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General and Specific Sanitation.

ALTHOUGH hookworm infection (anchylostomiasis) is so rare in this country as to be unknown except among miners, the principles governing its control give an illustration of the relationship between specific and general control over infection, which is not without value for British hygienists. For this reason a monograph recently issued by the Rockefeller Institute for Medical Research[1] is deserving of attention. Hookworm disease is chiefly a rural disease in Brazil as elsewhere, and is most prevalent where there is complete disregard of elementary sanitation, especially in warm climatic conditions, which favour the life of the hookworm embryo in the soil, and encourage workpeople to go barefooted.

Dr. Smillie's investigation shows that hookworm disease is most common in the ages between fifteen and forty. It may be correctly described as an industrial disease, as it occurs chiefly in unshod field-workers. This fact comes out more clearly when a distinction is drawn, as it should be, between hookworm infection and hookworm disease. The importance of this distinction is gradually becoming appreciated in public health. In diphtheria it forms an essential consideration; and rational measures cannot be devised for the prevention of tuberculosis, which have no regard for this distinction. In male children under ten years of age the average number of intestinal hookworms per person was 39, increasing to 169 between ten and twenty, and over 200 in men between twenty and forty years old. The injury to health occurs chiefly in the persons showing heavier incidence of intestinal worms.

The work of Looss and his successors proved that the chief mode of hookworm infection is through the skin, by its contact with fæcally contaminated moist earth, the mouth being an incidental and altogether unimportant channel of infection. This important fact in natural history suggests the two chief methods of control of the disease, the provision of latrines and covering for the feet. The third line of action, that of treatment of infected persons, has relatively smaller importance; and in Dr. Smillie's judgment treatment may properly be limited to field-workers, and may be disregarded for persons under five and over fifty-five years of age. Hookworm disease being an industrial malady, the construction of latrines in the working fields as well as domestically is indispensable if the disease is to be controlled; and the difficulty of reform in this direction is seen in the statement that there are practically no latrines in rural Brazil. As regards the second method of control, it has been found that the use of a crude pair

[1] "Studies on Hookworm Infection in Brazil, 1918–20." Second paper by Dr. Wilson G. Smillie (Monographs of the Rockefeller Institute for Medical Research, No. 17, May 12, 1922).

of half shoes by farm-workers has reduced infection to less than one-tenth of the usual rate suffered by those who did not wear shoes.

Only a few outstanding points in this valuable report have been cited, but enough has been given to show that in hookworm disease we have a notable illustration of the close connexion between elementary sanitation and the prevention of disease. In England we associate this connexion chiefly with diarrhœa and enteric fever, and William Budd's researches will always furnish the classical illustration of the close relations between defective latrine accommodation and the spread of infection as soon as typhoid fever is introduced into a village. The association is probably wider than is usually suspected. The relation of excessive diarrhœa to the continuance of conservancy systems in English towns and villages has been repeatedly emphasised, and there is strong reason for assuming a similar association of these systems with excessive pneumonia in young children.

But the hookworm story emphasises even more the importance of exact knowledge of the infecting agent. The provision of shoes or even their compulsory wearing is a novelty in sanitary administration from a British point of view; but it appears to be the most urgent need where hookworm disease is endemic. So, likewise, the fact that hookworm disease is an occupational disease shows where preventive work is chiefly needed, while the distinction between incidental infection and actual disease points to the persons among whom administrative control must be chiefly attempted. These contentions are illustrated in the paper by the wasted effort displayed in such public health work as the "swat-the-fly" campaign, in which a vast amount of effort and much money are expended in fruitless endeavours to eliminate flies by wholly illogical methods.

The Vegetation of High Asia.

Southern Tibet: Discoveries in Former Times compared with my own Researches in 1906–1908. By Sven Hedin. II. *A List of Flowering Plants from Inner Asia, collected by Dr. Sven Hedin, determined by various authors, and compiled by C. H. Ostenfeld and Ove Paulsen.* Pp. 25+100+8 plates. (Stockholm: Lithographic Institute of the General Staff of the Swedish Army, 1922.) 30 marks.

KNOWLEDGE of the vegetation of High Asia is now extensive. The climate, while leaving something to be desired in other respects, favours the preparation of botanical specimens, and travellers in the inclement uplands of Tibet and the Pamirs have supplied much material for herbarium use. Yet, owing to circumstances beyond their control, this material compares unfavourably with that secured by explorers in temperate and tropical regions. As a result, our acquaintance with the flora of High Asia is still far from exhaustive.

Geographical reconnaissance involves the investigation of as much ground as an expedition can map, and is thus somewhat incompatible with an intensive study of the vegetation of a given area throughout a round of the seasons. Any combination of the two activities means either that geography must be content with fewer data, or that botany must rest satisfied with indifferent material. The best botanical results of geographical expeditions are obtained during halts made when plants are in active growth.

The traveller in temperate regions may arrange his halts. In the tropics, as in high latitudes and at great altitudes, halts usually depend on meteorological conditions. Those caused by heat or rain coincide with periods of vegetative activity; those due to cold and snow occur when plants are dormant. The arctic-alpine flowering season is, besides, so brief that when the explorer sets out he may find only leaf-specimens; ere his journey ends, he may collect only specimens of plants the seeds of which have fallen. He may, if fortunate, secure complete material of species general along his route but he must be prepared for the possibility that his specimens of local plants are not always identifiable.

The botanical interest in any collection of plants from High Asia is therefore intelligible. Underlying this interest is a hope that new material may resolve old doubts. That hope explains our attitude towards arctic and alpine collections as compared with those from temperate latitudes or moderate elevations. A difference of a few days in the dates on which particular arctic or alpine camping-grounds were visited may give assurance to identifications originally tentative. The value of any High Asian collection is thus enhanced if it comes from districts already carefully investigated.

The importance of a census of the flowering plants found by Dr. Sven Hedin in the course of his various journeys in Inner Asia during 1894–1907 will therefore be readily appreciated. This census, compiled by workers so careful and competent as Prof. C. H. Ostenfeld and Dr. O. Paulsen, affords concrete evidence of the effects upon botanical survey of the exigencies of geographical exploration at great heights, and exemplifies the disadvantages against which the traveller on lofty uplands must contend.

The praiseworthy pains the authors have taken to identify many incomplete specimens have been more than justified by their results. Notwithstanding their care, the compilers have felt debarred from suggesting specific names in the case of eleven, or 4 per cent. of the 275 plants enumerated. If to these we add the cases in which specific determination remains more or less doubtful, we have a total of 27, or nearly 10 per cent. of the whole. The authors have laid those who may study this census under a lasting obligation by recording the precise condition of the material available and thereby indicating why, as well as where, doubt attaches to certain identifications.

The imperfection of much of Dr. Hedin's material has induced the authors to restrict themselves to a taxonomic enumeration of the plants actually found by that eminent traveller in East Turkestan, the Pamirs, and Tibet, and to regard their work as supplementary to that of Dr. Hemsley[1] and Madame Fedtschenko.[2] Other considerations may have weighed with workers who are recognised as authorities both on plant-distribution and plant-association, when deciding that phytogeographical or ecological discussion is not yet feasible.

The census shows that Dr. Hedin collected 57 distinct plants in East Turkestan, 72 in the Pamirs, and 185 in Tibet, but that two only of the plants enumerated were found by him in all three regions; only one not met with in Tibet was found both in East Turkestan and the Pamirs, and only eight not met with in the Pamirs are recorded both from East Turkestan and Tibet, while no fewer than 27 not met with in East Turkestan are recorded both from the Pamirs and Tibet.

These figures are not surprising when regard is had to the fact that all the Pamir plants were collected at elevations of 12,000-15,000 feet and all the Tibetan ones were found at elevations of 8500-17,000 feet, whereas 44 of the 57 plants reported from East Turkestan were met with at altitudes of only 2750-3500 feet. Conformity as regards elevation may account for the appreciable common element in the Pamir and the Tibet vegetations; disparity in this respect may explain the relative isolation of East Turkestan. That isolation may indeed be greater than the census suggests. All the East Turkestan plants reported from altitudes exceeding 3500 feet were found in one or other of three localities. The thirteen plants in question include one of the three recorded as common to East Turkestan and the Pamirs and seven of the ten recorded as common to East Turkestan and Tibet.

One of these three localities is Toghde-gol, 9100 feet, in southern Tsaidam. This locality is cited in the census for four plants. Only in the case of two of these is the place said to be in East Turkestan; under the others it is said to be in Tibet. Another of the localities is Bash-kurgan, 8750 feet, south of Lop-nor, which is cited for five plants. In connexion with two of these the place is said to be in East Turkestan, under a third it is stated to be on the East Turkestan-Tibet frontier, and in connexion with the two remaining plants the locality is placed in Tibet. The third locality, Tatlik-bulak, 6500 feet, is mentioned in connexion with eight plants. Here we have no such formal inconsistency; on each occasion the place is attributed to East Turkestan. But this does not remove all doubt; Tatlik-bulak lies south-east of Lop-nor and therefore farther east than Bash-kurgan.

It is possible that this discrepancy of statement merely reflects a difference in point of view. In floristic studies it is often convenient to respect political boundaries; in phytogeographical ones it is always desirable to recognise natural frontiers. From an ethnic standpoint all three localities may belong to East Turkestan; the evidence of the plants themselves suggests that from a botanical standpoint all three belong to Tibet. However this may be, the census prepared by Prof. Ostenfeld and Dr. Paulsen appears to justify one general conclusion. While it is clear that East Turkestan can be properly included in the region our authors speak of as "Inner Asia," it must be excluded from the region for which Dr. Hemsley has employed the term "High Asia."

How deeply we are indebted to Dr. Paulsen for our acquaintance with the vegetation of the western Pamirs, the drainage of which is towards Ferghana and the Oxus, readers of NATURE are already aware. Regarding the plants of the eastern Pamirs, the streams of which flow towards Yarkand, we have hitherto known little beyond what was to be learned from a few specimens gathered by Sir F. E. Younghusband thirty years ago in the Pamir of Taghdumbash. All save one of the Pamir plants in Dr. Hedin's collections are reported from the eastern half of the region; the evidence they afford is thus of unusual importance.

Unfortunately, that evidence is still far from complete. From the Taghdumbash Pamir, which from its connexions to the south and the east should perhaps prove the most "critical" of these high valleys, we have again to be content with a few specimens. Nearly 30 per cent. of Dr. Hedin's Pamir plants are from the Karakul Pamir, probably the least critical of the eastern valleys. More than 40 per cent. were gathered on the slopes of Mustagh-ata, highest of the Pamir peaks, but in this case it is not clear that all the Mustagh-ata plants were collected in one Pamir. Until the vegetation of these various eastern Pamirs has been investigated as exhaustively as that of the Little Pamir was by Lt.-Col. Alcock during the Pamir

[1] The Flora of Tibet or High Asia: W. B. Hemsley, assisted by H. H. W. Pearson (Journ. Linn. Soc., Bot. vol. xxxv. pp. 124-265, 1920).
[2] Flore du Pamir: Olga Fedtschenko (Act. Hort. Petrop., vol. xxi. pp. 233-471, 1903; *ibid.* vol. xxiv. pp. 123-154, 1904; and pp. 313-355, 1905; *ibid.* vol. xxviii. pp. 97-126, 1907; and pp. 455-514, 1909).

Boundary Commission and as that of the Alichur Pamir was by Dr. Paulsen during the second Danish Pamir Expedition, the last word on the vegetation of this region as a whole must be left unsaid. The numbers of plants found by Dr. Hedin in all the eastern valleys visited by him falls short of the number which Lt.-Col. Alcock has taught us may be found in a single western one.

The evidence supplied by Dr. Hedin, imperfect though it be, does, however, sustain the general conclusion, based on our acquaintance with the vegetation of the western Pamirs, that while many plants are common to all, some are peculiar to each.[3] Another general conclusion to which the material obtained by Dr. Hedin appears to point is that it may prove more convenient and natural to employ the term "High Asia," restricted by Dr. Hemsley to Tibet, in an extended sense which will include also the "Pamirs."

Tibet is by far the largest of the three regions visited by Dr. Hedin; he collected there twice as many plants as he found in the Pamirs, and three times as many as he gathered in East Turkestan. The plants from Tibet which the authors have been compelled to describe as new are five times as numerous as the new species reported from both of the other regions. The authors of this census are therefore fully justified in remarking that its main interest lies in the Tibetan plants therein discussed. These facts notwithstanding, it is more impossible to deduce conclusions regarding the vegetation of Tibet from the evidence here supplied than it is to do so in the case of East Turkestan or of the Pamirs. The phytogeographical indications are sometimes as inconsistent as in the case of East Turkestan and are, if possible, more inexplicable than they are as regards that region. Localities are at times placed in Inner Tibet with no indication of latitude or longitude, and therefore with only imperfect clues as to their precise situation. When more precise indications are supplied, Inner Tibet is now given as synonymous with Northern, anon as synonymous with Eastern Tibet. Certain localities are said in one case to be in North Tibet, in another to be in East Tibet. The list itself forms part of the sixth volume of a work entitled "Southern Tibet," yet it does not include any plant said to have been collected in South Tibet.

Perhaps the most interesting individual species in the list is one which Prof. Ostenfeld has proposed to treat as the type of a new genus, Hedinia. Though thus characterised, this plant, as it happens, is not a new discovery. It is one that so long ago as 1852 was referred by Dr. T. Thomson to the Cruciferous genus Hutchinsia, with the characters of which it conforms so indifferently that in 1861 it was transferred by Sir J. D. Hooker to the genus Capsella as admittedly a very aberrant member. In 1904 Mr. W. Lipsky was so impressed by the unsatisfactory character of both these suggestions that he transferred the plant to the genus Smelowskia. With this particular genus, however, the plant has less natural affinity than it has with either Capsella or Hutchinsia. The treatment now accorded the plant by Prof. Ostenfeld is certainly more convenient than any hitherto proposed. It is to be hoped that it may also prove to be more natural and that it may provide a lasting memorial to the explorer whose name it is intended to perpetuate.

[3] Nature, vol. cvii. p. 270 (April 28, 1921).

Alcohol as a Fuel.

Power Alcohol: Its Production and Utilisation. By G. W. Monier-Williams. Pp. xii + 323. (London: Henry Frowde and Hodder and Stoughton, 1922.) 21*s*. net.

THE enormous increase in the number of engines using motor spirit throughout the civilised world, and the demand for other products of mineral oil, have forcibly directed attention to the great problem of the world's reserves of oil, and to alternative sources of fuels suitable for engines where a fuel of high vapour pressure is necessary. Dr. Monier-Williams deals in his opening chapter with this big problem—the motor fuel question—in a very comprehensive and clear manner. It is shown that while in 1913 the import of petroleum spirit into the United Kingdom was 101 million gallons, by 1920 the imports had reached 200 million gallons. In the United States (where it is said that there is one motor car to every eight of the population) the motor spirit consumption rose from 1200 million gallons in 1914 to 2680 million gallons in 1918.

It is clear that this modern development of locomotion, together with the requirements for aviation, will make further and further demands upon Nature's not inexhaustible reserves of suitable fuel. Although much has been accomplished in rendering a greater proportion of the crude oil available as fuel, by widening the distillation range, by "cracking" heavier fractions, and by taking out the more easily condensible portions of natural gas ("casing head gasoline"), the world is undoubtedly faced with the big problem of Nature's reserves of oil and the possibility of alternative supplies of liquids of sufficiently high vapour pressure to supplement, or in the long run largely to replace, the motor spirit derived from crude petroleum. Dr. Monier-Williams says "a complete solution of the motor fuel problem can only be found in the opening up of extensive, and as yet unproved, new areas of supply, together with the introduction of fuels derived from other sources than petroleum."

Allowing the exclusion of a liquid fuel produced by inorganic agency, he considers that "contemporary vegetation constitutes the only alternative to bituminous mineral deposits as a source of motor spirit, and it would seem that it must eventually supply (as alcohol) a large proportion of the world's requirements." To-day it is a question of the comparative cost of alcohol and petroleum spirit, and alcohol is at a serious disadvantage. In concluding his first chapter Dr. Monier-Williams cogently observes that "the balance of evidence certainly favours the view that before many years have elapsed the supply of petrol will be permanently unequal to the demand, and that power alcohol, considered from the standpoint of a supplementary and not necessarily competitive fuel, has an undoubted future before it."

The many problems associated with the economic production of fuel alcohol have received a great deal of attention, and the author has given a most complete account of the chemical and economic questions involved. In his later chapters he gives very full information on the results which have been obtained in practice with alcohol, and fuel mixtures containing it, and particular mention should be made of the excellent chapter on the chemical and physical properties of alcohol from the motor fuel standpoint. Here are included the important results which have recently been obtained by Ricardo, Tizard and Pye, and Ormandy.

One of the outstanding problems in connexion with fuel alcohol must be the bearing of excise regulations on its production, and the associated question of denaturing. When duty-free denatured alcohol was legalised in 1855 the duty was only 12*s.* per bulk gallon; to-day it is 6*l.* 3*s.* 3*d.* per gallon of 95 per cent. alcohol. To protect the revenue many onerous conditions have to be applied to production, and these necessarily are reflected in the costs, but some relaxation has already been sanctioned since 1921. It is now possible to import power alcohol as bulk cargo at certain ports, denature it in bond with at least 25 per cent. of petrol, benzol, or other approved substance, and to distribute the spirit without further restriction for power purposes alone. Dr. Monier-Williams deals very fully with these questions of excise supervision and denaturation, but concludes, after summarising the ideal requirements of a denaturant, that no substance has yet been found which fulfils satisfactorily all these conditions.

Whether "Power Alcohol" is considered from the point of view of the chemist, the engineer, or the general reader, it gives a complete and well-balanced consideration to all the problems associated with the production and utilisation. Sooner or later alcohol seems bound to play no small part in our means of transport, but above all it is necessary to-day to maintain a proper sense of proportion, and this Dr. Monier-Williams may justly claim to have preserved. Enthusiastic advocates of a new development so often fail to recognise economic limitations.

J. S. S. B.

Chemistry and Life.

La Chimie et la Vie. By Georges Bohn and Dr. Anna Drzewina. (Bibliothèque de Philosophie scientifique.) Pp. 275. (Paris: Ernest Flammarion, 1920.) Price 7.50 frs. net.

BEYOND a short chapter with general statements concerning colloids, nucleoproteids and lipoids, and a chapter insisting upon the specificity of the chemistry of living animals and plants, chemistry plays no more part in the arguments of the authors of "La Chimie et la Vie" than many other sciences. The authors do not deal with pure chemistry, but with chemical physics—the object of which is to determine the influence exerted by physical conditions such as pressure, temperature and concentration of solutions on the progress or change of direction of chemical reactions. They object to the tendency to localise the various properties of plants and animals to particular chemical substances, and suggest that ferments, hormones, antibodies, etc., may not be specific substances so numerous and varied as the effects they produce; but they may be, on the contrary, various methods of activity of a limited number of substances resulting for the most part from the disintegration of living matter.

The main thesis of the book shows how insolubly bound up with one another are all the various branches of biological science. Discussion centres around recent work from practically every branch—chemistry, physical chemistry, zoology, botany, physiology, psychology, general biology, cytology, embryology, medicine, serology. The authors show how fruitful has been the introduction of chemistry to the study of phenomena of life and to what degree chemical physics has restored interest in and revived problems of biology. Some of their own work is recorded briefly. They describe how a double Hydra can be produced from a single Hydra by temporarily depriving the organism of oxygen, and how the symmetry of the Stauridium is altered by a simple change of environment.

The authors consider that the law of van't Hoff and Arrhenius may be applied to vital actions—development of the egg, reproduction, respiration, rhythm of the heart, and growth—and that the "law of reciprocal phenomena" holds for sleep, secretion, movement and growth. They also attempt to establish a parallelism between form and movement, considering that the same factors acting through the same mechanisms are concerned with both. In the origin of form and in the origin of movement, physics and geometry are working in unison with chemistry.

Immunity, Abderhalden's "ferments of defence," anaphylaxis, agglutinins, hæmolysins, precipitins, the secretions of the interstitial glands of the reproductive organs, and hormones in general receive attention. Interesting experiments of tropisms, of fertilisation by chemical means, of experimental parthenogenesis, and of plant grafting, extend the scope of the book. The authors consider that the substances which kill are at the same time the substances which give life; thus, a tumour is submitted to the same physicochemical determination as a developing organ.

The attempt to co-ordinate in a readable and instructive form the recent discoveries of biological interest is certainly successful, and the book is inexpensively though well arranged.

Aristotle in English.

The Works of Aristotle translated into English. De Caelo, by J. L. Stocks; *De Generatione et Corruptione*, by Harold H. Joachim. (Oxford: Clarendon Press, 1922.) 10*s*. net.

