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Biology and the Race.

THE presidential address to the South African Association for the Advancement of Science, delivered by Prof. H. B. Fantham at Salisbury on June 29, deserves perusal by all interested in the broader problems of biology in its relation to national polity. There are probably few biologists who will regard as unjustified the note of pessimism which makes itself heard here and there in the address: there are equally few who will fail to recognise its common sense and constructive value, or to admit that much of what is addressed to South African listeners is well worthy of attention in Great Britain.

Dealing first with the immense spread of education in western Europe and America during the last six or seven decades, Prof. Fantham asks, Has it fulfilled its expectations? This question must be answered in the negative; not, however, that education is itself at fault, but rather that the swarming into the universities of all and sundry in search of a vocational training has brought with it the development of the examination system with its resultant overwhelming of the truly educative by the merely informative function. Initiative, instead of being developed, has been diminished or killed, and the universities, from being the homes of culture and the training-grounds of leadership, have tended to become mere training-colleges for the professions. The universities in turn react upon the schools owing to prospective teachers concentrating their attention upon such subjects as, at the moment, 'pay.' During training in the technique of teaching due attention is paid to drill in the 'principles' of education and psychology, but little to the fact that without solid biological foundations such principles are liable to be no more than the fleeting fads and hypotheses of the day. The teacher is told to 'follow the child': to make study interesting instead of to make the pupil interested in study. He is unimpressed by the important need to make the child fit into his biological environment by attention to the so-called small things of life—politeness, tidiness, consideration for others, the team spirit, the avoidance of sloppiness—mental, moral, or physical.

The instilment of biological principles into the school curriculum means the development of common sense, the appreciation of cause and effect, the development of personal effort, personal observation, personal thinking—all as different as possible from the familiar product of the present

day with its absorptiveness of what is served up to it, its responsiveness to popular catchwords and slogans, and its belief in conferences and committees.

No section of Prof. Fantham's address is more deserving of serious consideration than that in which he directs his attention to some of the sociological difficulties of the day. He points out the impossible handicap to which the white race is submitting itself by the ever-growing burden of social services with their crowds of officials. Amongst the most costly of these services is school education, but this burden is not incapable of being lightened. 'Frill subjects and snippets' should be eliminated or paid for by the parent. It is suggested that the education provided free by the State should be restricted to 'the three R's,' the study of the mother tongue—including grammar and composition, the general elements of observational and experimental science, with needlework and cookery for girls, together with a cultural subject, such as singing. Secondary education should not be free—it is a curious human weakness that what is not paid for is not appreciated—but generous help should be available in the way of scholarships to those who are mentally qualified to take full advantage of them.

It is perhaps prudent to hesitate before we dismiss all this as old-fashioned, and to ask ourselves seriously whether there is not contained in it a very large infusion of common sense.

Prof. Fantham, being a distinguished South African biologist, we naturally turn with special interest to what he has to say on the colour problem, for there are few problems in which attempts to reach a true solution have been more interfered with by the intrusion of sentiment uncontrolled by scientific knowledge. Here we have the opinion of a biologist who realises, as all biologists do, that the black skin of the negro is the outward expression of profound differences of a more obscure kind, which mark him off from the white race as distinctly as does his non-attainment of what we call civilisation, with its complex social organisation, its great cities, its high art, its written language, during all these untold centuries of his undisturbed sojourn in Africa.

Prof. Fantham has no doubt that the proper line of policy is that of social segregation of the two races. Racial admixture is disastrous in its results. "When once chromosomes of Bantu origin get mingled in white families they cannot be bred out, as is so often popularly supposed, but will exhibit themselves in unfortunate ways and at unfortunate times throughout the ages." What we have to do is to make the black man a happier and better black man, not to attempt to make him an imitation white man. He is a country man. He should be settled in the country and trained in practical agriculture, in hygiene and sanitation. He should not be brought into towns and made to do all the manual labour of the whites—with the resultant encouragement of sloth and idleness amongst them.

It will be seen that Prof. Fantham's address deals with matters that have been much in the air at the moment. As the columns of NATURE have repeatedly testified during the last few months, the rôle of science in the school education of the citizen is attracting at the present time much attention and giving rise to much discussion. Not infrequently in the course of such discussion the main issue tends to be obscured through the persistent failure to keep distinct in the mind the two main functions of education—the first in importance, as it is in time, that of educating in the strict sense, of developing to the highest possible extent all these various capacities which combine to produce all-round ability, such as accuracy and rapidity in observation and the accumulation of experience, involving on one hand skill in actual observation, and on the other, skill in drawing rapidly and accurately sound conclusions therefrom; and the second, that of providing the mind with a store of knowledge and culture. Although the boundary between these two functions of education is naturally not a sharp one, it is imperative in order to secure clarity of discussion that its existence should not be ignored.

As a matter of fact the educational utility of the two main branches of science—physical on one hand and biological on the other—is related to these two main functions of education. As a discipline for the young child, to develop the powers of observation and of reasoning upon the basis of observation, it would appear unquestionable that it is the physical division of science that is the more useful. By it alone are provided those simple types of observation, capable of exact measurement and of repetition over and over again under approximately the same set of conditions, which are necessary for the best training in observational accuracy. Moreover, the mathematical methods employed in the treatment of its observations afford a quite unrivalled training in logical reasoning.

It is, on the other hand, in the later task of school education, that of turning out the well-informed citizen, that the claims of biology to

play an important part are quite irrefutable. In a complex modern State, with its citizens linked together into a biological whole of the greatest complexity, depending for its continued existence upon the applications of biology to food-supply, sanitation, medicine, surgery—its everyday discussions and conversations dealing with subjects like evolution, genetics, birth-control, heredity, public health, and so on—it is clearly absurd that the citizen should not be provided with the foundation of biology without which such discussion is apt to be not merely futile but actually harmful.

While probably all qualified by their own experience to form an opinion will be in agreement up to this point, there is unfortunately up to the present no agreed scheme of instruction in elementary biology for schools. The best of such courses as do exist in a few of the great public schools are commonly modelled upon what is required for the first M.B. examination. Even for its own special end—that of providing a sound foundation of scientific biology for the superstructure of the medical curriculum—this type of course is looked at askance by many competent judges, but quite certainly it is not what is required by our ordinary budding citizens. What is required for the education of the general citizen is not a mass of details regarding the 'insides' of men, or rabbits, or crayfish; it is not a collection of packets of ignorance or very incomplete knowledge done up in wrappings of polysyllabic words; it is rather a general knowledge of such of the main developments of biological science as are of importance, either practical or cultural, in the citizenship of the civilised State.

Each of the two main branches, then, of science—the physical and the biological—has its own rôle to play in elementary education, and it is of the greatest importance to realise this. It is of equal importance to realise what is wanted from each branch. In neither case is it masses of complicated detail. In the case of physical science, it is the careful repetition of observation and experiment in their simplest forms and the recording and treatment of the results arithmetically, the object being to train the young child in accuracy and rapidity of observation and reasoning. In the case of biological science, it is the acquirement of general knowledge regarding main results rather than training in the method of obtaining these results that is required by the citizen.

While the physicist may justly claim upon this showing that it is physical science that plays the more fundamental part in the educative process, in actual practice the recognition of this claim has led to strange results, namely, on one hand the denial to biological science of any place in the school curriculum at all, and on the other, to that hypertrophy of the physical science portion of the curriculum which finds its expression in the schools undertaking courses in chemistry of a standard which is really that of the university. It is a common complaint, as already noticed in NATURE, that students of science and medicine in our universities have to waste an appreciable part of their time at the university in repeating what they have already done at school. The harm is much more than mere waste of time, for the quality of instruction in the average school laboratory is obviously not in a position to claim equality with that of a university department under the inspiring headship of a leader in his science.

When complaint is made of the large and even preponderating part played by science in certain modern developments of our educational system, it is well to bear in mind that 'science' in this connexion is apt to mean simply physics or chemistry. As stated in NATURE of Aug. 13, of the candidates from grant-aided secondary schools in England in the First School Examination in the year 1926, no less than 40·2 per cent. offered chemistry as a subject but only 2·5 per cent. offered general science. While overwhelming arguments can be adduced for science on the lines above indicated being given an important place in the school training of the average citizen, it is difficult to find any justification at all for bringing him up as a specialist in physics and chemistry completely unversed in science outside their limits.

Royal commissions are commonly regarded as the resort of harassed politicians when seeking a means of relieving some inconvenient form of public pressure. But occasionally they achieve great results, and the present would seem a really appropriate time for the appointment of a strong commission to deal with the general question of national education. When such a commission is appointed it is to be hoped that its personnel will consist not of academic specialists, but rather of persons who combine recognised intellectual prestige with understanding and breadth of vision, and that its terms of reference will be as wide as possible so as to include the whole range of education from the elementary school to the university. The selection of the personnel should provide a means of securing that its activities would be confined to big things and not wander away into the desert of detail.

Réaumur and his Work on Ants.

The Natural History of Ants: from an Unpublished Manuscript in the Archives of the Academy of Sciences of Paris. By René Antoine Ferchault de Réaumur. Translated and annotated by Prof. W. M. Wheeler. Pp. xvii + 280 + 4 plates. (New York and London: Alfred A. Knopf, 1926.) 25*s*.

RENÉ ANTOINE FERCHAULT, Seigneur de Réaumur, was born at La Rochelle in 1683. After a short course of training in the law, he devoted himself to the serious study of mathematics, and at the age of twenty-four years was admitted a member of the Academy of Sciences. His life for the next fifty years was one of constant application to scientific research in the departments of physics, metallurgy, crystallography, and meteorology, as well as natural history. His work included experiments on torsion, on the ductility of metals, on the manufacture of steel, of tin-plate, and of porcelain. In physics he investigated the temperature of mixtures, and devised the scale which long remained the prevailing system of thermometric graduation on the Continent.

Réaumur's chief interest, however, lay in natural history, and his achievements both in observation and experiment were truly remarkable. He was the first to describe the ambulacra of starfishes, and to him were due the first systematic observations on the reproduction of cast limbs in the Crustacea, which he attributed to the presence of minute living particles, called by him *petits œufs*. The physiology of digestion engaged his attention, and some well-devised experiments enabled him to demonstrate the action of gastric juice upon proteid foodstuffs. But the object towards which his efforts were mainly directed was the study of the instincts, life-history, and general behaviour of insects; and it is on his writings in this department of research that his reputation among present naturalists chiefly rests.

The volume before us contains a careful transcription of the hitherto unpublished "Histoire des fourmis," which was apparently intended to form part of the seventh volume of Réaumur's "Mémoires pour servir à l'histoire des insectes," of which six volumes were issued between 1734 and 1742. To the original text, Prof. W. M. Wheeler has added an excellent translation and a series of valuable annotations. In these he has performed the useful task of giving at length many passages of other authors to which Réaumur refers, and the still more meritorious office of interpreting and correcting Réaumur's statements in the light of present knowledge. It may perhaps be remarked in passing that it would be well if some competent person were to render a like service to the biological treatises of Aristotle. It was scarcely to be expected that the pioneer work even of so shrewd and capable an observer as Réaumur should be free from errors of faulty inference, arising partly from limited opportunities and partly from imperfection of the optical means at his disposal. He was the first to observe the fact that ants ascend trees for the purpose of feeding on exudations furnished by aphides and scale-insects, but it is not surprising that his account contains one or two inaccuracies. So, too, the microscopic technique of his day did not enable him to recognise that the workers were not really sexless, but were normally sterile females.

To Réaumur is due what is perhaps the earliest experiment in phototropism. He also was probably the first to observe recently fecundated females in the act of founding colonies. Gould, to whom the original observation of this proceeding is commonly attributed, did not publish his account until 1747, whereas Réaumur's must have been written (though not published) before 1743. The same remark applies to Réaumur's discovery of the feeding of larvæ by liquid disgorged by the workers; also described by Gould in 1747. Another of Réaumur's records contains the first account of mutual feeding among ants; and yet another, only recently verified, deals with the facilities provided by the workers for the larvæ in the act of spinning their cocoons. Experiments were started by him with the object of ascertaining whether ants would tolerate the presence of larvæ belonging to an alien community. These experiments, however, apparently did not extend beyond the limits of the same species.

In all Réaumur's work, painstaking and thorough as it was, it is curious to recognise that systematic zoology made little or no appeal to him. His interest lay almost entirely in observation and experiment on insect behaviour, scarcely at all in insect morphology. Classification in his day was in its infancy, and we need not be surprised that he draws no distinction between ants and termites. But when we find him saying, "It seems to me that the many hundreds and hundreds of species of gnats and very small moths which exhibit nothing more remarkable than a few slight differences in the form of the wings or the legs, or varieties of coloration or of different patterns of the same colours, may be left confounded with one

another," we cannot but realise how widely his point of view differs from that of the modern zoologist.

Still more startling, as Prof. Wheeler says, "is his conception of the insects as a natural class, since, like other naturalists of his day, he not only included in it the worms, polyps, mollusks, arachnids, myriopods, and crustaceans, but also the reptiles." The limit is perhaps reached in his remark: "The crocodile is certainly a fierce insect, but I am not in the least disturbed about calling it one." Laxity of this kind was not likely to commend itself to Cuvier, in whose article in the "Biographie universelle," mainly eulogistic, it is possible to discern a certain coolness in regard to Réaumur's merits as a naturalist. Not much sympathy was to be expected between men whose temperaments and methods differed so widely as those of Réaumur and Buffon, and as a matter of fact none existed. There is, however, no sufficient reason for supposing that the non-publication of the concluding volumes of the "Mémoires" was due to an intrigue set going by Réaumur's formidable rival.

Prof. Wheeler's book is well printed and well produced. It will be of great value to all those who are interested in the historical stages of our acquaintance with the habits and life-history of the remarkable insects of which it treats.

F. A. D.

Metalliferous Mining Methods.

The Working of Unstratified Mineral Deposits. By George J. Young. With a Chapter on The Hæmatite Ores of Cumberland and Furness, by T. S. Durham. (Benn's Mining Series.) Pp. 466 + 12 plates. (London: Ernest Benn, Ltd., 1927.) 42*s.* net.

THIS volume forms the second of a series of works dealing with the various phases of mining which is being produced by Messrs. Benn, Ltd., under the general editorship of Prof. Henry Louis. To quote the editor's introduction, "There is probably no industry that depends upon so great a variety of other arts and that involves so many branches of science as does mining, nor one that includes such a complexity of operations." The most important of all the phases is the winning and working, or extraction of the deposit.

Mineral deposits, broadly speaking, can be divided into two divisions, namely, unstratified and stratified, the former being essentially metalliferous, and the latter largely coal and stratified ironstone and such deposits as the Rand goldfield.

The subject of extraction is so wide and varied that the editor of the series has wisely decided to treat it in two volumes, and this volume deals essentially with the working of unstratified deposits. The remaining volumes of the series are being written by British mining engineers, but the author of this particular volume is a well-known American. As the United States of America is the largest metal-mining country in the world at the present time, the choice of the author is a wise one, as he has been able to draw upon the accumulated knowledge of his own country to furnish examples and descriptions of the methods of working every conceivable type of deposit. The book is therefore very largely a manual of American practice. There is, in addition, at the end of the book, a short chapter by T. S. Durham describing the methods of working the hæmatite ores of Cumberland and Furness.

The book can be divided into four parts, namely, a general consideration of mining methods and mineral deposits, followed by the three main chapters dealing with narrow, wide, and large ore bodies respectively.

The chapter on ore deposits refrains from any comments on the genesis of such deposits, but discusses generally their practical features, such as their varying shape, size, depth, physical characteristics, the effect of the enclosing walls and the behaviour of the surrounding earth masses during and after excavation.

In many deposits the line of demarcation between the suitability of open cast and underground methods of working is indefinite. It is quite impossible to lay down any law on the subject, and no attempt is made to do so.

The chapter on mining methods is good and comprises two main features; first, a description of the various forms of supports used in underground mining and the conditions under which they may be used advantageously or must of necessity be adopted. The merits of timber supports, the permanent filling of the excavation with waste rock, and the use of broken ore as a temporary support are fully discussed. The second portion of the chapter deals with the many variations of three simple methods of working which are characterised by the line of advance of the working faces, namely, upwards, downwards, or horizontally. One of these three methods, combined with the materials used for supporting the excavation, constitutes the system of working employed to excavate any given deposit.

One of the particular features of this book is the

attention paid to the methods employed for working large low-grade deposits upon which the modern mining industry has largely to rely owing to the small comparatively rich deposits of the nineteenth century becoming exhausted. This necessitates the handling of large quantities of material, and many of the methods of working described in detail have been devised for this purpose. When dealing with large quantities small economies make all the difference between profit and loss, and attention is directed to points where saving can be effected.

The selection of a mining method is based primarily on its suitability for the physical conditions of the ore body and upon the cost comparison of different methods that may be applicable under the given conditions. Costs are expressed in terms of labour and materials, sometimes graphically and sometimes in tabulated form. This will enable engineers in other parts of the world to compare the working costs of their own mines with those given by the author for alternative methods.

In the three chapters dealing specifically with ore bodies of various sizes—a narrow size being one less than 12 feet thick, while the subdivision of the remainder into wide and large ore bodies allows for a very elastic treatment—the author discusses the characteristics of such deposits and then proceeds to show how variations in their characteristics affect the method of working. This entails primarily a general statement of the principles involved and is followed up by detailed descriptions of the application of these principles. Many examples of successful application are given, and it is in these chapters that the author's wide experience of American metalliferous mines is displayed at its best.

In mining unstratified deposits, no general law as to the method of working to be adopted can be laid down. Each individual case has to be decided on its merits, and the decision is further complicated by the uncertainty which always exists as to the size, shape, and future value of the deposit. Knowing this, stress is laid upon the necessity for development work and the provision of ample 'ore in sight.' The numerical value of the 'development ratio' is not, however, fully discussed.

When it is realised that metal mines are being worked at deeper levels every year, and that one of the determining factors in the successful operation of deep, and therefore hot, mines is the comfort of the workers, more space might have been allotted to the necessity for an ample flow of cool dry air round the working faces. The provision of adequate ventilation is intimately bound up with the method of working employed.

The book is bulky, being printed on thick paper, and, at the same time, loosely bound. As it should find a place in the library of all metalliferous mining engineers, whose sphere of work is often far from modern means of transport, it might well have been compressed into a smaller and stronger volume. The print is large and easy to read, and the illustrations, many of which have been specially prepared for this volume, are excellent. It is the most complete work dealing with the mining of unstratified minerals yet published.

The Egyptian God of Medicine.

Imhotep: the Vizier and Physician of King Zoser and afterwards the Egyptian God of Medicine. By Dr. Jamieson B. Hurry. Pp. xvi+118+13 plates. (London: Oxford University Press, 1926.) 7*s.* 6*d.* net.

THE author of this volume, himself a doctor of medicine, is inclined to chide the medical profession for neglecting its true patron saint, who was in practice more than two thousand years before either Hippocrates or Galen. It is doubtless partly to help Imhotep to his own that Dr. Hurry has written the present book. It is, as it could not but be, based on Sethe's masterly memoir on the same subject written twenty-four years ago. There is not much to be added to this—Sethe's work does not age rapidly—but what there is Dr. Hurry has found and added. The most striking additions are the Nechautis Papyrus from Oxyrhynchus, which, if its story could be trusted, would put back the full deification of Imhotep by 2000 years, Gauthier's article on the Imhotep festival, and Milne's on the *graffiti* in the Sanatorium of Der el-Bahrî. We are at a loss, however, to understand why he has completely ignored the account of King Zoser given by both the epitomisers of Manetho the Egyptian historian, which, if Sethe's clever and convincing conjecture be correct, is a description of Imhotep himself.

Imhotep was an Egyptian Leonardo da Vinci—architect, writer, and physician in one. Though the discoveries at Saqqara during the last two winters have shown that his achievements in building must have been very considerable, it is as a doctor that he survived in the memory of the Egyptians. How soon he became what Dr. Hurry

describes as a "medical demigod" we cannot say: probably shortly after his death. In this stage he remained, if we hesitate to accept the evidence of the papyrus mentioned above, until the Persian period, about 525 B.C., when he first appears with the full attributes of a god. These developments in his status Dr. Hurry describes very clearly and with due regard for the value of various types of evidence. Both here and in the all too short chapter on Egyptian medicine, he shows a happy ability to clothe an ingenious conceit in a neat garb, and this makes his book very readable.

A few small points, mostly lying outside the main line of the argument, call for remark. Dr. Hurry has been a little unfortunate in his authorities on some points connected with Egyptian belief. Thus the Liturgy of the Funerary Offerings did not aim at changing the offerings into "a divine and spiritual food, which was partaken of by the souls of the departed" (p. 13). One of the most certain things about Egyptian belief is that the dead were envisaged as still physically living, though perhaps in a slightly different sense from that in which they had lived here. Hence the need for mummification to preserve the body, and the terror lest this should be destroyed. This physical body needed physical food, and that is precisely what was given to it. A similar error appears on p. 64, where Dr. Hurry states that what persists after death is the *ka* or double, and that it is this 'part' of a man which needs the nourishment. What eats the food is in reality no *ka*, but the dead man himself. For such mistakes the Egyptologists and not Dr. Hurry are to blame. On p. 15 we read that the Kheri-heb priest was "by the common people . . . regarded as the mediator between the King and the unseen powers of the universe." Such an idea is totally un-Egyptian. In Egyptian religion the king is in theory the only priest, and the whole funerary ritual is performed by him as the incarnation of Horus for the dead person conceived as Horus's dead father Osiris. There can be no mediator between the king and the gods or the dead.

