl, of Prof. A. Wegener's "The Origin of Continents and Oceans"; "What is Man?" by Prof. J. A. Thomson; and "The Origin of Magic and Religion," by W. J. Perry, describing briefly the growth and spread of religion and magic.

Our Astronomical Column.

Fireball of September 7.—Mr. W. F. Denning writes: "About 35 descriptions of this object, which appeared about 7 h. 45 m. G.M.T., were received from Cornwall, Devonshire, and South Wales. It was of considerable size and brilliancy, and it left a trail which remained visible for 10 or 12 minutes, according to several of the observers. A number of the reports which have been received are not of any scientific utility, for they are mere descriptions of the brightness of the phenomenon without including any precise details of the position of the flight and duration. Some of the observations, however, contain all the data necessary for computing the real path of the meteor.

"The radiant point is indicated at 260°–12°, and the height from about 69 to 26 miles descending along a course 100 miles in length, at a velocity of 20 miles per second. It extended from south-west of Land's End to about 25 miles west of Lundy Island, and it lit up brilliantly the sea and coast of Cornwall in the district nearly over which the meteor descended."

Prof. Lindemann's Theory of the Spiral Nebulæ.—The *Observatory* for September contains two articles criticising this theory, which suggested that the spirals were clouds of cosmic dust, expelled from the galaxy by light-pressure, and shining by reflected starlight. Prof. Perrine considers the idea of their shining by reflected light untenable, on the ground that at least one of them, N.G.C. 1068, has some bright lines in its spectrum, which show the same radial velocity as the dark ones; in case of reflection the latter would be double the former. Mr. A. C. Gifford notes that the presence of layers of dark obstructing matter in many of the spirals negatives the idea of reflected light from the galaxy, a point which was also made by Mr. Reynolds.

Prof. Perrine agrees with the suggestion of expulsion from the galaxy, but holds that the spirals are no longer merely dust clouds, but that a large number of stars have formed in them by condensation; they are autonomous systems, perhaps 100 light-years in diameter; the novæ in them are supposed to be similar to, but perhaps smaller than, galactic novæ; they may be caused by stars colliding with streams of cosmic dust.

Mr. Gifford notes that Lick Observatory photographs show that the number of spirals approaches a million; assuming with Lindemann that each has a mass of ten thousand suns, we obtain an aggregate mass greater than we can reasonably suppose to have been expelled from the galaxy, since it exceeds many estimates of the united mass of the galactic stars. He agrees with Perrine in supposing that the spirals contain many condensed stars, and ascribes the novæ observed to collisions of star with star.

Soldner and the Gravitational Shift of Light.—Prof. T. J. J. See and others have lately asserted that J. Soldner had anticipated Einstein in 1801 in announcing the double shift of light-rays passing near the sun. R. Trumpler examines the matter in Pub. Ast. Soc. Pacific for August, and shows, as might be expected, that the double value arises solely from an arithmetical blunder of Soldner's, who was of course using the Newtonian Law. Soldner's aim was to find the deflexion due not to the sun, but to the earth. Curiously enough, a second arithmetical blunder caused his result to be ten times too great, *i.e.* 0·001″ instead of 0·0001″; both values are far too small for practical measurement.

The charge of plagiarism against Einstein is thus shown to be completely unfounded. Cavendish had investigated the shift at about the same time as Soldner, but did not get the erroneous double value. They both assumed the corpuscular theory of light. The idea that the shift was to be expected on the wave theory came much later.

Star-gauges at Lund Observatory.—Nos. 30 and 31 of the Lund Meddelanden contain some useful work on star-gauging. The first is a rearrangement of the gauges of Sir William and Sir John Herschel. They are reduced to galactic longitude and latitude, and expressed as star density per square degree in each region measured. References are also given to the sheets of the Franklin Adams chart containing the region; the greatest and least numbers per square degree are 9630 and 20.

No. 31 contains details of the star-counts made at Lund on the Franklin Adams charts. Separate figures are given for each magnitude down to the 15th and for different distances from the centre of the plate. The density per square degree in each zone is also given. It will be remembered that Chapman and Melotte published a similar study of these plates in the memoirs of the R.A.S. However, as there is room for personality in the estimates of magnitude, an independent count is quite useful. At present there is no general discussion of the results of the count, but this will doubtless follow; in the meantime the work is very serviceable for reference.

Research Items.

THE ORIGIN OF AMERICAN QUILL-WORK.—The methods of American quill-work are figured and described in the August issue of *Man* by Mr. H. Ling Roth. Mr. Ling Roth remarks that the principle of capping the quill ends over a band of weft, twined-work, or sinew, distinguishes the technique of American quill-work from that of other peoples—Tyrolese or Nepalese—who practise quill decoration. But, strange to say, the same method is used by Ainu mat-makers, and bearing in mind the ethnic connexion between north-east Asia and north-west America, he suggests that the American technique was brought from Asia, and that Americans in later times, finding that the soft porcupine tail-quills were adaptable for this form of decoration, made use of the comparatively new-found material, and gave us the much-admired quill-work ornamentation, an invention in itself of no mean order.

THE WINNEBAGO AMERICAN INDIANS.—The chief contribution to the thirty-seventh annual report of the Bureau of American Ethnology, 1915–16, published in the present year, is a monograph on the Winnebago tribe by Mr. Paul Radin. The Winnebago and closely related tribes, like the Missouri, Oto, and Iowa, certainly represent the second westward migration of the Siouan tribes. It is impossible to say when they entered Wisconsin, but if they can be identified with the builders of the effigy mounds, they came from the south or south-east. But it is remarkable, if this theory be accepted, that no effigy mounds are found in Illinois, and it may be assumed that the Winnebago developed the mound-building habit after they had reached Wisconsin; or that other types of mounds in Illinois are the work of them and kindred tribes. It is also possible that since the effigy mounds are undoubtedly associated with the clan organisation, this type of social organisation was adopted by the Winnebago only after they had entered Wisconsin. This well-illustrated monograph gives an elaborate account of the history, archæology, material culture, social customs, clan organisation, and the cults of the Winnebago.

THE THRESHER SHARK.—In *Science* of July 13 Prof. W. E. Allen gave a description of the behaviour of a thresher shark (*Alopias vulpes*), as observed by him on the coast of California. We have received from Prof. Allen another account of the same occurrence. The shark was seen in pursuit of a small fish, which it overtook, and then, turning sharply downwards and to the right, made a whip-like stroke with its long tail, almost instantly followed by another stroke; as a result the victim was badly crippled and would have been an easy prey, had the shark not been frightened off. Prof. Allen concludes that the long whip-like tail of Alopias is a highly efficient weapon for crippling its prey, and he contrasts the methods of this shark with those used by the soupfin shark (*Galeus zygopterus*), which chases a fish with its mouth directed towards the fugitive, trying to snap it up when close enough to so so.