THE great Oxford version of Aristotle could scarcely have begun to deal with that philosopher's physics and cosmology at a more opportune time than the present. It is only a year or two since Prof. Whitehead, speaking with all the authority that belongs to his utterances on such a subject, warned us that the first explicit beginnings of the "bifurcation" which has infected nearly all subsequent philosophising about Nature and natural science, are explicit in Aristotle, and that the duty of the *Naturphilosoph* of the present day is to put himself back at the Pythagorean standpoint represented by Plato's "Timaeus" and study the "passage" of nature with a mind freed from the prejudices begotten of a substance-attribute metaphysic.

This weighty modern endorsement of Bacon's old complaint that Aristotle corrupted natural science at its sources by his "dialectic," must have set many who know little Greek wishing to have the means of knowing more accurately than can be known from modern summaries exactly what the Aristotelian interpretation of Nature was. The translation of the "De Caelo" by Mr. J. L. Stocks and of the "De Generatione" by Prof. Joachim comes very opportunely to meet the need, so far as Aristotle's astronomical and physical doctrines are concerned. It is to be hoped that we shall not have to wait much longer for the versions of the "Physics," the treatise which expounds the Aristotelian mechanics of the universe, and the "Meteorologica," which deals with the "sublunary" department of cosmology.

The University of Oxford may be highly complimented on producing an English version of the two historically very important works before us, which may be taken by all but specialist scholars as equivalent to the original text. In constituting the actual Greek text, both translators have done excellent work in removing a large number of the singularly infelicitous alterations made by Prantl, the editor of the Teubner editions. Mr. Stocks has given a very generous amount of annotation to the explanation of his divergencies from Prantl; Prof. Joachim, having recently published his own recension of the "De Generatione," naturally makes his version avowedly from that text, and thus escapes the necessity of critical notes. It is perhaps a pity, in view of the appeal his version should make to many who are scarcely likely to possess his text and commentary, that he has not recorded quite briefly at least the more important of his differences from one of the standard texts, *e.g.* Bekker's. Of course it is inevitable that the fuller and more argumentative annotations of Mr. Stocks should at times require him to take sides on disputable points of reading or exegesis, and he himself would, no doubt, be the first to admit that appreciation of the value of his work does not imply agreement with all his decisions on such issues. To agree or disagree in detail would only be possible after a special minute study of Mr. Stocks's notes in conjunction with the Aristotelian text and the commentary of Simplicius.

We note that on one very important point the exact meaning of the original seems to have been misconceived. We believe it can be made clear that the kind of motion of the earth stated in "De Caelo," ii. 293 b 30 ff., to be spoken of by Plato in the "Timaeus," is not "rolling" of any kind. If that had been meant, Aristotle would not have been so careful to say that the "Timaeus" speaks of something different, "motion *at* the centre." It is clear also that axial rotation cannot be meant, for reasons into which space will not permit us to enter. The poetical word used in the "Timaeus" and repeated by Aristotle (ἴλλεσθαι) appears properly to describe "to-and-fro" motion, "oscillation," or "excursion" about a mean position. If we suppose that Aristotle knew, as he could scarcely help knowing, the correct interpretation of the Platonic phrase, we see at once why he is so careful to distinguish this movement of the earth "to and fro" about "the middle" from all theories of movement "round the middle." The point is important, because, in speaking of movement "round the middle," Aristotle has just mentioned (293 a 28 ff.) an argument for it which we know, on the authority of Theophrastus, to be Platonic. It follows, therefore, that Plato is included among the "many others" who seem to agree with the Pythagoreans in denying that the earth is "at the middle," and that Aristotle was well aware that the theories Plato ascribes to Timaeus are not necessarily Plato's own theories, as has erroneously been assumed by almost all expositors of Platonism. A. E. T.

A Rock-Desert.

Ministry of Finance, Egypt. Petroleum Research. Bulletin No. 10. *Topography and Geology of Northern Sinai.* Part 6, Session 1919-1920. By F. W. Moon and H. Sadek. Pp. vii+154+51 plates. (Cairo: Government Publications Office, 1921.) P.T. 50.

IT is no disparagement to the scientific observations recorded in this volume if we notice its handsome mode of production at the outset. In printing, illustration, and the inclusion of coloured sections, it will bear comparison with the work of any Geological Survey in the world. Two coloured maps on the scale of 1:250,000 are folded in a pocket at the end, and these are mounted on linen, a feature almost unique in official publication.

The researches that are placed in this permanent form before the public could not have been undertaken by private enterprise. Their object is to furnish a basis on which exploration may go forward in search of petroleum in Sinai, guided by the stratigraphy of a difficult and arid region. The oil-indications occur in Upper Cretaceous strata, mainly in the Cenomanian series, and any local concentration that may be found will depend on these beds as the primary sources of supply. Two places where the conditions seem favourable have been recommended to the Egyptian Government as sites for boring (p. 142). The clean exposures of rock-edges allow the geologist to read the structure of this desert country, as he can among the splendid folds of the Lange Bergen or in the high plateaus of Arizona. The features of a rock-desert are admirably pictured in photograph No. 12, where something is seen of the most notable structural feature of the region, the Cretaceous beds being strongly folded as they are traced downwards, while the conformable Eocene above them is almost undisturbed. The dome-structure sought for by oil-prospectors is thus present in the areas where beds older than the Santonian are exposed, but is scarcely to be traced in higher series. The authors, after a useful historical review (p. 37), advise the abandonment of the term Nubian Sandstone as indicating a stratigraphical horizon.

A thin band of potassium salt has been found under Gebel Sinn Bisher, a place where old workings, probably for rock-salt, may be traced. We may note the spelling Gebel, for Jebel, now adopted in Egyptian memoirs, which will commend itself equally to English-speaking folk. We congratulate Messrs. Moon and Sadek on carrying out this fine piece of mapping in a country where "life is, at its best, a very hard one," and where the Arab natives speak, quite happily, of their "homes" in caves cut in the mountain sides.

G. A. J. C.

Our Bookshelf.

La Géographie de l'Histoire: Géographie de la Paix et de la Guerre sur Terre et sur Mer. Par Jean Brunhes et Camille Vallaux. Pp. vi+716. (Paris: Félix Alcan, 1921.) 40 frs. net.

Two distinguished French geographers have collaborated in producing a volume on the relations of geography and history, which is really a treatise on political geography. Rather more than half the volume is concerned with the principles of the subject, and the remainder with their application to current political and social problems, arising out of the redistribution of territory and alterations in frontiers after the war.

Beginning with the thesis that man is the chief geographical agent, since he can more effectively modify the surface of the earth than the physical agencies at work, the authors consider the distribution of man. Regions of dense population may be either zones of passive concentration where conditions favour increase in numbers but do not demand any great degree of effort in order to find nutriment, and zones of active concentration where man, reacting against conditions not wholly favourable, triumphs by the exercise of effort. In the first category are regions of high temperature with considerable atmospheric humidity and abundant surface water, like the Chinese river valleys or the Nile delta. In the second category are oceanic borderlands and islands in temperate regions where conditions entail some struggle against sea and climate but are not unpropitious. In this category also are the areas where temperate forest has to be cleared and where coalfields are exploited.

From these "facts of fixation" the authors pass to "facts of movement" and discuss the influences behind migration and human movements. Some of the most important chapters in the book are those which deal with the growth and stability of states and the positions favourable to sites of capital cities. In struggle, though not necessarily war, the authors see one of the essentials for the healthy life of a state. Struggle means growth, but a state of political and social equilibrium means stagnation and decay. We have no space to do justice to this volume, and have indicated only a few of the ideas it contains. Every step in the authors' arguments is abundantly illustrated by concrete examples. The only drawback to the book is its lack of lucidity in places. The style at times is more ponderous than one would expect from French writers. There are black and white maps and full indices.

Handbuch der Pflanzenanatomie. Herausgegeben von Prof. K. Linsbauer. Allgemeiner Teil: Cytologie (Die Organe der Zelle). Band 1., Zelle und Cytoplasma. Von H. Lundegårdh. Pp. 192. Band 2., Allgemeine Pflanzenkaryologie. Von Prof. Dr. G. Tischler. Pp. 384. (Berlin: Gebrüder Borntraeger, 1921.) 2*l.* 5*s.*

THE volumes under notice are the first two in a series to be published under the general title "Handbuch der Pflanzenanatomie." The complete series as projected will number 15 or 20 volumes by various authors, under the general editorship of Prof. K. Linsbauer. It will include volumes on cytology, histology, galls, experimental anatomy, and a series on the "anatomy" of the various plant groups from Mycetozoa to flowering plants. Two volumes—both unfinished—have already been issued, the first, by Dr. H. Lundegårdh, dealing with the cell and cytoplasm; the second, by Prof. G. Tischler, giving a general account of the plant nucleus. The price quoted in English money for the two volumes, in paper covers, is unjustifiably high, and must mean a huge rate of profit for the publishers. The sale on these terms is not likely to be very wide.

The first volume begins with a history of plant anatomy and the cell theory, occupying 60 pages, and illustrated by figures from Hooke, Malpighi, N. Grew, and others. Then follows an account of cell structure and form, with numerous illustrations. The protoplasmic connexions between cells are considered at some length. Other topics considered are the arrangements of cells in tissues, and the physical and chemical organisation of the cell.

The second volume treats of the plant nucleus in considerable detail, beginning with the morphological and chemical organisation of the resting nucleus, and its relations to the cell as a whole. This part occupies 232 pages. The remainder of the volume, which is as yet incomplete, deals with nuclear division and its various forms in different plant groups. The numerous figures are taken from the cytological literature of the last thirty years.

Thirty-fifth Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution. 1913–1914. In 2 Parts. Part 2. Pp. viii+795-1481. (Washington: Government Printing Office, 1921.)

THIS volume forms an important supplement to that which preceded it, giving a collection of bardic chronicles and songs illustrating the beliefs and customs of the Kwakiutl, a fishing-tribe on the coast of Vancouver Island. It has been compiled by Mr. G. Hunt, a member of the tribe, and the text is given in the tribal dialect with an English translation. It is not easy reading, but the report in the preceding volume supplies an adequate commentary. It forms an impressive picture of life in the lower culture. We have traces of totemism in the shape of paintings of animals on the sides of the house door and posts erected with special ceremonies. Much of the ritual consists of orgiastic dances, performed by men and women in a state of nudity, wearing masks, their faces being painted with charcoal, on which swan-down is stuck, their heads and necks adorned with pieces of red cedar. It also assumes a more brutal form. In one account we read: "The Rich-Woman carried in her arms a body, leading the Cannibal; and the Tamer went on the right-hand side of the Cannibal, and the One-Who-Presses-Down went on the left-hand side of the Cannibal, and each of the four eats part of the corpse—that is, the Cannibal and the Rich-Woman, and the Fire-Dancer and his Grizzly-Bear-of-The-Door." Scattered through the book are interesting accounts of the initiation of novices, the magical effect of names, magical songs sung to secure the capture of salmon, prenuptial incontinence, marriage by purchase and the levirate, burial in trees, magical transformation of men into animals, and much other matter of interest to anthropologists. It is well that these facts should have been recorded, as the tribe is rapidly coming under "civilised" influence. In one list of gifts we read of blankets, canoes, jewellery, forty sewing-machines, and twenty-five phonographs.

(1) *Lehrbuch der Elektrotechnik.* Von Dr. E. Blattner Erster Teil. Vierte Auflage. Pp. ix+423. (Bern: K. J. Wyss Erben, 1922.) 20 fr.
(2) *Electricity.* By Sydney G. Starling. (Science in the Service of Man.) Pp. viii+245. (London: Longmans, Green and Co., 1922.) 10*s.* 6*d.* net.
(3) *"Lektrik" Lighting Connections.* With Introductory and Explanatory Notes by Gus. C. Lundberg and the late W. P. Maycock. Seventh Edition (Thoroughly Revised). Pp. 156. (London: A. P. Lundberg and Sons, 1921.) 1*s.* net.

(1) WE welcome the fourth edition of the first volume of Dr. Blattner's text-book. The principles of electrical engineering are very clearly stated and as the international symbols and nomenclature are adopted it can be readily understood even by a student whose knowledge of German is limited.

(2) Mr. Starling has written an interesting popular work on electricity. The subjects of the various chapters are well chosen, theory and practice being evenly balanced. The epoch-making discoveries of recent years in radio-telegraphy and in the theory of the atom are included.

(3) The third of the works under notice is a useful little book on electric wiring. It shows various ways of wiring electric lamps so that they can be controlled from several different places and also how the light they give can be varied. The special switches used for these purposes are described.

Early British Trackways, Moats, Mounds, Camps, and Sites. A Lecture given to the Woolhope Naturalists' Field Club, at Hereford, September 1921. By Alfred Watkins. Pp. 41+20 plates. (Hereford: The Watkins Meter Co; London: Simpkin, Marshall and Co., Ltd., 1922.) 4*s.* 6*d.* net.

IN this little book the author attempts to show that during a long period, going back at least to neolithic times, all trackways were in straight lines marked out by experts on a sighting system. Such sighting lines went from mountain peak to mountain peak with secondary sighting points on the lower ground. It is fairly obvious that long distance roads in primitive times would tend to lie in a more or less straight line between prominent peaks. This scarcely needs verification, and Mr. Watkins' case must rest mainly on his intermediate points. These he finds in mounds, moats, tumps, churches (occupying the site of an earlier mark), stones, trees, and camps, holy wells, and the like. Place-names are also called in to support his argument. Without entering into a detailed examination of his evidence, which the reader may do with the aid of an ordnance map, it may be said generally that in some cases the so-called sighting marks were the objective of the road as in the case of a holy well or a ford, and that others, such as a burial mound or an encampment, owed their position to the previous existence of a road.

Poverty and its Vicious Circles. By Dr. Jamieson B. Hurry. Second and Enlarged Edition. Pp. xvi+411. (London: J. and A. Churchill, 1921.) Price 15*s.* net.

THE first edition of this detailed study of poverty was published before the war. In this second and enlarged edition the general plan of the work remains unaltered, but the author has revised and extended the original chapters and has written several new ones. Further, he has viewed his subject more from the international standpoint. His "vicious circles" are the various elements entering into the causation and perpetuation of poverty which aggravate or intensify the causes out of which they grew by lowering the standard of life and efficiency. Dr. Hurry describes in detail the effect of such factors as defective housing, defective feeding, defective clothing, defective education, defective credit, unemployment, insecurity, and the like. Each is considered separately, it being a part of the author's theory that each factor must be diagnosed and attacked in isolation; but the interaction of the circles one with another is both recognised and considered. The last portion of the book deals with remedial measures and gives a useful historical survey of poor relief under the State and by local authorities, and of the scope and objects of a number of private or semi-public voluntary organisations.

Plant Materials of Decorative Gardening: The Woody Plants. By Prof. Wm. Trelease. Second Edition, Revised. Pp. xliii+177. (Urbana, Ill.: The Author, University of Illinois, 1921.) 1 dollar.

BY the help of this handy little volume a careful observer, who will make himself acquainted with the technical terms as explained in the glossary at the end of the book, may learn the name of any hardy tree, shrub, or woody climber that he is likely to find cultivated in the eastern United States—apart from the extreme south—or in northern Europe, except on the more pretentious estates, or in nurseries or botanical establishments. It accounts for 1150 distinct kinds, representing 247 genera and 782 species. For a few hopelessly complicated genera, such as haws, cotoneasters, and roses, only the most easily recognised species have been admitted. By means of a dichotomous key, divided into four sections—trees, bushes, undershrubs or bog or rockery plants, and woody climbers or scramblers—the name of the genus may be determined. The greater part of the book is occupied by a systematic description of the genera under their families, and under each genus is given a key to the species.

Common Plants. By Dr. M. Skene. (Common Things Series.) Pp. 271+26 plates. (London: Andrew Melrose, n.d.) 6*s.* net.

DR. MACGREGOR SKENE has produced a very readable series of essays, written in thirty-three chapters around different common plants, which are made the texts for a popular presentation of many of the problems and achievements of the modern study of plants. In the opening sections the themes of plant nutrition and the world's food supply are grouped around the wheat plant. Other chapters treat, for the popular reader, the various groups of plants, while still others are concerned with the rise of a land flora and various problems of the inter-relations of plants and animals, water supply, reproduction, and the relations of plants to man. The paper is unfortunately of poor quality, but the essays are excellently informed and attractively written, with lucid style and a human point of view.

Scientific Management in the Home: Household Engineering. By Mrs. Christine Frederick. (Efficiency Books.) Pp. 527. (London: George Routledge and Sons, Ltd., 1920.) Price 12*s.* 6*d.* net.

THERE is no place where the application of science is more desirable than in the home, and none where it is more commonly neglected. Mrs. Frederick, whose work is already known in this country through her connexion with *The Ladies' Home Journal*, here presents the story of her success in managing her own home. Science is to be found pleasantly blended with common sense in the pages of this book, which is to be recommended to the notice of private individuals as well as to those who are concerned with the teaching of domestic economy.

Précis de physiologie végétale. Par Prof. L. Maquenne. (Collection Payot.) Pp. 175. (Paris: Payot et Cie, 1922.) 4 frs.

THE author of this little book is a professor at the Museum d'Histoire naturelle in Paris, and here reproduces in simple, lucid, and attractive form the substance of a course of lectures given at the Museum for more than twenty years. The subjects briefly treated include osmosis, colloids, germination, growth, assimilation, respiration, etc. The definition of such terms as osmosis and colloid are not above criticism, but any one with no previous knowledge of the subject should find it an attractive and, on the whole, an accurate presentation of the general features of plant physiology.

Dictionary of Botanical Equivalents: French-English, German-English. By Dr. E. Artschwager and E. M. Smiley. Pp. 137. (Baltimore, Md.: Williams and Wilkins Co., 1921.) n.p.

THIS little dictionary of botanical terms should prove useful, especially for students. It is nearly all German, only 15 pages being devoted to the French-English portion. The pages are interleaved, so that additional terms can be entered at any time. The explanations given are not always happily chosen or accurate. Thus *zeitlicher Dimorphismus* is rendered "polymorphy."

Letters to the Editor.

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

The Mode of Feeding of the Jelly-fish, *Aurelia aurita*, on the Smaller Organisms in the Plankton.

WHILE engaged in investigations (carried out with the aid of a Government grant) on the oyster beds in the River Blackwater, a jelly-fish (about 8 cms. in diameter) kept as a pet was given large numbers of oyster larvæ to see what it would do with them. From the fate of the oyster larvæ it was at once seen that the adult jelly-fish, *Aurelia aurita*, feeds definitely and—normally—automatically on smaller plankton organisms in a manner resembling that in which bivalves, some worms, and other animals feed on plankton. On adding the oyster larvæ to the jar in which the jelly-fish was living, it was observed that the larvæ were quickly formed up on the ex-umbrella surface of the jelly-fish in lines embedded in mucus and were also swept on to and retained in quantity on the oral arms. This immediately raised suspicion, and the jelly-fish was thereupon fed at intervals and carefully observed.[1] It was found that small plankton organisms of about the size of oyster larvæ were collected from the ex-umbrella surface of the jelly-fish and carried, mainly by ciliary action, towards the rim of the umbrella. The rhythmic waves of contraction of the bell or umbrella assist in carrying the strings of collected plankton-food to the edge of the umbrella, whence they are transferred—by a process not yet fully worked out—either to the oral arms or to the under surface of the rim of the umbrella. At the rim of the umbrella in this jelly-fish there is narrow curtain fringe cut normally into 8 segments so that one portion of the fringe lies between two of the marginal sense-organs (tentaculocysts). The fringe therefore resembles that often seen at the rim of a parasol except that it consists normally of 8 segments. The tentacles arise from the edge of the umbrella at the base of and outside this fringe.

It has thus been seen that by some means—partly by ciliary action and partly by contraction of the bell—a portion or all of the plankton collected on the ex-umbrella surface of the jelly-fish is transferred to the inner or outer sides of these umbrella fringes. Food-particles consisting of the smaller plankton organisms are, however, also collected on the inner surface of the umbrella and apparently also on the bases of the rim tentacles and transported in mucus by ciliary action to the inner side of the fringe at the edge of the umbrella. Plankton is therefore collected by both ex- and sub-umbrella surfaces and probably also on the bases of the rim tentacles and transported thence to the rim fringe. When the plankton reaches the rim fringe it is carried by ciliary action along the base to the *middle* of each segment of the rim fringe. Thus when an Aurelia has been feeding there are normally 8 blobs of food collected in the middle portions of the 8 rim fringes, which lie exactly opposite the straight adradial canals. It is curious that the point at which the blobs of food are constantly collected is not specially differentiated in any way unless it be by the development of an extra pucker in the rim fringe, which permits the accommodation of the food-mass. As and when the blobs of food are collected, it can be observed that the jelly-fish deliberately and apparently consciously licks them off by passing over each the separated lips of an oral arm. The cilia on the internal faces of the arm quickly take charge of the food-mass and pass it into the groove made by the infolding of the sides of the oral arm. From the groove in the oral arm the food can be seen to be carried towards the mouth proper and travel by its own channel into the appropriate gastric pouch to be digested. When an Aurelia is actually feeding, food can be seen to be passing into the gastric pouches by four main channels. Oyster larvæ dropped on to the central region of the arms near the mouth appeared to be greedily accepted, and within a few minutes had passed into the gastral pouches by ciliary action through one or other of the four main food-channels. There are, however, two subsidiary food-channels to each gastric pouch, so that on occasions three strings of food can be seen passing into one gastric pouch.