On p. 77 we find the curious remark, "More complicated operations were performed on the domestic animals than on man." This is a most interesting example of how errors arise. In the tale of King Khufu and the magician Dedi (Papyrus Westcar) the king wishes to see Dedi perform his vaunted trick of cutting off a head and fastening it on again, and commands a prisoner to be brought for this purpose. The following sentence is obscure, but it would seem that Dedi suggests making his experiment not on a human being but on one of the domestic animals. This I take to be the origin of Dr. Hurry's statement: at least I can find no other.

In Appendix B, on the name Imhotep, the author has been dogged by ill luck. The transliteration Ij-m-ḥtp is a purely German form, the German *j* representing our consonantal *y*. Read therefore Iy-m-ḥtp. Secondly, the verb *ḥtp* means not 'to satisfy,' but, intransitively, 'to be content.' Thirdly, there is no 'particle' *m* meaning 'as' or 'in the guise of'; this *m* is precisely the preposition meaning literally 'in' of which Dr. Hurry has just been speaking. Fourthly, though it is not grammatically impossible that the element *Iy* should be the imperative, yet the rarity of this form and the absence of variants of the name showing the much more common form *Mi* make it unlikely.

In conclusion, I hope that Dr. Hurry's conception of the high standard of Egyptian hygiene is a true one, but I cannot help feeling that if he had excavated, as I have, an Egyptian city, he would have misgivings.

T. E. PEET.

The Vegetation of the British Empire.

Aims and Methods in the Study of Vegetation. Edited by Prof. A. G. Tansley and Dr. T. F. Chipp. (Published by the British Empire Vegetation Committee.) Pp. xvi + 383 + 19 plates. (London: The Crown Agents for the Colonies, 1926.) 12*s*. 6*d*.

OWING to the foresight and initiative of Sir Joseph Hooker, we now possess published floras of many of the British colonies, but such floristic data is only the pioneer work which should form the basis for further research. The time has now come when the investigation of the vegetation of the Empire can be profitably undertaken, and indeed urgently demands attention. Quite apart from the value of such knowledge for its own sake, an ecological survey of the Empire is of paramount importance for its further economic development. To exploit the natural vegetation of any region to the best advantage, we require to know much not only with respect to its existing composition and structure, but also its potentialities under the more or less artificial conditions imposed by man.

The British Empire Vegetation Committee appointed by the Imperial Botanical Conference in 1924 in furtherance of these aims has published the volume before us. The first section comprises a brief account of the nature of plant communities,

the method of their investigation and the factors of the habitat, whilst the remainder is in the nature of a symposium of essays by different authors which, though often overlapping, have their chief value in the diverse viewpoints which they present, with consequent diversities of technique and emphasis. Moreover, many useful practical hints are furnished for the investigation of the respective areas dealt with. Of especial interest are the sections on the ecology of fungi and lichens by Mr. Ramsbottom.

Perusal of these pages emphasises the need in vegetation studies for accurate empirical descriptions unbiassed by any theory which attempts to fit the communities observed into a hypothetical succession series or to find their equivalence with communities in other areas which have been investigated on different lines. Too rigid a uniformity is much to be deprecated, but if the attempts at classification of plant communities are to be rescued from their present somewhat chaotic condition, it is essential that the various aspects of the community and habitat alike should be studied. At present we know much concerning the soil conditions in the communities of one region, of the putative successions in another, of the physiognomy or the biological relations in a third. Each of these lines of investigation has, indeed, at one time or another, served as the basis of a more or less exclusive classification, but if the pages of this volume serve no other purpose than to bring about a wider and more uniform basis of investigation of the communities within the Empire, the task of the synecologist of the future will be appreciably diminished.

How important, from the economic viewpoint, is a knowledge of the plant communities and the successions of any area, is shown by the changes which fire protection has wrought in India, to which Prof. Troup directs attention in his suggestive survey of Indian forest vegetation. Such protection has not only resulted in replacement of grassland by forest, but has also produced profound changes in the composition of the forest itself. The widespread effect of the shifting cultivation practised in the tropics is emphasised by several of the contributors. To this cause both Prof. Troup and Dr. Stamp attribute many of the grassland areas and bamboo thickets in the forest regions of India and Burma, whilst the same factor is held by Dr. Chipp as initially responsible for the forest retreat in West Africa. Prof. Bews shows how a study of the successions in the grass communities of South Africa has both explained the conflicting views respecting the value of burning and supplied the criteria for ensuring the appropriate and successful use of this method.

It cannot, however, be too strongly urged that if the fullest use is to be made of ecological methods for the solution of economic problems, it is essential that the study of vegetation should be accompanied by a parallel study of the animal ecology. The valuable conclusions arrived at by Dr. Cockayne in his studies of palatability in the tussock grasslands of New Zealand, have shown how profound an effect the selective action of grazing animals may produce, whilst the thickets of *Zizyphus œnoplia* in the Central Provinces or the spread of *Opuntia inermis* in Australia serve but to show that man is not alone in upsetting the balance of Nature to the detriment of his environment.

E. J. SALISBURY.

Our Bookshelf.

The Music of the Spheres: a Nature Lover's Astronomy. By Florence Armstrong Grondal. Pp. xiii + 334 (24 plates). (New York: The Macmillan Co., 1927.) 21*s.* net.

THE author has collected a large number of myths and poetical references associated with the heavenly bodies, and has woven them into a discursive description of the stars in their constellations and of the members of the solar system. The first ten chapters are replete with legends by which the more spectacular stellar objects (bright stars, double stars, clusters, and nebulæ) may be remembered. The remaining seven chapters are descriptive of the sun and its satellite members of the solar system; an interesting perspective of the geological processes through which our planet has passed is given in one of these chapters. Simple language and illustrations are employed generally, but a few terms such as 'spectroscope,' 'seconds' (of arc) might have been explained. A brief description of a refracting and a reflecting telescope is left to the final paragraphs, which contrast unfavourably with the opening sentences of the book. Occasionally accuracy of statement is sacrificed for rhetoric—the sun's corona is described as 'flaming,' and prominences are spoken of as 'burning gases.' The sentences on p. 12 concerning the measurement of the sun's diameter and those of only four or five of the stars convey a wrong impression of astronomical measurement. A mis-statement appears on p. 74, where the distance of the Andromeda nebula is given as 36,000 light years instead of one million. Incidentally, the quotation on p. 76 is from Keats, not Longfellow.

With slight exception, the reproductions of photographs are admirable and make a very attractive feature of the book; a few star charts (coloured for preference) showing the whole heavens would, however, have assisted the reader

in linking up the many constellation diagrams, a few of which appear somewhat redundant. Finally, it should be remarked that the volume is essentially a gift-book, with its large print, heavy paper, and choice reproductions, and it will be unfortunate if its cost should deter any one from possessing a copy or placing one in the hands of a friend.

Handbuch der biologischen Arbeitsmethoden. Herausgegeben von Prof. Dr. Emil Abderhalden. Lieferung 220. Abt. 11: *Chemische, physikalische und physikalisch-chemische Methoden zur Untersuchung des Bodens und der Pflanze*, Teil 3, Heft 5. *Ernährung und Stoffwechsel der Pflanzen. Methoden der mikrobiologischen Bodenforschung.* Von Selman A. Waksman. Pp. 715-864. (Berlin und Wien: Urban und Schwarzenberg, 1927.) 7·20 gold marks.

THE study of the activities of soil micro-organisms is of comparatively recent origin, and consequently the methods employed for such researches are not well known, and in many cases have not attained the degree of standardisation necessary for comparative investigations. This is particularly the case with regard to the numerous methods employed for counting the numbers of soil bacteria, protozoa, fungi, or algæ, and for estimating the degree of activity of such members of the soil population. The present part of Abderhalden's "Handbuch" should prove exceedingly useful to soil investigators. S. A. Waksman has acted as general editor and has contributed the mycology and bacteriology sections, with the exception of that on cellulose decomposition, which is written by Chr. Barthel of Stockholm. The technique used in the study of soil algæ and protozoa is described by B. M. Bristol-Roach and D. W. Cutler respectively.

With a subject growing so rapidly as soil microbiology, any book is to a certain extent out-of-date before it is published, and though doubtless certain sections of the present part of "Abderhalden" would be slightly altered if rewritten, yet it can be safely recommended as the most up-to-date work on the subject.

Grundriss der Kriminalbiologie: Werden und Wesen der Persönlichkeit des Täters nach Untersuchungen an Sträflingen. Von Prof. Dr. Adolf Lens. Pp. vii + 252. (Wien: Julius Springer, 1927.) 15 gold marks.

DR. LENZ, as director of the University Criminological Institute of Graz, is well fitted to describe to us the influence of the personality on criminals, and in this book he does this in an extremely able manner. His case material consists of criminals from the prison at Graz and the Petty Assize prisons in Vienna and Graz. He regards crime as the resultant of the interaction of personality and its environment. In the personality he includes the physical structure as well as the psychical, and in this is following much the same lines as Kretchmer does in his well-known "Korperbau und Charakter."

The author divides his book into four parts. The first part deals with his method of investigation and the nature and problems of criminal biology. The second part is concerned with the nature and development of personality, the importance of symbolism and the reaction of the personality to its environment. In the third part, the actual crime and its relation to the personality and its environment are considered. The fourth part deals with the sensory, intellectual, and volitional tendencies, the structure of the ego, and the relation of crime to the sex and herd instincts.

Graphit: Charakteristik, Erzeugung, Verarbeitung und Verwendung. Von Dr. Eugen Ryschkewitsch. (Chemie und Technik der Gegenwart, Band 7.) Pp. xii + 323. (Leipzig: S. Hirzel, 1926.) 14·50 gold marks.

THIS monograph is an interesting and well-printed volume, commendable for good arrangement of the subject matter. Though the author admits that his sources of reference are limited, he offers much up-to-date information, giving considerable attention to a detailed description of the chemical, physical, crystallographic, and mineralogical characteristics of graphite; this is invaluable alike to student, manufacturer, and consumer. The dressing and refining of the material are dealt with in a more cursory manner than is usual in books on this subject, but the writer nevertheless indicates the fundamental principles of preparation in a lucid manner. There are also some interesting chapters on the distribution of the raw material and its origin in Nature, on the artificial formation of graphite, on industrial applications, and on commercial statistics; in the last, the author's criticism of certain figures published by the Imperial Mineral Resources Bureau is noteworthy, as it indicates that he does not quote even supposedly reputable information without duly pondering on its value. The book may be considered an asset to a scientific or technological library.

The Nature of Man. By Dr. G. A. Dorsey. Pp. viii + 104. (London: Harper and Bros., 1927.) 3*s.* 6*d.* net.

IN this little book Dr. Dorsey has in mind the practical and immediate application of the scientific study of man. "Everything said in this book may be taken personally," he says, in his opening chapter, and his concluding words are: "Nothing is known of God's will; enough is known of Nature to point the way Man must travel if he is to survive and the goal he must desire to make the most of his nature." Dr. Dorsey's method of attacking the problem is by an exposition of man's nature and activities as an individual and as a member of family and other social groups upon a purely mechanistic basis. The mind, the soul, the group mind, the herd instinct, in short, the whole of the material of the psychologist, as well as his terminology, disappear in favour of what science 'knows'—visceral behaviour, genetic behaviour, somatic behaviour, social behaviour, and cultural behaviour. Dr. Dorsey's little book is an aid to clear thinking, even if his readers will not be prepared to go the whole way with him.

Letters to the Editor.

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

Structure in Surfaces of Liquids.

MR. HATSCHEK, in his interesting article in NATURE of June 11, p. 857, has shown that colloidal solutions and even the simplest suspensions of solid particles in liquids exhibit a property which is absent from all true liquids; namely, residual rigidity, or at least a coefficient of viscosity that depends upon the rate of shear. He has advanced no explanation of this remarkable result, which would, however, appear to be just one manifestation of a general property of all surfaces involving liquids.

In an address delivered by me before the Mid-West Regional Meeting of the American Chemical Society at Madison in June 1926 (since communicated for publication in the *Journal of the American Chemical Society*), absolute measurements of the adsorption of such substances as *p*-toluidine in the surfaces of their aqueous solutions were adduced, which made it evident that the excess of dissolved substance in the surface is several times greater than that which can be close-packed as a monomolecular film resting upon the surface. This demonstrates that the surface of a liquid possesses a depth which is considerable as compared with the diameter of a molecule, and the obvious inference was drawn that chains of oriented molecules of dissolved substance extend inwards into the solution until they are broken up through thermal agitation. The usual structure of the surface even of pure liquids would appear to be a single complete layer of oriented molecules with numerous unstable chains of oriented molecules extending therefrom into the liquid. It is evident that this hypothesis predicts a quasi-rigidity in the neighbourhood of all surfaces bounding a liquid, and suffices to explain the facts mentioned by Mr. Hatschek.

Evidence for the truth of this hypothesis is to be found in many fields. For example, in numerous experiments upon adhesion and adhesives, whether with pure substances or mixtures, liquid or solidified, we have always found "the thinner the film, the stronger the joint," the effect increasing most rapidly when the thickness of the layer under investigation is reduced to the order of a millionth of an inch. It likewise serves to explain the considerable effective range of molecular attraction without involving more than direct action of molecules upon others with which they are immediately in contact. Another illustration is given by the effect of finely divided 'fillers' such as carbon upon the strength and resiliency of rubber tyres or by the effect of oil upon troubled water. It is gratifying to find that recently Sir William Hardy (*Jour. Gen. Physiol.*, **8**, 641; 1927) has come to similar conclusions from experiments on lubrication.

In an article in the *Journal of Physical Chemistry* (**30**, 239-247; 1926), I put forward as a general explanation of the high apparent viscosity of many colloidal solutions the tendency of colloidal particles to aggregate into larger secondary structures ramifying through or partially enclosing large tracts of solution that are thereby effectively immobilised. Mr. Hatschek (*J. Phys. Chem.*, **31**, 383-392; 1927) has attacked this quite general hypothesis, which includes many special cases, in favour of one single form of it. It seems preferable to retain the more general and inclusive view. Whatever form of ramifying aggregate is present in a colloidal solution, the surfaces of the colloidal particles will be surrounded by chains of oriented or linked molecules extending towards each other and thereby imparting far greater effective rigidity and apparent viscosity than could be produced by the colloidal particles or aggregates themselves.

JAMES W. MCBAIN.

Department of Chemistry,
Stanford University, California,
Aug. 11.

The Production of Sound by Heat.

THE 'singing tube' has been the subject of a number of short sketches by me in American scientific journals. There is one form of it, however, that was exhibited at the Cavendish Laboratory in February last that has never been published, and a brief description of the tube in general and of this special form may be of interest to the readers of NATURE.

The singing tube came to my notice quite by accident while blowing a mercury vapour trap for

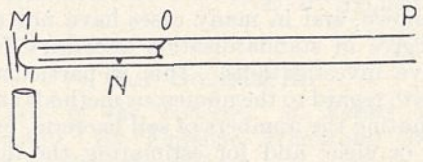


FIG. 1.

high vacuum work. Two reasons may be assigned as to why it was not discovered long before by research workers doing their own glass-blowing. They are: (*a*) the trap was blown of Pyrex glass (Monax would have answered quite as well), which permitted of more intense heating than soda glass, and (*b*) the sequence of operations in blowing happened to be such that it revealed this particular phenomenon. It was soon found that the tube could be given the more compact form shown in Fig. 1, drawn approximately to scale. The inner tube (a test tube) is held in the position shown by three legs fused to the outer wall, and to secure it against mechanical breakage three small supporting nibs (only one is shown) are equally spaced at *N*. Roughly, the area of the open end of the inner tube should be equal to the annular area between it and the outer tube. The outer tube is closed at *M*. When the tube is cool, place the tip *M* in a Bunsen burner flame (as shown in Fig. 1) and in a few moments the tube will emit, at its open end *P*, a tone of remarkable purity and loudness. The pitch depends

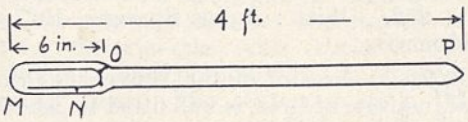


FIG. 2.

on the length of the tube from *O* to *M* to *P*, this length corresponding approximately to one-quarter of the wave-length of the tone emitted. Extensions attached at *P* lower the pitch. Two similar tubes simultaneously heated will sound beats. Many additional beautiful and striking experiments may be performed.

The special form of the tube alluded to above is made much longer, and in addition is closed at *P*, as shown in Fig. 2. On holding this tube in the hands and heating the tip *M* in a Bunsen flame the operator will feel the tube begin trembling, then violently, and yet no sound is heard. The whole

performance is uncanny and one is in danger of dropping the tube. The vibration of the air within will continue for some moments after the tube is removed from the flame. These vibrations may be made audible by placing the closed end P against a resonating body—one's head, a tin can, a light table, or against a wooden blackboard.

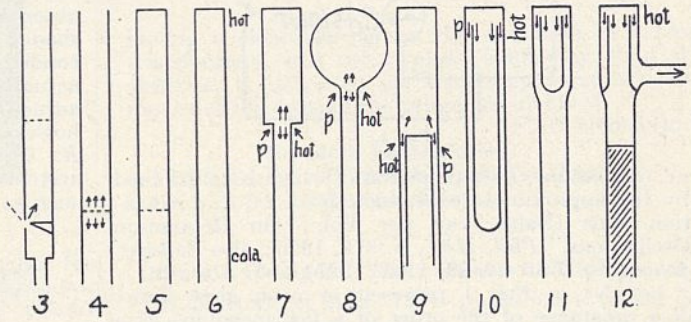
The intensity of the tone emitted by these tubes is dependent upon the temperature difference that is established between the tip M and the rest of the tube. The pitch, as previously stated, is determined by the dimensions and is little affected by a change in temperature. It may be of interest to remark that when the body of the tube *NOP*, Fig. 1, is at room temperature, the tube will begin to sing when the tip is heated to about 400° C. When *NOP* is cooled to liquid air temperature, the tube will sing when the tip M is maintained at *room* temperature, which makes the temperature difference in this instance about 200° C. By extrapolation it was found that the temperature difference required if it were possible to cool *NOP* to absolute zero would be 80° Kelvin. The pitch of the tone emitted in each of the above examples is correspondingly lowered.

The following physical explanation, in collaboration with Dr. Jakob Kunz, University of Illinois, is offered:

In the organ pipe, energy is supplied by a stream of air which encourages the vibrations in a one-sided way, so that the vibrating column receives an impulse each time when the air moves upward towards the node in the middle of the pipe, Fig. 3, and receives no impulse in the opposite motion. It looks as if a pendulum were kept in oscillation by receiving at one end of its path an impulse always in the same direction. If we were to apply the momentum of the air-jet at the centre of the tube, vibrations of the column would be discouraged.

We can communicate momentum to a vertical open-air column by heating it. If we heat the air in the tube in Fig. 4 by a wire net placed in the lower half of the tube, we shall obtain a uniform current of air upwards. If the air is vibrating, then as it is moving inward its vibration is increased by the momentum of the upward stream of air, but not increased by moving downward. When we place the hot wire net in the middle of the tube it will tend to increase the pressure of the gas when it is a minimum, *i.e.* it will discourage oscillations. The same will happen when we place the net above the middle. In order to encourage oscillations we have to add momentum in a position and at a moment such that the pressure in the node increases more than it would do on account of the oscillations alone. If we put the hot wire net at the lower end of the tube, *i.e.* in a loop, the effect will be very small, or zero. The transfer of heat will depend upon the temperature of the air in contact with the wire net, being greatest when the temperature is lowest. But the temperature in the loop at the lower end does not vary; therefore, the transfer of heat in this position of the gauze does not give rise to oscillations. It tends only to raise the temperature of the gas uniformly. *Heat must therefore be applied between a loop and a node.*

If we cover the upper end of the tube, Fig. 5, with the hot net in the most favourable position, the sound ceases, and if we heat by means of a Bunsen burner the outside at the top, as in Fig. 6, we get no sound. This was considered by Rayleigh as possible ("Theory of Sound," vol. 2, p. 231). But if we change the cross-section of the tube, as in Fig. 7, and heat at p, then the tube will emit a sound. The pressure in the upper half of the tube will increase, partly because the air is heated, partly because of the condensations of the air in the node on the top. The air will expand, and now the expansion in the narrow neck is aided by the air being heated by the wall. Here the oscillations are encouraged because each time when the air is expanding by the oscillation the expansion is increased by the heat. In each cycle the vibrating particle receives one push in the right direction. It is this one-sidedness of the action which encourages the oscillations. Moreover, as the heat here has the tendency to increase the pressure near the node, the oscillations will start very readily. A slight modification of this experiment is the glassblower's bulb, Fig. 8, which emits a sound when heated around the neck, p. Instead of making the lower part of the tube narrower, as in Fig. 7, we might proceed as in Fig. 9, where the annular area takes the place of the narrow tube in Fig. 8. A modification of this tube is



the tube of Fig. 10, which will sound when heated at p and is much more sensitive. It is evident from the explanation that this tube will not sing when the lower end of the inner tube is open, because the one-sidedness of the action is destroyed. Slight modifications of Fig. 10 are the tubes represented in Figs. 11 and 12. If we place a hot wire net inside the tubes of Figs. 7, 8, 9, 10, 11, 12, where the hot flame was outside, the tubes will produce a sound. In all cases, in the organ pipe, in Rijke's experiment (Fig. 4), and in the tubes in Figs. 7-12, the oscillations of a column of air are maintained by a one-sided addition of momentum at the right moment and in the right place.

These experiments belong to a large variety of phenomena in which a direct motion is transferred into a periodic motion, or, electrically speaking, where direct current is transformed into alternating current.

CHAS. T. KNIPP.

Cavendish Laboratory,
Cambridge,
July 12.

Frequency Demultiplication.