THE PERIODICITY AND MIGRATIONS OF LOCUSTS.—In the *Bulletin of Entomological Research* for July, Mr. B. P. Uvarov discusses the habits of the swarming locust, *Schistocerca gregaria* (*peregrina*), which is the only Old World representative of the genus. The locust *Acridium flaviventre*, Burm., is regarded as no longer a distinct species but as the solitary phase of the dimorphic species *S. gregaria*. Mr. Uvarov agrees with the conclusion of Vosseler that the migration of *S. gregaria* either as nymphs or adults has nothing to do with need for food or with the search for new breeding-grounds, and a solution of the phenomenon is not yet forthcoming. Künckel d'Herculais has observed, and Vosseler has studied more thoroughly, the extremely interesting colour changes in the individuals forming migratory swarms. These changes in *S. gregaria* are very pronounced, and Mr. Uvarov believes that they are in direct physiological connexion with the maturation of the sexual products, and of the development and reduction of the fat-body. The life-cycle of this species is very poorly known and its permanent breeding-grounds and the conditions under which breeding takes place are greatly in need of study. The author's conclusion regarding two different phases of the species suggests a promising line of investigation. Opportunities should be taken during years of mass invasions to observe the conditions of existence of the migratory phase, and also during years of minimum prevalence, when the solitary phase is most likely to be met with. Observations of this kind recorded by Morstatt in East Africa suggest that the periodicity of locusts is not due to invasions from outside, but to increased local multiplication under dry conditions.

SURVEYS IN NORTH-WEST YUNNAN.—In the *Geographical Journal* for September there is published a map of part of North-West Yunnan which has been corrected by Mr. E. A. Reeves from the observations of Prof. J. W. Gregory and Mr. C. J. Gregory, Mr. Kingdon Ward, and Mr. E. C. Young. This map shows that part of the Salween River between about lat. 27° 30′ N. and lat. 26° 30′ N. is entirely unmapped. Most of the longitudes depend upon traverses and not on astronomical determinations. The altitudes along Prof. Gregory's route are based on a series of boiling-point observations.

DISTRIBUTION OF LAND AND SEA IN PAST TIMES IN AUSTRALASIA.—Now that the hypothesis of drifting continents has added a new fascination to palæogeography, geologists will find the series of maps and considerations put forward by Prof. W. N. Benson, of the University of Otago, New Zealand, of permanent value for consultation ("Palæozoic and Mesozoic Seas in Australasia," Trans. New Zealand Institute, vol. 54, p. 1, 1923). The paper is a highly interesting "attempt to trace the geographical evolution of Australasia," and the author concludes that the opening of the Cainozoic era saw Australasia broken into blocks, the various regions thenceforth having individual and not connected histories. These regions provide the geographical features traceable at the present day. Prof. Benson takes us from the Tēthys belt to the Antarctic fringe, and he even includes (pp. 46 and 48) such a detail as the evidence of glaciation on the borders of Western Australia and South Australia at the close of Cretaceous times.

THE LAVAS OF THE PACIFIC BASIN.—Dr. H. S. Washington has traced the sequence of three types of basic lavas in Hawaii in the past, and the irregular outpouring of all of these types at the present day, from the collation of a large series of analyses, mostly due to his own work, and forming a very solid contribution to petrography (*Amer. Journ. Sci.*, vol. 206, p. 465, June 1923, and vol. 207, p. 100, August 1923). It may be remembered that this indefatigable author ("The Deccan Traps and other Plateau Basalts," Bull. Geol. Soc. America, vol. 33, p. 803) has recently concluded that the marked fluidity of basalts forming widely spread flows depends on their high iron-content, and not on temperature or water. They show, indeed, little explosive tendency. Judd and Cole (Quart. Journ. Geol. Soc., vol. 39, p. 457, 1883), discussing the prevalence of glassy products in Hawaii, laid stress on the temperature-factor; but recent experiments in the Kilauea crater do not indicate anything abnormal in this respect. Washington's analyses, like those of Cohen, show that the Hawaiian lavas are olivine-basalts and basaltic andesites, without any unusual iron-content that might render them more fluid than the materials that have given rise to plateaux elsewhere. The remarkable prevalence of basaltic glass among the Pacific lavas remains unexplained.

CAINOZOIC MAMMALIA IN AMERICAN MUSEUMS.—The mounting of fossil mammalian skeletons, from material that is often marvellously complete, has become a fine art in the United States, and W. D. Matthews' paper, "Fossil Bones in the Rock," in the admirably illustrated journal *Natural History* (vol. 23, 1923; American Museum of Natural History) describes the process in a specific example. We learn how the blocks of stone are removed from the quarry, how the bones are cleaned from the alluvium of the swamp that proved a grave for their first owners, and how a reconstruction is made on one side of the mounted skeleton to represent the animal in its habit as it lived. The author deals with the three forms that abound, to the exclusion of other and even neighbouring mammals, in a quarry in Early Miocene strata near Agate, Sioux County, Nebraska, where they were first discovered in 1877. The species are *Diceratherium cooki*, a dwarf par-horned rhinoceros a little larger than a pig (see also NATURE, vol. 110, p. 585, 1922); *Moropus elatus*, a clawed ungulate, combining characters of the horse, the rhinoceros, the tapir, and the titanothere, and as large as a modern camel; and *Dinohyus hollandi*, the giant pig, which is the largest known entelodont, and was presumably of savage disposition. Mr. Matthews suggests that some common drinking-habit brought these three animals into association; but may we not picture the formation of an *enclave* by three communities at some attractive spot, like those indicated by C. B. Moffatt and other naturalists in the case of wild birds on coastal flats? The museum picture (p. 368) of the association is delightful. M. R. Thorpe (*Amer. Journ. Sci.*, vol. 207, p. 91, August 1923) treats of new restorations in the Yale Peabody Museum, and illustrates *Merycoidodon gracilis*, one of the oreodont ungulates, walking delicately; its larger relative, *M. cuthbertsonii*, grazing copiously; and the carnivore *Daphœnus vetus*, thin-flanked and prowling. The specimens are from the Middle Oligocene White River beds of the prolific Sioux County, Nebraska. In the following number of the *Journal*, p. 229, the same author describes the progress of our knowledge of the Merycoidodontidæ from Leidy's work in 1848 onwards, and points out a number of primitive and also carnivore-like characters in the group.

UPPER AIR RESULTS IN JAPAN.—The Journal of the Meteorological Society of Japan for January contains a communication on the summary of pilot-balloon observations at Tokorozawa by Mr. Sekine. The observations were carried out at the aerodrome of the Military Aviation School at Tokorozawa, situate in 35° 48′ N. Lat. and 130° 28′ E. Long. from observations with a single theodolite and with 40 gm. balloons, from January 1921 to September 1922. The results of 81 trustworthy ascents were used to obtain the average wind velocity and the wind directions. The observations confirm the prevalence of the great westerlies at heights above 1500 m. According to the author's opinion the height of the monsoon in this region is limited to 1500 m., above which the return current prevails to 4000 m., while above this, again, the anti-trade is said to have a slight northerly component.