After noticing the way in which this jelly-fish feeds it was realised that the kind of plankton in the sea at a particular moment could be speedily found out by capturing individuals and extracting and examining the collected food-masses from what may now be called the food-pouches on the rim of the umbrella opposite the straight adradial canal. Fortunately it was a simple matter to catch specimens of Aurelia recently washed into the oyster pits at high tide. Examination of such food-masses taken direct from the Aurelia showed them to consist of the following planktonic organisms: gastropod larvæ, of Crepidula and others, oyster larvæ (black spat), copepods, various species including Calanus and Harpacticids, Epicaridian larvæ in fair quantity, larvæ of cirripedes and copepods, Cypris larvæ of balanoids, young polychætes, especially Polydora, a good number of rotifers, algal threads green and brown, in one case with a large colony of vorticellids attached, eggs of polychætes or rotifers, eggs and tadpoles of Ciona and other ascidians, nematode worms, tintinnoids, a number of diatoms of several species, and some sand grains. In one instance an Aurelia was liberated for a few minutes in an oyster pit, which contained what was practically a good natural culture of the diatom Nitzschia. On examining the food-masses extracted from the food-pouches of this particular jelly-fish a few minutes after immersion in the water, fairly large numbers of the diatoms were found embedded in the mucoid food-mass.

It is clear, therefore, that Aurelia feeds mainly on what is technically termed medium to coarse plankton, but that it also captures small quantities of the finer plankton. In addition it is well known that larger organisms are taken and eaten, but from the above description it would seem that in the normal habitat of this jelly-fish, plankton organisms of the smaller kind will constitute the main diet.

From the relatively slight morphological variations which occur in the group to which Aurelia belongs, it would seem highly probable that a similar but probably modified mode of feeding occurs throughout the group. In some members of the group it is well known that young fishes frequently take shelter under the umbrella and often inside the cavities of the jelly-fish with impunity, but hitherto it has been difficult even to guess at a reasonable explanation of the association of a jelly-fish with—what has often been considered legitimate prey—young fishes. The mode of feeding in Aurelia, however, suggests a possible explanation of this phenomenon if, as is very likely, other allied jelly-fishes feed in a similar way. The aggregation of plankton-food in masses provides an excellent opportunity for parasites, as

[1] Gemmill (Proc. Roy. Phys. Soc. Edin., vol. xx. part 5, 1921) records some interesting notes on food-capture and ciliation in the ephyra of the jelly-fish, which are not, however, the same as in the adult, the structure of which is more complex.

is seen in the case of the pea-crab and various bivalve molluscs and ascidians, or Myzostoma and Antedon. Now many jelly-fishes are infested with amphipods such as Hyperia, and it is a reasonable deduction that these crustaceans may be feeding on the food material collected by the jelly-fish. Thus, if the young fishes which take shelter below the umbrella of a jelly-fish assist the jelly-fish by keeping down ecto-parasites such as Hyperia, then an intelligible explanation is offered of the association of young fishes with such an apparently voracious host as a large jelly-fish, for in return the jelly-fish in these circumstances would have less of its own food stolen. J. H. ORTON.

Oyster Store, Packing Shed Island,
West Mersea, July 2,
and The Laboratory, Plymouth, July 14.

Roche's Limits for Satellites.

THE notice in NATURE (July 15, p. 89) respecting Dr. Fountain's work on Roche's limit for satellites brings to my recollection some estimates which I made many years ago with respect to the stability of satellites moving close to the surface of Mars (Trans. Roy. Dub. Soc., 1897, vol. vi.).

The question arose in connexion with a theory accounting for the "canals" as resulting from stresses set up in the surface rocks of Mars by the proximity of such satellites. The doubling of the canals came out nicely and the curvature of the canals as mapped by Lowell, Douglass, and Pickering was in agreement. But the doubt arose as to whether former satellites of sufficient magnitude could have preserved their stability when circulating around the planet with the requisite degree of approximation.

Assuming that the satellite possessed the cohesive strength of basalt and taking the case of Phobos supposed to be moving in an orbit but 23 miles from the planet's surface (*i.e.* with but five miles separating the surfaces of planet and satellite), I found that the satellite, even at this distance, would be stressed only to one-seventh of its breaking strength.

J. JOLY.

Trinity College, Dublin, July 15.

Optical Definition and Resolving Power.

IN Mr. Mallock's letter on "Definition, Resolving Power and Accuracy," published in NATURE of May 27 (vol. 109, p. 678), reference is made to the measurement of star images on eclipse plates, from which one might infer that the evidence for the Einstein deflexion of light obtained in 1919 was of a very doubtful character.

I have had no experience in measuring star images; but there is little doubt that if the same order of accuracy can be obtained as is possible in measuring spectrum lines, the Einstein deflexion should be easily determinable with a focal length of 19 feet, provided that it can be disentangled satisfactorily from the scale correction.

In my method of measuring photographs of spectra the image of a line is not bisected by a thread, but a positive copy is superposed on the negative in the micrometer and the coincidence of the two images estimated. By this means the intervals to be measured are doubled, and an extraordinary degree of precision is attainable with practice, as is shown by the agreement between different measurers. I have often had occasion to repeat measures made by one of my assistants of the shifts of the solar lines with reference to the arc lines, and we rarely differ by an amount exceeding 0·001 mm. in the interval measured. This is the result of taking the means of six settings in each line, and the probable error derived from the accordance of settings is usually about half a micron.

Probably star images cannot be measured so accurately as this by the ordinary method of bisection, but a skilled measurer should be able to determine the position of a star easily within 0·005 mm. or, on the scale of the eclipse plates, within 0″·18.

J. EVERSHED.

Kodaikanal, June 24.

Interspecific Sterility.

DR. BATESON in his letter on interspecific sterility (NATURE, July 15, p. 76) seems to lay insufficient emphasis on certain facts. If one considers plant and animal species in general, it would appear that interspecific sterility is by no means so general as was formerly assumed to be the case. Among the Œnotheras, in which great numbers of species crosses have been made, complete fertility, in the sense that large numbers of fertile offspring are produced, is the rule unless the forms differ in chromosome number. Even species of Œnothera which come from widely separated regions and differ conspicuously in all their characters, including flower-size, are fertile in crosses. That a certain amount of gametic and zygotic sterility also frequently occurs is of course well known, and it is probably correctly interpreted in terms of lethal factors. But lethal factors are not peculiar to wild species, for numbers of them arise in the mutations of *Drosophila melanogaster*.

Among animals, interspecific sterility appears to be more widespread, but even here the Bovidæ are, I believe, all interfertile. The contrasted condition of the Equidæ, at least as regards the horse and the ass, is accounted for by the difference in their chromosome numbers. In the Drosophilidæ, where interspecific sterility is extreme, there is a considerable range in chromosome form and number. The two species, *Drosophila melanogaster* and *D. simulans*, which are extremely alike and have similar chromosome groups yet produce sterile hybrids, might be cited as corresponding exactly to Dr. Bateson's conception of interspecific sterility. But it is an extreme case, and there are probably more numerous instances to cite on the other side.

Dr. Bateson refers to the case of *Œnothera gigas* and agrees that tetraploids frequently do not breed freely with diploids. But he says that "the applicability of that example is exceedingly doubtful" because we "can scarcely regard an unresolved pair of twins, such as the tetraploid must be, as a specifically distinct organism." It is this statement in particular to which I should be inclined for several reasons to take exception. In the first place, in calling the tetraploid an "unresolved pair of twins" Dr. Bateson scarcely recognises the intimate character of the union involved. I formerly analysed (*Arch. f. Zellforsch.* vol. 3, pp. 525-552, 1909) the changes which have occurred in *Œ. gigas* in so far as this could be done by comparative cell measurements, and found that the cell units were not merely larger, owing to the doubling in the chromosome content of their nuclei, but that in various tissues they were altered in shape, the increase in one dimension having been much greater than in another. Moreover, the genetic behaviour of *Œ. gigas* indicates, as de Vries first contended, that some other change has taken place in the germplasm of this species, in addition to the doubling of the chromosomes.

I have only recently been convinced on this point by comparisons of *Œ. gigas* with the tetraploid forms obtained by Winkler (*Zeits. f. Botanik*, 8, 417-531, 1916) from his grafting experiments with the tomato. Here the tetraploid form apparently arises through the fusion of pairs of somatic nuclei where the cut surfaces of the cells are in contact. The forms obtained in this way appear to be merely tetraploid, stouter but without any alteration in the shape of leaves or other organs such as occurs in *Œ. gigas*. Winkler shows that these tetraploids have larger cells, nuclei and chloroplasts, but there are apparently no changes in cell shape except in the pollen grains, which have four pores instead of three just as in *Œ. gigas*. There seems no reason to alter my original interpretation of this change in the pollen grain as a direct result of the altered space relationships between the larger cell and its nucleus in the tetraploid forms.

It therefore appears probable that in some experimental tetraploid forms, such as Winkler's Solanums and probably the Marchals' tetraploid mosses, all the changes are such as follow directly from the original doubling of the chromosomes, while in others such as *Œ. gigas* and certain wild tetraploid species, an additional change has taken place in the germplasm. One cannot yet, however, regard this as fully proven.

It might also be pointed out here that the wide occurrence and evolutionary significance of tetraploid species in nature has not yet been generally realised by biologists. In Potentilla, for example, a whole group of wild species is tetraploid as compared with others. Species with $4X$ chromosomes are also known to occur in many other genera, such as Lactuca, Crepis, Muscari, Acer, etc. Such a doubling of the chromosome number must have occurred in connexion with the origin of many wild species and genera.

Tetraploidy undoubtedly forms a barrier to free crossing with diploid forms in any line of descent. I therefore see no reason why such forms as *Œ. gigas* arising in cultures should not be regarded as mutations significantly accompanied by partial interspecific sterility. For both in cultures and in Nature the cross-breds with unbalanced chromosome groups tend to be eliminated, leaving the pure forms each to perpetuate itself. R. RUGGLES GATES.

King's College, Strand, London.

The Influence of Science.

IN his letter to NATURE (July 15, p. 78) Sir George Greenhill does well in directing attention to the fact that the quarrel between Galileo and the Holy Office was largely a domestic quarrel between two opposing schools of thought. It is historically a fallacy, though a very common one, to suppose that the freedom of experimental inquiry was secured in consequence of the action of the Roman Curia in the case of Galileo. So long as scientific investigators confined themselves to their own legitimate subjects of study, and left doctrinal and Scriptural matters alone, freedom of experimental inquiry was never interfered with by ecclesiastical authority. Nicholas Copernicus was a devout Catholic priest, and his heliocentric doctrine was freely taught, even in ecclesiastical colleges, until Galileo interested himself as a champion of the system.

For Galileo, as all historians testify, was a truculent and hot-headed controversialist, who, in spite of the advice of his friends not to raise the question (I quote from his contemporary Guicciardini, the Tuscan ambassador), " demanded that the Pope and the Holy Office should declare the Copernican system to be founded on the Bible; he wrote memorial after memorial. Paul V., wearied with his importunities, decreed that the controversy should be determined in a Congregation, and having sent for Cardinal Bellarmine, ordered him to bring it immediately before the Holy Office." Let me make use of an analogy from the practice of our own English Courts to elucidate the matter. The Court of King's Bench was originally constituted to judge cases pertaining to the King's peace. To widen its jurisdiction, all classes of injuries, even actions for breach of contract, had to be interpreted as acts of violence, even though perpetrated by otherwise peaceful citizens.

Similarly, the Holy Office had, by its procedure, to consider every case submitted to it, with reference to heresy and orthodoxy. Let us also bear in mind that Holy Scripture must ordinarily be interpreted literally, unless a rigid proof can be adduced to the contrary. What rigid proofs, in the then state of scientific knowledge, could Galileo allege in support of his contention that the Copernican system was founded on the Bible? Let us recall in passing that such eminent men of science as Tycho-Brahe and Bacon rejected the system, while Descartes would not admit the hypothesis as proved, and that the Cardinals of the Congregation, so far as proofs of Copernicanism were concerned, had perforce to rely upon the opinion of their scientific advisers. The only proofs that were brought forward were the analogy of Jupiter's satellites, the moon-like phases of Venus, and the simplicity with which the theory accounted for the observed motions of the planets. The other alleged proofs from the tides and the earth's magnetism were worthless.

On the other side was the apparent authority of the words of Scripture, the universal experience of mankind, which seemed to attest that the earth was immovable, while the sun, moon, and stars moved round it, and the Ptolemaic system which for centuries had explained in a satisfactory manner the apparent movements of the planets. In such circumstances what could the Congregation do but declare, according to the forms of the court, that the Copernican system was heretical, in the sense that it contravened the literal and obvious meaning of Scripture? According to the knowledge of that time, the Copernican system was " false and absurd philosophically, inasmuch as it expressly contradicts the doctrine of Holy Scripture." The proviso and restriction is noticeable.

What did Galileo do? Instead of teaching the Copernican theory as a scientific hypothesis, after a most generous reception in Rome in 1624 by his friend Pope Urban VIII., he returned to Florence, and in his famous Dialogue not only lampooned his benefactor, but was guilty of gross contempt of court. For such egregious contempt of court an English judge would rightly commit a man to prison. Galileo had as a penance to recite certain prayers, and was sent to a beautiful villa at Arcetri, where, free from the disturbing influences of controversy, he was at liberty to pursue his favourite studies.

As Whewell says in his " History of the Inductive Sciences," pp. 425-6, " The persecutors of Galileo are still held up to the scorn and aversion of mankind; although, as we have seen, they did not act until it seemed that their position compelled them to do so, and then proceeded with all the gentleness and moderation which were compatible with judicial forms." Or, to quote another non-Catholic, Prof. A. De Morgan (English Cyclopædia, " Motion of the Earth "), " We heartily wish all persecutions, Catholic and Protestant, had been as honest and as mild." Nor did the Roman Curia possess a monopoly in opposition to Copernicanism. Martin Luther went further, for he considered Copernicus to be an arrogant fool, who wrote in defiance of Scripture, while Melancthon declared that such mischievous doctrines should be suppressed by the secular arm.

Finally, is it not time that this old bogy of the case of Galileo, as a proof that the Church was opposed to scientific research, should be decently buried? "The Papal power," wrote De Morgan (*loc. cit.*), "must on the whole have been moderately used in matters of philosophy, if we may judge by the great stress laid on this one case of Galileo." Cardinal Newman dubbed it rightly as "the one stock argument."

A. L. Cortie, *S.J.*
Stonyhurst College Observatory, Lancs.
July 17.

Surface Tension and Cell-Division.

In a recent paper on "Surface Tension and Cell-Division" (Q.J.M.S. 66, pp. 235-245), Mr. J. Gray maintains that "cell-division may be accounted for by the movement of the two asters away from each other," and that "there is no necessity to postulate regions of differential surface tension at the poles or equator of the cell."

These conclusions are drawn chiefly from the results of a series of experiments in which the effect of "acid" sea-water on the cleaving eggs of *Echinus miliaris* is interpreted in the light of the effect of increased hydrogen-ion concentration on an oil-water interface. Mr. Gray points out that there is undoubtedly a lipoid or oily phase in the protoplasmic surface, but, if any value is to be placed on the analogy between the effect of acid on cleaving eggs and on an oil-water surface, one has to suppose that the lipoid phase in the protoplasmic surface is a continuous phase, otherwise two different types of surface are being dealt with. This view, as pointed out by Bayliss (2nd Brit. Assoc. Rep. Colloids, 1918), would necessitate that the volume of the cell should not have any definite relation to the osmotic pressure of the external solution.

In these experiments it was shown that if the egg, in which a cleavage furrow had appeared, is placed in "acid" sea-water, the furrow disappears and, owing to the unknown force which elongates the egg, equilibrium is attained when the egg has the form of a cylinder with hemispherical ends. The shape of the dividing egg is stated to be dependent entirely on (*a*) the surface tension at the egg surface, and (*b*) the other force acting against the surface tension which produces elongation of the cell axis and is "associated in some way with the elongation of the astral figure." Now the pressure inside the fluid egg at any region due to surface tension can be determined from the curvature of the egg surface in that region. Since the egg is presumed to be in equilibrium at any stage during mitosis, any inequalities in pressure due to the surface tension and resulting from the varying curvature, must be counteracted by the second "elongating" force. In the case quoted above, in which the dividing egg is in equilibrium when its shape is that of a cylinder with hemispherical ends, it is easy to show that the pressure inside the hemispherical caps due to surface tension is exactly twice the pressure inside the cylindrical portion due to surface tension. Thus the elongating force, of which the astral figure is to some degree an expression, must produce a differential pressure on the inside of the egg surface, such that the pressure exerted over the middle cylindrical portion is uniform and equal to half the pressure produced over the hemispherical ends. If the view is accepted that the mitotic figure is in any way connected with the force that produces elongation and cleavage of the egg, I think the hypothesis that this force is essentially a polar force must be adopted, and it is difficult to see how any polar force could produce such a distribution of forces as is necessitated to produce equilibrium in the fluid cylindrical egg described by Mr. Gray.

He further describes an experiment as due to Plateau, on a drop of oil placed between two metal rings "so as to form a complete cylinder" (of course, with spherical end surfaces), which, on moving the two rings apart, changed in form, when the distance between the rings became greater than $\frac{2}{3}$ the diameter of the rings, in the same way as a dividing egg. The exact reference to this experiment is not given, but the experiment is very similar to one that Plateau carried out on the stability of a fluid catenoidal surface. According to Mr. Gray a cleaving egg can be divided into three parts: a middle cylindrical portion and two convex ends to this cylinder. The middle cylinder is taken to be analogous to the drop of oil in Plateau's experiment. It is obvious, however, that the whole of this experiment depends on the fact that the two rings, as they are being moved apart, exert a lateral thrust on the surface film of the drop. Is one, then, to believe that the force which causes the egg to elongate also exerts a lateral thrust in two parallel planes corresponding to the two rings? Actually, if there is sufficient oil between the two rings they may be moved apart to a distance equal to π times the diameter of the rings before the central cylindrical portion becomes unstable and divides, but this in no way resembles the form of any cleaving egg, so far as I am aware.

While I quite agree with Mr. Gray that the mitotic force counteracts the effects due to surface tension, it seems to me that one cannot account for the stability of his cylindrical stage on the supposition of uniform surface tension over the whole egg surface, without ascribing to that mitotic force properties that one would hesitate to ascribe to forces focussed round two definite centres. Unless the view that the forces which elongate the egg are correlated with the spatial relations of the two centrosomes is adopted, all the morphological evidence of the mechanism of cell-division is neglected.

In the introduction to his paper Mr. Gray says that theories postulating a higher or lower surface tension at the equator of a cleaving cell are of little value, as "there is no apparent means of determining how such a state of affairs could arise." In many cells it has been shown that the cytoplasmic inclusions are arranged around the centrosomes as foci, and further, that the distribution of these elements may be correlated with the apparent activity of the centrosomes. From this it may be inferred that there are substances in the egg which are repelled or attracted, either directly or indirectly, by the centrosomes. One of the first events in the cleavage of an Echinus egg is the appearance of two "active" centrosomes. These are approximately symmetrically placed in the egg and move apart from one another. Substances repelled by the centrosomes will tend to gather at the surface of the egg, but, as the centrosomes move apart, these bodies, once having reached the surface, will move towards that region of the egg surface in the plane in between the two centrosomes, which is termed the equator of the egg. If the presence of these substances in the surface film of the egg affects in any way the surface tension of the protoplasmic surface, here is a mechanism whereby there may arise a differential surface tension over the surface of the cleaving egg.

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July 14.

Electricity and Matter.[1]

By Sir ERNEST RUTHERFORD, F.R.S.