IT is a well-known fact that when a sinusoidal E.M.F. (of the form $E_0 \sin \omega t$) is available, it is a relatively simple matter to design an electrical system such that alternating currents or potential differences will occur in the system, having a frequency which is a whole multiple of the applied E.M.F., *e.g.* 2ω, 3ω, etc. For example, when the E.M.F. $E_0 \sin \omega t$ is applied to a diode-rectifier, the current in the anode circuit will include a component of double frequency, *i.e.* 2ω. This is therefore one method of frequency multiplication. Several other methods could easily be mentioned.

Now we found it is also possible to design an electrical system such that when the above-mentioned

E.M.F., $E_0 \sin \omega t$, is applied to it, currents and potential differences occur in the system the frequencies of which are whole submultiples of the frequency of the applied E.M.F., *e.g.* $\omega/2$, $\omega/3$, $\omega/4$ up to $\omega/40$.

To this end one can make use of the remarkable synchronising properties of relaxation-oscillations,

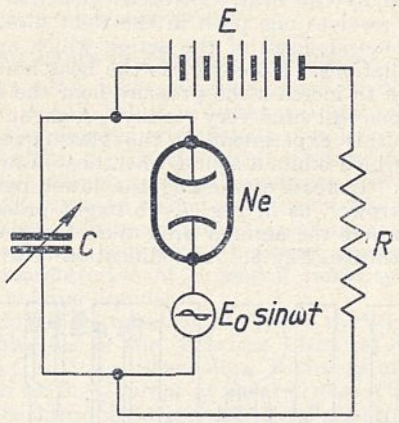


FIG. 1.

i.e. oscillations the time period of which is determined by the approximate expression $T = \pi/2\, C\, R$, a relaxation time (Balth. van der Pol, "On Relaxation Oscillations," *Phil. Mag.*, p. 978, 1926; also *Zeitschr. f. hochfreq. Technik*, **29**, 114; 1927).

Let *Ne* in Fig. 1 represent a neon glow lamp, R a resistance of the order of a few megohms, C a variable condenser of approximately maximum 3500 cm. capacity and E a battery of say 200 volts. In the absence of the E.M.F. $E_0 \sin \omega t$, this system will oscillate with a time period $T = \alpha\, C\, R$ where α is a number of the order unity. With the E.M.F. $E_0 \sin \omega t$ present, where E_0 may be of the order of 10 volts (considerably lower voltages also give the same result) it is found that the system is only capable of oscillating with *discrete frequencies*, these being determined by *whole submultiples of the applied frequency*. For example, with $E_0 = 0$, give C a small value such that the natural relaxation frequency of the system is 1000 periods per second. Next apply the alternating voltage $E_0 \sin \omega t$, where ω may be made $2\pi \times 1000$ sec.$^{-1}$, then the system will go on oscillating with a frequency 1000 sec.$^{-1}$. When now the applied $E_0 \sin \omega t$ is left as before but C is gradually increased to a much greater value, it will be found that the system continues to oscillate with a frequency 1000 sec.$^{-1}$. If C is next increased still further, the frequency of the oscillations in the system (as detected, for example, with a telephone coupled loosely in some way to the system) suddenly drops to 1000/2 sec.$^{-1}$, to maintain this value over a certain range of the capacity value. If C is increased still more, the frequency suddenly jumps to 1000/3 sec.$^{-1}$, and so on up to 1000/40 sec.$^{-1}$. In some recent experiments it was found possible to obtain a frequency demultiplication up to the ratio 1 : 1/200. Often an irregular noise is heard in the telephone receivers before the frequency jumps to the next lower value. However, this is a subsidiary phenomenon, the main effect being the regular frequency demultiplication. It may be noted that while the production of harmonics, as with frequency multiplication, furnishes us with tones determining the musical major scale, the phenomenon of frequency-division renders the musical minor scale audible. In fact, with a properly chosen 'fundamental' ω, the turning of the condenser in the region of the third to the sixth subharmonic strongly reminds one of the tunes of a bagpipe.

In conclusion, we give in Fig. 2 the measured time periods (which are thus found to be a series of discrete subharmonics) as a function of the setting of the condenser C. The dotted line in the figure gives the frequency with which the system oscillates in the absence of the applied alternating E.M.F. The shaded parts correspond to those settings of the condenser where an irregular noise is heard. In the actual experiment the resistance R was, for ease of adjustment, replaced by a diode. The experiment, however, succeeds just as well with an ohmic resistance R. Obviously the same experiment succeeds with all systems capable of producing relaxation-oscillations such as described in the papers quoted.

BALTH. VAN DER POL.
J. VAN DER MARK.

Natuurkundig Laboratorium der
N. V. Philips' Gloeilampenfabrieken,
Eindhoven, Aug. 5.

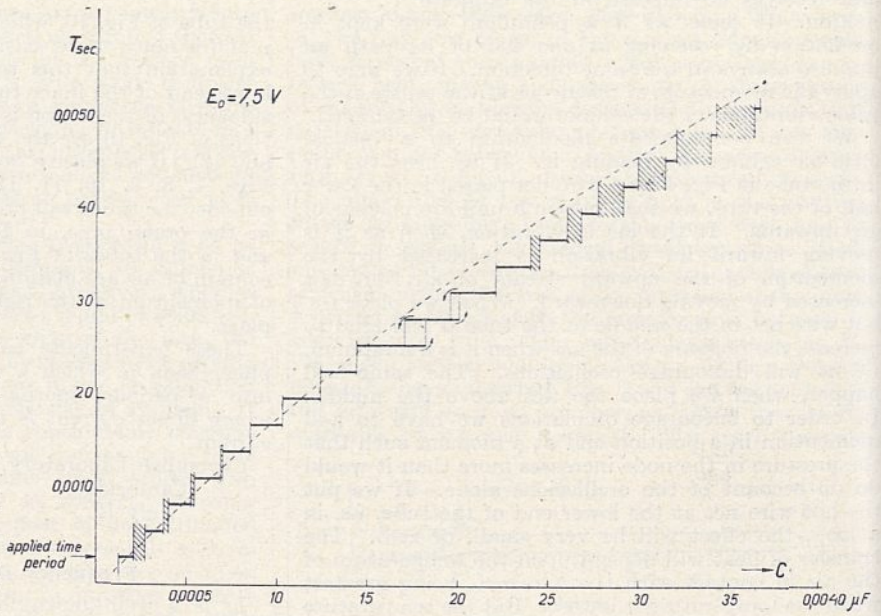


FIG. 2.

Movement in Fluid Dielectrics under Stress.

IT has been suggested to me that I should describe briefly, for the benefit of readers of NATURE who may be interested, some experiments which I showed at the High Tension Conference in Paris a few weeks ago.

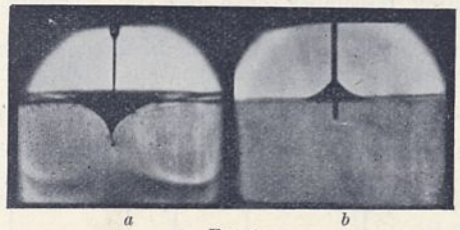
In January last, as the result of a suggestion by Mr. G. L. Addenbrooke, who had previously investigated the phenomenon, I was able to demonstrate at the annual exhibition of the Physical Society, and

again at the Royal Institution, the rise of an oil surface under a charged sphere and the depression under a charged point. As the result of a series of further experiments, it is clear that these first two effects represent two distinct classes of phenomena, namely :

(1) The attraction of a high dielectric constant medium through a low dielectric constant medium into the strongest part of the field, and of course the repulsion of a low dielectric constant medium through one of high dielectric constant from the strong to the weak field, and

(2) the movement of a fluid dielectric under the influence of a stream of ionised air repelled from an electrode.

Fig. 1, *a*, shows the cratering of an oil surface under an upper needle-point at about twenty thousand volts

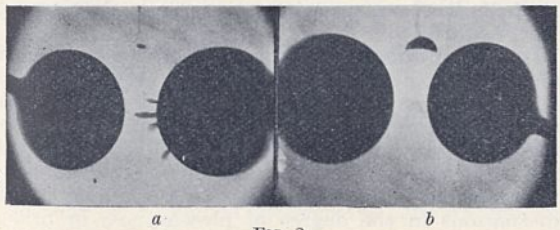


a *b*

FIG. 1.

alternating. This is effect (2). Air bubbles enter the oil at the point of the crater, but except at quite low voltages they circulate with the mass of oil *towards* the point.

When a thin rod is employed as upper electrode with its end immersed in the oil, the application of the voltage raises the meniscus as is expected from consideration (1) above and shown in Fig. 1, *b*. When a certain value of the voltage is attained, however, the oil is thrown down to its 'no voltage' level accompanied by violent circulation of the oil along the surface away from the electrode. By using in turn a number of electrodes of different diameter and comparing the voltage at which the conditions changed from a steady holding of the oil to the circulation, the calculated stress in the air was found to be the same as previously published values for critical stress in air around cylindrical wires.



a *b*

FIG. 2.

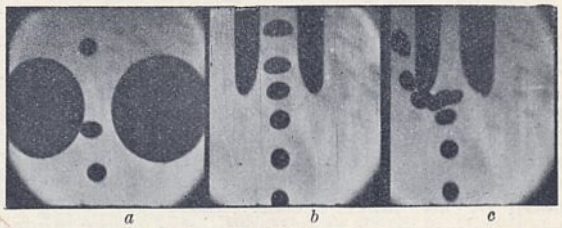
The electric wind effect is further shown by the repulsion of oil along the surface of a sheet of oiled paper standing on a flat electrode around an upper electrode in contact with the paper.

Several effects arising out of consideration (1) above are shown in the remaining figures.

Fig. 2, *a*, shows the attraction of castor oil (d.c. = 4·5) globules in a bath of transformer oil (d.c. = 2·1) into the strong field between two spherical electrodes, with 25 k.v. difference of potential alternating, where they line up. Fig. 2, *b*, shows the repulsion of transformer oil globules in a bath of castor oil away from the strong field.

In Fig. 3, *a*, bubbles of air rising through oil between charged spheres are elongated and repelled from the field, while Figs. 3, *b*, and 3, *c*, show the same effects between plates. In the last figure the effect was so strong as to compel the stream of bubbles to avoid the gap entirely.

The study of these movements is very much assisted by kinematograph projection, and besides



a *b* *c*

FIG. 3.

having a close bearing on the operation of cables, transformers, and other plant employing fluid dielectrics, it seems to me that they form a useful means of illustrating the principles involved.

P. DUNSHEATH.

Research Laboratories,
W. T. Henley's Telegraph Works Co., Ltd.,
Gravesend, Kent.

Climatic Changes: Their Causes and Influences.

IN NATURE of Aug. 13 is published a review by Prof. J. W. Gregory of Dr. C. E. P. Brooks's recent book, "Climate through the Ages." Referring to the remarkable evidence of a medieval deterioration of climate in Greenland, collected by the Danish expedition to Herjolfsnes, Prof. Gregory suggests that the alleged absence of ice before the thirteenth century was contradicted by the Sagas and had not been supported by any records of contemporary change of climate in Great Britain.

It is true that Sir Richard Gregory, in his presidential address to the Geographical Association in 1924, summarised a large mass of literary references dealing with British climate in historical times and failed to find any indications of such changes. Nevertheless, Dr. Brooks since that date has collected together a considerable body of evidence pointing to a medieval maximum of rainfall in Britain, Europe, and parts of Asia. This evidence is given in Chapters xviii. and xix. of "Climate through the Ages."

A paper on "Early Water-mills in Relation to Changes in the Rainfall of East Kent," read before the Royal Meteorological Society on May 18 of this year, gives documentary records indicating that a period of heavy rainfall was drawing to a close in the latter part of the thirteenth century. The inconstant streams, or nailbournes, of Kent had been studied fairly completely by Mr. W. Whitaker (Memoir of Geol. Survey, 1908), who found that their flow depended only on the saturation level of the district. Unfortunately, Mr. Whitaker did not extend his search back beyond the fifteenth century, consequently he did not discover the extraordinary difference between the present character of these streams and that revealed by the entries in "Domesday Book" of watermills situated high up their valleys.

It would be absurd to accuse Prof. Gregory of adopting the forensic trick of passing over in silence unwelcome evidence. Probably he considers that the facts have been misinterpreted. It is not, perhaps, unreasonable to ask for his alternative explanation of these records. Quotations of the alleged critical

passages in the Sagas would also be welcomed by readers unfamiliar with this literature.

GEORGE M. MEYER.

Victoria Terrace, South,
Low Fell, Gateshead,
Aug. 18.

I DID not refer to the two chapters mentioned as I had discussed that evidence twice previously (*Geog. Jour.*, vol. 43, 1914) and in a later paper in the *Edinburgh Review*. I read the two chapters with interest as they show the indefiniteness of the evidence carefully collected by Dr. Brooks, except as regards the local minor variations which are inevitable. Its inconsistency as indications of any world-wide or even widespread considerable climatic variation is shown by Mr. Meyer's case. He claims from the east Kent watermills that "a period of heavy rainfall was drawing to a close in the latter part of the thirteenth century." Dr. Brooks's table 22 (p. 345) gives a census of floods and droughts in Britain; the maximum of floods, No. 9, was in 1051–1100; and instead of droughts in 1251–1300 being at a minimum, they were at a maximum. The figures for the seven half-centuries are as follows:

	Storms and Floods.	Droughts.
1001–1050 . .	2	3
1051–1100 . .	9	1
1101–1150 . .	5	10
1151–1200 . .	1	3
1201–1250 . .	8	7
1251–1300 . .	8	13
1301–1350 . .	3	7

The thirteenth century had more recorded droughts, according to this table, than any century before the seventeenth. Mr. Meyer refers also to Asia; and according to Dr. Brooks's table 27 (p. 364) for China, the thirteenth century was less rainy than either its predecessor or successor. The figures for raininess are: tenth century, 36; eleventh, 37; twelfth, 49; thirteenth, 36; fourteenth, 49.

I have not the Sagas to refer to, as I write from the country, but my remark regarding them was made after consultation with an authority on East Greenland who knows the Sagas well. I warmly welcome Dr. Brooks's advocacy of the dependence of glaciations and climatic variations on geographical changes: and in accordance with that argument would expect that so great a change as the absence of ice from the Arctic Ocean and from the East Greenland Sea would have been attended by more marked changes in British weather than those recorded by Dr. Brooks.

J. W. GREGORY.

Fluctuations in Affective Reactions to the Odour of Caraway Oil.

DURING a period of two months I have arranged thirty odours in order of preference on forty occasions. Unfortunately, circumstances did not permit of this serial arrangement at regular intervals. As was to be expected, the position in the series of the very pleasant and the very unpleasant odours showed considerably less (if any) variation than the position of the relatively neutral odours. Fluctuations in the affective reactions to caraway oil claimed attention, as the median place in the series was found to be higher (fourteenth) after lunch than that before (sixteenth). A similar post-prandial preference, though not so pronounced, was noticed in the case of dill oil, which likewise contains carvone. Musk appeared to be experienced as relatively less pleasant after the meal. In the case of camphor, rosemary oil, menthol, sassafras oil, fennel oil, and a few other odours, no consistent fluctuations of this nature were observed.

A further phenomenon of some interest proved to be that a rise in the preference for caraway oil appeared to be correlated with a fall in the preference for the odour of camphor and rosemary oil. A similar negative correlation of affective reactions, though relatively low, appeared in the case of dill oil and camphor. The accompanying diagram (Fig. 1), showing fluctuations in the median position of caraway oil and camphor on different dates, also indicates an interesting possibility of a periodic fluctuation in affective reactions to odours. Such fluctuations have been previously observed by me in the case of a few female subjects during menstruation, while a certain

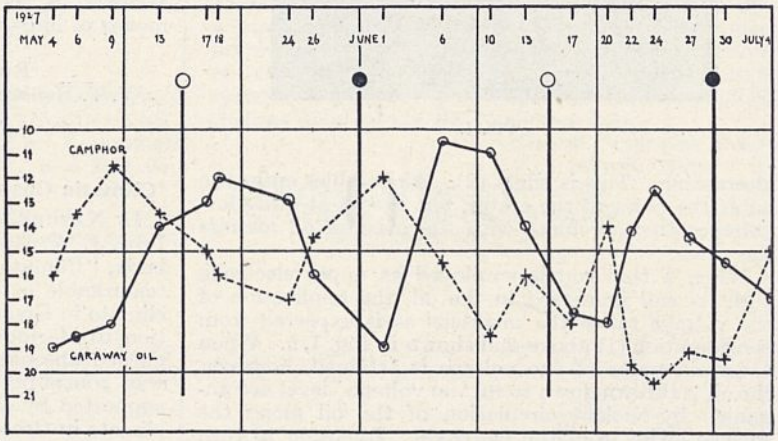


FIG. 1.—Fluctuations in relative preference to odour of caraway oil and of camphor. Numbers on axis of ordinates refer to median position in a series of thirty odours arranged in order of preference. White circles indicate date of full moon, black circles date of new moon.

correlation between menstruation and lunar periods has been demonstrated by Arrhenius (*Skand. Arch. f. Physiol.*, 1898), as quoted by H. M. Fox (*Proc. Roy. Soc.*, B, vol. 95, 1923). A ten-day periodicity in Obelia has been recorded by R. Elmhirst (NATURE, Sept. 5, 1925).

In view of abundant information on the anatomical and physiological relations between the organs of smell and sex in man, facilities are required for further experimentation on a large scale, taking into consideration the various factors involved, physical, chemical, physiological, and psychological. It may be mentioned that, notwithstanding common belief, fluctuations in the degree of pleasantness or otherwise of odours, are by no means always concomitant with affective reactions due to recall of associations.

J. H. KENNETH.

The Homestead,
Clynder, Dumbartonshire.

Hot-wire Microphone and Audio-resonant Selection.

UNDER the heading "News and Views" on page 235 of NATURE for Aug. 13, reference is made to my recent paper to the Radio Society of Great Britain on the "Hot-wire Microphone and Audio-resonant Selection." The writer of the note is, I fear, too optimistic with regard to the possible applications of my paper. The invention relates to the selection and

recording of Morse telegraphic signals. I think that his conclusion that there is no reason why more frequencies could not be selected in the wave bands at present employed for broadcasting misses the point.

Broadcasting employs a band of radio-frequency wave-lengths, and the whole range of audio-frequencies between about 26 oscillations per second to about 8000 have to be received simultaneously. Audio-resonant selection, on the other hand, can be carried out on very sharply tuned radio-frequencies, and its whole object is to pick out one musical note only, and to reject all other audio-frequencies except that to which the resonator is attuned.

If this principle were applied to broadcast reception, one note only would be picked out whenever it occurred, and all the rest of the music would be rejected.

I notice also that I am credited with a statement that Sir Wm. Preece described the "Hot-wire Microphone or Thermo Telephone" to the Royal Society in 1880. In point of fact, these are two separate instruments, and, as I pointed out in my lecture, Sir Wm. Preece described the thermo-telephone in 1880, but the hot-wire microphone (or red hot wire telephone transmitter, as it was then called) was described by Prof. Geo. Forbes to the Royal Society in 1887.

G. G. BLAKE.

Onslow Road,
Richmond, Surrey, Aug. 16.

A Vibrating Soap Jelly.

SOME years ago, H. N. Holmes showed that a silicic acid jelly could be prepared which gives a musical tone on tapping. It is perhaps worth putting on record that the same phenomenon can be exhibited by a soap jelly, as Mr. P. van Campen happened to discover in this laboratory. A bottle had been nearly filled with ordinary soft soap and set aside. After a few months it turned out that a clear jelly had been formed. On tapping the bottle gently, it gave a very low but distinctly audible tone. It is particularly noteworthy that, whereas the silicic acid jelly is rather stiff and brittle, the soap jelly is very soft, and yields to a slight pressure of the finger.

The pitch of the tone was very low. It was a little higher after the soap had been kept at room temperature for about three months. After cooling in the ice-box, the pitch was raised again a little, as might be expected. When warmed above 25°, the jelly began to melt, but set again when cooled and showed the phenomenon anew.

It would appear that the soap crystallises to a network of crystal fibres possessing sufficient rigidity to allow sound vibrations. At a low temperature the crystals increase in number and in size at the cost of the solution contained between the network, whilst they dissolve again on warming.

I am informed that the same phenomenon has sometimes been observed in a soap factory in Holland.

E. H. BUCHNER.

Chemical Laboratory,
The University, Amsterdam.

Electric Charges on Omnibuses.

WHEN light steam waggons fitted with rubber tyres were first run upon the roads, it was found desirable to provide an earthing device consisting of a short piece of chain which dangled from the vehicle to the ground in order to dissipate the electric charge which accumulated on the vehicle due to the escape of the steam.

Under favourable weather conditions and after descending a long incline with the brakes on, the ordinary motor omnibus also becomes charged to such an extent that upon approaching the bus, just before it has stopped, a spark about 1 cm. long bridges the gap between the hand-rail and the passenger's finger.

The spark is quite attenuated, and the only sensation is a slight pin-prick, though this might be unpleasant to people who are specially sensitive to electric shocks; and it would seem that an earthing device similar to that used on steam waggons should be provided.

That such a shock is present is known to some of the conductors, and it is usually attributed to some slight leakage from the magneto, though this is unlikely in view of the length and comparative weakness of the spark.

I have frequently noticed this effect in boarding a No. 111 bus about half-way down Crouch Hill, N.8.

L. BELLINGHAM.

71 Hornsey Rise,
London, N.19.

Food-Value of Pasture Grass.

THE editorial article in NATURE of July 16 directs attention to the important results secured at the Cambridge School of Agriculture on the value of young pasture grass as a concentrated food for stock. In the Prairie Provinces of Canada, annual and winter annual cereals are used very widely for both hay and pasture. It may be of interest, therefore, to refer to some analyses of such material carried out at the University of Alberta.