RESISTANCE GLASSWARE.—There has recently been added to the list of resistance glassware another make produced by the well-known firm of Messrs. Chance Bros. and Co., Ltd. This new British laboratory glass forms the subject of a pamphlet received from the firm stating the result of tests made on its chemical and thermal resistance at the National Physical Laboratory. Four reagents were employed to test the resistance to chemical attack, namely, steam and water at four atmospheres pressure, boiling and evaporating hydrochloric acid of specific gravity 1·15, boiling 2N-caustic soda and a mixture of 2N-ammonium chloride and (1 to 3 of water) ammonium hydroxide. The second and fourth of these reagents produced no action that could be detected. Comparative tests using another make of British resistance glass showed the new glass as distinctly its superior in resisting the action of water and steam and hydrochloric acid while it was inferior in respect to the caustic soda test, although even here it had the advantage of remaining unclouded after attack. Flasks of the new glass, filled with molten paraffin wax and plunged into water at 15° did not crack until temperatures between 210° and 240° C. were reached, being much superior to the glass selected for comparison. On these results, the new glass quite worthily takes a position among the resistance glasses of the first rank.

RADIO DIRECTION FINDING BY RECEPTION.—The Department of Scientific and Industrial Research has published the first of a series of special reports dealing with the work of the Radio Research Board. The report, which is made by R. L. Smith Rose and R. H. Barfield, gives a discussion of the practical systems of direction-finding by reception. They divide the various systems of radio-telegraphic direction-finding into three distinct groups which they call the single frame coil, the Bellini-Tosi, and the Robinson systems. They first give the history of direction finders and then a simple approximate theory. They demonstrate that in all general particulars the underlying principle of the three systems is the same. It has to be remembered that a tilted wave front does not produce directional errors. A very large number of experiments were made on damped and undamped waves to find the relative merits of the three systems. The variations from the true directions given by the methods were found to be in close agreement. At night time the direction for the minimum value was not sharply defined, and so large observational errors sometimes occurred at night. The experimental results show that all existing systems give results which are practically identical with a single twin loop rotating about a vertical axis. Whatever distortion is produced in an arriving electromagnetic wave by the geographical surroundings, and whatever the cause of the variations experienced both by day and night, all the systems were affected to the same degree. An advantage claimed for the Robinson set is that it can be used in a noisy room. No experiments, however, have yet been made to determine the relative merits of the systems in this respect.

The Liverpool Meeting of the British Association.

THE meeting of the British Association which concluded on September 19 was in many ways notable, and marked the successful introduction of various changes in the local and scientific proceedings. In point of numbers it was the third largest meeting (Australia in 1914 excepted) in the long history of the Association, but the actual number of tickets taken is not the only criterion for success. Figures are, however, of some value; for one of the objects of the Association, namely, to spread knowledge of science and what it stands for, can be most successfully accomplished by an appeal to the public receiving ready response.

While the membership numbered 3296, not less than 15,000 people attended the free public lectures in Liverpool and the surrounding boroughs, while more than 7000 paid admission to the Scientific Exhibition held under the auspices of the Association in the Central Technical School on September 10-22, and this number does not include members of the Association itself, who were admitted free.

Further, the sectional meetings were almost all not merely well attended but often overcrowded, a condition which spoke well for the enthusiasm for scientific knowledge among the members, but also illustrated the attractiveness of the programmes.

The inaugural meeting, when the president delivered his address, was remarkable for the fact that the whole proceedings were broadcasted, and in two halls in Liverpool the wireless version was accompanied by lantern illustrations identical with and shown simultaneously with the originals shown during the address itself in the Philharmonic Hall. The address was well heard in most parts of the British Isles, and was even picked up so far away as Switzerland. This is, indeed, an example of the development of physical science since the last Liverpool meeting held in 1896.

The place of the customary second evening lecture was taken by a most successful scientific soirée given by the Local Committee at the University. A wonderful series of experimental and other exhibits had been arranged and a most comprehensive programme had been prepared, but unfortunately, owing to the awkward lay-out of the University Buildings, it must have been nearly impossible for very many of the large and enthusiastic gathering to see properly one-half of all the interesting things on view or to hear many of the excellent series of lecturettes. Such a soirée, however, is full of value and was greatly appreciated, and the excellence of all the arrangements at it reflected the greatest credit on all those concerned in its organisation.

A delightful reception was given by the Lord Mayor and Lady Mayoress in the splendid suite of buildings comprised by the Walker Art Gallery, Picton Reading Room, Hornby Library, and the Museum, which for the purpose were all thrown *en suite*. Seldom if ever have these rooms been seen to better advantage, and the arrangements for dealing with such a large gathering left nothing to be desired.

Important points in the work of the various Sections will be dealt with in special articles, but, as already mentioned, sectional activity was more pronounced than at any recent meetings.

In the physical and chemical sciences this was no doubt partially due to the presence of a remarkably large number of the most brilliant workers in these fields. With Sir Ernest Rutherford as president of the Association, Prof. McLennan as president of Section A, and Prof. Donnan of Section B, and the presence of Sir William Bragg, Sir Oliver Lodge, Profs. Bohr, Langevin, G. N. Lewis, Coster, Hevesy, and a host of other well-known names, these Sections could scarcely fail to be of unusual importance and interest. Indeed, Sections A and B represented an extraordinarily representative gathering of the great men of all countries. Other sections were equally happy in the importance of the subjects they presented, and possibly to the lay mind proved an even greater attraction than the recent developments of atomic theory and the electrical constitution of matter.

It was most satisfactory to find the true scientific interest of the meeting as undiminished as in pre-War years, and this Liverpool meeting a worthy successor to the very successful one of a quarter of a century ago.

The fifty-five general and sectional excursions arranged this year were all well patronised, the number of applications for many exceeding the possible number for the excursion. As practically all the excursions at this meeting had a more or less definite scientific interest as distinct from mere picnics, it is clear that members are as keen to follow science afield as in the lecture room.

At the close of the meeting a party went for four days on a visit to the Isle of Man. Granted good weather they should have seen all that is most interesting in the Island to archæologists, geologists, botanists, and marine biologists.

In conclusion a word must be said about the Reception Room. Few cities possess a hall at once so commodious, convenient, or beautiful as St. George's Hall. The fine tessellated floor (unknown to most even of Liverpool citizens, since it has not been on view for nearly twenty years) was greatly admired, and with the comfortable furnishing and floral decorations made a charming central meeting-place for members. The Reception Room was rarely empty, and helped in no small measure the success of the meeting by forming a convenient and comfortable rendezvous.

The Liverpool Meeting of 1923 will certainly be handed down as one of the really successful meetings of recent years. ALFRED HOLT.

The International Meteorological Conference at Utrecht.

SINCE the first steps were taken in 1853 towards international co-operation in meteorology, the International Meteorological Organisation has had a varied career, its meetings sometimes taking the form of congresses of plenipotentiaries appointed by Governments and convened through diplomatic channels, and sometimes of conferences of directors of meteorological services and observatories meeting without official aid.

Until 1919 the Organisation had no written constitution, but at the first Conference held after the War, at Paris in 1919, " Règlement de l'organisation météorologique internationale " was formally adopted. According to these rules the International Meteorological Organisation comprises: (1) Conferences of Directors; (2) the International Meteorological Committee; (3) Commissions. The Conferences are to meet every six years and to consist of " all heads of Réseaux of stations in each country and the Directors of Meteorological Observatories which are official and independent of one another," to whom are added a number of directors of private institutes and representatives of Meteorological Societies.