IT has been customary in the earlier Kelvin lectures to give an account of some phase of Kelvin's work. I could easily follow this custom by concentrating on the publications of Kelvin that deal with the proof of the atomic nature of matter and the dimensions of atoms and molecules, including the first suggestions of the mechanism of atomic constitution. This was a subject in which Kelvin was permanently interested. In his Royal Institution lecture of 1883, reprinted in "Popular Lectures and Addresses," vol. 1, he gives an illuminating account of the different lines of evidence that all converge to a cumulative proof that matter is coarse-grained or atomic in structure and set a definite minimum limit to the dimensions of the atom. His deduction of the diameter of the water molecule from the cooling effect observed when a water film is stretched, is one of the most notable of these examples. In his later papers he accepts Stoney's arguments in support of the atomic nature of electricity, and in a paper of curious title, "Æpinus Atomised,"[2] he restates the old theory of Æpinus of the nature and relation of positive and negative electricity in a more modern form, by assuming that the negative electricity in an atom is distributed in the form of definite units called "electrions"—or electrons, as we should now term them—held in equilibrium embedded in a sphere of uniform positive electrification. This was the first type of model atom put forward. A similar type of atom, developed and worked out in detail by Sir J. J. Thomson, played a notable part in giving a concrete view of atomic structure which was directly amenable to mathematical calculation. In some of his later papers, Kelvin devised types of atoms which, under certain disturbances, broke up with explosive violence, simulating in behaviour the atoms of radium. While keenly interested in such speculations, there remained the curious anomaly that he did not accept entirely the current explanation that radio-activity was a consequence of the successive disintegrations of atoms.

The discovery in 1897 of the individual existence of the negative electron of small mass, and the proof that it was a component of all the atoms of matter, was an event of extraordinary significance to science, not only for the light which it threw on the nature of electricity, but also for the promise it gave of methods of direct attack on the problem of the structure of the atom. This discovery of the electron, coupled with the recognition of the atomic nature of electricity, has created a veritable revolution in our ideas of atoms.

The first definite proof of the close relations that exist between electricity and matter we owe to the famous experiments of Faraday on the passage of electricity through electrolytes. It was clear that the simple numerical relations found by him between the electrochemical equivalents of the elements and their atomic weights could be simply interpreted by assuming that electricity was atomic in character and that the charges carried by the individual ions were integral multiples of a fundamental unit of charge. It is curious to note the long interval that elapsed before the idea of the atomic nature of electricity was generally accepted by men of science—possibly because of the great difficulty of obtaining confirmatory evidence. The suggestion was mentioned by Maxwell and Helmholtz, although with reservation, but was revived with conviction by Johnstone Stoney, who suggested that the name "electron" should be applied to the fundamental unit of electricity and made a rough estimate of its magnitude. Actually, as we know, the term "electron" is now used to denote not the actual value of the unit of charge, but the free atom of negative electricity.

Following the discovery of the independent existence of the electron and the proof of the production of charged ions in gases by X-rays and other radiations, it was implicitly assumed by men of science that electricity must be atomic in nature, and all the experimental data were interpreted on this view. It was found by Townsend that the charge carried by the ions produced in gases and by the electron itself was numerically equal to that carried by the hydrogen ion in the electrolysis of water, which was taken as the fundamental unit. By the ingenious device of balancing the weight of a charged drop by the attraction of the electric field, Millikan was able to give a very direct and convincing proof of the correctness of this view and to determine the magnitude of the fundamental unit with great precision. Knowing the value of this constant, the electrochemical data give us immediately the mass of the atom of each of the elements. While no one now doubts the atomic nature both of matter and of electricity, it should be noted that the atomic nature of matter is in reality a consequence of the discrete nature of electricity, for all the evidence indicates that the atom itself is a purely electrical structure.

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It was soon recognised that the negative electron of small mass was an actual disembodied atom of electricity, and that its apparent mass was electrical in origin. Sir J. J. Thomson had shown as early as 1881 that a charged body in motion behaved as if it had an additional electric mass due to its motion. The moving charge generates a magnetic field in the space surrounding it, resulting in an increase of energy of the moving system which is equivalent to the effect produced by an increase of the mass of the body. The experiments of Kaufmann and others on the swift electrons ejected from radium showed that the mass of the electron, while sensibly constant for slow fields, increased rapidly as the velocity of the electron approached that of light. This variation of mass was in good agreement with calculations based on the electrical theory. Later, Einstein from considerations of relativity showed that for any material particle, whether charged or not, the mass m must vary with speed according to the relation $m/m_0 = (1-\beta^2)^{-\frac{1}{2}}$, where m_0 is the mass for low speeds, and β is the ratio of the velocity of the particle to the velocity of light. Experimental results agree closely with this calculation.

Since there must always be electric mass associated with the movement of electric charges, it is natural

[1] From the thirteenth Kelvin lecture, delivered before the Institution of Electrical Engineers on May 18.

[2] *Philosophical Magazine*, March 1902.

to suppose that the mass of the electron is entirely electrical in origin, and no advantage is gained by supposing that any other type of mass exists. If the atom is a purely electrical structure, the mass of the atom itself must be due to the resultant of the electric mass of the charged particles which make up its structure. We shall see that only a small fraction of the mass of an atom can be ascribed to the negative electrons contained in it, but the main part is to be ascribed to the positively charged units of its structure. One of the main difficulties in our attack on the question of atomic constitution has lain in the uncertainty of the nature of positive electricity. Without entering upon the changes in point of view on this important question, it may suffice to say that the evidence as a whole supports the idea that the nucleus of the hydrogen atom, *i.e.* a positively charged atom of hydrogen, is the positive electron. No evidence has been obtained of the existence of a positively charged unit of mass less than that of the hydrogen nucleus, either in vacuum tubes or in the transformation of the radioactive atoms, where the processes occurring are very fundamental in character.

It might *a priori* have been anticipated that the positive electron should be the counterpart of the negative electron and have the same small mass. There is, however, not the slightest evidence of the existence of such a counterpart. On the views outlined, the positive and negative electrons both consist of the fundamental unit of charge, but the mass of the positive is about 1800 times that of the negative. This difference in the mass of the two electrons seems a fundamental fact of nature and, indeed, is essential for the existence of atoms as we know them. The unsymmetrical distribution of positive and negative electricity that is characteristic for all atoms is a consequence of this wide difference in the mass of the ultimate electrons which compose their structure. No explanation can be offered at the moment why such a difference should exist between positive and negative electricity.

Since it may be argued that a positive unit of electricity associated with a much smaller mass than the hydrogen nucleus may yet be discovered, it may be desirable not to prejudge the question by calling the hydrogen nucleus the positive electron. For this reason, and also for brevity, it has been proposed that the name "proton" should be given to the unit of positive electricity associated in the free state with a mass about that of the hydrogen nucleus, namely, about 1·007 in terms of O=16. A name for this unit will be found very convenient in discussing the inner structure of atoms. In the following, the term "electron" will be applied only to the well-known negative unit of electricity of small mass.

On the classical electrical theory, the mass of the electron can be accounted for by supposing that the negative electricity is distributed on a spherical surface of radius about 1×10^{-13} cm. This is merely an estimate, but probably gives the right order of magnitude of the dimensions, though it should be pointed out that in some recent theories of Compton and others it has been supposed that the electron behaves like a flexible ring, the dimensions of which are about 10^{-11} cm., or about 100 times the original estimate. Without going into these difficult questions, what little experimental evidence there is seems to me to support the older estimate of size. Taking the view based on the older theory, the greater mass of the proton is to be explained by supposing that the distribution of electricity is much more concentrated for the proton than for the electron. Supposing the shape spherical, the radius of the proton should be only $\frac{1}{1800}$ of that of the electron. If this be so, the proton has the smallest dimensions of any particle known to us. It is admittedly very difficult to give any convincing proof in support of this contention, but at the same time there is no evidence against it. From the point of view of simplicity of explanation, it is natural to make the assumption that the proton and the electron are the fundamental units of which all atoms are built.

It would take too long to consider in any detail the gradual development in the last twenty years of our ideas on the structure of atoms. Progress has depended mainly on a clearer understanding of the relative part played by positive and negative electricity in atomic structure. It is now generally accepted that the atom is an electrical system and that the atoms of all the elements have a similar type of structure.

The nuclear theory of atomic constitution has been found to be of extraordinary value in offering an explanation of the fundamental facts that have come to light, and is now generally employed in all detailed theories of atomic constitution. At the centre of each atom is a massive positively charged nucleus of dimensions minute compared with the diameter of the atom. This nucleus is surrounded by a distribution of negative electrons which extend to a distance, and occupy rather than fill a region of diameter about 2×10^{-8} cm. Apart from the mass of the atom, which resides mainly in the nucleus, the number and distribution of the outer electrons, on which the ordinary physical and chemical properties of the atom depend, are controlled by the magnitude of the nuclear charge. The position and motions of the external electrons are only slightly affected by the mass of the nucleus. According to this view of the atom, the problem of its constitution naturally falls into two parts—first, the distribution and mode of motion of the outer electrons, and secondly, the structure of the nucleus and the magnitude of the resultant positive charge carried by it. In a neutral atom the number of external electrons is obviously equal in number to the units of positive (resultant) charge on the nucleus.

The general conception of the nuclear atom arose from the need of explanation of the very large deflections experienced by swift α- and β-particles in passing through the atoms of matter. A study of the number of α-particles scattered through different angles showed that there must be a very intense electric field within the atom, and gave us a method of estimating the magnitude of the charge on the nucleus. Similarly the scattering of X-rays by the outer electrons provided us with an estimate of the number of these electrons in the atom, and the two methods gave concordant values. The next great advance we owe to the experiments of Moseley on the X-ray spectra of the elements. He showed that his experiments received a simple explanation if the nuclear charge varied by one unit in passing from one atom to the next. In addition, it was deduced that the actual magnitude of the nuclear charge of an atom in fundamental units is equal to the atomic or ordinal number when the elements were arranged in order of increasing atomic weight. On this view, the nuclear charge of hydrogen is 1, of helium 2, lithium 3, and so on up to the heaviest element uranium, of charge 92. It has been found that between these limits, with few exceptions, all nuclear charges are represented by known elements.

This relation, found by Moseley, between the atoms of the elements is of unexpected simplicity and of extraordinary interest. The properties of an atom are defined by a whole number which varies by unity in passing from one atom to the next. This number not only represents the ordinal number of the elements, but also the magnitude of the charge of the nucleus and the number of outer electrons. It could scarcely have been anticipated that, possibly with few exceptions, all nuclear charges between 1 and 92 would represent elements found on the earth. With the exception of the radio-active elements, the atoms are all stable for intervals represented by millions of years. The atomic weight of an element is not nearly so fundamental a property of the atom as its nuclear charge, for its weight depends upon the inner structure of the nucleus, which may be different for atoms of the same nuclear charge.

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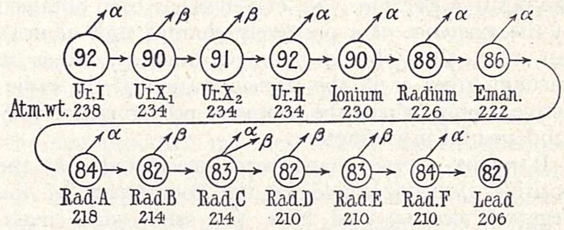
The most definite information we have of the structure of the nucleus has been obtained from a study of the modes of disintegration of the radio-active atoms. In the great majority of cases the atoms break up with the expulsion of a single α-particle which represents the doubly charged nucleus of the helium atom; in other cases a swift β-ray or electron is liberated. There can be no doubt that these particles are liberated from the nuclei of the radio-active atoms. This is clearly shown by the variation of the atomic numbers of the successive elements in the long series of transformations of uranium and thorium (see Fig. 1). The expulsion of an α-particle lowers the nuclear charge of the atom by two units and its mass by four, while the expulsion of an electron raises it by one. On this simple basis we can at once deduce the atomic number and, consequently, the general chemical properties of the long series of radio-active elements. In this way we can understand at once the appearance in the radio-active series of isotopes, *i.e.* elements of the same nuclear charge but different atomic masses.

The existence of isotopic elements was first brought to light from a study of the radio-active elements. For example, radium-*B*, radium-*D* and the end product, uranium-lead, are isotopes of lead of nuclear charge 82, but of masses 214, 210, and 206 respectively. As regards ordinary chemical and physical properties, they are indistinguishable from one another, differing only in properties that depend on the nucleus, namely, atomic mass and radio-activity. For example, radium-*B* and radium-*D* both emit β-rays, but with different velocities, while their average life is widely different. Uranium-lead, on the other hand, is non-radioactive. Many similar examples can be taken from the thorium and actinium series of elements. These illustrations show clearly that elements may have almost identical physical and chemical properties and yet differ markedly in the mass and structure of their nuclei.

From the radio-active evidence it seems clear that the nuclear structure contains both helium nuclei and electrons. In the uranium-radium series of transformations, eight helium nuclei are emitted and six electrons, and it is natural to suppose that the helium nuclei and electrons that are ejected act as units of the nuclear structure. It is clear from these results that the nuclear charge of an element is the excess of the positive charges in the nucleus over the negative. It is a striking fact that no protons (H nuclei) appear to be emitted in any of the radio-active transformations, but only helium nuclei and electrons.

Some very definite and important information on the structure of nuclei has been obtained by Aston in his experiments to show the existence of isotopes in



Uranium-radium series

FIG 1.

the ordinary stable elements by the well-known positive-ray method. He found that a number of the elements were simple and contained no isotopes. Examples of such "pure" elements are carbon, nitrogen, oxygen, and fluorine. It is significant that the atomic weights of these elements are nearly whole numbers in terms of $O=16$; on the other hand, elements such as neon, chlorine, krypton, and many others consisted of mixtures of two or more isotopes of different atomic masses. Aston found that within the limit of error—about 1 in 1000—the atomic weights of these isotopes were whole numbers on the oxygen scale. This is a very important result, and suggests that the nuclei of elements are built up by the addition of protons, of mass nearly one, in the nuclear combination.

[Experimental evidence was here given of the liberation of protons from the elements boron, nitrogen, fluorine, sodium, aluminium, and phosphorus. See NATURE of May 6, p. 584.]

From the radio-active evidence, we know that the nuclei of heavy atoms are built up, in part at least, of helium nuclei and electrons, while it also seems clear that the proton can be released from the nuclei of certain light atoms. It is, however, very natural to suppose that the helium nucleus which carries two positive charges is a secondary building unit, composed of a close combination of protons and electrons, namely, 4 protons and 2 electrons.

From the point of view of simplicity, such a conception has much in its favour, although it should be mentioned that it seems at the moment impossible to prove its correctness. If, however, we take this structure of the helium nucleus as a working hypothesis, certain very important consequences follow. On the oxygen scale, the helium atom has a mass very nearly 4·000, while the hydrogen atom has a mass 1·0077. The mass of the helium atom is thus considerably less than that of four free H nuclei. Disregarding the small mass of the electrons, in the formation of 1 gram of helium from hydrogen there would be a loss of mass of 7·7 milligrams.

It is now generally accepted that if the formation of a complex system is accompanied by the radiation of energy E, the reduction of the mass m of the system is given by $E=mc^2$, where c is the velocity of light. This relation between mass and energy follows not only as a direct consequence of the theory of relativity, but can be derived directly from Maxwell's theory, as pointed out by Larmor. On this relation, the energy E liberated in the formation of 1 grm. of helium from hydrogen is equal to $6{\cdot}9 \times 10^{18}$ ergs or $1{\cdot}6 \times 10^{11}$ gramme-calories. This is an enormous amount of energy, large compared even with the total energy emitted during the complete disintegration of 1 grm. of radium and its products, namely, about $3{\cdot}7 \times 10^{9}$ gramme-calories. It can be calculated that the energy radiated in forming one atom of helium is equivalent to the energy carried by three or four swift α-particles from radium. On this view we can at once understand why it should be impossible to break up the helium nucleus by a collision with an α-particle. In fact, the helium atom should be by far the most stable of all the complex atoms.

It has been pointed out by Perrin and Eddington that in all probability the energy of radiation from our sun and the stars is derived mainly from the enormous emission of energy accompanying the formation of helium from hydrogen. If this be the case, it is easy to show that sufficient energy can be derived from this source for our sun to radiate at its present rate for several thousand million years, whereas the older theories of Kelvin and Helmholtz, in which the heat of the sun is ascribed to the gradual concentration of the material under gravity, make the life of the sun much shorter than modern estimates of the age of the earth and appear to be quite inadequate to provide the requisite energy.

This interesting suggestion of the probable origin of the greater part of the enormous energy radiated by the sun and stars is one of the first-fruits of the investigations on the structure of atoms. It is believed that the formation of helium from hydrogen occurs under certain conditions in the great central furnace of the sun and stars, but there is no evidence, so far, that this combination can be produced under laboratory conditions. It may be that it can be effected only under conditions of very high temperature and enormous intensity of radiation such as occur in the interior of a sun. Even then the process of formation may go on at a very slow rate and for periods measured by millions of years.

Most workers on the problem of atomic constitution take as a working hypothesis that the atoms of matter are purely electrical structures, and that ultimately it is hoped to explain all the properties of atoms as a result of certain combinations of the two fundamental units of positive and negative electricity, the proton and electron. Some of the more successful methods of attack that have been made on this most difficult of problems have been indicated. During recent years, unexpectedly rapid advances have been made in our knowledge, but we have only made a beginning in the attack on a very great and intricate problem.

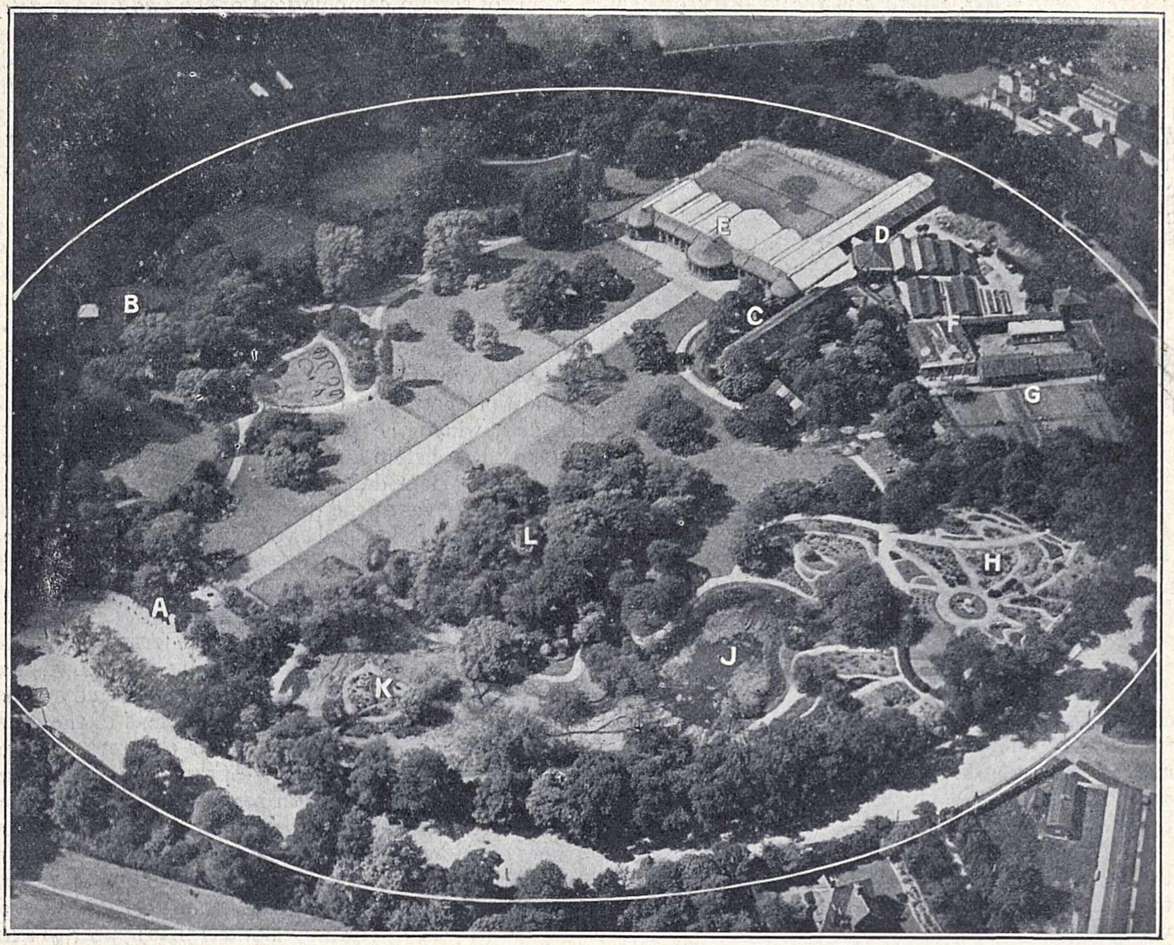
Great difficulties arise the moment we consider why the nucleus of an atom holds together, and progress seems likely to be slow because it seems clear that the ordinary laws of force between electrified particles break down at such minute distances. There are, however, a number of obvious lines of attack that may yield us very valuable information. In particular, a closer study of the modes of transformation of radio-active bodies, where the process of devolution of elements takes place before our eyes, may be expected to give much important data. During recent years the study of the γ- or very penetrating X-rays from radio-active bodies has progressed very rapidly. The general evidence indicates that the γ-rays, like the α- and β-particle, have their origin in the nucleus. The study of the γ-rays thus gives us information of the frequency of vibration of the electrons which form part of the nuclear structure. In addition, Ellis has shown that it appears probable that the laws of quantum dynamics which govern the motions and vibrations of the outer electrons apply also to the nuclear electrons. If this conclusion can be verified, it offers the hope that we may be able later to form some idea of the detailed structure of nuclei. There are also a number of other lines of evidence that will have to be taken into account in formulating any definite theory of the evolution of the elements; for example, Harkins has pointed out some very interesting relations that appear to exist between the relative abundance of elements in the earth and their atomic number, while the close study of stellar evolution should ultimately throw much light on the general problem.