The dry matter of young wheat plants, collected at various times in the autumns of 1921 and 1923, contained from 21 to 34 per cent. of crude protein, of which about 90 per cent. was in a fluid condition in the cells. Of the total dry substance in the plants, from two-thirds to three-fourths was contained in the tissue fluids. The detailed analyses have been published in another connexion (*Alta. Coll. of Agr. Research Bull.* No. 1; 1924; and *Jour. Agric. Sci.*, **16**, 522-538; 1926).

While no feeding trials were made, the analyses seem to leave no doubt that this material should rank as a high-class concentrate.

R. NEWTON.

Edmonton, Alberta, Canada,
Aug. 12.

Corrosion of Copper Pipes.

THE presence of a metal tends to inhibit the corrosion of a more electro-positive metal. On the other hand, when a metal is coated with a material to which it is electro-negative, it is well known that intense local corrosion is apt to ensue if defects arise in the coating.

Copper utensils are effectively protected by a coating of tin, the potential between copper and tin being about +0·4 volt. Tin, however, is not a suitable lining for copper water pipes. The explanation of this anomaly is that in a pipe the tin lining does not keep bright. On tarnishing it becomes more electro-positive and is ultimately electro-positive to copper. In this condition it is pernicious.

The potential between copper and the tarnished tin lining of a pipe (in water) was found to be −0·1 volt: this pipe failed by local corrosion.

A. F. DUFTON.
F. L. BRADY.

Building Research Station,
Garston, Herts,
Aug. 15.

The Outstanding Problems of Relativity.[1]

By Prof. E. T. WHITTAKER, F.R.S.

IT was in January 1914 that Einstein (*Zeits. f. Math. u. Phys.*, **63**, p. 215; 1914) made his great departure from the Newtonian doctrine of gravitation by abandoning the idea that the gravitational potential is scalar. The thirteen eventful years which have passed since then have seen the rapid development of the new theory, which is called General Relativity, and the confirmation by astronomers and astrophysicists of its predictions regarding the bending of light-rays by the sun and the displacement of spectral lines. At the same time a number of new problems have arisen in connexion with it; and perhaps the time has now come to review the whole situation and to indicate where there is need for further investigation.

Prof. G. F. FitzGerald of Dublin long held an opinion which he expressed in 1894 in the words: "Gravity is probably due to a change of structure of the ether, produced by the presence of matter" (FitzGerald's "Scientific Writings," p. 313). Perhaps this is the best description of Einstein's theory that can be given in a single sentence in the language of the older physics: at any rate it indicates the three salient principles, first, that gravity is not a force acting at a distance, but an effect due to the modification of space (or, as FitzGerald would say, of the ether) in the immediate neighbourhood of the body acted on; secondly, that this modification is propagated from point to point of space, being ultimately connected in a definite way with the presence of material bodies; and thirdly, that the modification is not necessarily of a scalar character. The mention of the ether would be criticised by many people to-day as something out-of-date and explicable only by the circumstance that FitzGerald was writing thirty-three years ago; but even this criticism will not be universal; for Wiechert and his followers have actually combined the old ether theory with ideas resembling Einstein's by the hypothesis that gravitational potential is an expression of what we may call the specific inductive capacity and permeability of the ether, these qualities being affected by the presence of gravitating bodies. Assuming that matter is electrical in its nature, it is inferred that matter will be attracted to places of greater dielectric constant. It seems possible that something of this sort was what FitzGerald had in mind.

Let us now consider some of the consequences of Einstein's theory. One of the first of them is that when a planet moves round a central attracting body in a nearly circular orbit, the perihelion of the orbit advances by (approximately) $6\pi v^2/c^2$ in each revolution, where v is the planet's velocity and c is the velocity of light. This gives for the motion of the perihelion of Mercury almost exactly the amount (42″ per century) which is found from observation. Another consequence is that light-rays which pass near a massive body are deflected, the bending at the sun's limb being 1″·75. This was confirmed observationally by the British expeditions to the eclipse of May 1919, and still more decisively by the Lick Observatory expedition to the Australian eclipse of September 1922: the Lick observers found for the shift 1″·72 ± 0″·11, which differs from Einstein's predicted value by much less than its estimated probable error. Yet another result of general relativity is that, by the Principle of Equivalence, light which reaches us from a place of different gravitational potential (such as the sun) must exhibit a kind of Doppler effect. This 'gravitational shift of the solar spectral lines' is now generally admitted to be confirmed by comparisons of wave-lengths at the centre of the sun's disc with wave-lengths from the arc *in vacuo*; and in 1925 the effect was observed, on a much larger scale, by W. S. Adams in the spectrum of the companion of Sirius.

Besides the effects which have been verified observationally, there are many consequences of Einstein's theory which are of interest as opening up new fields or presenting new inter-relations of phenomena in astronomy and physics. For example, there is a contribution to the precession of the equinoxes which, unlike ordinary precession, does not depend on the oblateness of the earth. Again, the bending of the rays of light near a gravitating body, which has been observed in the case of the sun and the companion of Sirius, may, theoretically at any rate, be so pronounced that the ray is permanently captured by the attracting body, and describes for ever a track round and round it, which approaches spirally and asymptotically to a circle the centre of which is at the centre of gravitation. Yet another deduction is that an electrified body, or a single electron, which is at rest in a varying gravitational field, must emit radiation. Indeed, now that a definite connexion has been set up between electricity and gravitation, the whole of electromagnetic theory must be rewritten.

As a further illustration of the (as yet) unexplored possibilities of the new physics, let us consider the well-known equations for the potential of Newtonian gravitation, namely, Laplace's equation in space where there is no matter, and Poisson's equation in space where matter of density ρ is present. In general relativity, when the field is statical, these are replaced by an equation which reduces to Laplace's equation in one extreme case (when no matter or energy is present at the point) and to Poisson's equation in another extreme case (when the energy is entirely in the form of ordinary matter), but it offers an infinite variety of possibilities intermediate between the two, in which energy is present but not in the form of ordinary matter. It is possible that this equation, which evidently suggests an approach to the new wave-mechanics, may play as important a part in the microphysics and astrophysics of the future as the equations of Laplace and Poisson have played in the ordinary physics of the past.

[1] From the presidential address to Section A (Mathematical and Physical Sciences) of the British Association delivered at Leeds on Sept. 5.

The fundamental researches of Einstein and Hilbert, with the discovery of the field equations of gravitation, were published in 1915. At that time German scientific journals did not reach Great Britain regularly, and British physicists and mathematicians were mostly occupied in one way or another with duties arising out of the Great War; so that comparatively little notice was taken of the new theory on this side of the North Sea during the first year or two of its existence, and indeed it was not until the end of the War that most of us had any opportunity of studying it. In Germany, however, it was quickly realised that general relativity was one of the most profound and far-reaching contributions that had ever been made to science. Its successful prediction of new phenomena of a most unexpected kind was an event of the first importance, but still more significant was its complete subversion of the foundations of physics and reconstruction of the whole subject on a new basis. From time immemorial the physicist and the pure mathematician had worked on a certain agreement as to the shares which they were respectively to take in the study of Nature. The mathematician was to come first and analyse the properties of space and time, building up the primary science of geometry; then, when the stage had thus been prepared, the physicist was to come along with the dramatis personæ—material bodies, magnets, electric charges, light, and so forth—and the play was to begin. But in Einstein's revolutionary conception, the characters created the stage as they walked about on it: geometry was no longer antecedent to physics, but indissolubly fused with it into a single discipline. The properties of space, in general relativity, depend on the material bodies that are present; Euclidean geometry is deposed from its old position of priority, and from acceptance as a valid representation of space; indeed its whole spirit is declared to be alien to that of modern physics, for it attempts to set up relations between points which are at a finite distance apart, and thus is essentially an action-at-a-distance theory; and in the new world no direct relations exist at all except between elements that are contiguous to each other.

The scheme of general relativity, as put forward by Einstein in 1915, met with some criticism as regards the unsatisfactory position occupied in it by electrical phenomena. While gravitation was completely fused with metric, so that the notion of a mechanical force on ponderable bodies due to gravitation attraction was completely abolished, the notion of a mechanical force acting on electrified or magnetised bodies placed in an electric or magnetic field still persisted as in the old physics. This seemed to be an imperfection, and it was felt that sooner or later everything, including electromagnetism, would be re-interpreted and represented in some way as consequences of the pure geometry of space and time. In 1918, Weyl proposed to effect this by rebuilding geometry once more on a new foundation. He devised a geometry more general than the Riemannian geometry which had been adopted by Einstein; instead of being specified, like the Riemannian geometry, by a single quadratic differential form, it is specified by a quadratic differential form and a linear differential form together. Thus he succeeded in exhibiting both gravitation and electricity as effects of the metric of the world.

The enlargement of geometrical ideas thus achieved was soon followed by still wider extensions of the same character, due to Eddington, Schouten, Wirtinger, and others. From the point of view of the geometer, they constituted striking and valuable advances in his subject, and they seemed to offer an attractive prospect to the physicist of combining the whole of our knowledge of the material universe into a single unified theory. The working out of the various possible alternative schemes for identifying these more general geometries with physics has been the chief occupation of relativists during the last nine years. Many ingenious proposals and adaptations have been published, and more than one author has triumphantly announced that at last the problem has been solved. But I do not think that any of the theories can be regarded as satisfactory, and within the last year or two a note of doubt has been perceptible; Were we after all on the right track? At last Einstein himself (*Math. Ann.*, **97**, p. 99; 1926) has made up his mind and renounced the whole movement. The present position, then, is that the years 1918–1926 have been spent chiefly in researches which, while they have contributed greatly to the progress of geometry, have been on altogether wrong lines so far as physics is concerned; and we have now to go back to the pre-1918 position and make a fresh start, with the definite conviction that the geometry of space-time is Riemannian.

Granting, then, this fundamental understanding, we have now to inquire into the axiomatics of the theory. This part of the subject has received less attention in Great Britain than elsewhere, perhaps because of the more or less accidental circumstance that the most prominent and distinguished exponents of relativity in England happened to be men whose work lay in the field of physics and astronomy rather than in mathematics, and who were not specially interested in questions of logic and rigour. It is, however, evidently of the highest importance that we should know exactly what assumptions must be made in order to deduce our equations, especially since the subject is still in a rather fluid condition.

What we want to do, then, is to set forth the axiomatics of general relativity in the same form as we have been accustomed to give to the axiomatics of any other kind of geometry—that is, to enunciate the primitive or undefined concepts, then the definitions, the axioms, and the existence-theorems, and lastly the deductions. In the course of the work we must prove that the axioms are compatible with each other, and that no one of them is superfluous.

The usual way of introducing relativity is to talk about measuring-rods and clocks. This is, I think,

a very natural and proper way of introducing the doctrine known as 'special relativity,' which grew out of FitzGerald's hypothesis of the contraction of moving bodies, and was first clearly stated by Poincaré in 1904, and further developed by Einstein in 1905. But general relativity, which came ten years later, is a very different theory. In general relativity there are no such things as rigid bodies—that is, bodies for which the mutual distance of every pair of particles remains unaltered when the body moves in the gravitational field. That being so, it seems desirable to avoid everything akin to a rigid body—such, for example, as measuring-rods or clocks—when we are laying down the axioms of the subject. The axioms should obviously deal only with the simplest constituents of the universe. Now if one of my clocks or watches goes wrong, I do not venture to try to mend it myself, but take it to a professional clockmaker, and even he is not always wholly successful, which seems to me to indicate that a clock is not one of the simplest constituents of the universe. Some of the expounders of relativity have recognised the existence of this difficulty, and have tried to turn it by giving up the ordinary material clock with its elaborate mechanism, and putting forward in its place what they call an atomic clock; by which they mean a single atom in a gas, emitting light of definite frequency. Unfortunately, the atom is apparently quite as complicated in its working as a material clock, perhaps more so, and is less understood; and the statement that the frequency is the same under all conditions, whatever is happening to the atom, is (whether true or not) a highly complex assumption which could scarcely be used in an axiomatic treatment of the subject until it has been dissected into a considerable number of elementary axioms, some of them perhaps of a disputable character.

It seems to me that we should abandon measuring-rods and accurate clocks altogether, and begin with something more primitive. Let us then take any system of reference for events—a network of points to each of which three numbers are assigned—which can serve as spatial co-ordinates, and a number indicating the succession of events at each point to serve as a temporal co-ordinate. Let us now refer to this co-ordinate system the paths which are traced by infinitesimal particles moving freely in the gravitational field. Then it is one of the fundamental assumptions of the theory that these paths are the geodesics belonging to a certain quadratic differential form. The truth or falsity of this assumption may, in theory at any rate, be tested by observation, since if the paths are geodesics they must satisfy certain purely geometrical conditions, and whether they do or not is a question to be settled by experience.

Granting for the present that the paths do satisfy these conditions, let us inquire if a knowledge of the paths or geodesics is sufficient to enable us to determine the quadratic form. The answer to this is in the negative, as may easily be seen if we consider for a moment the non-Euclidean geometry defined by a Cayley-Klein metric in three-dimensional space. In the Cayley-Klein geometry the geodesics are the straight lines of the space; but a knowledge of this fact is not sufficient to determine the metric, since the Absolute may be any arbitrary quadric surface.

In order to determine the quadratic form in general relativity we must, then, be furnished with some information besides the knowledge of the paths of material particles. It is sufficient, as Levi-Cività has remarked, that we should be given the null geodesics, *i.e.* the geodesics along which the quadratic form vanishes. In the Cayley-Klein geometry these are the tangents to the Absolute; in general relativity they are tracks of rays of light.

So from our knowledge of the paths of material particles and the tracks of rays of light we can construct the particular quadratic form, and then we are ready for the next great axiom, namely, Einstein's Principle of Covariance. The point I wish specially to make is that in the above treatment there has been no mention either of length or of time: neither measuring-rod nor clock has been introduced in any way. We have left open the question whether the quadratic form does or does not represent anything which can be given directly by measuring-rods and clocks. For my own part I incline to think that the notions of length of material bodies, and time of clocks, are really rather complex notions which do not normally occur in the early chapters of axiomatic physics. The results of the ether-drift experiments of D. C. Miller at Mount Wilson in 1925, if confirmed, would seem to indicate that the geometry which is based on rigid measuring-rods is actually different from the geometry which is based on geodesics and light-rays.

The actual laws of Nature are most naturally derived, it seems to me, from the Minimum Principle enunciated in 1915 by Hilbert. This principle is the grand culmination of the movement begun 2000 years ago by Hero of Alexandria with his discovery that reflected light meets the mirror at a point such that the total path between the source of light and the eye is the shortest possible. In the seventeenth century, Hero's theorem was generalised by Fermat into his "Principle of Least Time" that "Nature always acts by the shortest course," which suffices for the solution of all problems in geometrical optics. A hundred years later, this was further extended by Maupertuis, Euler, and Lagrange, into a general principle of 'Least Action' of dynamical systems, and in 1834, Hamilton formulated his famous Principle which was capable of reducing all the known laws of Nature—gravitational, dynamical, and electrical—to a representation as minimum-problems.

Hilbert's minimum principle in general relativity is a direct application of Hamilton's principle, in which the contribution made by gravitation is the integral of the Riemann scalar curvature. Thus gravitation acts so as to make the total amount of the curvature of space-time a minimum: or, as we may say, *gravitation simply represents a continual effort of the universe to straighten itself out.* This is general relativity in a single sentence.

I have already explained that the curvature of space-time at any point at any instant depends on the physical events that are taking place there: in statical systems, where we can consider space of three dimensions separately from time, the mean curvature (*i.e.* the sum of the three principal curvatures) of the space at any point is proportional to the energy-density at the point. Since, then, the curvature of space is wholly governed by physical phenomena, the suggestion presents itself that the metric of space-time may be determined *wholly* by the masses and energy present in the universe, so that space-time cannot exist at all except in so far as it is due to the existence of matter. This doctrine, which is substantially due to Mach, was adopted in 1917 by Einstein, and has led to some interesting developments. The point of issue may be illustrated by the following concrete problem: If all matter were annihilated except one particle which is to be used as a test-body, would this particle have inertia or not? The view of Mach and Einstein is that it would not; and in support of this view it may be urged that, according to the deductions of general relativity, the inertia of a body is increased when it is in the neighbourhood of other large masses; it seems needless, therefore, to postulate other sources of inertia, and simplest to suppose that *all* inertia is due to the presence of other masses. When we confront this hypothesis with the facts of observation, however, it seems clear that the masses we know to exist—the solar systems, stars, and nebulæ—are insufficient to confer on terrestrial bodies the inertia which they actually possess; and, therefore, if Mach's principle were adopted, it would be necessary to postulate the existence of enormous quantities of matter in the universe which have not been detected by astronomical observation, and are called into being simply in order to account for inertia in other bodies. This is, after all, no better than regarding some part of inertia as intrinsic.

Under the influence of Mach's doctrine, Einstein made an important modification of the field-equations of gravitation. He now objected to his original equations of 1915 on the ground that they possessed a solution even when the universe was supposed void of matter, and he added a term —the 'cosmological term' as it is called—with the idea of making such a solution impossible. After a time it was found that the new term did not do what it had been intended to do, for the modified field-equations still possessed a solution —the celebrated 'De Sitter world'—even when no matter was present; but the 'De Sitter world' was found to be so excellent an addition to the theory that it was adopted permanently, and with it of course the 'cosmological term' in the field-equations; so that this term has been retained for exactly the opposite reason to that for which it was originally introduced.

The 'De Sitter world' is simply the universe as it would be if all minor irregularities were smoothed out: just as when we say that the earth is a spheroid, we mean that the earth would be a spheroid if all mountains were levelled and valleys filled up. In the case of the De Sitter universe, the levelling is a more formidable operation, since we have to smooth out the earth, the sun, and all the heavenly bodies, and reduce the world to a complete uniformity. But after all, only a very small fraction of the cosmos is occupied by material bodies; and it is interesting to inquire what space-time as a whole is like when we simply ignore them.

The answer is, as we should expect, that it is a manifold of constant curvature. This means that it is isotropic (*i.e.* the Riemann curvature is the same for all orientations at the same point), and is also homogeneous. As a matter of fact, there is a well-known theorem that any manifold which is isotropic in this sense is necessarily also homogeneous, so that the two properties are connected. A manifold of constant curvature is a projective manifold, *i.e.* ordinary projective geometry is valid in it when we regard geodesics as straight lines; and it is possible to move about in it any system of points, discrete or continuous, rigidly, *i.e.* so that the mutual distances are unaltered.

We are thus brought to the question of the dimensions of the universe: What is the length of the complete straight line, the circuit of all space? The answer must be furnished by astrophysical observations, interpreted by a proposition which belongs to the theory of 'De Sitter's world,' namely, that the lines of the spectrum of a very distant star should be systematically displaced; the amount of displacement is proportional to the ratio of the distance of the star from the observer to the constant radius of curvature R of the universe. In attempting to obtain the value of R from this formula we meet with many difficulties: the effect is entangled with the ordinary Doppler effect due to the radial velocity of the star; it could in any case only be of appreciable magnitude with the most distant objects, and there is the most serious difference of opinion among astronomers as to what the distance of these objects really is. Within the last twelve months the distance of the spiral nebula M 33 Trianguli has been estimated by Dr. Hubble, of the Mount Wilson Observatory, at 857,000 light-years, and by Dr. Perrine, the Director of the Cordoba Observatory, at only 30,000 light-years; and there is a similar uncertainty of many thousands per cent. in regard to all other very remote objects.

In these circumstances we hesitate to assign a definite length for the radius of curvature of the universe; but it is millions of light-years, though probably not greater than about a hundred millions. The curvature of space at any particular place due to the general curvature of the universe is therefore quite small compared to the curvature which may be imposed on it locally by the presence of energy. By a strong magnetic field we can produce a curvature with a radius of only 100 light-years, and of course in the presence of matter the curvature is far stronger still. So the universe is like the earth, on which the local curvature of hills and valleys is far greater than the general curvature of the terrestrial globe.

Influence of Internal Secretions on Sex Characters.

AT the Edinburgh meeting of the British Medical Association, Dr. F. A. E. Crew opened an interesting discussion in the Section of Physiology and Bio-chemistry on the "Influence of Internal Secretions on Sex Characters." The importance of the organs of the endocrine system in regulating and controlling sex characteristics has been recognised for the past thirty years or so, but it is only recently that we have come to have a clear understanding of the rôle of the component members of this glandular system and the balanced action which exists between them.

Crew classified the sex dimorphic characters as (1) primary genotypic, (2) secondary genotypic (including the primary gonadic), and (3) secondary gonadic. There is no difficulty in demonstrating the dependence of the secondary gonadic characters on the physiological activity of the gonad. It is now established that the gonad influences the growth of the long bones, the development of the muscular and nervous systems, and plays an important part in general metabolism. The gonad also exerts a powerful influence over the structure and functions which form the secondary sex-dimorphic characters.

The function of the gonads in regulating growth and development may be studied by the usual experimental procedure, namely, (1) removal of the gonad, (2) implantation of the gonad, and (3) administration of preparations of the gland.

The effect and results of removal of the gonad will vary according to the development of the body and the physiological condition at the time that the operation is carried out. These conditions may be summarised as (1) pre-pubertal, and (2) post-pubertal. The first result of castration before the age of puberty is the hinderance to further development of the reproductive system. Castration on one side produced no effect, the retention of a single testis being sufficient to maintain normal function. In the human, castration at the same stage is known to prevent the growth of hair on the face, the development of the thorax, pelvis, and to preserve the voice of childhood. Further, metabolism is disturbed, the deposition of fat is marked, accumulating under the breasts and in gluteal regions.

The effect of castration on the development of the long bones has been well studied, and the evidence is now clear that the absence of the active gonad leads to an abnormal growth of bony tissues. Poucet in 1897 found that the bones and skeleton of the castrated rabbit were larger than those of the control. Geddes has also shown that the process of ossification is prolonged, and that the long bones are unduly long. These findings do not necessarily imply that the processes of nutrition and growth are opposed to reproduction. After castration, there is not only absence of the internal secretion from the gland, but there is further a loss of balance in the endocrine system during a period of rapid development of the body structure.