The International Meteorological Committee is appointed by each Conference to act until the meeting of the next Conference, and is to all intents and purposes the executive body of the Conference, for it carries out the decisions of the past Conference and prepares the business of the next. Each member of the Committee must belong to a separate country and must be the director of an independent meteorological establishment. Commissions are appointed by the Committee "to advance the study of special questions," and members are appointed simply from the point of view of their personal qualifications to assist the work of the Commission. In this way the assistance of men of science and private gentlemen unassociated with official services is made available and freely used.

When the Conference met in Paris in 1919 the political state of the world was so abnormal that invitations could not be sent to some countries, and many other countries were not able to be represented. It was therefore felt that another Conference should be called as soon as conditions became more favourable and all countries without exception could meet in council. When the International Meteorological Committee met in London in 1921 it was considered that such a time was rapidly approaching, and the invitation of Prof. van Everdingen, director of the De Bilt Observatory, Holland, for a meeting of the Conference in Utrecht during 1923 was accepted. The return to normal political relationship has not been so rapid as was expected, and the troubles of the early months of 1923 made it look at one time as if the Conference would have to be postponed, but it was finally decided not to cancel the invitations which had been despatched in December 1922, and this course has been justified by the successful meetings of the Conference held in Utrecht on September 7–14.

The meetings of the Conference were preceded and followed by meetings of several Commissions. The Commissions for Agricultural Meteorology, Solar Radiation, Terrestrial Magnetism and Atmospheric Electricity, Weather Telegraphy and Maritime Meteorology were held before the Conference (September 3–6), and the Commission for the Study of Clouds and the Commission for the Upper Air met after the Conference (September 14). For the meetings of the Commissions and Conference fifty members were present from Argentine (1), Austria (1), Belgium (2), Brazil (1), Denmark (1), Spain (2), Finland (1), France (5), Great Britain (5), India (1), Japan (4), Norway (3), Holland (11), Poland (2), Portugal (1), Russia (2), Sweden (3), Switzerland (2), Czecho-Slovakia (2).

At the first meeting of the Conference on Friday, September 7, Sir Napier Shaw (Great Britain) was elected president, and Dr. Hesselberg (Norway) secretary-general. After the president's address had been delivered and certain business matters disposed of, it was decided to remit all reports and resolutions submitted to the Conference to five sub-commissions for preliminary consideration and the preparation of suitable recommendations. This distribution occupied the greater part of the meeting on Friday afternoon, when the Conference adjourned until the following Tuesday to give the commissions time to prepare their reports. When the Conference reassembled on Tuesday it worked very hard for three days considering the sixty odd resolutions submitted for its approval.

The great development of the use of wireless telegraphy in the dissemination of meteorological data has necessitated very intricate co-operation between meteorological services all over the world, especially in Europe. As the information is distributed broadcast for the use of any one who cares to receive it, it is highly desirable that the messages issued in the various countries should be of the same form and in the same code. As the result of untiring work of the Weather Telegraphy Commission under the guidance of its energetic president, Lieut.-Col. Gold, the New International Code is now used by twenty-two meteorological services. The arrangement of the times of issue of the wireless messages to prevent interference is also a difficult matter and necessitates close co-operation. It is not surprising, therefore, that twenty resolutions were submitted to the Conference by the Weather Telegraphy Commission. These dealt with such questions as the wording and interpretation of the code, times of issue, description of the stations, reduction of pressure to sea-level, additional observations, and the establishment of sub-commissions to watch the working of the code and to study proposals for improvements. A new departure was the agreement to add a new group of figures to certain messages, to allow experiments to be made of a new method of forecasting, based on a close study of cloud forms, which has recently been developed by the French Meteorological Office. It was very gratifying that it was not found necessary to alter the International Code, for it is extremely difficult to carry through a change when so many services are concerned, and it would jeopardise all the progress made towards the use of a uniform message if changes were made by some and not by others.

The resolutions submitted by the Commission for Maritime Meteorology were less numerous, but they contained references to several remarkable advances towards the extension of synoptic methods to ships at sea. The Commission recommended the adoption of a code to be used for wireless weather messages sent out from ships. The code consists of eight groups of figures, the first four of which are called universal groups and will be the same for all ships in all parts of the world; the second four, called national groups, will be different according to the office which organises the issue, and will be designed to meet the different needs of the various services. This proposal, which was accepted by the Conference, marks a great advance in international co-operation in all parts of the world. The Conference also recorded its appreciation of the work performed on board the *Jacques Cartier*. This is a French ship which has made experiments during voyages between America and Europe of collecting meteorological information by wireless telegraphy from ships and shore, preparing a meteorological chart of the Atlantic, and then broadcasting forecasts for the use of ships. The *Jacques Cartier* carries an officer of the mercantile marine trained in the French Meteorological Office, who is assisted by a clerk lent by that office. Further developments along these lines are to be expected.

The power of the method of "correlation" when applied to meteorological data is now generally recognised by meteorologists. The success of Dr. G. T. Walker, who employs this method in his forecasts of the Indian monsoon, is well known. Such work, however, fails unless homogeneous data extending over a long period are available. Prof. Exner, of Vienna, brought this matter before the Conference, and a resolution was adopted expressing the opinion that the publication of long and homogeneous data from a number of stations at distances of about 500 or 1000 kilometres from one another would be of great value. Not content with expressing this opinion, the Conference asked Dr. G. T. Walker to supervise the working of the resolution so far as Asia is concerned, and similarly Prof. F. M. Exner for Europe, Mr. H. H. Clayton for America, and Dr. G. C. Simpson for Africa, Australia, and the ocean generally.

The Conference was unable to solve the problem submitted to it by the Commission for the Upper Air regarding the international publication of upper-air data. That these data should be collected and published in a uniform manner is highly desirable, but all the efforts of Sir Napier Shaw, the president of the Commission, to find a possible way of doing so have been unavailing. Such an undertaking would be expensive and would require financial aid from all countries concerned. In present circumstances it is not surprising that such aid is not forthcoming, and all the Conference could do was to make suggestions for meeting temporarily the pressing need for the rapid circulation of results obtained by means of sounding balloons. The data obtained by the use of aeroplanes and pilot balloons are too numerous to be handled internationally at present, and the Conference therefore recommended that each country should publish its own data.

Many resolutions dealing with agricultural meteorology, terrestrial magnetism, atmospheric electricity, solar radiation, and the upper atmosphere were adopted, but space does not allow of further details here.

One of the most important questions dealt with by the Conference was its relationship to the International Union of Geodesy and Geophysics. The great growth of the official weather services of all civilised countries has provided so many questions of administration and organisation for international consideration, that this side of the activities of the International Meteorological Organisation has swamped the scientific side. At recent meetings of the Conference and Committee there has been no time for scientific discussion, and therefore little to attract the members of the Organisation other than those connected with the great official meteorological services. A resolution was therefore considered to alter the rules in such a way as to limit membership of the Conference to directors of meteorological services. There was practically no opposition, and the rule governing the membership of the Conference now reads as follows :—

" The Officers of the Committee shall invite to the Conference all heads of Réseaux of stations in each country which are official (d'état) and independent of one another."

It was generally understood that this would remove from the work of the Organisation all questions of pure science, and that the science of meteorology would be considered only in so far as it is applied to the needs of the meteorological services. Practically, this is no change in the work of the Organisation, but it makes a clear distinction between the sphere of the International Union of Geodesy and Geophysics and the sphere of the International Meteorological Organisation. There should now be no material overlap between the work of the Union, which considers meteorology from the scientific side, and the work of the Organisation, which " studies only those questions which are of interest to all national meteorological services and which necessitate the utilisation of their own network of stations."