The Royal Botanic Society's Gardens.

THE gardens of the Royal Botanic Society, Regent's Park, are one of the landmarks of London. They occupy the whole of the Inner Circle of Regent's Park, an area of nearly 20 acres. The accompanying aerophotograph shows very well their main features. The Society was established by Royal Charter in 1839, "for the promotion of botany in all its branches, and its application to medicine, arts, and manufactures, and also for the formation of extensive botanical and ornamental gardens within the immediate vicinity of the metropolis." The first president was the Duke of Richmond, and the first secretary James De Carle Sowerby, a botanist and artist, whose father, James Sowerby, was a well-known botanist in his time. The latter was author of "English Botany," a classic collection of coloured drawings of British plants, and other works. The son, James De Carle Sowerby, inherited his father's tastes as a botanist and artist. He also handed on to *his* son and grandson the office of secretary, the latter resigning shortly before the war.

Their Majesties the King and Queen and Queen Alexandra, and H.R.H. the Prince of Wales are patrons of the society, and the present President is Viscount Lascelles. The grounds of the gardens were originally intended as the site for a royal palace, and had been used as a nursery garden. They were cleared and laid out as an example of English landscape gardening, an artificial lake being excavated and a mound formed near the centre of the ground in the process. In 1845 the conservatory was erected. It was the first large iron house built in England, the palm-house at Kew being constructed later. The herbaceous garden, in which the plants were arranged according to the natural orders, was also a novelty in its time. It contains a warm-water tank in which *Victoria regia* is grown very successfully every year. In the late summer this is one of the sights of the gardens. In this house are also grown bananas, rice, bamboo, sugar cane, the sacred lotus, as well as a variety of tropical water plants and climbers. Some of the other houses are devoted to orchids, succulents, ferns, stove plants and bedding plants.

A practical gardening school was established in 1897, and has done excellent work. Lady gardening students were first admitted in 1904, and they have been very successful. They now number 22, and a new students' house was recently built for them. The course in practical gardening extends over three years, and includes practice in all the operations of gardening, as well as a certain number of lectures. Those who have completed the course have been very successful in the gardening competitions of the Royal Horticultural Society and in obtaining situations.



[*Photo by Central Aerophoto Co.*

ROYAL BOTANIC GARDENS.

A=MAIN ENTRANCE. B=MUSEUM AND LIBRARY. C=FELLOWS' ROOMS. D=VICTORIA REGIA HOUSE AND GREENHOUSES. E=CONSERVATORY. F=STUDENTS' HOUSE: PRACTICAL GARDENING SCHOOL. G=KITCHEN GARDEN. H=ORDER BEDS AND METEOROLOGICAL INSTRUMENTS. J=LAKE. K=ROCK GARDEN AND SUNDIAL. L=TOWER AND SUN RECORDER.

includes economic and medicinal plants, and has proved very useful to botanical students throughout the history of the gardens. As early as the 'eighties of last century 600-800 students' tickets were issued annually. The gardens have also been and are still an important source of specimens for botanical teaching in London. The kitchen-garden and rock-garden are other features having their special uses.

The greenhouses are now in need of replacement, and that process will begin shortly with the erection of two new and modern houses. The museum contains an important collection of economic products, particularly of tropical plants. The library is chiefly devoted to economic botany, including agricultural and horticultural publications. The Victoria House

The gardens are also recognised as a meteorological station for London. The society possesses a complete set of instruments, and daily observations are made and published. The records include ground temperatures and sunlight.

In the years before the war the gardens ceased to make progress and fell into debt. Beginning in 1906, a Commission from the University of London considered the possibility of incorporating them into the University and making them the centre of a Botanical Institute, but the scheme was not adopted. Since the war the gardens have taken on a new lease of life. An energetic Superintendent has been appointed, who has already increased considerably the utility and the amenities of the gardens. Ground has been set apart for genetic experiments under the direction of Prof. Ruggles Gates, of King's College, London. Several hard tennis courts have also been built, which are a considerable source of income.

In 1919 a Government Committee was appointed under the chairmanship of Sir David Prain, to consider how the work of the Royal Botanic Society could be made more useful from the scientific and educational point of view. Definite recommendations were made, which it is hoped will be carried into effect as funds become available. The recommendations included (1) the establishment of a School of Economic Botany, where a knowledge of economic and tropical plants and their products could be obtained; (2) an Institute of Research, especially on the living plant and its physiology; (3) a centre for teaching in horticulture; and (4) courses in school gardening for teachers. When these are all carried out they will involve an annual expenditure of about 3000*l.* for salaries and expenses, and an initial outlay of some 5000*l.* for laboratories and equipment. Such an Institute of Economic Botany would be of enormous value to botany in this country, and in particular would contribute much to the economic development of our tropical possessions.

It is highly desirable that the necessary funds for this purpose should be forthcoming in the near future, so that the reconstruction of greenhouses and other buildings, which has become essential, can be carried out in a scheme harmonious with the present arrangements of the gardens. Botany in Great Britain has occupied in some respects a unique position, especially in its many-sidedness and in the closeness of the relations which have usually existed with economic, agricultural, and horticultural interests, and an Institute of Botanical Research of the kind recommended by the Government Committee in 1919 would probably do more than any other measure for the advancement of botanical science throughout the Empire. Any public-spirited citizen who would set the example of subscribing funds for this purpose would earn the gratitude of all those who have at heart the development of botanical science for the welfare of mankind.

Obituary.

S. P. SMITH.

THE name of Stephenson Percy Smith, whose death is reported at New Plymouth, New Zealand, is probably more widely known than any other among students of Polynesian ethnology. Mr. Smith was born at Beccles in Suffolk, and arrived with his parents at the infant settlement of New Plymouth on February 7, 1850. In 1855 he entered the Government Survey Department, passing upwards through all grades and becoming Surveyor-General in 1889, a post which he held till his retirement in 1900. Among a number of important and arduous departmental undertakings carried through with conspicuous ability were the survey following the great eruption of Tarawera, and the mapping and charting of the Chatham Islands and the Kermadecs. His ability in affairs was recognised and made use of by the New Zealand Government on several occasions, perhaps most notably when he was dispatched to Niue, where he drew up the constitution under which that island has prospered ever since.

In spite of his varied services to the State, it is in another capacity that he will be best remembered, namely, as the leading authority on Polynesian traditions. A few months before his death a fourth edition appeared of "Hawaiki: The Whence of the Maori," a book which has been more widely read and more often quoted than any other modern work on Polynesia. In its latest form it has been considerably expanded, and it is weightier and more mature, even, than before. He published several other books dealing with the Maori, and a very large number of papers, every one of which is of value.

A service to ethnology almost as important as the publication of his own works was performed by Percy Smith in the capacity of president of the Polynesian Society and editor of its Journal. He was the most prominent of its founders in 1892, and he presided over it and guided it until his death. Thirty volumes of the Journal have appeared, and the immense industry and the scholarship involved in editing them and in translating numberless papers published in them, would alone constitute a notable life-work. By thus providing a means for the rapid publication of ethnological research in New Zealand and the Pacific he performed a service for anthropology in that part of the globe probably greater than has been rendered by any other worker in the field. He was an honorary member of many scientific societies in different parts of the world, and in New Zealand had been honoured by a Fellowship of the New Zealand Institute, and by the award of the Hector Medal.

No one could meet Percy Smith without recognising the strength and range of his intellect. He rendered ready help alike to great and small. His loss will be felt not only by those who knew him personally and experienced his generous help, but by every student who begins research in the field of which he was the unchallenged master.

H. D. S.

WE notice with regret the announcement of the death, on July 27 last, of Dr. A. J. Harries. Dr. Harries, who was born in 1856 and received his medical education in London and Brussels, was well known for his work on electro-therapeutics and kindred subjects. Among a number of medical works which he published was "A Manual of Electro Therapeutics," issued in 1890; he was also the author of papers on the dangers and uses of electricity, including one contributed to the Leeds meeting of the British Association in 1890, in which it was pointed out that current strength, as well as voltage, is an important factor in estimating the danger to life from accidental contacts with "live" wires and structures.

Current Topics and Events.

DR. E. T. WHITTAKER, professor of mathematics in the University of Edinburgh, has been elected a Foreign Member of the Reale Accademia dei Lincei, Rome.

SIR CHARLES PARSONS, inventor of the Parsons steam turbine, Dr. J. H. Tudsbery, until recently secretary of the Institution of Civil Engineers, and Mr. C. le Maistre, Secretary of the International Electro-Technical Commission in London, have been elected honorary members of the Royal Dutch Institute of Engineers.

THE D. G. Elliot gold medal of the National Academy of Sciences of the United States of America has been awarded to Dr. O. Abel, professor of palæobiology in the University of Vienna for his work, "Methoden der paläobiologischen Forschung," which forms a part of Abderhalden's "Handbuch der biologischen Arbeitsmethoden."

THE Franklin Gold Medal of the Franklin Institute of Philadelphia was presented on July 26 by Lord Balfour to Sir Joseph J. Thomson, in the presence of a distinguished gathering of men of science from Great Britain, Canada and the United States of America. This medal, which was instituted in 1914 by Samuel Insull, is awarded annually "to those workers in physical science or technology, without regard to country, whose efforts . . . have done most to advance a knowledge of physical science or its applications."

MR. W. H. DINES, Director of the Aerological Observatory of the Meteorological Office at Benson, has retired after many years' service in connexion with the upper air. The *Meteorological Magazine* for July, speaking of his retirement, mentions Mr. Dines as a link with the past. After a training in mechanical engineering, and with a Wrangler's degree at Cambridge, he was specially qualified to undertake the direction and management of an observatory for the upper air. Much of his earlier work was effected with kites. The upper air work is said by Sir Napier Shaw to have been successful beyond hope and expectation, though both were high, and pre-eminence is claimed for the high-water mark of the investigations in this country. Mr. Dines's services to science and the State have been of the highest order and of very special value during the development of aircraft and engines, and the maximum result has been achieved with the minimum of cost. His payment as Director was a small honorarium and out-of-pocket expenses.

A LOAN collection of water-colours of New Zealand, by Mr. C. N. Worsley, is at present being shown in the New Zealand Court of the exhibition galleries of the Imperial Institute. The pictures give an excellent impression of the beauty of the scenery of New Zealand. Among the new collections recently added to the galleries is a representation of the resources of British North Borneo, which includes an exhibit illustrating the important tobacco industry.

THE annual exhibition of the Royal Photographic Society for the present year will be held at 35 Russell Square, W.C.1, from September 18 to October 28, inclusive. The exhibition will comprise the following sections: Pictorial Prints, Pictorial Lantern Slides, Pictorial Colour Transparencies and Prints, Natural History Subjects, Photomicrographs, Radiographs, Astronomical, Aerial, and Spectrum Photographs, Stereoscopic Slides, Scientific Colour Work, and Technical Applications of Photography.

A CONFERENCE of representatives of the various branches of the dairy industry in this country, held on July 28 at the Ministry of Agriculture, under the chairmanship of Sir Francis Floud, was addressed by Prof. H. E. Van Norman, president of the World's Dairy Congress which it is proposed to hold in October 1923 at Philadelphia. At the conclusion of the meeting, the following resolution was passed:—"That this meeting, having heard Professor Van Norman's statement of the objects, etc., of the World's Dairy Congress to be held in the United States of America in October 1923, is of opinion that this country should be adequately represented at the Congress, and it requests the Ministry of Agriculture in conjunction with the Ministry of Health to invite the various Associations and bodies interested in the Milk Industry to nominate representatives to serve on a General Committee to organise the representation of the Industry in England and Wales at the Congress."

MR. NORMAN L. SILVESTER sends us from Pangbourne, Berks, a specimen of Scabious having a remarkable malformation of the head. Presumably a case of forking of the original bud, one "half" has grown to produce a complete head, the other "half" has remained short and produced a few florets only.

MR. K. NORRIS, Purley, writes to record that an albino crested newt (*Molge cristata*) was found in a pond at Sanderstead, Surrey, on Friday, June 30. Instead of the usual form, dark grey or blackish brown, with orange underparts blotched with black, the specimen is creamy white with pink eyes. It is at present exhibited at the naturalist's stores of Mr. G. A. Bentall, 392 Strand, W.C.2.

WE recently mentioned (July 8, p. 54) a communication by Mr. Hazeldene Warren published in the June issue of *Man*, on the subject of the Red Crag Flints of Foxhall. In the July issue of *Man* Mr. J. Reid Moir presents a rejoinder to Mr. Warren's criticisms. We cannot find space for further reference to the discussion, but think it worth while to direct attention to Mr. Moir's reply.

IN an article on radio direction-finding in flying machines in NATURE of July 8, p. 59, it was stated that Mr. Gregory Breit worked out mathematically the nature of the field from the two horizontal coils which are used, but no other names are mentioned. Mr. Breit now writes to point out that the work on direction-finding was carried out by Messrs. Kolster and Dummore, and that the use of two horizontal coils as a transmitter was due to Mr. Willoughby. Mr. Breit's own work was confined to the calculation of the radiation from the Willoughby transmitter.

THE Imperial Bureau of Mycology, in addition to its other activities, has recently begun the publication, under the editorship of the director, Dr. E. J. Butler, of the *Review of Applied Mycology*. One of the important functions of the Bureau is the accumulation and distribution of information on all matters connected with the diseases of plants, and the co-ordination of investigations in this particular field of study to enable workers in all parts of the world to keep in touch with recent research. In order that this may be accomplished a complete index of the literature is to be kept, and abstracts of the more important investigations will be published. The review is being issued monthly and several numbers have already appeared. The importance of a periodical of this kind issued by a competent authority is obvious, and if only the abstracting can be maintained at its present high level and the review published punctually, with abstracts well up-to-date, it will be of great service to economic mycologists.

MAJOR T. F. CHIPP, Conservator of Forests, Gold Coast, since 1921, and previously assistant director of the Botanic Gardens, Singapore, has been appointed assistant director of the Royal Botanic Gardens, Kew. Major Chipp received part of his early training at Kew and worked as a temporary technical assistant in the Herbarium. Later he went as demonstrator in botany at the Birkbeck College, and in 1910 was appointed an assistant Conservator of Forests in West Africa.

Our Astronomical Column.

LARGE FIREBALL ON JULY 26.—The Toronto correspondent of the *Times*, in a message dated July 26, reports that a loud explosion shook the ground for 20 miles round Wynward, Saskatchewan, and that a giant meteor was seen to fall into the Big Quill Lake. A large fiery ball was observed by many persons in the district to drop from the clear sky, and after it had sunk in the waters of the lake, clouds of steam are said to have risen from the surface.

Other reports have come from Vanscoy, south-east of Saskatoon, which is in longitude 107½° west, and north latitude 52½°. The inhabitants of this neighbourhood heard five or six explosions, and the ground lying between Vanscoy and Pike Lake was severely shaken.

No further details of a definite character have yet been received, and it is difficult from the information at hand to draw safe conclusions other than that a large fireball descended near the places named, and apparently fell to the earth. The date of July 25 or 26 is one when large meteors are usually abundant. The principal shower is sometimes directed from near the stars α_1 and α_2 Capricorni. The meteors of this shower are often brilliant, and they traverse long paths with slow motion. It is quite possible that one of the objects composing this stream may have fallen to the earth, and is identical with the fireball observed.

THE SYSTEM OF CASTOR.—This interesting system has been the subject of much research since the earliest known observation of it as a binary by Bradley and Pound in 1719. The determination of the period was nearly hopeless until comparatively recently; until 40 years ago some computers put forward values so large as 1000 years. But with the approach to periastron, which is due in some 30 years, the problem is simplified, and Mr. W. Rabe, in an exhaustive study of the system in *Astr. Nach.*, No. 5164-5, gives the following elements: $a = 6''\cdot06$, $e = 0\cdot5593$, $i = 66°\cdot79$, $\omega = 81°\cdot97$, $\Omega = 32°\cdot55$, T = 1954·73, Period 306·28 years. The probable error of the period is given as 5 years. The orbit coincides practically with the minimum ellipse drawn by Mr. Lewis in his Memoir on the Struve double stars. The analysis of the observations by Mr. Rabe supports the suggestion, first vaguely made by Mr. Burnham (Mon. Not. R.A.S., vol. 51), that the fainter star has a fairly close unseen companion, the period being about 8½ years. The spectroscopic observations of radial velocity are stated to agree with this hypothesis. The parallax of the system is discussed, and the value $0''\cdot0745$ adopted. The combined mass is then 5·74 in terms of the sun; Rabe assigns 3·33 of this to the brighter star, 2·41 to the fainter. If the supposed unseen companion is real then its mass accounts for 0·60 of the 2·41.

Both of the visible stars are spectroscopic binaries, and from the velocities measured it had been conjectured that the fainter star was the more massive. This, however, involved the doubtful assumption that the spectroscopic orbits were coplanar with the principal orbit, an assumption rendered improbable by Mr. Rabe's discussion. As the distant companion C is also a member of the system, there would seem to be at least six components altogether.

The proper motion of the centre of gravity could not be given till the mass-ratio was determined. Mr. Rabe gives it as $-0^s\cdot0134$ in R.A., and $-0''\cdot108$ in Decl. Combining this with the radial velocity, and correcting for solar motion, the true velocity is 10·46 km./sec. towards R.A. 305°·5, Decl. +42°·5. This agrees with the motion of a group of 22 A-stars of Drift I discussed by Prof. Plummer.

THE DOMINION ASTROPHYSICAL OBSERVATORY, VICTORIA.—Publication No. 26 of vol. i. of this observatory contains a list of 88 new spectroscopic binaries discovered there, in addition to the first 100 announced in No. 10. The spectrograph is mounted on the 72-inch reflector which is used as a Cassegrain with equivalent focal length 100 feet. Analysis of the stars shows that they are distributed through all spectral types, but 90 per cent. belong to types B, A and F. Of the B-stars about every second one investigated proved to be binary, suggesting that duplicity may be the normal accompaniment of the attainment of this type, for in some cases the variable velocity would not be detected if its component in the line of sight was small. The following star of the pair Σ 1890 (separation $3''\cdot5$) is one of the stars on the list. The preceding star has a fixed velocity, while the following one shows in the violet "beautiful sharp double lines with a separation of about 70 km." Another star is Boss 4777, which is the distant companion (46″) of β Lyrae.

Research Items.

THE KWAKIUTL INDIANS.—The report of the Peabody Museum of American Archæology and Ethnology, at Harvard University, for 1920–1921, published in 1922, records the results of many expeditions. The one of chief interest to British readers is a visit to the Kwakiutl Indians of British Columbia, made by Dr. C. F. Newcombe, to look for the few remaining house-posts or other large carvings of those Indians. From Kalukwis village on Tournour Id. he secured two fine house-posts, about sixteen feet high and nearly four feet across. Each is carved with figures representing the speaker of the chief and the ancestral grizzly bear who was friendly to the founder of the family, giving him rights to certain dances, and teaching him the use of the appropriate masks. These carvings are now on exhibition, and a house group of Kwakiutls has been added to the fourteen previously illustrating the home life of the American Indians. A new Hall of North American Ethnology was opened to the public in September 1920, but it needs more cases before the collections can be finally arranged. With the reduction in the price of plate glass, it is hoped that these cases will soon be added.