Castration after onset of puberty is followed by disappearance of the beard and redistribution of the body fat and hair. It is clear that castration never induces any condition resembling the female type; the condition is infantile and not female. Extirpation of both ovaries in the human after puberty is followed by cessation of menstruation. Atrophy of the genitalia is also well marked. The operation may also lead to emotional disturbances, headache, fainting, and intestinal disturbances.

Probably the most interesting results which have been obtained are those on gonad implantation. There is no difficulty in demonstrating that an animal which has been castrated at an early age will develop normally if a testis is successfully implanted. It is also possible to restore the female characters by implanting ovarian tissue after ovariotomy. The degree of restoration possible will depend on (1) the age of the animal at the time of castration or ovariotomy, (2) the condition of the tissues at the time of implantation, and (3) the interval between the two operations. It will be seen that restoration is not possible if pathological changes have taken place in the tissues after removal of the gonad. Further, secondary sex characters can be re-established, as has been shown by Nussbaum. Castration of the male frog inhibits the development of the sexual pad on the first digit of each fore-limb, but after introduction of pieces of testis into the dorsal lymph sac, the swelling on the thumb and hypertrophy of the muscles of the fore-limb took place as in the normal animal.

It is possible to feminise a male by castration and subsequent implantation of ovarian tissue; the mammary glands are stimulated into activity while the male sex organs diminish in size. The converse is also possible, namely, to masculinise a female by ovariotomy and subsequent implantation of testes. These experiments certainly suggest that the sex hormones are specific.

Much attention has recently been devoted to implantation of testicular grafts from anthropoids into the human host. The success of these operations will depend not only on the technique of the operation but also on the ability of the host to provide the nutrition necessary for the continued life of the implant. The effect of the graft on the body will depend on the condition of the tissues at the time of operation. It is possible to supply and supplement the gonadic hormone and to re-establish the balance between the components of the endocrine system. It is not possible, however, by increase of sex hormone to re-establish a physiological condition if pathological changes have taken place.

In Crew's study of about one hundred and fifty hermaphrodite pigs, he has found only testicular tissue present, though usually intra-abdominally. The sex characters, however, fell into a graded series from a normal male up to an almost female type of animal. A certain minimum threshold of secretion exists which is essential before

differentiation of the sex characters can occur. A condition of ovo-testes is frequently found amongst pigs either on one or both sides. The ovary is always cephalic and on the left side, showing that differentiation must take place from right to left and from cephalic to caudal poles. If the ovary was able to initiate the development, the animal would tend to develop female characters during its early days, the degree of maleness appearing later in life depending upon the extent to which the secretion of the slower differentiating testes was able to counteract the ovarian secretion. This would explain the tendency to maleness exhibited in the human by girls as they grow older. Macmillan's recent discovery of a chemical test for sex should prove useful in the solution of these problems.

Evidence that the ovarian extract as at present used is responsible for the slow ante-pubertal growth of the female sex-organs is not conclusive. The supposed hypertrophy is sudden, occurring within forty-eight hours, and it only produces the changes associated with œstrus. Injection into the new-born rat is without effect, while injection into the animal three weeks old produces œstral changes. Further, ovarian extract does not produce the psychical changes normally associated with the œstrus cycle. Parkes, from his investigations, concluded that the ovarian extract at present in use probably contains the responsible factor for the production of œstral changes, and that another substance is responsible for the pubertal and psychical changes.

Evidence was put forward by Glynn in the discussion for the supposed relationship of the suprarenal cortex to secondary sex characters. This evidence is summarised under the four headings :

(1) Embryological—Cortex of the suprarenal gland and the ovary and testis are derived from the same source.

(2) Physiological—Enlargement of the suprarenal glands during pregnancy.

(3) Pathological—In hermaphroditism there is bilateral enlargement of the suprarenals in the female.

(4) Clinical—Hypernephroma or tumour of the suprarenal associated with pseudo-hermaphroditism.

In females suffering from adrenal hypernephroma, there is often atrophy of the mammary glands, ovary, and uterus, with cessation of menstruation, alteration in metabolism, mainly fat metabolism, and a general tendency to increase the male primary and secondary sexual characters at the expense of the female.

Tumour formation in the adrenals leads to a profound disturbance of normal metabolic conditions, and it is possible that while the endocrine glands may exert no direct influence upon the secondary sex characters, yet they may have a pronounced indirect effect by bringing about abnormal conditions of metabolism. Crew has demonstrated that cockerels, fed on thyroid from the time of hatching, developed female colour and type of feathering. Further, gonadectomy and gonad implantation do not lead to any apparent change in the metabolism of the animal, and, after operation, the endocrine glands appeared to be normal. It appears probable, then, that the secondary sex characters are under control of the gonad secretion, but with abnormal conditions of metabolism, a new threshold for the differentiation of the tissues is established.

The British Association at Leeds.

THE general opinion on all hands seems to be that the meetings of the British Association in Leeds have been a great success ; certainly from the point of view of the citizens of Leeds, they will be remembered as a fitting celebration of the arrival of summer. After the most dismal August in the recorded meteorology of the area, the meetings have heralded a change to sunny weather and blue skies, with that bracing keenness in the air that prevents lassitude. Whilst the excursions have thus been made doubly enjoyable, the weather has also been appropriate for the strenuous follower of sectional activities.

Comparatively few seats were empty when the president's address was delivered in the Majestic Picture Theatre. This meeting was noteworthy for the announcement by the president of the Council's support of a movement to purchase Charles Darwin's home and estate at Downe, so that it may be retained in perpetuity for the nation. The enthusiastic applause of the vast audience showed their cordial sympathy with the proposal. Sir Oliver Lodge, who, in the absence of the retiring president, H.R.H. The Prince of Wales, was in the chair and introduced Sir Arthur Keith, alluded in felicitous terms, as also later did the president himself, to the generous anonymous gift of £100,000 to the appeal fund of the University of Leeds—a sum to be devoted to the erection of the new library. The announcement of this gift in the press on the same day as the inaugural meeting naturally added to the general enthusiasm with which the proceedings were initiated, and gave added force to the vice-chancellor's hope, expressed in his opening remarks of welcome at the inaugural meeting, that on a future occasion the University may be then able to accommodate all the activities of the Association within its walls. It has since been announced that the University owes this gift to Sir Edward Brotherton, a well-known chemical manufacturer with works at Leeds and Liverpool, to whom the University was already indebted for a gift of £20,000 for bacteriological research. Sir Arthur Keith's reference to the possibility of acquiring Darwin's house at Downe has borne fruit, for an amount sufficient to purchase and maintain the house has been offered by Mr. G. Buckston Browne, whose name will be associated with this gift to the nation.

Both the University and the civic authorities have thrown themselves whole-heartedly into the work of entertaining their guests ; the dinners

given to the president, vice-presidents, and other prominent members of the Association by the Lord Mayor and the vice-chancellor of the University being representative of a large amount of civic and private hospitality, in which neighbouring towns have also joined. Both York and Harrogate entertained large parties of scientific visitors right royally when the week-end permitted the members of the Association to scatter into various parts of the three Ridings.

One feature in the meeting that was perhaps particularly appreciated was the effort made to provide for the comfort of members on excursions. On all general excursions, besides the leader who explained the particular points of interest, another guide accompanied each party whose sole task was to consider the comfort of visitors, and in case of any emergency to see that arrangements were made to meet it without distracting the official leader from his duties.

Both the civic reception on Thursday evening and the University reception on the night of Tuesday, were very successful, if crowded, functions. Particular distinction was given to the civic reception by the presence of H.R.H. Princess Mary, Viscountess Lascelles, to whom a number of prominent citizens, vice-presidents, members of the Council, and officials of the Association were presented. Princess Mary afterwards made a tour round a number of the beautiful rooms of the Art Gallery which were thrown open to the throngs of visitors on this occasion.

Perhaps the most striking feature of the University reception to the visitors was the vast extent and elaborate equipment of the technological departments of the University which were thrown open for their inspection with a large amount of the full scale machinery in operation. Visitors were then able to see industrial processes, such as dyeing, manufacture and treatment of leather, spinning and weaving, etc., carried out upon a manufacturing scale and at the same time worked in conjunction with intensive scientific investigation.

On Friday night a most successful dance was held in the Dance Hall of the Majestic Picture Theatre. The Lord Mayor's party, which included the president of the Association and the vice-chancellor of the University, attended after a dinner given by the Lord Mayor in the Town Hall, whilst Sir Oliver Lodge was to be seen with the party coming fresh from listening to Prof. Millikan, who had been giving the first of the evening discourses to a large audience in the Albert Hall. Sir Oliver danced nearly every item of the programme, and many citizens of Leeds present on this and other social occasions of the meeting will probably have gained quite a different conception of the human side of the scientific members of the community from that usually held, as a result of this and similar light incidents of a notable scientific assembly.

SCIENTIFIC APPARATUS AND DEMONSTRATIONS.

During the week of the meeting, demonstrations were given of Mr. J. L. Baird's television and 'noctovision' apparatus. The latter (which employs infra-red radiation in the place of light) is regarded by the inventor as likely to be of commercial value at an earlier date than the former, since he hopes to apply it to navigation in fog. The reproductions are at present comparable with those obtained with the earliest kinematographs, and are marred by flickering and coarseness of detail, but the inventor has in view some solutions of the outstanding problems which may well prove successful, like those adopted in the earlier art. Whether or not Mr. Baird will be victorious in the competition with formidable foreign rivals which lies in front of him is a matter for speculation, but at least a tribute of admiration must be paid to the ingenuity, courage, and enterprise of a British inventor who has achieved considerable success in the teeth of great difficulties. An indulgent view may therefore be taken of some aspects of the exhibits which were more relevant to the popularisation of the invention than to its technical development.

An exhibition of apparatus in the crypt beneath the Reception Room formed a valuable addition to the proceedings of the Association. The exhibition was generally similar to, though on a smaller scale than, that held annually in London by the Physical and Optical Societies, and it is to be hoped that such an exhibition will become an annual feature of the meetings, since it enables scientific workers from all parts of the country to see some of the latest improvements in scientific apparatus. It is of course impossible to mention many of the most interesting exhibits, but a word must be said of that contributed by the Lancashire and Cheshire Coal Research Association, which included some most interesting fossil remains illustrating the natural history of coal, in addition to preparations and samples of coals and their ingredients. A wool research reflector for assuring even illumination in colour comparisons was attributable to the Woollen and Worsted Industries Research Association, but research associations generally did not take this opportunity of illustrating their work for the benefit of fellow-investigators and others likely to be interested in it. Amongst the more recent applications of science to practical purposes, the use of an analytical quartz lamp for such purposes as the testing of bank notes and the examination of palimpsests was illustrated. The emitted radiation is restricted by a filter to a band in the neighbourhood of 3660 Å.U., and the fluorescence produced gives a sensitive indication of slight variations in the irradiated surface. Another interesting exhibit was a refrigerator without mechanical moving parts, a quantity of captive ammonia being forced through a repeating cycle of condensations and evaporations merely by the application of heat to one vessel and of cooling water to another connected with it. Refrigeration is effected by evaporation produced by mixing the liquid ammonia with hydrogen.

Visitors to Leeds this year had an opportunity of making themselves better acquainted with a medium which is already finding its place in the service of education, namely, broadcasting. Many

people are coming to feel that what the school of to-day most urgently needs is enrichment, and this topic was the theme of many discussions in Section L (Education). In fifty years we have evolved a machine capable of high efficiency in turning out pupils reasonably well equipped for beginning to acquire knowledge, but still there are those masses who must leave school at 14 years of age with only the dimmest perception of the treasures of science and art that are their rightful inheritance. Let any one who doubts this study the text books in use in the public elementary school or hear their musical instruments or ask to see their scientific apparatus, or their playgrounds. But those who see the deficiencies most acutely are in despair at the cost of providing a proper equipment under present economic conditions, and it is for this reason that they are turning their attention to a new means of enlarging the scope of a school however remote and enriching its resources without excessive cost.

At the Reception Room, some hundreds of people were able to hear the special programmes arranged by the British Broadcasting Corporation to enable schoolmasters and others to judge how clearly and naturally broadcast matter can to-day be presented in the class-room. At the University a large room was divided into two parts, one of which represented a model studio, while the other did service as a class-room. A large number of members visited these rooms during the week, especially during the evening of the reception, and there were many who appreciated, perhaps for the first time, the extent to which it is possible for a speaker to project his personality into a room full of people, even when the appeal that he makes is to the auditory and not to the visual sense. Some thousands of schools are now listening regularly to these transmissions, using them to supplement the ordinary curriculum.

The new programme and syllabus of transmissions to schools and the provisional programme for adult transmissions are now ready and can be obtained from the British Broadcasting Corporation on application.

In connexion with a paper on the slaughtering of animals for food, a demonstration was given by the Royal Society for the Prevention of Cruelty to Animals in the municipal slaughter-house. After 12 pigs, bullocks, calves, and sheep had been dispatched with a captive bolt pistol (humane killer) a local butcher who was opposed to this instrument asked permission to demonstrate the use of the poll-axe on a bullock. The first blow of the axe proved ineffective, and a second had to be given before the bullock was felled.

TEXTILE RESEARCH.

As was fitting for a meeting held in Leeds, special provision was made for the discussion by the sections concerned of textile problems. The British Research Association for the Woollen and Worsted Industries issued a 48-page pamphlet by Dr. S. G. Barker and A. Frobisher dealing with its origin, constitution, and work in connexion with the special meetings arranged for the discussion of textiles. The Association is of firms engaged directly or accessorily in the woollen and worsted industries, and its headquarters are in Leeds. Among the most debatable of textile problems is that of the 'quality' of the raw material, the fibres. Judgment based upon the observations of sight and touch and crystallised by experience, grades cotton, classifies wools and tops, and selects silks with an accuracy that has sufficed for many generations of manufacturers and will no doubt continue to do so, at least to some extent, for many years to come. But science holds no realm that admits of investigation too sacred or too unfruitful for such investigation, and elasticity tests, grease estimations, diameter measurements, staple lengths, all now contribute to a more accurate, more trustworthy estimation of 'quality,' though the writers of this pamphlet wisely state that "the precise factors affecting quality as regards spinning are as yet unknown," and again, "one of the outstanding problems in wool research is the investigation of the precise definition of the term 'quality.'" The amount of work being done upon a determination of the measurements and properties of wool fibres may be gauged from a list of the headings under which the chemical aspects of the problem are surveyed—the action of acids, alkalis, and soaps; the estimation of alkali and of sulphuric acid; the sulphur content; bleaching and chlorination; and the action of ammonia; and the chemical decomposition of wool at 100° C.

The physical properties of wool have also been the subject of carefully thought out investigation, and the work of Dr. Shorter, at one time on the staff of this Association, is sufficiently well known to need but mention. Since his departure, the work of evaluating the properties of wool—regarded as an amphoteric colloid—has proceeded apace, and elasticity, regain, thermal conductivity, and electrification are topics of investigation noted in the work of the Association's physical laboratory. The action of bacteria and mildews upon wool has also been the subject of, at any rate, preliminary work, though in these aspects as well as the chemical and physical aspects the work is described as "only a beginning of the attack on the great problems." "The scientific side must be closely related to the technical or trade side, and valuable as the scientific data are, yet the object of their discovery must be their application to the industry." The Association's claim that this point is ever to the fore in its work is well substantiated, and the relationship of the previously determined chemical and physical properties to such technical problems as the migration of alkali when scoured cloth is drying off from the damp state and the faults engendered thereby in subsequent processes, notably dyeing, wool scouring, the elimination of tar-marking and branding, and the all-important subject of the fading of dyestuffs, are all instances of this type of valuable work.

The comprehensive lecture delivered by Dr. S. G. Barker on the subject of the fading of

dyestuffs made it clear that here was a piece of work of which much has been done, but of which much—the greatest part perhaps—yet remains to be done. Work yet closer to the trade processes has also been done, and apparatus likely to be of general use has been devised; the Research Association stroboscope may be mentioned in this connexion. The list of publications of the Association which, with a plan of its buildings, concludes the pamphlet, is an excellent indication of the comprehensive character of its work, and it is perhaps regrettable that the liaison between those engaged in pure science and those in technical research is not stronger and more generally established. No doubt wider publication of the work of research associations might help materially in this respect.

Honorary Degrees.

In a congregation of the University of Leeds in the Great Hall on Tuesday, Sept. 6, at 12 noon, the following honorary degrees were conferred:—*LL.D.*: Sir Arthur Keith, Conservator of the Museum and Hunterian professor of the Royal College of Surgeons of England; Her Grace the Duchess of Atholl, Parliamentary Secretary, Board of Education; The Hon. Sir Charles Parsons. *D.Sc.*: Prof. J. S. Haldane, honorary professor and director of the Mining Research Laboratory, Birmingham University; Dr. N. V. Sidgwick, reader in chemistry in the University of Oxford; Prof. F. O. Bower, emeritus professor of botany in the University of Glasgow; Dr. R. A. Millikan, chairman of the Executive Council of the California Institute of Technology and Director of the Norman Bridge Laboratory of the Institute. *Ph.D.*: James Graham, Director of Education, Leeds.

Report of Council.

The report of the Council presented to the General Committee on Aug. 31, expresses profound gratitude to Sir Alfred Yarrow for his munificent gift of £10,000 to the funds of the Association for general purposes, and accepts the wise condition that the gift should be expended as to both capital and interest within twenty years.

The Council has had under discussion with the Board of Trade the question of the duty required by H.M. Customs on the introduction of kinematograph films into Great Britain for scientific purposes and not intended for commercial uses. The matter was referred to the Lords Commissioners of H.M. Treasury, from whom a reply was received that "having regard to the impracticability of framing a statutory exemption which would be free from grave difficulties of definition and administration," they were unable "to submit to Parliament proposals of the nature desired by the Association."

Reference is made in the Council's report to the two conferences called to consider the possibility of establishing a Science News Service. The essential condition for success of such a scheme is that scientific societies and institutions themselves should desire its organisation.

In view of the lack of unanimity and of enthusiasm evinced at the two conferences, the committee appointed to indicate the ways in which this support might be given, considers that no useful purpose would be served by communicating with the scientific societies. The opinion is expressed, however, that should sufficient funds be forthcoming for the establishment of a Science News Service, the Council of the Association—possibly in co-operation with the British Science Guild—might appropriately undertake the organisation of the service.

The Council has had under consideration the question of inviting "the co-operation of the British Science Guild in considering whether, having regard to the close community of scientific interests between the Association and the Guild, their objects would, as the Council believe, be more fully attained by means of a working union between the two societies; and if so, by what means such union would best be given effect." A joint committee of the two bodies has prepared a report in which the general methods by which such a fusion might be effected are stated. This report came before the General Committee of the Association on Sept. 6, when it was decided that the Council be authorised to continue the negotiations and report to the meeting of the General Committee at Glasgow.

Next year's meeting of the Association will be held at Glasgow under the presidency of Sir William Bragg. The meeting in 1929 will be held in South Africa, and invitations have been received to meet at Bristol in 1930 and Leicester in 1932.

Obituary.

Prof. H. R. Procter, F.R.S.

HENRY RICHARDSON PROCTER, born at North Shields in 1848, was the son of a tanner, a member of the Society of Friends. He was educated at Bootham School and received his scientific training at the Royal College of Chemistry and the School of Mines. He entered the tanning industry and remained on Tyneside until 1891, when he was invited to the Yorkshire College, Leeds, to take charge of a new department to be opened there in the special interest of the leather industry. In this Procter achieved distinguished success, and his work afforded as fine an example as could well be cited of the part which applied science may properly take within the circle of university studies. Students came to Procter from all parts of the world. He was a thorough man of science, an eager and fruitful investigator, and an excellent teacher. He gave to the industry the means of scientific control and development in many directions, and placed his discoveries freely at its disposal. His text-books have long been the standard works in the science of leather manufacture.

Though Procter's scientific studies were centred

upon the problems of the leather industry, he revelled in pursuing their general theoretical bearing, and wherever they carried him he read himself in with great thoroughness. It was typical of his mental proclivities that he should have been the translator of the first text-book of practical physics —Kohlrausch's—that found general use in physical laboratories in Great Britain. His later researches on gelatine were of fundamental importance and exhibited his power of dealing with the most abstruse problems of colloid chemistry.

Beyond this, Procter was a man of wide culture, keenly interested in languages, literature, and philosophy. He was an excellent countryman and had much of the artistic sense which has appeared so strongly in his sons.

The value set upon Procter's work was so great that when the time arrived for his retirement, a movement took place for the establishment of a research laboratory which should serve as a memorial and as a place where he could continue his investigations. This project secured international support, and in 1914 Procter became the first honorary director of the international research laboratory at Leeds bearing his name. The honour done to Procter was fully earned by the scientific and industrial value of his labours, but it was intensified by the respect and affection in which he was held for his personal qualities. His fine character, his devotion, unselfishness, and modesty, together with his great companionableness, endeared him alike to his pupils, his colleagues, and the members of the industry to which he rendered such memorable service.

Procter was elected fellow of the Royal Society in 1923 and received the honorary degree of D.Sc. from the University of Leeds. He was honorary president of the International Association of Leather Trade Chemists, of which he was a founder, and he received the freedom and livery of the Leathersellers' Company. He died on Aug. 17 at Newlyn, Cornwall, where he lived in happy retirement after leaving Leeds. A. S.

PROF. E. B. TITCHENER.

THE announcement of the death of the English psychologist, Prof. Titchener, in his sixty-first year, which occurred after a short illness at Ithaca, N.Y., on Aug. 3, will be received in Great Britain with mingled feelings of regret and surprise. Regret will be felt for the loss of one who spent his abundant energies so generously in nursing to adolescence a new-born science. Surprise will be felt at the tidings that Titchener remained an Englishman, despite his thirty-five years' residence at Cornell University, and that with his full record of work he had only attained the age of sixty years at the time of his death.