At the last meeting of the Conference, when the new International Meteorological Committee had been elected and Sir Napier Shaw was about to terminate his long connexion with international meteorology, Col. Delcambre, the head of the French Meteorological Office, rose and in a short eloquent speech expressed the regard every member of the Conference felt for Sir Napier Shaw and the debt which meteorology owed to him. He then proposed that Sir Napier should be elected an honorary member of the International Meteorological Committee, an honour never before bestowed. The proposal was accepted with prolonged applause and much feeling, for all felt that this was a happy way of marking their appreciation of the great work done by Sir Napier Shaw for international meteorology.

The newly elected Committee met the next day and appointed Prof. van Everdingen president, and Dr. Hesselberg secretary. The office of vice-president was left vacant for the present.

The general feeling at the end of the meetings, frequently expressed, was that good work had been done and much progress made. Good feeling between members from all countries was very marked throughout.

The Emerald Table.

By E. J. HOLMYARD.

ONE of the most famous of alchemical tracts is the Emerald Table (" Tabula smaragdina "), ascribed to the almost mythical " founder of chemistry," Hermes Trismegistos. Not merely is it regarded as a masterpiece by the medieval alchemists themselves, but later historians of chemistry have written innumerable articles in a vain attempt to solve its perennial mystery. The Latin text of the Tabula has been printed so many times that it is unnecessary to reproduce it here; it may be seen in Kopp's " Beitr. zur Gesch. der Chemie," p. 377, while an English translation is given by Thomson in his " History of Chemistry," p. 10.

The problems presented by the Tabula are shortly as follows : (1) In what language was it originally written ? (2) What is its age ? (3) Has it anything whatever to do with alchemy ? The third of these problems need not be discussed in this place : it is sufficient to remark that it has always been considered alchemical in nature, and in that judgment we may reasonably acquiesce.

The question of the age of the work needs a fuller treatment. It was first printed at Nuremberg in 1541, under the title " Hermetis Trismegisti Tabula smaragdina, in ejus manibus in sepulcro reperta, cum commentatione Hortulani," but according to Kircher (" Oedipus Aegyptiacus," 1653, II. ii. p. 428) it is mentioned by Albertus Magnus in his " Liber de secretis chymicis," which is, however, probably spurious. Kriegsmann (" Hermetis Trismegisti . . . Tabula smaragdina," 1657) maintained that the work was originally written in the Phœnician language, and says that, according to some, the Emerald Table was taken by a woman called Zara from the hands of the dead body of Hermes in a cave near Hebron. Other authors inform us that Alexander the Great, on one of his journeys, discovered the sepulchre of Hermes and in it the tract inscribed upon a table of emerald. These obviously legendary accounts led many historians of chemistry to doubt the great age of the Tabula, and Thomson (*op. cit.* p. 13) says that " it bears all the marks of a forgery of the fifteenth century." Kopp, however, showed that it was well known to European alchemists in the middle of the thirteenth century, and that it was mentioned by Albertus Magnus (1193–1282) in a work which is undoubtedly authentic, namely, the "De rebus metallicis et mineralibus" (lib. 1, tract. 1, cap. 3). The commentary on the Tabula by Hortulanus, to which reference has already been made, might be used to show an even greater antiquity, if Hortulanus were safely to be identified with John Garland (1202–1252), but this identity is open to grave doubt.

The last word on the subject was that of Prof. E. O. von Lippmann, in his admirable book "Die Entstehung und Ausbreitung der Alchemie" (Berlin, 1919, p. 58): "Ein griechisches Original der 'Tabula smaragdina' ist nicht bekannt, und da die syrischen und arabischen Chemiker ihrer überhaupt keine Erwähnung tun, so bestehen berechtigte Zweifel an ihrem vorgeblichen Alter; so alt wie der gesamte zugehörige Litteraturkreis könnte sie aber dem soeben Ausgeführten zufolge immerhin sein, und die Anführung des Hermes Trismegistos, sowie die Herübernahme des im Lateinischen ganz ungebräuchlichen Wortes *telesmus* (τελεσμός) lassen eine Übersetzung aus dem Griechischen mindestens als möglich erscheinen." In short, although the earliest definite mention of the Tabula is that made by Albertus Magnus, there is a possibility that the claim of the alchemists, namely, that it was translated from the Greek, was well founded.

The following observations, therefore, would appear to be of considerable interest, as throwing further light upon both the age of the Tabula and the language in which it was written. The celebrated Jābir ibn Ḥayyān, who flourished in the last half of the eighth century A.D., wrote a very large number of books on alchemy, a partial list of which is given by Al-Nadīm in his encyclopædia, the "Kitāb al-Fihrist" (tenth century A.D.). This list was compiled partly from Jābir's own catalogue of his writings, and there seems to be no doubt of its authenticity, especially as about fifty of the books mentioned are still extant. The first book on the list is one entitled "Kitāb Usṭuqus al-Uss al-Awwal," a title which Berthelot ("La chimie au moyen âge," iii. 32) translates "Le livre d'Estaqès, le premier myrte." This mysterious translation is explained by the fact that apparently Berthelot's translator did not know the meaning of the word *Usṭuqus* and mis-read *Ās* (myrtle) for *Uss* (base or foundation). *Usṭuqus* is, I believe, an Arabic transliteration of the Greek ἑστηκώς, which is used by Aristotle in the sense of "firm" or "solid," and was extended in meaning to include the basis of anything, and thus, for example, the "four elements" as the basis of all things.

The "Kitāb Usṭuqus al-Uss al-Awwal" (al-Awwal = *the first*) is followed by a second (al-Thānī) and a third (al-Thālith), and although no MSS. of these works are known in Europe, there are, I believe, some in India, where in 1891 a lithographed edition was published. The copy I have used was kindly lent me by Mr. A. G. Ellis of the British Museum. Now, in the second book of the *Usṭuqus* (p. 41 of the lithographed edition) occurs the passage: "Balīnās mentions the engraving on the table in the hand of Hermes, which says:

'Truth! Certainty! That in which there is no doubt!

'That which is above is from that which is below, and that which is below is from that which is above, working the miracles of one [thing].

'As all things were from One.

'Its father is the Sun and its mother the Moon.

'The Earth carried it in her belly, and the Wind nourished it in her belly, as Earth which shall become Fire.

'Feed the Earth from that which is subtle, with the greatest power.

'It ascends from the earth to the heaven and becomes ruler over that which is above and that which is below.'

"And I have already explained the meaning of the whole of this in two of these books of mine."

Although the Arabic text of the Table is obviously corrupt, and the translation of it here given therefore uncertain in one or two minor points, there can be no doubt that a version in Greek was known to Jābir, since the correspondence of the above with the Latin text—the appropriate portions of which are appended—is very close:

"1. Verum sine mendacio certum et verissimum.

"2. Quod est inferius est sicut quod est superius, et quod est superius est sicut quod est inferius, ad perpetranda miracula rei unius.