THE ETHNOLOGY OF SCANDINAVIA.—Prof. H. F. Osborn contributes to *Natural History* of April last (vol. xxii. No. 2) an article entitled "Our Ancestors arrive in Scandinavia," in which, with good illustrations, he sums up the latest conclusions on its archæology. From the chronological table he argues that "it becomes apparent that what the far-distant north-west was to our American pioneers, what Ultima Thule was to ancient historic times, such was Scandinavia to the people of the Mediterranean borders. In the course of thousands of years implements, symbols, and inventions—useful, religious, or artistic—slowly found their way westward and northward, from Eastern Asia to Sweden, a distance which, thanks to the telephone, is to-day spanned in a few seconds. For example, copper is said to have been used at Anau, Turkestan, about 4000 B.C., and first appears in Sweden 1500 years later—namely, 2500 B.C. The Age of Bronze, which was in full sway in Egypt and Chaldea by 3000 B.C., makes its first appearance in Sweden eight hundred years later. Thus within a period of eight thousand years our ancestors arrived in Scandinavia and passed through a long hunting stage of evolution with only flint implements; through all the Neolithic phases; through a superb development both of the art of flint and of bronze; into the culminating period of the Age of Iron."

THE FORGING OF FINGER-PRINTS.—It is disconcerting to learn from an article by Mr. J. C. Goodwin in the third number of the new publication, *Dactylography*, that the practice of forging finger-prints is increasing and will soon become a problem for New Scotland Yard. The criminal must first obtain specimens of the prints of the dupe on whom he intends that suspicion should fall. This he does by arranging that the dupe leaves his prints on a glass, or on a polished piece of furniture, after which the prints are photographed. One method of forging involves the use of a rubber stamp, where a facsimile of the original is reproduced on the rubber by means of transfer paper, and the surrounding rubber deftly pared away with a sharp knife. The second method is to take a negative cast of the finger to be forged by pressing it into a mould of soft wax, plaster of Paris, clay, or even bread. A third process involves photographing a photograph of the prints to be forged on a reversed plate, which is clamped to a duplicate plate made of gelatine mixed with bichromate of potassium. The two are exposed to the light, with the photographic negative nearer to the light, and the sensitised surface touching the gelatine.

FOSSIL FISH FROM SOUTHERN ITALY.—Prof. Geremia D'Erasmo describes and figures in the Rendiconto dell' Accademia delle Scienze, Napoli (Ser. III., vol. xxviii.), some fossil fish from southern Italy. They comprise an almost complete Picnodont (*Cœlodus costati*, Heckel) from the cenomanian beds of Alessano, province of Lecce, where examples of this group are scarce; a Leptolepis from the cretaceous of Roccadevandro, province of Caserta; as well as a Seriola, a Thynnus, two species of Clupea, and a Pelamys from the pleistocene strata of Taranto.

REDESCRIPTION OF AN EOCENE LIZARD.—Discovered and described fifty years ago, the remains of *Saniwa ensidens*, Leidy, from the Bridger deposits (Eocene) of Wyoming, have only recently been properly developed from the matrix. The unusual perfectness of the skeletal remains thus revealed have justified their redescription by Mr. C. W. Gilmore (Proc. U.S. Nat. Mus., vol. lx.). The fossil proves to be a true member of the family Varanidæ, which therefore contains the genus Varanus, largely made up of living species of lizards, and the genus Saniwa, which now includes six or more extinct species, since Marsh's Thinosaurus is considered by the author as congeneric with Saniwa.

OWL FROM THE EOCENE OF WYOMING.—A fragment of a humerus and two vertebræ from the Bridger deposits of Wyoming were referred in 1873 by Dr. J. Leidy to a lizard which he named *Saniwa major*. The humerus is now shown by Mr. A. Wetmore (Proc. Acad. Nat. Sci., Philadelphia, vol. lxxiii.) to be avian and to represent an owl of the family Bubonidæ, similar in size to *Pulsatrix perspicillata*, Latham. It does not resemble closely any existing genus of modern North American owls, but in a way combines characters pertaining to several. The author assigns it tentatively to Shufeldt's genus Minerva under the new trivial name of *M. saurodosis*, but admits that that genus, founded on a claw at first referred to Aquila, although from the same formation and district, may yet prove to be an incorrect receptacle for the new species.

SYSTEMATIC BOTANY.—The forty-seven articles of the latest volume of the Kew Bulletin (Bulletin of Miscellaneous Information, Royal Botanic Gardens, Kew, 1921; 10s. net) are an index of the activities of the Royal Gardens. They are mainly of systematic interest, including revisions of genera, descriptions of novelties, and notes on plants of botanical or economical importance. A point of general interest which emerges is the indication of the great amount of work which remains to be done before we can have an accurate knowledge of the constituents of the floras of the different parts of the world. The revision of the Stipa grasses of Australia (by Miss D. K. Hughes) indicates 40 distinct forms in place of the 15 hitherto recognised; it also bears out the common experience, that variation in anatomical structure of the leaf-blade of grasses does not run parallel with the characters of leaf and flower from which we infer their relationships. The incomplete state of our knowledge of the Central American forest flora is well illustrated by a revision of the genus Belotia, and of the family Tiliaceæ, in which T. A. Sprague distinguishes eleven species, an increase of six on the number hitherto recognised.

A difficulty which the economic botanist frequently meets is illustrated by an inquiry (by S. T. Dunn) into the cause of the variability in the yield of camphor from the Camphor tree (*Cinnamomum Camphora*). Some trees are found to be worthless, the oil yielding no solid camphor on distillation. Careful examination discloses no perceptible botanical difference between good and worthless trees, but there may be peculiarities which affect only the chemical products of the tree. Such physiological varieties are known in rubber and timber trees. Investigation indicates that climatic conditions, the age of the leaves when cut for distillation, and the general health of the tree have an important bearing on the yield.

BRITISH AND IRISH PAGURIDEA.—The Paguridea (including hermit crabs and the stone crab) which have been found on the coasts of Ireland had been studied by Mr. C. M. Selbie, of the National Museum, Dublin, who died at the Somme in July 1916. The account now published (Fisheries, Ireland, Sci. Invest. 1921, I.) has been completed from Mr. Selbie's rough drafts by Dr. S. W. Kemp. The material reported upon, nearly all obtained by the Irish Fishery Cruiser, contains eleven species, one of which—*Nematopagurus longicornis*—has not hitherto been known from British waters. To complete the list of British and Irish representations of this tribe there are to be added an Irish species of Eupagurus recorded in 1866, and two species—one Diogenes and one Anapagurus—known from the shores of Great Britain but not yet discovered in Irish waters—a total of fourteen species. The majority of the species inhabit water that is shallow or of moderate depth, but one—*Parapagurus pilosimanus*—is a true deep-water species and occurs at depths ranging from 250 to 2260 fathoms. Three of the fourteen species extend north of the Arctic Circle and eight are found in the Mediterranean. There are keys to the families, genera, and species, and a systematic account is given of each species with notes on its distribution.

THE SEMI-DIESEL ENGINE.—Owing to the high price of fuel in France at the present time the Mechanical Arts Committee of the Société d'Encouragement pour l'Industrie nationale has thought it desirable to publish an account of the present position of the semi-Diesel engine, and in consequence the May issue of the Bulletin of the Society contains an article of nearly 100 pages on the subject from the pen of M. A. Schubert. It goes into the theory of the engine, the reasons which have led to its development, the forms which it at present takes in France and in other countries, and the oils which can be used in it. Under the last head the author deals especially with the vegetable oils which are produced in great quantities in the French colonies in Africa and in Asia. It concludes with a short account of the tests of such engines carried out recently by the Society in conjunction with the Automobile Club of France and the marine and agricultural authorities. From the results we gather that several engines of horse-powers from $2\frac{1}{2}$ to 50 show a consumption of oil of the order of 320 grams per h.p. hour, while one of 20 to 30 h.p. consumes 247 grams only. M. Schubert's article, while intended primarily for French engineers, will be found of great value by the engineers of this country.

UNDERGROUND WORKROOMS.—In the Annual Report of the Chief Inspector of Factories for 1921 special reference is made to conditions in underground workrooms. Of the 300 rooms inspected during the inquiry a number were expressly designed for use as workrooms and the conditions were satisfactory. But others were never intended for use in this way and the structural conditions render it impossible to secure good lighting, ventilation and sanitary conditions. Of the rooms visited about 61 per cent. were provided with means for flushing the rooms with air, in 20 per cent. the through ventilation was only partial, and in 19 per cent. it appeared that there was practically no through ventilation. It was considered that the state of the air was fresh or satisfactory in 68 per cent. of the rooms, while in 24 per cent. it appeared to be close or stale, and in 8 per cent. stagnant. In approximately 78 per cent. of the rooms the natural light was deemed insufficient to light the whole of the room, but, fortunately, in most cases the artificial lighting was considered satisfactory in intensity although glare due to imperfectly screened lamps appears to be common. There is no doubt that access of light through windows is often neglected; in some cases broken windows are obscured by sacking, cardboard, etc. Daylight is undoubtedly superior to all but the very best artificial lighting, and the effect of a mixture of daylight and artificial light is rarely satisfactory. Every effort should therefore be made to secure the maximum admission of natural light in underground buildings. Another drawback to the use of basements as workrooms is the tendency for dust to enter from the pavement outside. Mention is made of a case where a trough fitted under a grid ventilator at pavement level was found to be filled by about a quart of black dust. Muslin or gauze is sometimes fitted over ventilator-entries to prevent dust entering, but the pores of the material are liable to become choked and it requires frequent washing.

A CHEMICAL SPECTROMETER.—A spectrometer of entirely novel design has recently been produced by Messrs. Adam Hilger, Ltd., of 75a Camden Road, N.W.1. By the application of an autocollimating telescope the designer has been enabled to dispense with the collimator tube of the ordinary spectrometer. The arrangement of the components is shown in the sectional drawing, Fig. 1. The eye-piece E of the telescope contains, on the left, the slit and small autocollimating prism for introducing the light which, after passing through the object glass O, proceeds to the 30° prism P, is reflected from the silvered back surface and re-traces its path through the object glass to the eye-piece where the spectrum is viewed. The prism is rotated by means of a micrometer screw which is attached to a drum D giving readings direct in wave-lengths. The design of the instrument renders it extremely compact. In size and external appearance it is similar to a microscope and occupies about the same amount of table space. It has the additional advantage of ease in setting up, convenience in manipulation and low cost, compared with a spectrometer of the ordinary type having a similar degree of accuracy. Such an instrument should tend to encourage the more general use of spectroscopic measurements in chemical laboratories.

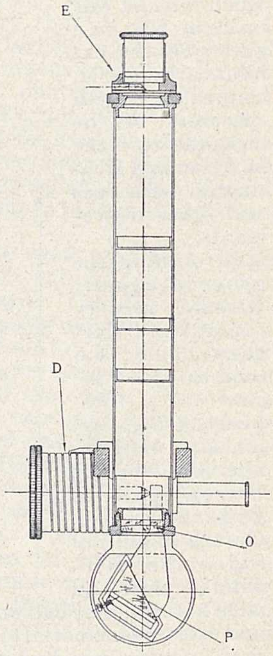


FIG. 1.

The Norman Lockyer Observatory.

UNVEILING OF A PORTRAIT MEDALLION OF THE FOUNDER.

ON Saturday, July 22, a portrait medallion of Sir Norman Lockyer was unveiled by the Astronomer Royal, Sir Frank Dyson, at the Norman Lockyer Observatory, Salcombe Hill, Sidmouth, in the presence of a large and distinguished company. The medallion, which had been executed by Sir Hamo Thornycroft, R.A., was erected in honour of the late Sir Norman Lockyer by his relatives and friends, and was presented by them to the Corporation of the Observatory. (A reproduction of the medallion, with the accompanying inscription, is illustrated in Fig. 1.) The guests were received on behalf of the Observatory Corporation by Sir Richard Gregory (chairman of the council), Mr. Robert Mond (chairman of the Corporation), and by Lady Lockyer. Much interest was taken by the guests in the exhibits arranged in connexion with the work of the observatory, the McClean and Kensington telescopes and other instruments.

In opening the proceedings Sir Richard Gregory remarked that they had assembled to take part in a ceremony of high significance both to the county of Devon and to British science. On the summit of Salcombe Hill, with its clear and wide horizon, they had united to dedicate with affection and esteem a memorial to the great astronomer, Sir Norman Lockyer, who had planted the observatory there. The event was one in which they might all be proud to participate, whether as Sir Norman's personal friends, as admirers of his life and influence, or as scientific students familiar with the remarkable advances of astronomical physics originated by him or inspired by his genius. His discoveries were inscribed upon the tablets of the stars, and in this temple of the skies they now met to manifest in reverence the honour in which they held him.

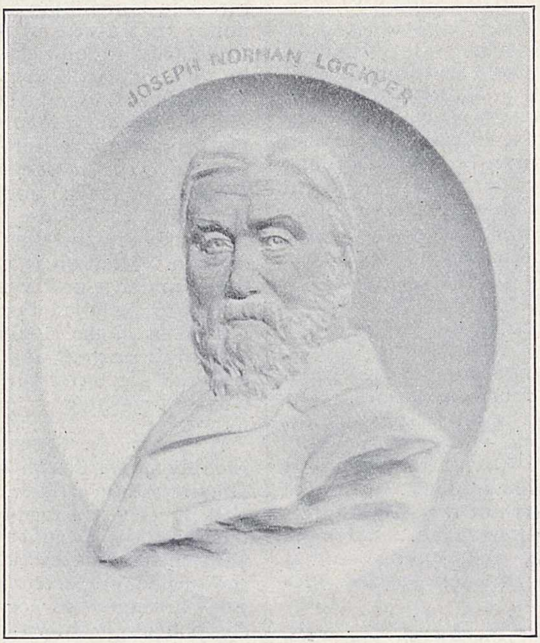


FIG. 1.—Portrait Medallion of Sir Norman Lockyer.

17TH MAY, 1836 - 16TH AUGUST, 1920
TO THE ENDURING MEMORY OF THE GENIUS AND CONSTRUCTIVE IMAGINATION OF

SIR NORMAN LOCKYER, K.C.B., F.R.S.,

CORRESPONDANT DE L'INSTITUT DE FRANCE.
HON. LL.D., GLASGOW, ABERDEEN AND EDINBURGH; HON. SC.D., CAMBRIDGE AND SHEFFIELD; HON. D.SC., OXFORD.

FOUNDER AND DIRECTOR OF THE SOLAR PHYSICS OBSERVATORY, SOUTH KENSINGTON, 1885-1913; AND OF THIS OBSERVATORY, 1913-1920.
FOUNDER AND EDITOR OF "NATURE," 1869-1919.
PIONEER IN THE INVESTIGATION AND INTERPRETATION OF THE CHEMISTRY OF THE SUN AND STARS AND IN THE SCIENCE OF ASTRONOMICAL PHYSICS.
DISCOVERER OF HELIUM IN THE SUN AND ORIGINATOR OF THE THEORY THAT HELIUM AND HYDROGEN ARE THE ULTIMATE PRODUCTS OF THE DISSOCIATION OF MOLECULES AND ATOMS.
FOUNDER OF THE SYSTEM OF STELLAR CLASSIFICATION BASED UPON ASCENDING AND DESCENDING TEMPERATURES IN ORDERLY CELESTIAL EVOLUTION.
REVEALER OF THE ASTRONOMICAL SIGNIFICANCE OF STONEHENGE AND OTHER ANCIENT MONUMENTS.
FOUNDER OF THE BRITISH SCIENCE GUILD FOR THE PROMOTION AND APPLICATION OF SCIENTIFIC METHOD TO PUBLIC AFFAIRS.

THIS PORTRAIT WAS ERECTED BY RELATIVES AND FRIENDS.

Lt.-Col. F. K. McClean said that he regarded it as a great honour to present, on behalf of relatives and friends, the medallion, so faithfully executed by Sir Hamo Thornycroft, to the observatory. It was his good fortune to have been associated with Sir Norman in the foundation of the observatory in 1912. Through the energy and enthusiasm of Sir Norman the observatory has proved a successful enterprise, and commencing as a private institution it has become a Corporation and is the first of its kind in this country. American observatories are more useful now, but the Norman Lockyer Observatory, though at present a baby, will grow and develop; and what its future may be can be seen by looking at the Mount Wilson, Yerkes, and Lick Observatories. So long as the observatory lasts, the name which it has the honour to bear will be the watchword of advance.

THE ASTRONOMER ROYAL'S TRIBUTE.

Sir Frank Dyson, in unveiling the memorial, said:

This portrait medallion is a pious tribute of relatives and friends to the memory of a man of genius. It recalls to our minds the features of a man we have known and honoured, and preserves his likeness for future generations. The name of Sir Norman Lockyer will always be associated with the application of the spectroscope to the study of the sun and stars. In this beautiful medallion Sir Hamo Thornycroft has given a true and striking portrait of a very earnest worker and great pioneer.

Like David Gill, another astronomer whom most of us know, Lockyer began as an amateur with a telescope in his garden and devoted his spare time to astronomy. The two men were alike in their energy and intense enthusiasm. One sees on nearly every page of his book on "Solar Physics," published in 1893, the delight which Sir Norman took in his work. He makes one feel that the years following Kirchhoff's explanation of the dark lines in the solar spectrum were glorious times for astronomers, who suddenly found a way to explore the chemical and physical constitution of the heavenly bodies. One could scarcely say that each day brought a new victory, but new victories and new problems followed one another very rapidly.

When Sir Norman Lockyer commenced his work in 1866, current views on the constitution of the sun were very different from those we now hold. Although Herschel's idea of the cool dark interior had been given up, some traces of its influence still remained. Faye conceived of the interior of the sun as a nebulous gas of feeble radiating power at a temperature of dissociation: the photosphere, on the other hand, being of a high radiating power and at a temperature sufficiently low to permit of chemical action. In the sunspot we see the interior nebulous mass. Balfour Stewart and De la Rue were opposed to this view and explained a sunspot as due to an inrush of matter from the sun's atmosphere into the photosphere. With a small direct-vision spectroscope on a 6½-inch equatorial, Sir Norman Lockyer examined the spectrum of a sunspot and compared it with that of the surrounding photosphere. He found no bright lines, but the same absorption lines as in the solar spectrum, and so far as he could judge with his small dispersion rather broadened. This supported Balfour Stewart rather than Faye. In a paper communicated to the Royal Society he laid stress on the importance of *detailed* spectroscopic study of the sun's surface. He also puts the question, "May not the spectroscope afford us evidence of the existence of the 'red flames' which total eclipses have revealed in the sun's atmosphere; although they escape all other methods of observation at other times?"

With the aid of funds from the Government Grant Committee he proceeded to construct a solar spectroscope of sufficient dispersion, and on October 20, 1868, wrote to the Royal Society: "After a number of failures which made the attempt seem hopeless I have this morning perfectly succeeded in obtaining and observing part of the spectrum of a solar prominence. As a result I have established the existence of three bright lines in the following positions:

I. Absolutely coincident with C.
II. Nearly coincident with F.
III. Near D.

The third line is more refrangible than the more refrangible of the two darkest lines by eight or nine degrees of Kirchhoff's scale."

A similar communication was made to the French Academy of Sciences, and in addition, the form of the prominence was roughly drawn. The letter to the French Academy was followed by a communication received the same day from M. Jannsen reporting the success of an expedition to observe a total solar eclipse. During the eclipse the idea had occurred to him of how the red flames could be made visible without an eclipse, and he carried it out on the following day. In this dramatic manner the observations of prominences was started, and their gaseous nature proved. The French Government struck a special medal in memory of the discovery and in honour of the discoverers.

Observation of prominences was after this success carried on with renewed vigour. By the simple device of widening the slit the forms of the prominences were seen in C or F light. A further important discovery was made almost at once. Sir Norman Lockyer found that bright C and F lines were visible all round the sun. In this way was discovered the existence of a continuous envelope round the sun of fairly uniform height except where it was heaped with prominences. This envelope was named the chromosphere and it was estimated to be about 5000 miles thick.

The behaviour of the F line, which is described as sometimes exceedingly brilliant and widening out so as to present a bulbous appearance above the chromosphere, and the existence of the line near D with no corresponding Fraunhofer line, suggested work in the laboratory. This was undertaken in conjunction with Edward Frankland. These investigations showed that the yellow D_3 line could not be obtained in the spectrum of hydrogen, however the conditions were varied. It was attributed by them to a new element, a light gas, as yet undiscovered on the earth, and the name helium was given to the element producing the line. As is well known, the D_3 line and allied lines were found to have great importance in stellar spectra, and in 1895 was found by Ramsay in a gas from the mineral cleveite. The subsequent history of helium and the prominent part it has played in physical science makes its initial discovery by Lockyer in the sun, twenty-six years before it was found on the earth, a most interesting episode in the history of science.