Edward Bradford Titchener was born at Chichester on Jan. 11, 1867. From Malvern College he entered the University of Oxford in his nineteenth year, where he became a classical scholar at Brasenose, obtaining first class both in Moderations in 1887 and in *Literae Humaniores* in 1889. He took his B.A. in 1890, his M.A. in 1895, and in 1906 he was awarded the degree of D.Sc. at that University. From classics and philosophy he passed to the study of physiology at Oxford, and worked there as a research student during the year 1889–90. Attracted to experimental psychology, he proceeded to Leipzig, where he studied under Wundt and obtained the Ph.D. degree in 1892. Returning later in this year to Oxford, he began to inquire into the possibility of obtaining a permanent teaching post in experimental psychology, while he was giving university extension lectures in biology. He was advised by Burdon Sanderson, however, that there were no immediate prospects in England, and consequently he accepted the immediate offer of an assistant professorship in psychology at Cornell.

Here from 1892 onwards Titchener spent the remainder of his life. In 1895 he was made Sage professor of psychology, and in 1910 his professorship became attached to the Graduate School of the University. His specific aims at Cornell were to emancipate psychology from the leading-strings of philosophy, to establish undergraduate, as well as post-graduate, instruction, to compile a graded series of text-books in psychology, and to organise laboratory research in the subject. His achievement of these aims was indeed remarkable. Within twelve years he had established a completely independent department of psychology, in which finally he had a staff of two professors, two instructors and three assistants. He had an annual entry of nearly one thousand undergraduates. In 1896 he published "An Outline of Psychology" (replaced in 1910 by his "Text-book of Psychology"). In 1898 his "Primer of Psychology" appeared (which in 1915 was replaced by "A Beginner's Psychology"). In 1908 his book on "Feeling and Attention" was published, followed in 1909 by "The Experimental Psychology of the Thought Processes."

Titchener's *magnum opus*, however, a thirteen years' task, the financial cost of which, he used to say, nearly ruined him, was his "Laboratory Manual of Experimental Psychology," issued in four volumes during the years 1901–5. While preparing this monumental work, he devised and standardised many useful pieces of apparatus for laboratory teaching. It was translated later into most European languages, and into Chinese and Japanese. It was the source of many later more elementary text-books, and it led to requests for his help in planning psychological laboratories in practically every part of the world.

In 1917 a commemorative volume of essays, marking the close of twenty-five years' teaching work at Cornell, was presented to Titchener by his friends and students. By the end of 1923 the number of his published articles had amounted to 190, while the papers issuing from his students (for which he was personally responsible) numbered 158. From 1894 until 1920 he acted as American editor of the British philosophical periodical, *Mind*, and during the years 1894–1925 he was associate editor, and finally editor, of the *American Journal of Psychology*.

Titchener's unbounded energy and his abilities

were suitably rewarded in the United States. He became Lowell lecturer at Cambridge; he was invited to give special courses of lectures at Columbia, Illinois, and elsewhere. He received the honorary degrees of D.Sc. at Harvard, Litt.D. at Clark, and LL.D. at Wisconsin. But throughout he remained a loyal British citizen and faithful to Cornell, refusing posts and honours that would have involved a change of nationality or a change of residence. He was offered, but declined, not only the chair of psychology at Harvard on Münsterberg's death, but also the presidency of Clark University, which became vacant on the retirement of Stanley Hall. As an Englishman, he could never be a candidate for admission to the U.S. National Academy of Sciences.

Though, however, so loyal as to nationality, Titchener's psychological sympathies ever centred around Wundt, in whose laboratory at Leipzig he had received his first introduction to experimental psychology. His attitude towards his students and his organisation of laboratory work were also typically German. His admiration for Wundt led him to translate into English the third edition of the "Physiologische Psychologie." Taking his manuscript to Germany, he found that Wundt was already issuing the fourth edition of this large work. Titchener set himself forthwith to make a translation of the fourth edition, only again to find on its completion that he had been overtaken by the fifth edition. Still undaunted, he began to translate the fifth edition, and he finally published a part of this translation. He also translated Külpe's "Outlines of Psychology." At the time of his death he was engaged on a work of his own, which he hoped to issue in the form of a "Systematic Psychology" in three or four volumes, the first of which he had practically completed before he passed away.

Titchener's married and domestic life was an exceptionally happy one. His home on Cornell Heights was delightful to visit. He suffered from all the virtues and failings of an unusually emotional temperament. He was unduly sensitive to neglect or injustice, and he did not easily brook any disagreement from his psychological views, especially on the part of his students and staff. On the other hand, no one could surpass him in kindness and generosity to his friends. He spent practically all his time in the laboratory or in his home; he was so rarely seen in the streets that it became a standing joke as to how he passed from one to the other. During his last years he began to form a collection of Oriental coins, which with his usual thoroughness he made one of the finest in America, learning Arabic in order to be able to read their inscriptions. He was interested in music, and during the years 1896–98 he acted as professor in charge of music at Cornell University.

We regret to announce the following deaths:

Sir John Benton, K.C.I.E., formerly chief engineer and secretary to the Government, Panjab Irrigation Branch, who was responsible for many of the great canal and irrigation schemes of the Panjab and Upper Burma, on Aug. 29, aged seventy-seven years.

Prof. C. Pulfrich, of the Zeiss optical works, Jena, the author of numerous publications dealing with his investigations with the spectrometer and refractometer, aged sixty-nine years.

Dr. Henry P. Talbot, for many years professor of analytical chemistry in the Massachusetts Institute of Technology, and a vice-president of the American Association in 1907, on June 18, aged sixty-three years.

Prof. Stuart Weller, professor of palæontological geology in the University of Chicago, who specialised on the faunas of the Mississippi valley, on Aug. 5, aged fifty-six years.

Dr. William P. Wilson, formerly professor of botany at the University of Pennsylvania, and since 1894 director of the Philadelphia Commercial Museums, on May 12, aged eighty-two years.

News and Views.

The Government scheme for linking up the Dominions with Great Britain by radio telegraphy has now been completed by the opening of the short wave beam stations to India. The fact that the Indian beam stations can work at high speed continuously for many hours during the monsoon period shows that the beam receiving aerials are little affected by atmospherics. The English transmitting station is at Grimsby and the receiving station is at Skegness, which are both in direct communication with the Central Telegraph Office of the G.P.O in London. The corresponding transmitting and receiving stations in India are at Kirkee, near Poona, and Dhond, 48 miles east of Poona, which are both linked directly with Bombay. Transmission from Grimsby to India takes place on wave-lengths of 16·2 and 34·5 metres (about 18,500 and 8700 kilocycles per second respectively). At Grimsby a five-mast aerial system, quite distinct from the three-mast aerial system of the Australian service, has been built. The masts are 277 feet in height with a distance of 650 feet between them. They are erected in a straight line which cuts at right angles the great circle passing through Grimsby and Dhond. The reflector behind the active aerials focusses the waves in a south-easterly direction on to the receiving aerials in India. A similar system has been built at Kirkee to concentrate the waves in a north-westerly direction towards England. Within a few weeks' time the Marconi Company will inaugurate a commercial beam radio service between Great Britain and South America and also one with the United States. Experiments have proved that it is possible to carry on radio telephony simultaneously with high-speed radio telegraphy. There is every prospect, therefore, that before the end of next year, it will be possible for telephone subscribers in England to call up subscribers in any of the Dominions overseas.

The celebration, on Aug. 30, of the golden wedding of Prof. H. E. Armstrong and Mrs. Armstrong was

made the occasion for the presentation to them of the portrait of Prof. Armstrong by Mr. T. C. Dugdale, exhibited in this year's Royal Academy. The presentation was made at a reception held at the house of Dr. Stephen Miall and Mrs. Miall, son-in-law and daughter of Prof. and Mrs. Armstrong. With the portrait was presented an illuminated album signed by the subscribers, among whom are a number of leading workers in diverse departments of chemical science. We are glad to be able to reproduce a photograph of the painting (Fig. 1). The address which accompanied it reads as follows:

"PROFESSOR AND MRS. HENRY EDWARD ARMSTRONG: Your Staff and Students of Chemistry of former years greet you with affectionate regard on this happy occasion of your Golden Wedding. As they are scattered all over the world, only a comparatively small body of them can subscribe to this personal Letter of Greeting, but in so doing, and in endeavouring to honour their Chief and his Lady, they know they are voicing the good wishes of all their Colleagues. They know, Professor Armstrong, that by your teaching, your breadth of vision, and your scientific use of the imagination, coupled with a sympathetic guidance and a real human understanding, you have inspired those who have been privileged to work with you to their lasting benefit. The consciousness of this grows with them; so, with perhaps a pardonable pride, they have purchased your portrait in this year's Royal Academy to mark the present occasion. They ask your acceptance of this portrait for the period of your lives, earnestly trusting that such useful lives may long be spared. Eventually, however, they propose presenting it to one of the London learned Societies in commemoration of a striking personality and as a lasting record of their appreciation and affection."

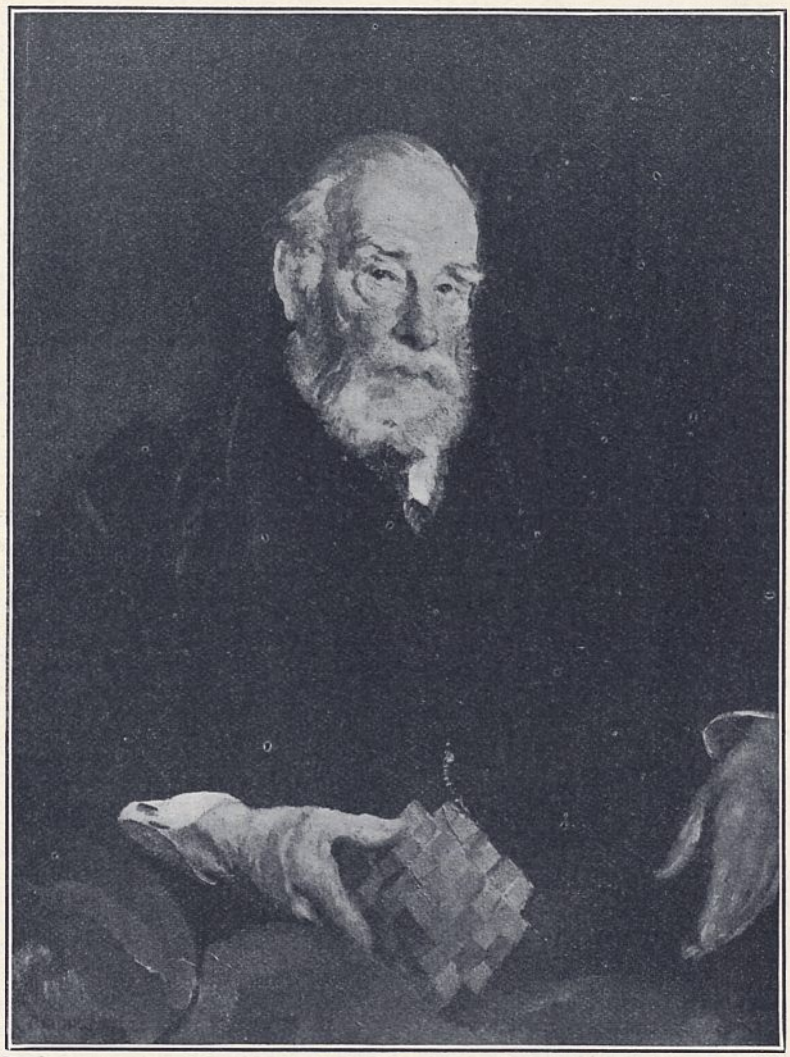


Photo. [*Paul Laib.*

FIG. 1.—Prof. Henry E. Armstrong, F.R.S. From a painting by T. C. Dugdale

THE installation of receiving sets for broadcasting has familiarised many with the idea of what electricians mean by an 'earth.' The subject is sometimes eagerly discussed by amateurs, and the difficulties experienced by those who installed lightning conductors many years ago are again being considered. For earthing the conduits used for protecting electric light wires, the Institution of Electrical Engineers is carrying out experiments so as to enable a good method of earthing to be specified. In the *Electrical Review* for Aug. 19, some suggestions are made for improving the methods of earthing electric lighting systems used at both generating and substations. In this case a very large earth current may flow if a fault develop in the system and it is necessary to make the joints and connectors large, permanent, and trustworthy. The resistance of the path in the earth varies with the composition and the moisture content. In dry weather it is often fifty times as great as in wet weather. Sometimes, when permanently damp soil cannot be reached, a pipe is run into the ground near the earth connexion and water poured into it in dry weather. It is known that the resistance of the 'earth' increases very rapidly at the freezing point. In Great Britain, however, it is unlikely that earth plates are likely to be buried in soil which is ever frozen. Iron pipes an inch in diameter can be used successfully to form an earthing system. Unless the ground is rocky, they can be driven into it until damp soil is reached. It is very seldom that a depth

of 20 feet is necessary. A number of these pipes about four feet apart and connected in parallel form a suitable earth for a supply network. Tests should be made to see whether the earth is capable of carrying the maximum possible 'fault' current. It is quite possible for an arc to form between loosely packed pieces of carbon and so melt the soldered connexions. Hence periodical tests should always be made.

THE rapid development of electric signs during the last few years has made many think that a more rigorous censorship of sententious texts and childish pictures is desirable. It shows the belief that advertisers have in the efficacy of continued repetition. In the July issue of *Progress*, published by the Allgemeine Elektricitäts-Gesellschaft of Berlin, there are interesting articles on electric signs and the flood lighting of buildings. A successful method of attracting attention, which is rapidly becoming popular, is to have an instantaneous time indicator, the large figures giving the time being controlled by a master clock. Stress is also laid on the importance of arranging the signs so that they are visible in daylight. Neon tubes seem specially suitable for the purpose. They are rather expensive to buy, but the saving of electricity during the first year by their use more than covers their cost. There can be no doubt, however, that the appearance of a street at night can be improved by 'flooding' beautiful buildings in it with light. Examples of flood lighting have been familiar to dwellers in London for many years, and we think that they provide a pleasing and unobjectionable method of advertising. Some interesting photographs are shown in *Progess* of the effects that can be produced at no great expense by flood lighting. In particular we would mention the Cathedral and banks of the Rhine at Bâle. The flood lighting also of St. Mary's Church at Lübeck shows up excellently against the dark background. In Germany, many municipal authorities and tramway companies grant permission readily to shopkeepers and others to mount cheap projectors for flood light purposes on the tramway and lighting poles.

EVER since the last attempt to reach the summit of Mount Everest in 1924, Italian climbers have been planning an expedition with the same end in view. The *Times* reports that the plans of the Italian expedition are now complete. The expense is to be borne by the city of Milan and the expedition is to be organised by the Milan Alpine Club. The Italians propose to approach the mountain from the Nepal side, which will necessitate the approval of the rulers of Nepal. This has hitherto been refused for any attempt on Mount Everest. If the veto is not removed, the Italian expedition proposes to make its object Mount Godwin-Austen (*K*2) in Kashmir, which is about 28,250 feet in height, and is said to offer difficulties fully as great as those of Mount Everest.

DR. DOROTHY JORDAN LLOYD has been appointed director of research to the British Leather Manufacturers' Research Association in succession to Dr. R. H. Pickard. Dr. Lloyd has been a member of the staff of the Association since its inception and has published papers on the chemistry of gelatine. Dr. Pickard's services will be retained for a time as consultant-director.

IT will be recalled that a Lister Centenary Exhibition was arranged at the Wellcome Historical Medical Museum, 54A Wigmore Street, in connexion with the centenary celebrations in London in April last. The Exhibition has already been visited by a large number of visitors from all parts of the world, and will remain open until Oct. 1.

THE July issue of *The Fight against Disease*, the journal of the Research Defence Society, contains a short obituary notice with excellent portrait of the late Prof. Starling, who gave unceasing support to the Society, and a report of the first Stephen Paget Memorial Lecture by Prof. Julian Huxley, entitled "Research and the Community." Quoting examples of the control of plant and animal pests by biological methods, of the breeding of strains of wheat immune to rust, and of the control of many human diseases, Prof. Huxley emphasised the importance of research to the whole community.

THE new Radiological Department of the Royal Infirmary, Edinburgh, was opened last October and is under the charge of Dr. J. M. W. Morison. A description of this department has been issued in the form of a brochure by Messrs. Watson and Sons (Electro-Medical) and will repay study by those interested in the lay-out and equipment of a radiological department, one of the most vital in the needs of a big hospital. There are others also to whom it may be of interest as showing the extent to which electro-technical invention is used by radiologists at the present time. The plans of the building are reproduced by courtesy of the architect, Mr. T. W. Turnbull.

THE Report of the Director-General (Mr. Robert Dick) of Public Health, New South Wales, for the year 1925, which has recently been issued, contains a record of the public health administration, communicable diseases and industrial hygiene of the State, and a report of investigations conducted in the microbiological laboratory. Dr. Badham describes an explosion in a sugar-refining factory which caused three deaths. The explosion was caused by the ignition of sugar dust, apparently by the breaking of the bulb of a portable electric lamp, while the men were clearing an accumulation of sugar dust from a dust-collecting system. A few explosions in flour mills caused in the same manner have been recorded.

THE Section of Geodesy of the International Union of Geodesy and Geophysics has recently issued Tome 2 of its *Travaux*, containing general reports prepared in connexion with the Rome assembly in 1922, though not then presented. They refer to the period 1912–1922, between the last meeting of the old International Geodetic Association at Hamburg, and

the Rome meeting of the new organisation, and may be regarded as continuing the triennial reports presented to its predecessor. The volume is of considerable size, the principal contents consisting of a comprehensive report on determinations of latitude, azimuth, and longitude, prepared by H. L. P. Jolly, research officer to the Ordnance Survey; a report by E. de Martonne on the 1913–1914 campaign of geodetic astronomy executed by the geographical survey of French West Africa; and a report by E. Soler, professor of geodesy at Padua, on relative measures of the intensity of gravity in all parts of the world. There are also shorter reports by G. F. Dodwell on radio determinations of longitude in Australia, and by J. de Graaf Hunter on deviations of the vertical.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A man or woman on the staff of the Association of Special Libraries and Information Bureaux to compile supplementary data for the "Aslib Directory of Sources of Specialised Information"—The Secretary, Aslib, 38 Bloomsbury Square, W.C.1 (Sept. 15). A lecturer in mining at the Denbighshire Technical Institute, Wrexham—The Secretary and Director of Education, Education Offices, Ruthin (Sept. 17). A temporary assistant lecturer in education at the University College of Swansea—The Registrar, University College of Swansea, Singleton Park, Swansea (Sept. 20). A deputy director of agriculture under the Government of the Punjab—The Secretary to the High Commissioner for India, 42 Grosvenor Gardens, S.W.1 (Sept. 24). An assistant examiner of Questioned Documents under the Government of India, with knowledge of chemistry, especially analytical chemistry, and of physics and photography—The Secretary to the High Commissioner for India, 42 Grosvenor Gardens, S.W.1 (Sept. 26). A mycologist for research at the Imperial College of Science and Technology on wood-destroying fungi—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (Sept. 26). Civilian education officers of the Royal Air Force, with practical qualifications for teaching engineering subjects—The Secretary, Air Ministry, Adastral House, Kingsway, W.C.2.

Our Astronomical Column.

AN EXTREMELY MASSIVE MULTIPLE STAR.—The star 27 Canis Majoris has been examined spectroscopically by Dr. O. Struve, and found to be a most interesting quadruple system. His results, which are published in the *Astrophysical Journal*, vol. 65, p. 273, show that two independent spectra are visible. These are of types *B5ne* and *B8*, and correspond to the two principal components of the system, which have a period of revolution of 3·2 years. Each of these components has, in addition, a much shorter period, indicating the presence of invisible companions. The masses of the stars in this system are found to be unusually large, the minimum value of the total mass being 950 times that of the sun. The masses of the two principal pairs ($A+B$ and $C+D$) are approximately equal, but the ratios A/B and C/D are not known. The mass of each star, however, must be in the average at least 238 times the solar mass. Attempts to attribute the line shifts to causes other than radial velocity are very unsatisfactory, and there seems at present to be no alternative to the acceptance of these enormous masses.

TABLES FOR EPHEMERIDES IN PARABOLIC ORBITS.—Some years ago a modification of the familiar equations, due to Gauss, that give the rectangular heliocentric co-ordinates x, y, z, was published; in this the co-ordinates are given in terms of $\tan v/2$ and $\tan^2 v/2$ multiplied by factors deducible from the elements of the orbit. Mr. Bengt Strömgren has calculated useful tables, which are published in *Meddelelser fra Kobenhavns Observatorium*, No. 58, and in *B.A.A. Memoirs*, vol. 27, Part 2. These give the natural values of $\tan v/2$ and its square, the argument being M, which is the interval from perihelion in days multiplied by $q^{-\frac{3}{2}}$. The values are given to five decimal places, so they suffice for fairly accurate ephemerides, but not for rigorous ones. They extend to 120° from perihelion; comets are seldom observed farther than this unless q is very small. The tables are designed for use with a calculating machine, and will considerably reduce the labour of forming an ephemeris.

STARS WITH BRIGHT IRON LINES.—Among the emission lines which are found in stellar spectra, the lines of iron occur more frequently than those of any other element except hydrogen. Stars in which these lines are found may be divided into four groups, namely, long period variables, peculiar stars of late types, stars of type *Be*, and novæ. In the *Astrophysical Journal*, vol. 65, p. 286, Dr. Merrill gives lists of stars showing bright iron lines in the second and third of these groups, as well as discussing all the available information concerning them. One point of great interest which emerges from this discussion is the fact that only the lines of ionised iron appear as emission lines in the majority of stars. This is the case even in the low temperature stars which possess very strong arc lines in their absorption spectra. The only stars in which emission lines of the neutral atom occur are the long period variables, and even in these cases enhanced lines are also present. It also appears that bright iron lines are found mainly in stars near the two extremes (B and M) of the temperature sequence, being absent in types A and F.