"3. Et sicut omnes res fuerunt ab uno meditatione unius, sic omnes res natae fuerunt ab hac una re adaptione.

"4. Pater ejus est Sol, mater ejus Luna, portavit illud ventus in ventre suo, nutrix ejus terra est.

* * * * * *

"7. Separabis terram ab igne, subtile a spisso, suaviter magno cum ingenio.

"8. Ascendit a terra in coelum, iterumque descendit in terram, et recipit vim superiorum et inferiorum."

The Balīnās mentioned by Jābir is Apollonius of Tyana, who was born a few years before the Christian era, and acquired a great reputation in the East as a wonder-worker and as a master of the talismanic art.

It seems, therefore, that we must antedate the "Tabula smaragdina" by four hundred years at least, and probably by twelve hundred; its existence in a Greek form is rendered in the highest degree probable, and it must be acknowledged that in the Tabula we have one of the oldest alchemical fragments known.

University and Educational Intelligence.

CAMBRIDGE.—The vice-chancellor, Dr. E. C. Pearce, in the course of his address on the opening of the new academic year on October 1, said that the University Grants Committee had informed him that from the academic year now opening the Government proposes to make an additional annual grant of 30,000*l.* to meet the needs of the University for superannuation, stipends, maintenance of the Library, extension of extra-mural work, and the women's colleges; in addition a non-recurrent grant, not exceeding 35,000*l.*, will be payable in respect of superannuation arrears.

GLASGOW.—Dr. J. R. Currie, professor of preventive medicine in Queen's University, Kingston, Ontario, has been elected to the newly established Henry Mechan chair of public health. Dr. Currie during the War was specialist sanitary officer at Toronto and Dunkirk, and was Medical Officer of the Scottish Board of Health 1919–1922. His work on the "Mustering of the Medical Service in Scotland," published last year, gives a stirring account of the efforts made in Scotland to keep up the supply of medical officers for the Army and Navy, and to organise the remainder for civil needs. Dr. Currie was secretary of the Emergency Medical Committee.

ST. ANDREWS.—Dr. Adam Patrick has been chosen by the University Court to succeed Prof. Stalker in the chair of medicine, and the directors of the Royal Infirmary, Dundee, have appointed him one of their physicians. Dr. Patrick is a graduate in arts with honours in classics and M.D. with honours of the

University of Glasgow. He has been assistant successively to Prof. Samson Gemmell and Prof. T. K. Munro, of the chair of medicine at Glasgow. During the War he was working for more than three years as a specialist in bacteriology in Malta and held other appointments in the Army Medical Service.

On the nomination of the Council of the St. Andrews Institute for Clinical Research, the Court has appointed Mr. Norman Maclennan to the lectureship in bacteriology vacant through the resignation of Lt.-Col. W. F. Harvey.

DR. ROHMANN, professor of physics at the Munster University, formerly at Strasbourg, has been appointed to the newly-founded chair of mathematics and physics in the Forstlichen College, Hann.

THE Bocconi Commercial University, Milan, has resumed this year the publication, suspended since 1915, of its Annuario. Its student enrolment shows a steady increase from 65 in 1915–16 to 352 in 1919–20, followed by a decrease to 293 in 1921–22. The teaching staff comprises 31 professors and lecturers. Annexed to the University are an institute of political economy and a laboratory of technical and commercial research.

THE Faculty of Medical Sciences of the University of London, University College, announces for 1923–24 that each of the departments for the preliminary and intermediate medical sciences is equipped not only for the preliminary and intermediate courses for medical degrees but also for more advanced work. Organised courses of advanced study in experimental physiology and biochemistry are provided, and there are post-graduation courses in hygiene and public health leading to the various diplomas and qualifications in public health. A special post-graduate prospectus is being issued.

STATE policies in regard to the financing of public instruction are described and criticised by Prof. Fletcher H. Swift of the University of Minnesota in Bulletin 1922, No. 6 of the United States Bureau of Education. The growth of expenditure on the public schools since 1871 in the United States has been 900 per cent., varying from 750 in the North Atlantic and North Central States to 1400 in South Atlantic and South Central and 4000 per cent. in the Western States. The professor opines that these expenditures will continue to increase, and he recommends that the major portion of the burden be shifted from the local communities to the State. He would have the State provide the cost of teachers' salaries, supervision, general administration, and the supply of such materials as text-books and laboratory apparatus, leaving to the local communities the provision, furnishing, repairing, operating, and maintaining of school buildings, together with responsibility for fuel, water, light, power, insurance, playgrounds, and play apparatus. He estimates that the State would, under such a distribution, have to bear from 75 to 80 per cent. of the total costs. To "worshippers at the shrine of the ancient fetish of local support and local control" he says this system has led to "multitudes of children being denied educational opportunity and the herding of thousands in dismal hovels under the tutelage of wretchedly underpaid teachers, while hundreds of communities are able to provide luxurious educational facilities." One would like to know whether Prof. Swift has seen Mr. Bernard Holland's article in the *Edinburgh Review* for January, in which some of the disadvantages of centralised control of education are set forth.

Societies and Academies.

PARIS.

Academy of Sciences, September 10.—M. Emile Roux in the chair.—M. **Hadamard**: Vortices and surfaces of slipping in fluids.—Louis **de Broglie**: Waves and quanta.—MM. **Mengaud** and **Mourié**: The meteorite of Saint-Sauveur (Haute Garonne): the circumstances of its fall.

CAPE TOWN.

Royal Society of South Africa, July 18.—Dr. A. Ogg, president, in the chair.—E. **Newbery**: On a proposed modification of the cathode ray oscillograph. The modification would fit the instrument better for the study of over-voltages.—J. S. **Thomas** and R. W. **Riding**: Note on the polysulphides of ammonium, with some considerations regarding the constitution of the polysulphides of the alkali metals. The action of sulphur on solutions of ammonium hydrosulphide in dry alcohol resulted in the formation of ammonium pentasulphide only. When sodium is the metal used, the tetrasulphide is formed; with potassium the pentasulphide. Ammonium pentasulphide in alcoholic solutions is capable of dissolving still more sulphur, and there is evidence of the existence of higher polysulphides; a heptasulphide has been isolated. Pyridine and nitrobenzene react with ammonium pentasulphide, giving highly coloured solutions. There is probably in the polysulphide molecule, two sulphur atoms in a different state of combination from the remainder, and the disulphides may be regarded as being derived from a form of hydrogen disulphide represented by the formula H.S.S.H. Higher polysulphides are then formed by the addition of sulphur to the disulphides, compounds of the type
R.S.S.R, R.S.S.R.,
‖ ‖ ‖ etc., being thus obtained. This
S S S
view is confirmed by the decomposition of ammonium pentasulphide into the disulphide and free sulphur. The reaction takes place at a low temperature and is quantitative in character.—M. **Rindl**: The active principle of *Homaria pallida* (Yellow Tulp). The active principle has digitalis-like physiological effects.

CALCUTTA.