These laboratory experiments of Lockyer's and Frankland's are of great importance. Sir Norman had a strong conviction, at this early date, that research should be carried on concurrently in the observatory and the laboratory. The spectra found in the observatory were to be interpreted by experiments on the differences produced by temperature, pressure, and varied methods of electric excitation. In this way spectroscopy would lead to knowledge not merely of the chemistry, but of the physical conditions of the heavenly bodies. One immediate conclusion was that the continuous spectrum did not necessitate a solid or liquid photosphere but could arise from a gaseous body. Further, that the absorption indicated by the Fraunhofer lines may take place in the photosphere itself, or very near it, and not in an extensive outer absorbing atmosphere. How fruitful this method of research became in his hands and those of his pupils we all know.

At South Kensington his work was to a large extent a natural development and exposition of the views he had previously formed. The idea of the dissociation of elements at increasing temperature led to a very extensive comparison of the arc spectra of metals with those obtained in the higher temperature or more intense electric conditions of the spark. In 1881 he found that the iron lines 4924·1 and 5018·6 were greatly enhanced in brightness when one changed from the arc to the spark spectrum. The lines of iron, titanium, manganese, chromium, and many other metals were exhaustively investigated at South Kensington. The names of Proto-Iron, Proto-Titanium, etc., were given the metals when in condition to give these enhanced lines. We know now more definitely that what was described as dissociation is loss of an electron, and that when this occurs the enhanced lines appear.

It is scarcely possible to exaggerate the important results which have accrued from the study of enhanced lines. They have contributed greatly to the interpretation of solar and stellar spectra, and have assisted in the sorting out of lines of different elements into series.

In the course of his life Sir Norman Lockyer made observations of no less than eight total eclipses of the sun. His use of a spectroscope without slit led to a continuous increase of our knowledge of the spectrum of the chromosphere and corona. It has always seemed to me that the most successful of all eclipse expeditions was the one which he led in 1898 and in which he had Prof. Fowler and Dr. Lockyer among his assistants. The differences between the chromospheric and Fraunhofer spectrum were clearly shown as regards the hydrogen and helium lines and the numerous enhanced lines of many metals. In addition the wave length of the principal corona line was determined and some hypotheses as to its origin disposed of finally.

In 1887 Sir Norman Lockyer put forward a scheme of stellar classification in which the stars were arranged according to an ascending and descending scale of temperature. He presented his views in a connected form in his book on "The Meteoritic Hypothesis," published in 1890. In 1902 he published "A Catalogue of 470 Stars classified according to their Chemistry," from material accumulated at South Kensington with an objective prism and studied in the light of laboratory researches. For a long time he stood alone. If we refer to the book of such a learned and judicious astronomer as Newcomb, we find in 1901 ("The Stars," pp. 220-225) that he takes a linear order of development of the stars from the blue to the red, with the sun at about the maximum temperature in the series. Sir Norman could not get over the difficulty that a great orb like Betelgeuse or Antares must be in a widely different condition from a small star like Gr. 24 or Kruger 60. With great freshness of mind and boldness of onlook he framed the meteoritic hypothesis. A comet served as his model for the nebulous beginning of a star. With gradual contraction temperature increased in accordance with Lane's Law till the B stage was reached, after which cooling began, so that in the course of its history a star went twice through the yellow and red stages.

Twenty years later Prof. H. N. Russell, bringing together facts and arguments from many sides, has confirmed Sir Norman's main idea. He has shown that stellar evolution proceeds in the line of increasing density, and that stars of the same temperature may be divided into giants and dwarfs in Prof. Hertzsprung's phrase—in the giants the temperature is increasing and in the dwarfs decreasing.

Sir Norman did not succeed in finding the spectroscopic criteria for giving the sizes of stars. These were found later by Adams and Kohlschulter at Mount Wilson. It is very pleasant to be able to direct attention to the success attending work in this direction now carried on at the Norman Lockyer Observatory.

I cannot conclude without expressing in one sentence the deep obligations which all men of science owe to Sir Norman Lockyer for founding Nature. One cannot speak too highly of the usefulness of this journal or of the pleasure one takes in reading it each week. Its long continuance is a testimony to the wisdom and foresight of its founder.

The few remarks I have made have dealt very briefly with the main lines of Sir Norman Lockyer's contributions to astronomy—The constitution of the sun—the variety and relationship of terrestrial spectra—stellar evolution. To each of these questions he brought a very fresh mind, and attacked them with courage and imagination. He was a great pioneer of solar and stellar physics. This portrait medallion with its inscription commemorates him in the most suitable place in the observatory which he founded, and which is faithfully carrying on the search prosecuted by him so diligently and successfully into the nature of sun and stars.

Constitution and Work of the Observatory

Sir Richard Gregory, in expressing the grateful thanks of the Corporation to the subscribers for their most acceptable gift, said:

As one who had the privilege of being associated with Sir Norman in different capacities for nearly thirty years, as research student, assistant editor of Nature, and in connexion with the great national organisation—the British Science Guild—created by him in 1905, perhaps I may be permitted to add my tribute to what the Astronomer Royal has said, and to state briefly what this observatory stands for and what we hope it will be in the near future. Sir Norman Lockyer was seventy-six years of age when he started to establish the observatory in 1912, and this in itself is sufficient to show his unbounded zeal and energy. An appeal for funds was made, and some generous supporters came forward, but the means for providing the necessary buildings and equipment, the site itself, and sums for maintenance for several years, were supplied mainly by Sir Norman and Lady Lockyer and Lt.-Col. Frank McClean. The observatory was incorporated in 1916, and its constitution is entirely democratic. Each member of the corporation, whatsoever his contribution, has a single vote, and membership is open to any one approved by the council.

The corporation is unique in its purpose and its constitution. It exists solely to maintain and develop this observatory, not for financial profit but for the gain of knowledge of the heavens. Its foreign members include some of the leading astronomers of the world, and a Research Committee, consisting of Sir Frank Dyson (Astronomer Royal), Prof. Eddington (Cambridge University), Prof. Fowler (Imperial College, South Kensington), and Prof. Turner (Oxford University), advises upon work which may be usefully undertaken. The management and control of the observatory are vested in the council, which is elected by the members.

In these days it may be difficult for some people to realise that a corporation can be formed in which all the services of the council and advisory committees are performed voluntarily, yet such is the case with this observatory corporation. Were it not, indeed, for gifts by members of the corporation, among them the Maharaj Rana of Jhalawar, Mr. Robert Mond, Miss Leigh Browne, Capt. W. N. McClean, and others, as well as for work willingly and freely undertaken, the observatory could not exist. In order to provide, however, for the salaries of the staff and general maintenance of the observatory, even on the present basis, it will be necessary to raise the sum of, at least, fifteen thousand pounds, as the funds hitherto subscribed provide less than one-half the annual income required to meet expenses. We are fortunate in having as director of the observatory Major Lockyer, and it is really wonderful what he manages to accomplish with his assistant, Mr. D. L. Edwards. There is no observatory in the kingdom where more photographs are being taken of the spectra of the stars, from which we learn something of celestial chemistry and are able to classify them from their beginnings as vast attenuated masses up to fervid suns which afterwards cool and condense to the dull redness and darkness of decaying worlds. A generation ago, celestial evolution was believed to proceed entirely on a down grade of temperature from the condition of incandescent gas in a nebula, but Sir Norman Lockyer showed that there is an ascent as well as a descent in stellar temperature, and this key to the classification of the stars is now generally accepted by astronomers.

The large number of photographs of stellar spectra accumulated by Sir Norman Lockyer and largely taken at this observatory under his direction and that of his son, are now being used to determine the distances of stars by a method due to Prof. W. S. Adams, one of the foreign members of the observatory. The measurements are being made by Mr. D. L. Edwards and Mr. W. B. Rimmer. The Department of Scientific and Industrial Research has made a grant to the latter for the purpose of carrying out a portion of this research while attached to the observatory. The equipment and opportunities here for both education and research in the physics and chemistry of celestial bodies are as full and free as could be desired by the most progressive student or investigator. The endowment of two or three research scholarships tenable at this observatory would be the best service that could be rendered to astronomy, and would certainly result in notable increase of our knowledge of the heavens.

It is remarkable that in the United States funds are provided for observatories and astronomical work, by both university institutions and private benefactions, on a scale far beyond anything available in this country. We once led in astronomy, but America now surpasses us both as regards great observatories and remarkable achievements. Whatever funds are required for buildings, equipment, and workers are readily forthcoming, whereas here benefactions for astronomical work are extremely rare. The Mount Wilson Observatory, where the best astronomical work in the world is now being carried on under the direction of Dr. G. E. Hale, one of our foreign members, cost more than a quarter of a million pounds, and has an annual income exceeding 40,000*l*. It possesses a 100-inch telescope, upon which more than 100,000*l*. has been expended, and it was in connexion with this instrument that nearly two years ago the remarkable achievement was accomplished of measuring the diameters of certain stars, among them the star Antares, which proves to have a diameter of 400 million miles. The Yerkes Observatory, Lick Observatory, Harvard College Observatory, and Lowell Observatory are other examples of great astronomical institutions in the United States which we both admire and envy. The difficulty there is not to obtain funds for astronomical work, but men who will devote their lives to it: here we have plenty of men eager to take up astronomical research but no means to provide them with the necessary instruments and modest salaries to maintain them.

The Norman Lockyer Observatory is the only institution of its kind in this country, and it owes its existence to the generosity of a few people who believe that to place here a temple devoted to the increase of knowledge of the heavens is to provide a mansion in the skies. The county, the nation, and the whole world of science, owe a deep debt of gratitude to the founder and to his supporters, for this fine building reaching out high unto the stars to question them and understand the messages they send us in their beams. For the means to continue and extend the work so nobly instituted and profitably begun, we appeal to all who are interested in the pursuit of knowledge for its own sake or because of its uplifting influence upon the spirit of man. In faith and hope we ask that this memorable occasion shall mark the beginning of a new and enlarged stage in the history of this observatory, and that the future will see upon this site a centre of modern astronomical research which will maintain the prestige of British science throughout the world and be a worthy memorial to the renowned astronomer who built here this tower from which the heavens can be scanned for intellectual expansion and the enlightenment which the spirit of man is ever seeking as to his destiny.

Col. J. E. H. Balfour, High Sheriff and Lord of the Manor of Sidmouth, expressed on behalf of the county appreciation of Sir Norman's association with Devon and the neighbourhood of Sidmouth. While Sidmouth was famed for its natural advantages of climate and scenery it was little thought that these advantages would be turned to such wonderful and useful purposes. He was glad to know that the confidence felt in the suitability of the site for the observatory had been amply justified, and he deemed it an honour to Sidmouth to possess such an observatory. He expressed the wish that the observatory would have a great future in the advancement of science and knowledge that it deserved.

The Rev. J. S. Cornish recalled that in his memory the grounds of the observatory were formerly one of the wildest and least useful parts of Salcombe Regis. He little thought it possible that from such an expanse of waste would arise an institution that had already become known throughout the scientific world. He referred to the stone of the old sun-worshippers, which still stands near the observatory land where now the modern astronomer reads the truth of the stars with his magnificent telescopes. He hoped that the observatory would become increasingly famous throughout the world, as was the heart's desire of its founder, Sir Norman Lockyer.

Lady Lockyer heartily thanked those who had assembled that day for the unveiling ceremony. Sir Norman looked forward to the observatory being a place where research students could carry out investigations in any branch of spectroscopic research. The provision of a library was essential to house the large collection of books. This would cost about 2000*l*. and they had not that amount of money to spend on it. She hoped a much greater interest would be taken in the work of the observatory, and that the expansion of its activities would not suffer from lack of support. Lady Lockyer expressed the gratitude of Sir Norman's family that his portrait was erected in the observatory which he founded and directed, and which now, by the wish of all the members, bears his name.

Pioneer Work in Submarine Cable Telegraphy.

THE jubilee celebrations of the Eastern Associated Telegraph Companies are so nearly contemporaneous as to seem to be almost part of the commemoration of the foundation of the Institution of Electrical Engineers, which antedated that of the Company by only a few months. These celebrations carry with them a warning not to lose our sense of historic proportion: they remind us that before a Society of Telegraph Engineers could be established, telegraph engineering had already been well founded, and that the great submarine cable company which now for fifty years has served the Empire and the whole world with such conspicuous ability and commercial success could scarcely have been the concept of the earlier pioneer days. Only when the art of submarine telegraphy had been amply assured of success could so great a commercial undertaking as that which the Eastern Telegraph Company is now celebrating be initiated.

The following notes on the pioneer work of the cable engineers and others have been drawn freely from the discourse which Sir Charles Bright delivered at the Electrical Engineers' commemoration.

Perhaps it is a little far-fetched to treat quite seriously the earliest suggestion that electric signals might be sent under the sea. Yet it is worth while to note that so early as 1811 an effort was made to discover a suitable insulating covering for a submarine wire and that the material used was indiarubber. The decisive factor whereby submarine telegraphy became a practical proposition was, however, contributed by Dr. Werner Siemens in 1847 when he laid a telegraph cable in Berlin with wires insulated by gutta-percha. Faraday, as Sir Charles Bright reminds us, was also at the same time directing attention to the insulating properties of this new material. Gutta-percha has never from that day to this had a serious rival for insulation of deep-sea cables.

Not that the pioneers had waited for it! Previously, in June 1845, the brothers Brett, although only small shopkeepers, in the true spirit of the old merchant venturers applied for government sanction to the provision of telegraphic communication between England and France. When the concession came in 1849, gutta-percha had come into its own and most of the cable laid was of copper wire with a half-inch coating of gutta-percha. The need for a special "shore-end" was recognised even then; but it is puzzling to know why a different insulation should have been adopted. Yet we read that "the shore-ends for about 2 miles from each terminus consisted of a No. 16 BWG. conductor covered with cotton soaked in indiarubber solution, the whole being encased in a very thick lead tube." It is scarcely surprising that it failed, but not before, by transmission of a few signals, it had demonstrated the practicability of ocean telegraphy. A "mad freak," a "gigantic swindle," but, like many another failure, a signpost to success. The next year a new concession was secured and the Submarine Telegraph Company was formed, but it was only floated on the capital of a railway engineer (Thomas R. Crampton) and his friends. The resulting cable, not completed until the end of 1851, marked another development of the engineer's art in cable-making. Küper, a colliery engineer, suggested sheathing the insulated wire with iron wires like a colliery pit rope; and so was reached the essential, and till now the final, form of the successful and trustworthy submarine cable.

Perhaps one day some one will write a work on "Government *versus* Enterprise" in the hope that responsible public servants may be taught by their predecessors' failures. In 1850 the Bretts again found that, "although sensible of their perseverance in bringing the submarine telegraph about," the Government could do nothing to help, and so—"landing rights" not having yet been invented—the Bretts proceeded on their own responsibility to span the Irish Channel. Ultimately success was achieved in 1853, with Charles Tilston Bright (aged 21) in command as engineer to the Magnetic Telegraph Company.

These efforts, however, although they had demonstrated the practicability of submarine telegraphy, had not finished the work of the pioneer—the great unfathomed depths of ocean had yet to be spanned. To put a cable miles deep on the bed of the Atlantic would be impossible, it was said, even if signals could be passed through the enormous length of 2000 miles. Of course pioneers are never very anxious to do anything but the impossible; so J. W. Brett, Cyrus Field (a wealthy American business man who incidentally had discovered, or perhaps invented, "landing rights" for Newfoundland) and Charles Bright (as engineer) projected and with other venturers formed the Atlantic Telegraph Company and secured the required capital in a few days. This was of course only the beginning of the pioneer engineers' work. The British and the United States Governments encouraged and helped the scheme with men-of-war, and at last on August 5, 1858, the shore-end having been duly landed at Newfoundland, the telegraph had bridged the ocean; and the *Times* could say "since the discovery of Columbus nothing has been done in any degree comparable to the vast enlargement which has thus been given to the sphere of human activity." Unfortunately, although the practicability of the scheme had been amply demonstrated and the engineering success was unquestionable, after about two months' work the communication failed—the conductivity of the cable was too low and the power applied to it was too high.

Then followed cables to the east—to Malta, Alexandria and India *via* the Persian Gulf, and it was not until 1865 that any further effort to lay a cable across the Atlantic was projected. In the meantime, Lord Kelvin had perfected his wonderful mirror apparatus, the progenitor of the syphon recorder; closer knowledge of the actual requirements had been secured and improvements in methods of manufacture developed. Also the paying-out and picking-up gear had been largely developed by Henry Clifford, and Brunel's great ship the *Great Eastern* was available to take the large core cable that Bright had succeeded in securing. By the end of 1866 there were two cables working across the Atlantic and the pioneers had about finished their part of the business. The next was routine—and skill combined with knowledge. Other cables followed, east and west; and then in 1872 commenced the great commercial achievements under Sir John Pender, which the Eastern Telegraph Companies are celebrating, after fifty years, with such justifiable pride.

International Chemistry.

THE International Union of Pure and Applied Chemistry held a successful annual meeting in Lyons on June 27-July 2. This was the third annual meeting and a good deal of time was, as on the former occasions, devoted to the details of organisation and the business of getting such an international body well established. Prof. Moureu has been president for three years and has had a difficult task in framing a policy for the score of nations who are now represented in the Union and in guiding them into harmony in these troublous times. He has achieved his desire, and the Union seems likely to continue for many years and to have an increasing importance. It is intended in the future to pay more attention to the purely scientific side of the subject and to attempt some discussions which will be of permanent value.

The Lyons meeting was well attended, about a hundred and twenty delegates taking part, among whom may be mentioned Messrs. Swarts and Timmermans (Belgium), Billmann (Denmark), Mourelo (Spain), Parsons, Bartow, and Washburn (United States), Grignard, Kestner, Marie, Moureu, and Perrin (France), Pope, Lowry, Hewitt, and Mond (Great Britain), Nasini and Paterno (Italy), Bodtker (Norway), Cohen, Kruyt, and Verkade (Holland), and Votoček (Czecho-Slovakia). Lyons is well provided with suitable buildings for the various meetings and social functions and there are many objects of interest in the vicinity. The commissions on nomenclature, publications, standards, food analysis, industrial hygiene, and international patents continued their work and presented interim reports. To carry out the recommendations of these commissions requires more money than the International Union can provide, and a finance committee was appointed to allocate such funds as are available to those commissions the needs of which seem to justify the expenditure the most. It will be a case of the survival of the fittest, and the members of the finance committee, Messrs. Fraser (U.S.A.), Bertrand (France), Pomilio (Italy), and Miall (England) are not likely to be very popular with the members of the various commissions.

M. Kestner presided over the commission on international patents, a difficult problem which admits of no speedy solution. He has a plan for dealing with some of the defects of the existing system but proposes no universal panacea for all the inventors' troubles. Those who are interested in this thorny question might well communicate with him or the Société de Chimie Industrielle in Paris.

Interesting papers on purely scientific subjects were read by Profs. Perrin and Vignon.

Owing to the inability of some of the members to visit Lyons at this time the important Committee on the Elements which replaces the old International Committee on Atomic Weights did not meet. It is now meeting or has just met in Paris, and an authoritative list of atomic weights, isotopes, and other such data should be issued at a suitable interval after that meeting.

The Union elected as president for the ensuing three years Sir William Pope, and as vice-presidents for the same period Profs. Bancroft, Paterno, Billmann, and Votoček. It is probable that two additional vice-presidents will in due course be elected also, a proposal which is necessitated by the growing number of the countries concerned in the Union.

The next meeting will be held in Cambridge in the latter part of next June, and a considerable effort will be made to render this meeting one of real chemical importance. The French, who have been very prominent in the early stages of the Union, have done such good work in very difficult circumstances that it is felt that the English must, to maintain the tradition now that things are becoming a little easier, play their part in a manner which will be worthy of the ancient University which offers its hospitality and of the new president who will direct the proceedings of the meeting.

It is quite likely that the Society of Chemical Industry will hold its annual meeting next year in Cambridge immediately after the meeting of the International Union and a considerable migration of British and foreign chemists may be expected.

Radio Broadcasting in Great Britain.

DISAPPOINTMENT has been expressed at the delay in introducing radio broadcasting, arrangements for the establishment of which have been under discussion for some time past by the Postmaster-General and manufacturers of radio apparatus. The necessity, however, for the most careful and thorough examination of all aspects of the question is best illustrated by considering the present position of broadcasting in the United States. Radio broadcasting was commenced by the Westinghouse Electric and Manufacturing Co., for the information and entertainment of the public. Their success, however, produced a host of imitators, and broadcasting stations were established indiscriminately, some privately and some publicly owned. Only during the last few weeks has the United States Government taken action to co-ordinate and control indiscriminate transmission from radio-telephonic stations. When two broadcasting stations send out messages at approximately the same wave-length the electrical waves interfere with each other and the listener hears the conversation of two people speaking at the same time. It is not surprising to learn that the absence of a co-ordinating authority in the United States has resulted in a service which is unsatisfactory to the public owing to the lack of general agreement as to hours of operation, wave-lengths employed, and the character of broadcasted matter.