REPORT OF THE ROYAL OBSERVATORY, CAPE OF GOOD HOPE.—The annual report for 1926 of the Royal Observatory, Cape of Good Hope, has just been issued. The meridian observations include all stars south of Decl. −30° down to mag. 7·5. Heliometer observations of planets are also being made. Dr. J. Lunt, who has been using the Victoria telescope for stellar spectroscopy for thirty years, has now retired; a programme of stellar parallaxes with the instrument has been commenced. The Cape section of the Astrographic Catalogue is now almost complete, the last volume being in type. It is noted that the number of meridian observations and of solar photographs are in excess of any previous year. A new clock, Shortt No. 10, has been obtained from the Synchronome Co., and is working satisfactorily. A radio time signal is sent out daily for the use of shipping in South African waters; another one is distributed three times daily by the local broadcasting association.

Research Items.

THE ORIGIN OF THE MASAI.—In the *Journal of the East Africa and Uganda Natural History Society*, No. 28, Mr. C. L. Bolton criticises the theories on the origin of the Masai and other non-Bantu races of Kenya and Uganda which were advanced by Mr. C. C. Luck in the *Journal* for August 1926. Mr. Luck suggested that the Masai were the descendants of the half tribe of Manasseh from the west of Jordan and the Nandi of Moab, and that there were many proofs of the influence of the ancient civilisation of Egypt-Mesopotamia in Central Africa. Mr. Bolton maintains, however, that Sir Charles Eliot's arguments against the Semitic origin of the Nilotic languages have never been met, while physically the Masai and Nandi exhibit none of the signs of a Semitic cross. The cultural evidence collected by Mr. Luck points to Egyptian influence. In addition, spitting for luck and on meeting a person is characteristic of the Mediterranean peoples, and dislike of swine, bewitching by means of anything from the body, aversion from the use of proper names for fear of witchcraft, the sun worship of the Nandi and the possible derivation of L'Oibon from the word for snake and wizard also point to Egypt. The Mosaic traditions noted by Merker may have originated in Egypt before the Jews left the country and hence reached central Africa, or they may have been introduced by Mohammedans or even by Jews trading up the Nile. As an alternative theory of origin, it is suggested that the Somali and Galla are the lineal descendants of the Macrobians of Herodotus, and as independent but unambitious people may have inhabited their present country possibly for thousands of years. The Masai and Nandi may be of Bantu stock crossed with a race from Egypt, possible the Automoli of Herodotus, perhaps themselves a mixed race who drove the Bantu peoples out and took their women. These Bantu still exist as the Wakamba, Kikuyu, and Kitosh. The Bahima appear to be Hamitic negroes with a dash of Aryan blood which may be due to a Persian infiltration of adventurers at the time of the conquest of Egypt by Cambyses.

BRITISH GALL MIDGES OF ECONOMIC IMPORTANCE.—The *Journal of the South-Eastern Agricultural College*, Wye, No. 24, July 1927, contains an important paper (pp. 65-146) by Mr. H. F. Barnes on British Cecidomyidæ or gall midges. In this memoir Mr. Barnes has gathered together all the essential information concerning these insects, while new and unpublished observations are also added. Under each species is given the original description (or, sometimes the first available one), its distribution, biology, control measures and parasites, wherever sufficient data are available. At the end of the paper there is a bibliography containing about 380 references and a useful index both of gall midges and of the plants which they affect. A comprehensive summary of this character, particularly in so obscure a family as the Cecidomyidæ, is particularly valuable to all engaged in agricultural and horticultural entomology, as well as to the general entomologist. Workers on this group of flies are extremely few throughout the world, and Mr. Barnes is doing good service in exploring the family so thoroughly. It may be mentioned that the present paper treats of the midges, the larvæ of which affect cereals, fodder crops, fruit, vegetables, and miscellaneous plants. It is the author's intention to supplement it later by additional parts dealing with the midges which attack trees and shrubs, together with others that are predaceous in habit and, therefore, beneficial. Copies of the paper under notice may be obtained at a charge of 3*s*. 6*d*. post free from the author, Rothamsted Experimental Station, Harpenden, Herts.

INVERTEBRATES FROM THE SPITSBERGEN BANKS.—In an investigation into the bottom fauna of the banks around Spitsbergen, undertaken in the summer of 1925 and 1926 by the *Tovik* and *Armauer Hansen*, Dr. James A. Grieg gives an account of the invertebrates from the bottom, and the stomach contents of certain fish caught ("Evertebrater fra bankerne ved Spitsbergen indsamlet av *Tovik* og *Armauer Hansen* somrene 1925 og 1926. Fiskenaering og bundfauna." By James A. Grieg. Bergens Museum Aarbok, 1926. Naturvidenskabelig raekke Nr. 5). Besides a few smaller fishes the stomach contents of *Gadus callarias*, *G. aeglefinus*, and *G. saida* were investigated, a long list of invertebrates being given for the two first mentioned, including many molluscs, crustacea, echinoderms, and annelids. A photograph shows the contents of the stomach of a specimen of *Gadus aeglefinus*, 75 cm. long. This food weighed 675 grams and included 6 living *Mya truncata* (44-52 mm. long) and 4 dead (49-59 mm. long). In addition to these were several other molluscs, Balanus shells, worms, echinoderms, and miscellanea. On the whole, the molluscs, crustaceans, worms, and echinoderms seem to be eaten indiscriminately by both cod and haddock. The crab *Hyas araneus* is common. There were several with eggs, and it was found in numbers inside the cod. *Hyas coarcticus*, so far only recorded once before from Spitsbergen, also occurred. *Pandalus borealis* was plentiful, bearing eggs in August. The bottom fauna of these regions consists of representatives of nearly all the large groups, including among the mollusca four species of Neptunea, the whole forming a good feeding ground for the fishes.

FISHING GEAR OF ENGLAND AND WALES.—A revised edition of Mr. F. M. Davis's excellent account of the fishing gear of England and Wales has recently appeared. (Min. Agric. and Fish., *Fish. Invest.*, Ser. 2, Sea Fish., vol. 9, No. 6, 1927. London: H.M. Stationery Office. 5*s*. 6*d*.) Several additions have been made, including a description of the Danish plaice seine, or *snurrevaad*, and of such more recent forms of trawling appliances as the Vigneron-Dahl trawl, the Rowton 'stream line' trawl, and the French *extenseur*, which consists of a buoyant otter board to which is attached a heavy weight. The important experimental work carried out by Taylor and Wells in America and followed up by Atkins in Great Britain, on the use of copper oleate as a net preservative, is also described. An enlarged bibliography, conveniently classified, includes references to accounts of foreign fishing gear and to a number of the more interesting historical treatises. The illustrations appear to be identical with those of the first edition, but their new arrangement as text figures inserted in appropriate positions has added considerably to their usefulness.

MUTATIONS IN HAPLOID DATURA.—The haploid Datura which was obtained by treatment with cold at the time of embryo-sac development has since been propagated by cuttings, and a completely homozygous F_1 has been obtained by self-pollination, as a few good pollen grains and eggs cells with twelve chromosomes are produced. Messrs. Blakeslee, Morrison, and Avery (*Jour. of Heredity*, vol. 18, No. 5)

have studied the offspring of such plants and have obtained in the second generation a mutant in which the cotyledons have the peculiarity of being closely curled. The life cycle is otherwise normal. By crosses with trisomic ($2n+1$) forms, it is found that this gene mutation is in the same chromosome which produces the 'Poinsettia' type when present in triplicate. This chromosome also contains the factors for purple or white flower. There is therefore linkage between curled cotyledons and white flower, and the amount of crossing over between them is found to be about 12·5 per cent. Another mutant of even greater interest, from descendants of the haploid, is called 'tricarpel,' since the flowers have three or sometimes four carpels instead of the usual two. The other flower parts are correspondingly increased in number, the leaves are narrower, stems more slender and often triforked. The changes in the flower are really of generic value. The gene for this mutation is found to be in the chromosome which produces 'reduced' when present in triplicate. The fact that these two mutations have appeared in the offspring of a necessarily homozygous haploid plant is emphasised as supporting the view that crossing is not necessary for the production of gene mutations. Their frequency (2·31 per cent. if two other unstudied mutants are included) indicates that the homozygous condition does not hinder occurrences of mutations.

PLANT GROWTH AND REACTION CHANGE IN CULTURE SOLUTIONS.—Dr. Tsung-Lê-Loo records some interesting experiments on the change of reaction in neutral salt solutions in contact with the root systems of living plants (*Japanese Journal of Botany*, vol. 3, No. 3, 1927). The phenomenon was thought by previous workers (Czapek and Nathansohn) to be due to the excretion of acids or alkali by the roots. The change in reaction is, however, too great to be ascribed to root excretion, and is now generally accounted for by the unbalanced absorption of anions and cations. In the present series of experiments, ammonium salts of inorganic acids were used as the source of nitrogen, the experimental plants including *Zea mais*, *Fagopyrum esculentum*, and *Oryza sativa*. In contact with the roots of the culture plants the reaction of solutions containing ammonium nitrate, chloride, and sulphate respectively, became considerably acidic, the order of the change being from 1·3 to 1·8 of *p*H in two weeks. In the case of solutions containing sodium nitrate the reaction became more alkaline, the *p*H changing to a similar degree. With ammonium monohydrogen phosphate and ammonium bicarbonate little change in reaction was noted. The increase in hydrogen ion concentration in solutions containing ammonium salts generally produced poor growth of the culture plants with the exception of paddy rice and buckwheat, which are evidently tolerant of an acidic medium. The slow and slight change in the case of phosphate solutions promoted favourable growth. A combination of two salts such as ammonium chloride and bicarbonate used as a source of nitrogen instead of a single salt, gave better results, and the fluctuation in growth ran parallel to the change in the reaction noted.

SOURCES OF UNDERGROUND WATER.—Prof. J. W. Gregory, in a paper read to the recent summer meeting of the Institution of Water Engineers at Glasgow, combats the common view that all underground water is derived from percolating rain. He affirms that the plutonic water set free in the cooling of the earth's crust was sufficient to fill the oceans to their present level irrespective of meteoric water, and he sums up the position by saying that subterranean water comes from three sources—rainfall, which soaks underground year by year, connate water, which is stored up in the beds at the time of their deposition, and plutonic water, which rises from the interior of the earth, and appears at the surface for the first time. This threefold origin complicates the distribution of subterranean water. Meteoric water, including both contemporary rainfall and connate water, is expected in permeable sedimentary rocks at depths not too great for the heat to debar the descent of water, or in which it is securely imprisoned; and though joints, which may occur in rocks of any kind, may be used for storage, useful supplies of meteoric water are as a rule confined to sedimentary rocks or to vesicular igneous rocks. Plutonic water, on the other hand, may have a more varied distribution, for during its ascent it may force its way into any overlying rock which contains spaces available for water-storage.

FOSSIL INSECTS.—Parts 8 and 9 of Dr. R. J. Tillyard's series of papers on the Kansas Permian insects deal with the Copeognatha and Hemiptera (*American Jour. Sci.*, 5, **11**, 315, 381; 1926). The familiar forms of the Copeognatha are the wingless species known as 'book-lice' or 'cabinet-lice.' The geological record of this order is very imperfect. Hitherto the only fossil forms known were found in the Oligocene (Baltic amber and Tertiary opal), but morphological evidence indicates that the order is an ancient one, and this has now been proved by the discovery of specimens, belonging to eight genera, in the Lower Permian of Kansas. These early forms, as might be expected, differ in many respects from their Oligocene and living descendants. The Hemiptera until recently were not known before the Lias, but during the last few years it has been shown that they were abundant in Australia in Triassic and Upper Permian times. Dr. Tillyard has now recognised four specimens in the Lower Permian of Kansas, and considers that they were derived from the more primitive forms of the Copeognatha. In a paper on the Upper Permian Insects of New South Wales (*Proc. Linn. Soc. N. S. Wales*, **51**, 265; 1926), Dr. Tillyard describes new forms belonging to the orders Mecoptera, Paramecoptera, and Neuroptera. The remains of the case of a caddis larva from the Lower Eocene of Tennessee are described by Prof. E. W. Berry (*Proc. U. S. Nat. Mus.*, **71**, art. 14; 1926).

BITUMINOUS SANDS OF ALBERTA.—The Scientific and Industrial Research Council of Alberta has issued a report on the famous bituminous sands, by Messrs. K. A. Clark and S. M. Blair, dealing mainly with the occurrence of these resources; two further reports are in course of preparation, one on the separation of bitumen from the sand, and the other on its utilisation. Although this report is well put together and contains much detailed information and good illustrations, we are rather at a loss to know why it should have been necessary to duplicate to such an extent the almost exhaustive work of S. C. Ells of the Mines Branch of the Canadian Department of Mines. It was only a year ago that an excellent memoir by that author appeared, though according to the present authors their work was planned to supplement that of the Mines Branch at Ottawa. The whole problem of these bituminous sands is that of their commercial utilisation; as potential sources of bitumen for road-making and similar purposes, they are admittedly of great value, but until an effective and cheap method of separation is devised, they lose much of their economic attraction. It is gratifying to note, therefore, that the authors have given this phase of the subject their careful attention and that still further investigations in this direction are in progress. They state that the hitherto

inefficient method of hot-water separation has been developed to give very satisfactory results, which, in view of the cost of transporting the raw material, is important, since it means that the bitumen can be extracted at the source and dispatched within and without the Province as a marketable product. Herein lies a solution to at least one of the difficulties which have so far confronted commercial exploitation on a large scale; on the other hand, present industrial conditions may be unfavourable to extensive development, and any new stimulus, as Mr. Ells pointed out previously, may be somewhat artificial.

PHILIPPINE COAL RESOURCES.—In *The Philippine Journal of Science* for May 1927 there is a succinct but clearly drawn picture of coal mining in the Philippine Islands. It is pointed out that coal deposits exist practically all over the Islands, but that the deposits are small, patchy, and irregular, the coal being either lignitic or sub-bituminous. Eight seams of coal are known, but only five are being worked, the thickness of the latter ranging from 30 cm. to about 4 m. The author records 18 different localities at which coal is worked, and there appear to be very many others. Nevertheless, the total tonnage of coal is estimated by him as only 21,200,000 tons, and the total production for the period 1842–1924 as 412,280 tons; only two localities have produced more than 100,000 tons within that period. The importation of coal during 1908–1924 has averaged close on 500,000 tons per annum. At present the local production does not exceed 50,000 tons per annum, and the author looks upon 100,000 tons as the probable limit. It is, therefore, clear enough that the coal production of the Philippine Islands can have only a local interest.

THE HELIUM MOLECULE.—The substance He_2 appears to be more stable than has been supposed. It is still only known from its spectrum, and cannot be isolated, but W. Weizel and C. Füchtbauer have succeeded in showing that the molecule is capable of performing inter-nuclear vibrations without dissociating. The measurements described by them in the *Zeitschrift für Physik* of Aug. 16 are an extension of the earlier work of Prof. W. E. Curtis, but had to be made with powerful prism spectrometers, as the bands which have now been studied are very feeble. Thirteen new bands have been classified, eleven being of an orthohelium type, and two of a parhelium type. The plates have not been examined with a photometer, but it is certain that transitions in which there is no change in the motion of the component atoms along their line of centres are much more frequent than transitions in which this occurs.

ELEMENT 61.—The isolation of the new rare earth element of atomic number 61 is the subject of an article by Dr. Hopkins in the *Journal of the Franklin Institute* for July. The circumstances which resulted in the discovery are related, and a further attempt is made to establish the priority of the American chemists and their right to name the element illinium. The presence of a new element was suspected during the course of some work on the red and infra-red regions of the spectra of neodymium and samarium which was carried out by the United States Bureau of Standards with the co-operation of the University of Illinois. This was due to the presence of 130 faint lines of unknown origin common to both spectra. The Bureau of Standards published these results in January 1922, whereas Prof. Rolla, who claims priority for himself and insists that the element must be called florentium, only *began* his work about that time. However, neither Hopkins nor Rolla published definite proof of the isolation of the element until last year. A useful bibliography is to be found at the end of the paper.

DISPOSAL OF LIQUOR EFFLUENTS FROM GAS-WORKS.—The Gas Effluents Research Committee, appointed by the Institution of Gas Engineers in June 1926, has recently issued its first report. The purpose of the Committee was to investigate the methods which might be adopted for minimising the production of gas liquor effluents or for rendering such effluents suitable for running into town sewers or into rivers and streams. The report contains a memorandum on the disposal of liquor effluents from gas-works, which forms a summary of existing knowledge of the problem and the contributions which have so far been made towards its solution. A list of important references is appended. A number of experiments of preliminary character have been carried out, and a short summary of the results is given. The disposal of effluents which result from the production of ammonia compounds is one of the most difficult parts of the whole problem. The constituents of the spent liquor include many which absorb oxygen and would unduly retard self-purification if admitted to streams and increase the difficulties of sewage purification if admitted to sewers in sufficiently large quantities. At the present time, however, the only satisfactory method of disposal appears to be the admixture of the spent gas liquor with sewage. It is necessary to provide means for adjusting the rate of admission in order to avoid large changes in the composition of the mixed sewage. In the meantime investigations are in progress with the view of reducing the volume and improving the composition of spent gas liquor resulting from gas-works practice.

STRESSES IN LARGE TURBO-GENERATORS.—The size of the turbines used by electrical engineers to drive their generators is steadily increasing. In designing large turbo-generators which run at 3000 revolutions per minute, it is necessary to calculate the enormous centrifugal forces and the resulting strains to which the rotating parts are subjected. During recent years, due to their high speeds, there have been a few explosions of the rotating parts which have caused considerable damage. The question of safety therefore is one of the chief considerations. In the July and August bulletins of the Oerlikon Co. of Zurich, an interesting description is given of the precautions which are taken and the tests which are made to ensure safety. A very large factor of safety is allowed for in the design. Instead of having only an overspeed test in an explosion proof chamber, the Company subjects the completed machine to a series of tests. For example, a 3000 r.p.m. rotor is first run at 2500 r.p.m. A special gauge then measures, with an almost incredible accuracy, after the temperatures have been equalised, whether there has been any permanent expansion. Tests are then made at 2900, 3200, 3400, and 3750 r.p.m., measurements being made after each test. If permanent expansion exceeding the permissible limits occurs, the rotor is rejected. Many further tests are made before the rotor is regarded as safe. The question of the stresses during an accidental 'short-circuit' of the generator has also to be considered. A 30,000 kilowatt turbo-generator requires about 1000 cubic feet of air per second for cooling purposes. Ordinary air contains about 8 milligrams of dust per cubic yard. Hence even when good air filters are used, large quantities of dust collect in blind corners and the fans get clogged. To prevent this the closed circuit method is adopted in the Oerlikon machines. The same air continually flows through the generators, the ducts forming a closed circuit.

An International Congress of Soil Science.

INTERNATIONAL meetings of scientific workers on soils have been held at intervals since 1909, when a small group met at Budapest. Eventually the International Society of Soil Science was formally constituted at Rome in May 1924. The new body held its first triennial Congress at Washington, D.C., on June 13-22, 1927, under the presidency of Dr. J. G. Lipman, of Rutgers University, New Jersey. About four hundred delegates were present. Very extensive preparations were made by the American Organising Committee on which Dr. Shutt, Dominion chemist, and other Canadian representatives served. Dr. Schreiner and Dr. McCall, of the United States Bureau of Soils, were chairman and secretary respectively of the executive committee. Thanks to the efforts of Dr. Lipman, no less than 75,000 dollars was obtained in donations from various sources towards the cost of the Congress, and the subsequent tour of North America. Some thirty nations accepted the invitation of the United States Government to send official delegates. The largest unit—more than twenty delegates—came from Soviet Russia; Germany sent ten, and Great Britain seven. Most of the countries within the British Empire were also represented.

President Coolidge honoured the Congress by attending the first session and delivering the opening address, in which he paid a tribute to European work on soils, and briefly traced the development of Federal expenditure on agricultural research from the modest initial grant of 1000 dollars in 1839 to the present day.

For convenience in administration the Society is organised in national sections, but for its scientific activities is divided into the following Commissions, or Sections:

(1) Physics.
(2) Chemistry.
(3) Biology and biochemistry.
(4) Fertility.
(5) Classification, nomenclature, and mapping of soils.
(6) Rural engineering and drainage.

These sections met both separately and jointly. Their work was much facilitated, first by the issue, on the opening day, of full abstracts in English, French, and German of all papers presented; and secondly, by the arrangement whereby the sections met independently at least once in the interval between the triennial conferences of the Society. Thus the Physics Commission met at Rothamsted in October 1926 to discuss the results of co-operative work on different methods of mechanical analysis of soil, arranged at the Rome meeting in 1924, and the Chemistry Section met at Groningen, Holland, in April 1926, to discuss soil acidity and methods of measurement. Difficult and doubtful points had therefore been fully examined before the Washington meeting, and one of the important tasks—securing uniformity in routine methods of analysis in the different countries—was appreciably lightened.

From the general body of papers presented a few main subjects may be selected for brief comment. Various forms of apparatus for mechanical analysis of soil continue to claim much attention, especially those types yielding data less affected by the serious errors, first noted by Coutts and Crowther at Rothamsted, that are inherent in the method of continuous weighing of the sediment. Further, a clearer distinction is now being drawn between this form of mechanical analysis, that aims at giving a particle size distribution curve for the soil, of use in research work, and the more usual type of routine analysis, that divides the soil into a few groups of particles, employed in the qualitative association of mechanical composition of soils with their field behaviour. The question whether this relationship can be made more definite by supplementing the mechanical analysis figures with other physical determinations, was examined from several viewpoints and was considered sufficiently interesting to be selected for the next co-operative investigation of the Physics Section.