Asiatic Society of Bengal, August 1.—F. C. **Fraser**: Zoological results of the Percy Sladen Trust Expedition to Yunnan, under Professor J. W. Gregory, in 1922.—Dragonflies. The collection consists of nearly 200 specimens, the majority of which belong to the sub-family Libellulinæ. The species are mostly Oriental, but a few Palæarctic forms occur from high altitudes. Twenty-three species are represented, of which seven are described as new.—B. **Prashad**: Observations on the respiration of the Ampullariidæ. After a short survey of the previous literature on the subject of the respiration of the apple snails, an account of the respiration in the common Indian *P. globosa* is given. The peculiarities noted in the case of the hill-stream form *Turbinicola saxea* are also described, and the probable causes of these peculiarities with reference to the hill-stream habitat are discussed.

Official Publications Received.

Proceedings of the Royal Society of Edinburgh, Session 1922-23. Vol. 43, Part 2, No. 8: The Theory of Alternants from 1896 to 1917. By Sir Thomas Muir. Pp. 127-148. 2*s*. Vol. 43, Part 2, No. 9: The Mechanism behind Relativity. By Dr. W. Peddie. Pp. 149-153. 9*d*. Vol. 43, Part 2, No. 11: Further Tests upon Dewar Flasks intended to hold Liquid Air. By Henry Briggs and John Mallinson. Pp. 160-169. 1*s*. Vol. 43, Part 2, No. 12: The Interior and Exterior Space-Time Forms of the Poincaré Electron in Weyl's Geometry. By John Marshall. Pp. 170-179. 1*s*.

Vol. 43, Part 2, No. 13: A Static Model of the Hydrogen Molecule. By Prof. H. Stanley Allen. Pp. 180-190. 1s. 6d. Vol. 43, Part 2, No. 14: The Slow Oxidation of Phosphorus. By Dr. Elizabeth Gilchrist. Pp. 197-215. 1s. 9d. Vol. 43, Part 2, No. 15: Notes on a New Method of Investigating Colour Blindness. By Dr. R. A. Houstoun and Dr. W. H. Manson. Pp. 216-218. 9d. (Edinburgh: R. Grant and Son; London: Williams and Norgate.)

Smithsonian Miscellaneous Collections. Vol. 74, No. 6: Designs on Prehistoric Pottery from the Mimbres Valley, New Mexico. By J. Walter Fewkes. (Publication 2713.) Pp. 47. Vol. 76, No. 1: Some Practical Aspects of Fuel Economy. By Carl W. Mitman. (Publication 2715.) Pp. 19. Vol. 76, No. 7: Description of an Apparently New Toothed Cetacean from South Carolina. By Remington Kellogg. Pp. ii+7+2 plates. (Washington: Government Printing Office.)

Commonwealth of Australia: Institute of Science and Industry. Bulletin No. 24: The Production of Liquid Fuels from Oil Shale and Coal in Australia. By R. E. Thwaites. Pp. 62. (Melbourne.)

Memoirs of the Indian Meteorological Department. Vol. 23, Part 6: On Indian Monsoon Rainfall in relation to South American Weather, 1875-1914. By R. C. Mossman. Pp. 157-242. (Calcutta: Government Printing Office.) 2 rupees.

Nova Acta Regiæ Societatis Scientiarum Upsaliensis. Ser. 4, Vol. 6, No. 2: Innere Bewegungen in den Zwischenschichten des Meeres und der Atmosphäre. Von O. Pettersson. Pp. 43. (Uppsala: E. Berlings Boktryckeri A.-B.)

Publikationer fra det Danske Meteorologiske Institut. Meddelelser Nr. 5: Meteorological Problems. By V. H. Ryd. 1: Travelling Cyclones. Pp. iv+124. (Kjøbenhavn: G. E. C. Gad). 5 kr.

Ministry of Public Works, Egypt. Physical Department Paper No. 10: A Barometric Depression of the Khamsin Type, by L. J. Sutton; Effect of Wind Direction on Temperature and Humidity at Jerusalem, by S. Krichewsky. Pp. 15+12 plates. (Cairo: Government Publications Office.) P.T. 5.

Scientific Survey of Porto Rico and the Virgin Islands. Vol. 2, Part 1: The Geology of the Lares District, Porto Rico. By Bela Hubbard. Pp. 115. (New York: Academy of Sciences.)

New Zealand Department of Mines: Geological Survey Branch. Bulletin No. 25: The Geology and Mineral Resources of the Collingwood Subdivision, Karamea Division. By M. Ongley and E. O. Macpherson. Pp. vi+52+4 plates+4 maps. (Wellington: W. A. G. Skinner.) 6s.

Proceedings of the Royal Society of Victoria. Vol. 35, Part 2: Containing Papers read before the Society during the months of August to December 1922. Pp. 115-217. (Melbourne.)

Proceedings of the South London Entomological and Natural History Society, 1922-23. Pp. xviii+152+8 plates. (London: Hibernia Chambers, S.E.) 10s. 6d.

Transactions of the Royal Society of Edinburgh. Vol. 53, Part 2, No. 18: The Igneous Geology of the Dalmeny District. By Dr. Frederick Walker. Pp. 361-375+1 plate. 2s. 9d. Vol. 53, Part 2, No. 19: The Physiography of the Moray Firth Coast. By Alan G. Ogilvie. Pp. 377-404. 3s. 6d. (Edinburgh: R. Grant and Son; London: Williams and Norgate.)

Memoirs of the Department of Agriculture in India: Entomological Series. Vol. 7, No. 12: Further Notes on *Pempheres affinis*, Fst. (the Cotton Stem Weevil). By E. Ballard. Pp. 243-255+4 plates. 1 rupee; 1s. 4d. Vol. 8, Nos. 1, 2, 3: *Hydrophilidæ* of India (Col.): a List of the Species in the Collection of the Agricultural Research Institute at Pusa (Bihar), by A. d'Orchymont; an Annotated List of Ichneumonidæ in the Pusa Collection, by G. R. Dutt; a Second Note on Odonata in the Pusa Collection, by Major F. C. Fraser. Pp. 34. 1 rupee; 1s. 6d. Vol. 8, No. 4: Notes on Indian Muscidæ. 1: Calliphorinæ Testaceæ; 2: Rhiniinæ, By Ronald Senior-White. Pp. 35-52+3 plates. 12 annas; 1s. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co.)

Agricultural Research Institute, Pusa. Bulletin No. 44: Observations on the Morphology and Life-Cycle of *Filaria recondita*, Grassi. By Prof. M. Anant Narayan Rao. Pp. 7+2 plates. 6 annas. Bulletin No. 145; Some Observations on Barren Soils of Lower Bari Doab Colony in the Punjab. By S. M. Nasir. Pp. 11. 3 annas. (Calcutta: Government Printing Office).

Indian Forest Records. Vol. 9, Part 7: Notes on the Possibilities of Camphor Cultivation from *Cinnamomum Camphora* in Northern India. By Stanley H. Howard, Wheatley A. Robertson, and John L. Simonsen. Pp. 34+6 plates. 1.4 rupees. Vol. 9, Part 8: The Constituents of some Indian Essential Oils. By John L. Simonsen. Parts 9-10. Pp. 8. 4.6 annas. (Calcutta: Government Printing Office.)

Field Museum of Natural History: Botanical Series. Vol. 5: Flora of Santa Catalina Island, California. By Charles F. Millspaugh and Lawrence W. Nuttall. (Publication 212.) Pp. 413+14 plates. (Chicago.)