The British Government has wisely and properly decided that broadcasting licences will not be issued until those interested in carrying out this work are agreed on a scheme which will ensure, in the first place, efficiency and continuity of broadcasting, and, in the second place, agreement respecting hours of working, wave-lengths, number and location of stations, etc. Only in this way can confusion be prevented. Furthermore, the Government desires to prevent the broadcasting of advertising matter, in addition to having to safeguard the interests of newspapers and news agencies, Army, Navy, and Air Force work, commercial radio-telegraphy, etc.

We understand that about twenty manufacturers applied to the Postmaster-General for leave to broadcast, and during the preliminary discussions it became evident that the erection, equipment, maintenance, and operation of a proper broadcasting station costs approximately 20,000*l*. per annum. A number of manufacturers therefore intimated their desire to abandon the idea of broadcasting, while about six of the strongest electrical concerns in the country interested in radio developments are prepared to continue. The manufacturers appointed a subcommittee to draft a scheme, and this committee reached agreement on all the main features of a broadcasting system for Great Britain. They were, however, unable to put forward an agreed scheme for one company to undertake broadcasting. It is now understood that the manufacturers have divided themselves into two groups, each of which is proceeding to form a broadcasting company, with one or other of which all manufacturers of radio apparatus would be associated. At the same time the Postmaster-General has intimated his willingness to give a licence to each of these companies to operate stations. The two groups between them undertake to establish a sufficient number of stations to serve the whole country. There will probably be one station belonging to each group in London and seven other stations distributed throughout Great Britain, divided between the two groups by mutual arrangement or, if agreement is not reached, by allocation of the Postmaster-General.

There is little doubt that details of working arrangements between these two groups will shortly be settled, and that broadcasting will be established on a basis which will give efficient and continuous service to the public without the hopeless confusion and lack of adequate control evident in the United States.

If each of the above nine stations is to have an annual cost of about 20,000*l*. per annum, the two broadcasting groups have to contemplate an outlay of 180,000*l*. per annum. In order to assist the groups in securing an adequate return for this enormous outlay, it has been suggested to the Postmaster-General that a portion of the licence fees paid by users of receiving sets should be returned to the broadcasting groups. The groups represent between them the whole of the manufacturers of radio apparatus in this country, and their constitution is such that a genuine manufacturer must be admitted if he so desires. The arrangement, therefore, does not exclude any genuine manufacturer, either now or in future, from playing his part in the business of manufacturing and selling receiving sets, and cannot therefore in any sense be regarded as creating a monopoly. Should the share of the annual licence fee paid to the broadcasting groups provide more money than is necessary to carry on the work, the licence fees could be automatically reduced.

Radio receiving apparatus lends itself particularly to manufacture abroad, in countries on the Continent where the depreciated exchanges make it possible to export receiving sets to this country at a price which would prohibit manufacture here. If this is allowed a promising new industry which will give employment to a very large number of people will be strangled before it has a fighting chance to succeed, and an opportunity of relieving distress arising from unemployment will be lost. Help for this industry, which may have ramifications far more important from the national point of view than the provision of entertainment or even methods of communication, may be given in some way. The Postmaster-General does not propose to license receiving sets unless made by members of one or other of the broadcasting organisations.

It is questionable whether manufacturers will be prepared to risk incurring the heavy expense attached to a broadcasting scheme if conducted in a proper manner, unless some assistance on the lines suggested can be provided. It is also not unreasonable to ask the public to assist in the cost of broadcasting, in view of the likelihood of providing programmes such as the following, which is typical of the best American stations.

"At six o'clock each evening, summary of important news, commercial, general, and sporting, followed at 7 P.M. by special addresses and lectures by business men and women. At 7.30 P.M. a bed-time or nursery story is provided for children, and at 8, for the remainder of the evening, a high-class musical programme comprising vocal and instrumental items or orchestral selections. Time signals are radiophoned at definite hours.

"On Saturdays the musical side of the programme is increased to include afternoon as well as evening performances. On Sundays church and chapel services and sermons are transmitted during morning and evening, with a Bible story for children during the afternoon.

"The lectures and music cover an extraordinarily wide range and appeal to all tastes, while the character of the broadcasted matter is varied and the quality is uniformly high. The tendency is to avoid transmission of gramophone music."

There will be nothing of interest to hear until broadcasting programmes are established, but a number of English stations can be set up very quickly once the preliminary discussions are completed and conditions of working settled, and there is reason to believe that by the autumn the country will be able to enjoy the best broadcasting in the world.

University and Educational Intelligence.

BANGOR.—Dr. Edward Greenly has been appointed "Special Lecturer" in geology. Dr. Greenly has for the last twenty years been engaged on a detailed study of the geology of Anglesey, and has recently published an account of his researches in a monograph "The Geology of Anglesey" (2 vols.), which has been issued under the auspices of the Geological Survey. For this work, Dr. Greenly received the Honorary Degree of D.Sc. from the University of Wales. Dr. Greenly is now studying the Carnarvonshire coast. His appointment as "Special Lecturer" will enable him to direct the studies of advanced students who wish to work in this district, which is well suited for geological research.

EDINBURGH.—At the recent graduation ceremonies on July 21, science was represented in the list of Honorary Graduates in Laws by the following: Sir Isaac Bayley Balfour and Sir J. Halliday Croom, recently retired from their respective chairs; Prof. J. B. Farmer of the Imperial College of Science and Technology, London; Sir Thomas Middleton, formerly of the Board of Agriculture; Mr. J. W. Mollison, late Inspector-General of Agriculture in India; M. Roger, Dean of the Faculty of Medicine of the University of Paris; Sir Charles S. Sherrington, Waynflete professor of physiology in the University of Oxford, and Dr. W. Somerville, professor of rural economy in the University of Oxford.

Dr. E. M. Wedderburn, known for his experimental work on seiches and for his services during the war as a meteorologist, has been appointed to the chair of conveyancing in the University.

LONDON.—Dr. J. F. Unstead, head of the geography department, Birkbeck College, has been appointed professor of geography in the University, in respect of the post held by him at Birkbeck College.

MANCHESTER.—The following have been awarded the degree of Doctor of Science: Mr. A. F. Campbell, for theses on (i.) The influence of the introduction of the methyl group into the phenol molecule; (ii.) The separation of phenol, ortho-, meta-, and para-cresols from crude coal tar and carbolic acids; (iii.) A method for the preparation of β-naphthyl-amine; and seven other papers. Mr. J. N. Greenwood, for theses on (i.) The constitution of copper-aluminium alloys; (ii.) Applications of optical pyrometry in steelworks practice; (iii.) Heat flow of steel during ordinary processes of manufacture; and six other papers. Mr. W. A. Harwood, for a memoir on upper air work in India. Mr. J. Holker, for a thesis on the periodic opacity of certain colloids in progressively increasing concentration of electrolytes; and twelve other papers. Mr. J. E. Jones, for theses on (i.) The distribution of energy in air surrounding a vibrating body; (ii.) The velocity distribution function of the stresses in a non-uniform rarefied monatomic gas; (iii.) The kinetic theory of electrical conduction in an ionised monatomic gas; and three other papers. Mr. J. Pearson, for memoirs on (i.) The Holothurioidea of the Indian Ocean; (ii.) Cancer; and a large number of articles and reports on biological work in Ceylon.

A PHYSICIST is required by the Research Association of British Motor and Allied Manufacturers for work as a senior research assistant. Applications are to be made by letter to the Secretary of the Association, 15 Bolton Road, Chiswick, W.4.

THE British Silk Research Association, Inc. (Kingsway House, Kingsway, W.C.2), invites applications for the appointment in its laboratory in Leeds of a chemist with research experience and special qualifications in physical chemistry. The latest date for the receipt of applications is August 11.

APPLICATIONS are invited for the position of a plant physiologist in the division of botany of the Department of Agriculture, Union of South Africa. Candidates must possess a University degree and have carried out research work in plant physiology. Applications, with particulars of education, qualifications and experience, etc., all in duplicate, must reach the Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2, not later than August 30.

A DIRECTOR of fisheries for Bengal is to be appointed shortly by the Ministry of Agriculture and Fisheries for a period of at least three years. Candidates are expected to have a first-class knowledge of marine biology, and practical experience in fishery work. Further particulars may be obtained from the Fisheries Secretary, Ministry of Agriculture and Fisheries, 43 Parliament Street, London, S.W.1, to whom all applications, accompanied by not more than six testimonials, should be addressed by, at latest, August 20.

Two research scholarships in veterinary science, each of the annual value of 200*l*. and tenable for three years, are being offered by the Ministry of Agriculture and Fisheries. The scholarships are open to candidates who have obtained the diploma of the Royal College of Veterinary Surgeons, or who have shown evidence of proficiency in medicine or other relevant branch of science. Applications will be received until August 15 on the prescribed form, of which copies may be obtained from the Ministry at 10 Whitehall Place, S.W.1.

THE prospectus for the year 1922–23 of the Technical College, Bradford, contains very complete accounts of the courses of study offered by the College. Diploma courses, which involve full-time attendance for three or four years, are arranged in the departments of civil, mechanical, and electrical engineering, textile industries, chemistry, dyeing, and occasionally in biology. These courses are suitable for students desirous of presenting themselves for the honours examinations of the University of London. There are also special day courses in these departments, and preparation is given for the professional examinations in medicine, dentistry, and pharmacy. Part-time day courses are arranged in various subjects which are suited to the needs of apprentices and others who are unable to devote the whole of their time to study. The prospectus gives particulars of the conditions for the admission of students, and there are also detailed syllabuses of the various courses.

THE Ramsay Memorial Fellowship trustees have made the following awards: Ramsay Fellowship of the value of 300*l*. tenable for one year, but renewable for a second year, to Dr. R. W. Lunt, of the University of Liverpool, and of University College, London, for the continuation of his work at University College, London, on chemical effects of electromagnetic waves over the frequency range, $10^5 - 10^8$ cycles; Glasgow Ramsay Fellowship of 300*l*. to Mr. J. A. Mair, of the University of Glasgow, who will continue his research on the chemistry of the terpenes; a special Fellowship of 300*l*. for one year to Mr. W. Davies, who has already held a Ramsay Fellowship for two sessions and whose work, especially that on the preparation of synthetic reagents from the toluic acids, shows special promise; Danish Ramsay Fellowship to Mr. Kristian Höejendahl, of the University of Copenhagen, who will pursue his research in the University of Liverpool; two Swedish Ramsay Fellowships, to Dr. J. O. G. Lublin and Mr. A. W. Bernton; and two Norwegian Ramsay Fellowships to Mr. Dag Nickelsen, who will work at the Imperial College of Science and Technology, and Miss Milda Prytz, who will work at University College, London. A special Ramsay Fellowship of the value of 350*l*., which was placed at the disposal of the National Research Council of the United States of America, has been awarded to Dr. C. S. Piggot, of Baltimore, who will begin work at University College, London, in October.

Calendar of Industrial Pioneers.

August 7, 1834. Joseph Marie Jacquard died.—A native of Lyons, which he helped to defend against the armies of the Convention in 1793, Jacquard was a weaver by trade. Becoming known for his ingenuity and his attempt to construct lace-making machines, he was employed by Carnot at the Conservatoire des Arts et Métiers, and on December 23, 1801, he patented his well-known loom for weaving figured materials. Though like Arkwright he met with much opposition, Napoleon in 1806 granted him a pension of 6000 francs and a premium on each loom erected.

August 7, 1913. Samuel Franklin Cody died.—Accidentally killed when flying at Aldershot, Cody was one of the most enthusiastic of the early fliers and was the designer and constructor of the machines he flew. Born in 1861 in Birdville, Texas, after a somewhat chequered career he gained a reputation by his experiments with kites, and in 1906 was appointed chief instructor in kite-flying to the British Army.

August 7, 1747. Martin Triewald died.—A promoter of industrial progress in Sweden, Triewald was born in Stockholm. He spent some years in England as manager of a coal mine at Newcastle, and on his return to his native country introduced the use of the Newcomen atmospheric engine.

August 8, 1873. Sir Francis Ronalds died.—One of the pioneers of the electric telegraph, Ronalds was the son of a London merchant. Born in 1788, he was early engaged in scientific pursuits, and in 1816, in the garden of his house in Hammersmith, laid down eight miles of wire through which he sent signals by the aid of a small frictional machine. From 1843 to 1852 he was honorary director of the meteorological observatory at Kew.

August 10, 1896. Otto Lilienthal died.—After achieving success as an engineer and manufacturer, Lilienthal in 1889 began his experiments in flight. With machines of his own construction he made many long gliding flights from the top of an artificial mound nearly 100 feet high at Lichterfelde, and it was while pursuing these experiments that he met with the accident from which he died.

August 12, 1848. George Stephenson died.—Recognised as the father of our railway system, and as the chief pioneer of the locomotive, Stephenson built his first successful locomotive in 1814 while engine wright at Killingworth Colliery. For the Stockton and Darlington Railway he constructed and drove the *Locomotion* with which the line was opened in 1825, and four years later achieved a notable success with the *Rocket* constructed for the Liverpool and Manchester Railway. Stephenson was engineer to both of these lines and was afterwards engineer also to the London and Birmingham, the Manchester and Leeds, the Manchester and Birmingham and other important railways. He was the first president of the Institution of Mechanical Engineers, founded in 1847.

August 13, 1897. Sir Isaac Holden died.—Born near Paisley in 1807, Holden at the age of ten began work in a cotton mill. From a shawl weaver he became a school teacher and then a book-keeper for a Glasgow worsted firm. Turning his attention to invention, with Lister (afterwards Lord Masham) in 1847 he took out a patent for combing and preparing genappe yarn and founded a factory at St. Denis, Paris. He afterwards concentrated his business at Bradford, where it became the largest woolcombing concern in the world. E. C. S.

Societies and Academies.

PARIS.

Academy of Sciences, July 3.—M. Emile Bertin in the chair.—The president announced the death of Prince Albert of Monaco, foreign associate of the Academy.—P. A. Dangeard: The structure of the cell in the Iris. In a recent communication the author has given a detailed description of the plastidome and spherome in the leaves of *Iris germanica*: this is supplemented in the present paper by similar details for the same formations in the tissues, petals, sepals, stamens, ovary and ovules. The plastidome and spherome are independent formations and have an existence as general as the nucleus in the plant cell.—André Blondel: The unsymmetrical electric arc between carbon and metals.—M. Albert Recoura was elected correspondant for the section of Chemistry in the place of the late M. Ernest Solvay.—The Permanent Secretary announced the death of M. Otto Lehmann, correspondant for the section of Mineralogy.—Armand Cahen: Singular solutions of differential equations of the first order.—Miécislas Biernacki: The displacement of the zeros of integral functions by derivation.—R. Jarry-Desloges: Contribution to the study of the surface of planets. The systematic observation of the planetary surfaces, especially of Mars, commenced in 1907 at Revard, have been continued in May and June of this year at Sétif, with the 37 cm. and 26 cm. refractors. The decoloration of certain dark areas in the southern hemisphere of Mars, observed in 1909 at Revard, has been seen again this year.—Jules Baillaud and Mlles. Bonnet, Clavier, and Lhomme: Distribution of stars in the Paris zone of the astrophotographic catalogue.—Axel Lindh: The absorption spectrum of sulphur for the X-rays. An examination of sulphur compounds grouped according to the valency of the sulphur. As in the case of chlorine previously studied, the limits of the K absorption for sulphur are displaced towards the shortest wave-lengths for the higher valencies.—Albert Portevin: The thermal treatment of cast pieces, and especially of cast projectiles. Thermal treatment produces porosity in the metal.—Roger G. Boussu: The limit of inflammability of the vapours of the alcohol-petrol system and of a triple system containing as base alcohol and petrol.—C. Matignon and M. Fréjacques: The transformation of gypsum into ammonium sulphate. Calcium sulphate was stirred with concentrated ammonium carbonate solution in approximately equimolecular proportions. Equilibrium was reached after five hours, about 96 per cent. being converted into ammonium sulphate.—Albert Granger and Pierre Brémond: The chemical composition of rock, supposed to be kaolin, from Djebel Debar, Algeria. This is formed of halloysite, associated with a hydrated aluminium silicate containing combined sulphuric acid.—Paul Thiéry: The upper Bajocian of Lorraine.—G. Denizot: The last variations of the marine level on the coasts of Basse-Provence.—P. Bugnon: The basifuge acceleration in the hypocotyl.—G. Nicolas: A new host of Phyllosiphon. This parasite was found on *Arum italicum* near Toulouse. This resembles *P. Arisari*, and if not belonging to a different species, constitutes a different biological strain, since although *Arisarum vulgare*, carrying *P. Arisari*, grows in the neighbourhood of *Arum italicum* in Algeria, the latter plant has not been found attacked by the parasite.—Pierre Lesage: Experiments on the movement of liquids in cell masses.—Jacques de Vilmorin and Cazaubon: The catalase of seeds. The presence of catalase cannot be taken in all species as a proof of the vitality of the seed.—Marc Romieu and Fernand Obaton: Comparative spectroscopic study of the green pigment of the Chetoptera and the chlorophyll of the green alga, *Ulva lactuca*. The chetopterin is regarded as a pigment of extrinsic origin, and is a modified chlorophyll.—Mme. Danysz-Michel and W. Koskowski: Study of some digestive functions in normal pigeons, fed with polished rice or kept without food. Comparative experiments made with pigeons on four different diets: normal diet, no food, polished rice only with and without daily injection of histamine. From the examination of the gastric juice and intestinal contents it is concluded that the observed facts can be explained without assuming the intervention of a vitamin.—J. Athanasiu: Nerve motor energy: electromyograms.—L. Garrelon, D. Santenoise, and R. Thuillant: The action of peptonic shock on the vago-sympathetic nervous system.—P. Wintrebert: The first manifestations of nervous co-ordination in the body movements of *Scylliorhinus canicula*—Pierre Girard: Remarks on a note of M. L. Lapicque on the mechanism of the exchanges between the cell and the surrounding medium.—W. R. Thompson: The theory of the action of entomophagous parasites. Increase in the proportion of hosts carrying parasites in cycle parasitism.—S. Metalnikow: An epizootic disease in the caterpillars of *Galleria mellonella*.—R. Cambier and E. Aubel: The culture of bacteria in a medium of definite chemical composition, with pyruvic acid as a base. The degradation of pyruvic acid. In these cultures the only source of carbon is sodium pyruvate. Three bacilli could be grown on this medium, the pyocyanic bacillus, Flügge's fluorescent bacillus, and the coli bacillus. Acetic, lactic, and glycollic acids were isolated from the cultures.

Official Publications Received.

Records of the Indian Museum. Vol. 24, Part 2, June: Notes on Crustacea Decapoda in the Indian Museum. By Stanley Kemp. XV.: Pontoniinae. Pp. 113-288+plates 3-9. (Calcutta: Zoological Survey of India.) 2 rupees.

The Institution of Civil Engineers. Engineering Abstracts prepared from the Current Periodical Literature of Engineering and Applied Science, published outside the United Kingdom. Edited by W. F. Spear. New series, No. 12, July. Pp. 228. (London: The Institution of Civil Engineers.)

Bureau of Education, India. Pamphlet No. 12: Science Teaching in England. By H. Banister. Pp. v+28+ii. (Calcutta: Government Printing Office.) 7 annas.

Ministry of Agriculture and Fisheries: Intelligence Department. Report on the Work of the Intelligence Department of the Ministry for the Two Years 1919–1921. Pp. 198. (London: H.M. Stationery Office.) 5*s.* net.

Ministry of Public Works, Egypt. Report on Investigations into the Improvement of River Discharge Measurements. By E. B. H. Wade. Part 2. (Physical Department Paper No. 6.) Pp. 12+14 plates. (Cairo: Government Publications Office.) P.T. 5.

Ministry of Public Works, Egypt: Physical Department. Meteorological Report for the Year 1917. Pp. x+118. (Cairo: Government Publications Office.) P.T. 30.

The Mauritius Almanac and Commercial Handbook for 1922 (with which is included an Appendix on Seychelles). Compiled by A. Walker. Pp. iii+3+xviii+viii+A66+B57+C67+D64+E40+F89+15. (Port Louis, Mauritius: General Printing and Stationery Co. Ltd.) 10 rupees.

Loughborough College, Leicestershire. Calendar, Session 1922–23. Pp. xx+216. (Loughborough.)

Forestry Commission. Second Annual Report of the Forestry Commissioners: Year ending September 30th, 1921. Pp. 44. (London: H.M. Stationery Office.) 9*d.* net.

Report for 1921 on the Lancashire Sea-Fisheries Laboratory at the University of Liverpool and the Sea-Fish Hatchery at Piel. Edited by Prof. J. Johnstone. No. 30. Pp. 237+13. (Liverpool.)