Bernice P. Bishop Museum. Bulletin 2: Early References to Hawaiian Entomology. By J. F. Illingworth. Pp. 63. Bulletin 3: Hawaiian Legends. By William Hyde Rice. Pp. 137. Bulletin 5: Crustacea from Palmyra and Fanning Islands. By Charles H. Edmondson; with Descriptions of New Species of Crabs from Palmyra Island, by Mary J. Rathbun. Pp. 43+2 plates. (Honolulu.)

Bulletin of the American Museum of Natural History. Vol. 49, Art. 1: Contributions to the Herpetology of the Belgian Congo, based on the Collection of the American Museum Congo Expedition, 1909-1915. By Karl P. Schmidt. Part 2: Snakes. With Field Notes by Herbert Lang and James P. Chapin. Pp. 146+22 plates. (New York.)

Reprint and Circular Series of the National Research Council. No. 45: List of Manuscript Bibliographies in the Biological Sciences. By Clarence J. West and Callie Hull. Pp. 51. (Washington: National Academy of Sciences.) 50 cents.

The University of Leeds: Department of Leather Industries. Report of the Advisory Committee on the Work of the Department during Sessions 1921-23. Pp. 10. (Leeds.)

Report on the Administration of the Meteorological Department of the Government of India in 1922-23. Pp. 16. (Simla: Government Press.) 4 annas.

Memoirs of the Department of Agriculture in India: Chemical Series. Vol. 7, No. 2: Studies of an Acid Soil in Assam, II. By A. A. Meggitt. Pp. 31-53. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co.) 12 annas; 1s.

Museums of the Brooklyn Institute of Arts and Sciences. Report upon the Condition and Progress of the Museums for the Year ending December 31, 1922. By William Henry Fox. Pp. 59+3 plates. (Brooklyn.)

Transactions of the Leicester Literary and Philosophical Society, together with the Report of the Council for 1922-23 and Annual Reports of the Sections. Vol. 24, 1923. Pp. 58. (Leicester.)

Ministerio da Agricultura, Industria e Commercio: Directoria de Meteorologia. Boletim Meteorologico. Anno de 1919. Pp. 154. (Rio de Janeiro.)

Records of the South Australian Museum. Vol. 2, No. 3. Pp. 331-457 +plates 5-22. (Adelaide.) 7s. 6d.

Journal and Proceedings of the Royal Society of Western Australia. Vol. 9, Part 1, 1922-23. Pp. 70. (Perth.) 5s.

Department of the Interior: Bureau of Education. Bulletin, 1923, No. 3: History of the Manual Training School of Washington University (St. Louis Manual Training School). By Charles Penney Coates. Pp. iii+86. (Washington: Government Printing Office.) 20 cents.

Commonwealth of Australia: Institute of Science and Industry. Pamphlet No. 3: The Co-operative Development of Australia's Natural Resources. By Gerald Lightfoot. Pp. 20. (Melbourne.)

Lyme Regis Museum of Geology and Archæology. Guide and Report, 1923. Pp. 16+2 plates. (Lyme Regis.)

Edinburgh and East of Scotland College of Agriculture. Calendar for 1923-24. Pp. 90. (Edinburgh.)

Proceedings of the Cambridge Philosophical Society. Biological Sciences, Vol. 1, No. 1. Pp. 62+5 plates. (Cambridge.) 12s. 6d. net.

Proceedings of the Royal Irish Academy. Vol. 36, Section A, No. 6: Experiments on Large Ions in Air. By J. J. Nolan and J. Enright. Pp. 93-114. Vol. 36, Section A, No. 7: Solutions of Systems of Ordinary Linear Differential Equations by Contour Integrals. By W. M'F. Orr. Pp. 115-130. Vol. 36, Section B, No. 5: The Constitution of Catechin. By James J. Drumm. Part 1. Pp. 41-49. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate.) 1s. each.

Proceedings and Transactions of the Croydon Natural History and Scientific Society. Vol. 9, Part 3, February 1921 to January 1923. (Croydon.) 5s. net.

The National Council for the Unmarried Mother and her Child. Fifth Annual Report, 1923. Pp. 16. (London: 117 Piccadilly.)

Diary of Societies.

TUESDAY, OCTOBER 9.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—E. H. Cunningham Craig: Recent Research bearing upon the Origin of Petroleum.

INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—W. J. N. Vanstone: The Pyramids of Egypt. (Ladies' Night.)

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—O. Brockbank: Petra, the Rose Red City.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—Dr. E. W. Bowell: The Radulæ and how to mount them.

WEDNESDAY, OCTOBER 10.

PREHISTORIC SOCIETY OF EAST ANGLIA (at Geological Society), at 2.15.—J. G. Marsden: Note on Flint Implements of Le Moustier Type from Camborne and Southampton.—Henry Bury: Some Aspects of the Hampshire Plateau Gravels (Presidential Address).—M. C. Burkitt: A Newly Discovered Transition Culture in North Spain.—A. L. Armstrong: Preliminary Report on the Discovery of a hitherto Unknown Phase of Early Mining at Grimes' Graves.—Major A. G. Wade: A Series of Ancient Flint Mines at Stoke Down, Sussex.

INSTITUTION OF WELDING ENGINEERS (at Holborn Restaurant), at 8.—Electric Welding; Gas Welding.

THURSDAY, OCTOBER 11.

INSTITUTE OF METALS (London Local Section) (at Institute of Marine Engineers), at 8.—Dr. D. Hanson: Chairman's Address.

FRIDAY, OCTOBER 12.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—C. T. Holland: The Snow and Ice Scenery of Switzerland.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—W. Y. Lewis: The Never Stop Railway.

PUBLIC LECTURES.

MONDAY, OCTOBER 8.

UNIVERSITY COLLEGE, at 5.—Prof. G. Dawes Hicks: The Philosophy of Bernard Bosanquet.—Prof. D. Jones: The Application of Phonetics to the Languages of the British Empire.

KING'S COLLEGE FOR WOMEN (Household and Social Science Department), at 5.—Prof. V. H. Mottram: Newer Aspects of Nutrition. (Succeeding Lectures on October 15, 22, 29; November 5, 12, 19, and 26.)

TUESDAY, OCTOBER 9.

KING'S COLLEGE, at 5.30.—Prof. H. Wildon Carr: The Hegelian Philosophy and the Economics of Karl Marx. (Succeeding Lectures on October 16, 23, and 30.)

UNIVERSITY COLLEGE, at 5.30.—Prof. C. Spearman: Psychology as Transfigured Behaviourism.

GRESHAM COLLEGE (Basinghall Street), at 6.—A. R. Hinks: Astronomy. (Succeeding Lectures on October 10, 11, and 12.)

WEDNESDAY, OCTOBER 10.

KING'S COLLEGE, LONDON, at 4.30.—Dr. C. Da Fano: Histology of the Nervous System. (Succeeding Lectures on October 17, 24, 31; November 7, 14, 21, and 28.)

UNIVERSITY COLLEGE, at 5.—Morris Ginsberg: The Sociological Work of the late Dr. W. H. R. Rivers;—at 7.—A. H. Barker: The Heating Equipment of a Small House.

SATURDAY, OCTOBER 13.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Capt. W. H. Date: Wireless Telephony—a Popular Exposition.