The Chemistry Section was largely concerned with soil acidity and base exchange phenomena, and the newer physical-chemical methods of investigating the absorbing complex. Prof. Wiegner, of Zurich, made a notable contribution to this subject. Prof. Bradfield, of Missouri, discussed the use of electro-dialysis in physico-chemical investigations of soils, a method that promises to be of great assistance in research work.

The Soil Biology and Biochemistry meetings were exceptionally well organised in a series of symposia, which included (*a*) direct and cultural methods of soil microbiology: Winogradsky's direct counting method received much attention in this section; (*b*) the soil population; (*c*) nitrogen fixation in the soil: in the course of the prominent contribution made by Japanese workers to this section, the new technique of serum-reaction for the classification of Azotobacter was discussed by Prof. Ago and Prof. Yoshida; (*d*) transformation of organic matter in the soil: this section was perhaps of the most general interest, particularly the question whether organic matter originates from lignin or cellulose, which was discussed by Dr. Waksman of New Jersey, and Mr. H. J. Page of Rothamsted.

In the Soil Fertility Section, additional examples of exceptional and abnormal soils were recorded, and the well-known work of the California Station on the growth of plants in culture solution and soil solutions was further developed.

The discussion on classification, nomenclature, and mapping of soils aroused great interest, especially in view of the presence of Prof. K. Glinka, of Leningrad, the acknowledged leader in this field. The outstanding contribution to soil science in recent years is undoubtedly that of the Russian workers in recognising the predominant influence of climatic environment on soil formation, and the demonstration of the different types of soil by means of soil profile examinations. Up to the time of the Rome meeting, these studies had been confined largely to eastern Europe, but the papers presented at Washington were evidence of the advances that have been made in nearly every country in the past three years. The sub-committees dealing with the soil map of Europe and of the Americas were able to report considerable progress.

Irrigation, drainage, and soil erosion problems occupied much of the attention of the sixth section, but time was reserved for a meeting with the Physics Section to discuss physical properties of soil and methods of measurement, including the dynamometer measurements of soil resistance made in the course of the Rothamsted work on the physics of soil cultivation, that have disclosed an unexpected degree of heterogeneity in apparently uniform soil.

During the Congress a number of addresses were given at general meetings by prominent representatives. Dr. Woods dealt with the origin and objects of the United States Bureau of Soils, and Dr. Baker with the trend of land utilisation in the United States; the present status of soil biology was discussed by Sir John Russell; Prof. Lemmerman of Berlin, and Prof. 'Sigmond of Budapest, dealt respectively with soil acidity determination, and the chemical character-

istics of soil teaching. The Russian delegates gave an account of soil work in their country in two sessions specially reserved for this purpose. This arrangement was much appreciated by the Congress, as it gave an opportunity for members to hear something of the extensive Russian work on soil science that, owing to its publication in Russian journals, has not hitherto been generally known.

The American committee also staged a very successful exhibition, in charge of Dr. Weir and Mr. Goll, of the United States Department of Agriculture, arranged in the following divisions :

(*a*) Representative soil types of the world, showing characteristic soil profiles (in monoliths).
(*b*) Soil maps.
(*c*) Methods and apparatus for physical and chemical work on soils.
(*d*) Soil fauna and flora, together with biochemical and biological apparatus.
(*e*) A complete collection of United States soil science literature.

The exhibition was by far the most complete one yet brought together, and its interest was enhanced by the inclusion of much of the apparatus and material discussed at the meetings of the Congress. It is the intention of the Committee to retain the monoliths of representative soil types as the basis of a permanent collection of the soils of the world.

At the conclusion of the Congress, the delegates joined a special train for a thirty-days' tour of the most important agricultural regions and soil belts of North America. Foreign delegates were the guests of the American Organising Committee during this tour. The route selected ran through the cotton belt, across the southern portion of the Prairie and the Great Plain to the irrigated area in Utah, and thence across the desert to the irrigated region in South California. The return journey was made through California, Oregon, and Washington to Vancouver, and thence by the Canadian National Railway through Alberta and Saskatchewan to Winnipeg. The tour then re-entered the United States, traversing the north and eastern sections of the Prairie before returning from Chicago to Washington, via Indiana, Ohio, and West Virginia. Many stops were made *en route* for the inspection of profiles typical of the local soils. This portion of the programme was arranged by Dr. Marbut, Chief of the United States Soil Survey, and his explanations of the various features in which some of the American soil types differed from the European soils—on which climatic classification was initially based—were of extreme value to European workers. Excursions were arranged at numerous points to see experimental stations, the local agriculture and objects of general interest.

A striking feature of these numerous trips was the generosity of organisations such as chambers of commerce, that arranged motor-cars for transportation, and provided meals for the whole party. It was evident, not only from the speeches of welcome at local centres, but also from informal talks with farmers and others, that the greatest interest was shown in the aim and objects of the Society ; the bulk of this can be directly traced to the general appreciation of the work of the United States Federal and State agricultural services, and the consequent recognition by both the rural and urban population of the fundamental importance to the country of a vigorous agricultural life.

B. A. KEEN.

A New Journal of Forestry.

SOME articles of considerable importance and interest appear in the first number of the new journal, *Forestry*.[1] The number opens with an article on "British Forestry," by Mr. R. L. Robinson, a Forestry Commissioner. Much of this has appeared in the last report of the Forestry Commission, which has been already discussed in NATURE. It is rather of the nature of propaganda for the public than a technical treatise, for all British foresters will be acquainted with the position the writer depicts. Mr. H. M. Steven, the editor, follows with a lengthy paper on the "Silviculture of Conifers in Great Britain." This, and a companion article on the "Silviculture of Hardwoods in Great Britain," by Mr. W. H. Guillebaud, are of high intrinsic value. In these papers the past history of the principal tree species of Great Britain to the present day are traced, the methods by which they have been grown, and the ills which have so generally resulted in latter times from these methods. The historical data which Mr. Steven gives on the subject of the Scots pine and the European larch, amongst other species, and Mr. Guillebaud's remarks on the oak and beech high forest, are well worthy of careful attention. If a word of caution is required, it may be confined to a necessary recognition that research and experiments based solely on the work of the past ten years should not be awarded, in the case of forestry, too great a prominence ; for definite data will only be attainable at the end of a rotation, and in some cases possibly not even then.

The succeeding two articles on the "Utilisation of Soft Woods in Great Britain," by Mr. John T. Smith, chiefly dealing with Scotland, and the "Marketing of British Hardwoods," by Mr. J. H. Newnham (Acorn), deal with the commercial aspects of forestry. There is little new in the articles, but the treatment of their subjects by the writers is not without interest to the professional forester, and some of the problems pointed out will need and are receiving careful attention. Nor do the remedies all fall within the scope of the forester. If the landowner of the future wishes to realise any return from the portion of his estate maintained under woodlands, he will have to adopt very different and drastic methods. The surest and the best will be to imitate some of his brother proprietors of land in France and learn how to manage his woods on sylvicultural lines himself. Unless the land tenure systems of Great Britain undergo a radical change, the country will not be able to depend, or afford to depend, solely on the efforts of the Forestry Commission for its timber requirements. In no country in Europe are the forests in sole State ownership. In the view of some experts the encouragement of the private owner to introduce a correct administration into his woodlands should form one of the chief objects of the Commission.

Major F. M. Oliphant deals with the inauguration of the new "Forest Products Research in Great Britain," and describes the various sections of the work to be undertaken ; whilst Mr. W. Dallimore considers, in the lighter vein, the æsthetic side of afforestation, voicing opinions which have received attention in the press on the subject of the ugly uniformity of "huge blocks of pines . . . the trees spaced with mathematical accuracy and only relieved by other blocks of another kind of dismal uninteresting tree." The writer's suggestions merit considera-

[1] *Forestry*. The Journal of the Society of Foresters of Great Britain, vol. 1, No. 1 (1927), 7*s*. 6*d*.

tion, especially the hope that all England's hedgerow trees and clumps and so forth are not doomed to disappear.

Omitting several other technical articles, reference may be made to four papers from a foreign source. These are: "A General Review of Post-War Forestry in Central Europe," by Dr. Ing. Franz Heske; "Some Recent Forest Research in Norway," by Erling Eide; "Recent Forest Literature in Denmark," by Carl Mar Møller; and "Forest Research in Finland," by Lauri Ilvessalo. Space will not permit a consideration of these papers, but the first calls for a brief remark. "The War and its consequences," says Dr. Franz Heske, "have changed Central Europe in many important points. Forestry being a well-developed and most essential part of the economic life in the respective countries, naturally could not escape the great transformations which have taken place." The writer deals with the changed conditions in Germany and the old Austrian monarchy. Immediately after the War, it appeared that forest policy and political conditions were the two items which required the most urgent revision. Later on, however, says the writer, the problems of reform in sylviculture and management came more and more to the front, and the question of increasing the productivity of forestry became dominant. He contends that these two directions of evolution can be clearly distinguished in the German countries; whereas in others, *e.g.* Czecho-Slovakia, political reforms have so far remained the chief interest. In this extremely interesting paper the author depicts the pre-War conditions of his subject and then deals with the post-War ones, as at present envisaged. The article is not, however, complete. It is "To be continued." Since at present the journal is only to appear once a year, it is a pity that the whole could not have been included.

Reviews of some seven books are dealt with. This is the weakest section of the journal. A far larger series of important forest publications could have found a place within the space allotted if some of the reviews included had been drastically cut down. If the high efficiency with which *Forestry* has been started can be maintained, all foresters in Great Britain should welcome and value such a professional journal.

The Danish Lobster Fishery.

MR. ERIK M. POULSEN has published an interesting survey of the Danish lobster fishery compared with that of Norway, Sweden, and other countries ("Om Hummeren og Hummerfiskeriet i de Danske Farvande." *Skrifter udgivne af Kommissionen for Danmarks Fiskeri*—og Havundersøgelser No. 10. Copenhagen, 1927). Lobsters in the Danish seas are found along the coast from a depth of a few metres to about 40 metres, on a stony or gravelly bottom. They are commonest on a stony bottom such as is found in the Northern Kattegat and Jammerbugton. Below a depth of about 40 metres they rarely occur, being replaced in the deeper waters down to about 300 metres by the Norway lobster (*Nephrops norvegicus*). The scarcity of newly hatched young in the upper water layers is remarkable, the author attributing this fact to the probable natural habitat being near the bottom even in the free-swimming stages, and after the third moult it apparently lives actually on the bottom.

Lobsters from the Danish Skaggerak coast are not merely larger than those from the Kattegat, but they are also distinctly larger than those from the Norwegian and Swedish Skaggerak coast as well as from the south-west coast of Norway. The reason for this is attributed to the difference of salinity and temperature, a high salinity and high temperature being agreeable to the lobster, a low salinity setting a limit to its distribution.

Marking experiments by the method used by Appelhöf in Norway and Trybom in Sweden were undertaken, small triangular pieces being cut away from the edge of the telson and tail fin which were easily recognisable. In this way even if the skin be cast the cuts are still visible. Out of one lot of 200 lobsters set free, only one made a long journey, nearly ten sea-miles; the others only went about one to three sea-miles. In a different lot a few journeyed ten to fifteen sea-miles. They are inclined to pass the summer in shallow water and the winter in deeper water, and this applies not only to the breeding females but also to others of a certain size which seem to need different conditions in the summer. The abundance of food in the shallower waters near the coast seems obviously an advantage for the newly hatched young. The author does not mention the hatching and rearing experiments made at Port Erin, Isle of Man, which prove conclusively that the newly hatched lobsters, and also those in the first few stages, feed on small planktonic organisms, especially copepods.

Interesting notes are given on the methods of catching lobsters, traps being chiefly used, the bait being flat fishes (plaice and dabs), small haddock, and fishing-frogs.

University and Educational Intelligence.

OXFORD.—The new Rockefeller School of Biochemistry will be opened by the Lord Chancellor, Viscount Cave, on Friday, Oct. 21, at 3.30 P.M.

THE City and Guilds of London Institute has received from the Corporation and City companies since its foundation forty-seven years ago contributions amounting to £1,156,094. Its report for the year 1926 deals with the affairs of the City and Guilds (Engineering) College, the Finsbury Technical College (finally closed in July 1926), the South London Technical Art School and the Department of Technology. The first-mentioned college was in 1907 merged in the Imperial College of Science and Technology, but the Institute continues to contribute to the cost of its maintenance. Of the two thousand degrees in engineering awarded by the University of London since 1903, nearly half have been won by students of this College. In 1926, for the first time, the degree was awarded on the College examinations, and the results show, says the Dean, that there is very little difference between the standards under the new and the old system, and he concludes that "whatever system of examination be applied to young men, provided they are properly trained, the result is substantially the same." The Department of Technology examined 13,985 candidates for its certificates, including 1788 at places outside the British Isles. The report suggests a doubt as to whether the movement in favour of demanding a more definite knowledge of elementary science (especially physics and chemistry) as forming the ground work of the main technical subject, has not been pressed too far.

THAT the teacher should never cease to be a student is, perhaps, a platitude. In few places, however, are there such opportunities for the teacher-student as are available in London. Lectures and classes for teachers, specially arranged by the London County Council, make it easy not only to follow up special subjects, but also to obtain a view of the wider background which gives significance to those subjects. Facilities are provided at fees which average less than 1s. per lecture for any one engaged in teaching in London, Kent, or Middlesex (other teachers are admitted at fees 50 per cent. higher),

and are designed to bring London teachers into touch with the latest developments in educational methods and to enable them to hear leading authorities on current questions of importance. The recently published Handbook to the Lectures for 1927-28 contains details of arrangements made to cover a vast number of subjects. In the science section are courses of lectures and lecture demonstrations on the application of physics to everyday life; light, with special reference to artificial light and its measurement; the Science Museum (intended to give a fuller acquaintance with the contents of certain of the Museum's engineering collections); science for elementary schools and for girls' schools; nature study, with special reference to the open spaces in and near London; nature study in infants' schools. By the courtesy of certain scientific societies, provision is also made for the disposal by the L.C.C. of a number of tickets of admission to their ordinary meetings. Domestic and health subjects include a single lecture on sunlight and health, and ten lectures on dietaries in relation to health. The geography section includes a course dealing with the relation between geography and agriculture. Experimental psychology and its bearing on education is to occupy five lectures. Particularly important is a course on modern thought and education, the purpose of which will be to consider the background of instructive ideas which controls the activities of this generation and is expressed in the contemporary attitude towards education. In most cases the Handbook gives, in connexion with the courses, lists of books recommended for study.

EDUCATIONAL Boards and Foundations in the United States are described in Bulletin, 1927, No. 10 of the Bureau of Education. The General Education Board has, since its foundation in 1902, appropriated 137 million dollars for the promotion of education in the United States. For the year 1925–26 appropriations amounted to 15 million dollars, half from principal and half from income. The Rockefeller Foundation spent 9 million dollars on health projects and medical education, including expenditure through its International Health Board and China Medical Board. The Laura Spelman Rockefeller Memorial appropriated for educational, charitable, and scientific purposes nearly 8 million dollars, including nearly one million dollars for the promotion of child study and parental education. The Carnegie Corporation of New York made grants amounting to 6 million dollars, of which more than 4½ million dollars went to library service, 600,000 dollars to activities in the fine arts, and 300,000 dollars to the newly formed movement for adult education. The Carnegie Foundation for the Advancement of Teaching disposed of an income of 1⅓ million dollars, devoted mainly to retiring allowances and pensions. Other important foundations described are the John F. Slater Fund for teacher training and other schools in the Southern States; the Jeanes Fund for the improvement of negro rural schools; the Phelps-Stokes Fund for improving New York slums and the education of negroes, Indians, and needy whites; the American Field Service Fellowships for French Universities; the Belgian Fondation Universitaire; the Julius Rosenwald Fund for charitable, scientific, educational, and religious purposes; the Baron de Hirsch Fund for aiding Jewish immigrants; the Kahn Foundation for foreign travel of teachers; the Commonwealth Fund for child welfare, rural hospitals, and education; and the Engineering Economics Foundation. The Commonwealth Fund maintains 23 fellowships, amounting to 125,000 dollars, for graduates of British universities for two years' study in American universities. Three are earmarked for British overseas dominions students.

Calendar of Discovery and Invention.

September 11, 1822.—Copernicus asserted the daily rotation of the earth on its axis, and showed that it accounted for the apparent diurnal revolution of the stars. He also showed that most of the known motions of the planets could be explained by assuming them to revolve round the sun, with the earth as one of them. The teaching of the Copernican theory was forbidden by the Church in 1615. On Sept. 11, 1822, the Pope repealed this decree, and permitted the Copernican views to be taught—nearly three hundred years after they were first published.

September 12, 1891.—A scheme for the electrical transmission of power on the three-phase system from Lauffen to Frankfurt a.M. in Germany was prepared by Michael von Dolivo-Dobrowolsky; the system was erected and put into operation on Sept. 12, 1891. The distance covered was 175 km., three copper wires of 4 mm. diameter being used. The alternator voltage was 55, and this was raised by transformers to 8500. The efficiency of transmission was 74 per cent.

September 13, 1850.—After years of labour, the engineers lowered the last of the tubes of the Britannia Bridge, over the Menai Straits, to its permanent resting-place on Sept. 13, 1850. The bridge has two spans of 460 ft., and two of 230 ft., at 104 ft. above high water. The official return of the cost was £601,865.

September 14, 1899.—The *Times* of this date reports that "for some weeks past experiments of great interest in wireless telephony, as distinguished from Signor Marconi's wireless telegraphy, have been carried on by Sir William Preece near Carnarvon. . . . Sir William has succeeded, without any intermediary other than the ether, in transmitting the sound of a series of taps. . . . They were distinctly heard at the receiving station by placing the newly invented ethereal telephone to the ear. . . . So far, it is stated, the system yields much more rapid results than Marconi's, although the sounds are not quite so distinct as desirable."

September 15, 1830.—A number of routes for a railway between Liverpool and Manchester had been proposed and surveyed before a final scheme was authorised in 1826. George Stevenson was the engineer, and the line, which was 31 miles in length, was opened for public traffic on Sept. 15, 1830. In 1845 it was amalgamated with the Grand Junction Railway, and in the following year these became part of the London and North-Western system. The gauge was 4 ft. 8·5 in., and the ruling gradient 1 in 89. There were 63 bridges on the line.

September 16, 1911.—Edward Whymper is most popularly associated with the tragic first ascent of the Matterhorn in 1865. He was the pioneer climber of many other peaks of the Alps, the Andes, and the Rockies. More than a successful mountaineer, he was a keen observer of geological phenomena, a student of glaciers, a first-rate collector, and a good wood-engraver. He died suddenly at Chamonix on Sept. 16, 1911. A plaque to his memory was unveiled at Zermatt in 1925.

September 17, 1607.—Thomas Harriott first saw the comet of 1607 (Halley's) from Ilfracombe on Sept. 17. He made observations upon it with a 'cross-staff,' giving the distances of the nucleus from the various stars. Harriott had been to Virginia as a surveyor with Sir Richard Grenville's expedition in 1585. He virtually gave to algebra its modern form, and applied the telescope to celestial purposes almost simultaneously with Galileo. With its help he studied the moon, "the new-found planets about Jupiter," and sunspots. W. C.

Societies and Academies.

PARIS.

Academy of Sciences, Aug. 1.—A. Lacroix: The composition and structure of the meteoric iron of Tamentit. The oxidation of meteoric iron at a high temperature. Analyses gave iron 91 per cent., nickel 8 per cent., cobalt 0·38 per cent., with some manganese, phosphorus, sulphur, carbon, and silicon. The meteorite weighed 510 kilograms, and a piece was cut off by means of the oxyacetylene blowpipe. Analyses of the magnetic oxide produced showed it to be free from nickel, and the metal fragments taken from the scoria showed a concentration of the nickel. The bearing of this on the composition of meteorites containing silicates is discussed.—F. E. Fournier: The resistance of water to the translation of hulls.—Gabriel Bertrand and Hirosi Nakamura: The physiological importance of nickel and cobalt. In an earlier communication (Bertrand and Machebœuf) it has been shown that traces of nickel and cobalt are normal constituents of man and of animals. Experiments on mice suggest that these two metals have a direct action in nutrition.—d'Arsonval: The heating of the tissues by high frequency currents. The thermal ammeter is generally employed to measure the strength of the currents used; but it is not a trustworthy guide when used as a measure of the heating of the tissue under treatment.—Léon Guillet, de Fleury, and Sensaud de Lavaud: The aluminium-silicon alloy known as 'alpax': its applications. Mechanical properties of the alloy cast at 575° and 775° C., after addition of sodium. It can be used in the construction of motor-car chassis.—G. Friedel: Forms assumed by myeline in contact with water.—Amé Pictet and H. Vogel: The synthesis of lactose. Equal weights of β-galactose and β-glucose, with a little zinc chloride, are heated under reduced pressure to 175° C. That lactose was obtained was proved by its melting point, solubility, and rotation. The osazone, nitrate, and acetate were prepared.—Charles Nicolle, Charles Anderson, and Jacques Colas-Belcour: A new pathogenic spirochæte (*Sp. Normandi*) transmitted by an Ornithodorus (*Orn. Normandi*).—Krawtchouk: The poles of analytical functions.—C. Irañez de Irero: A submarine link between Spain and Morocco, by means of an intercontinental tunnel. A tunnel across the narrowest part of the Straits would be impossible, as there are depths of more than 900 metres. A possible line is sketched out which would have a length of 48·2 kilometres, of which 32 kilometres would be under the sea.—F. Gonseth and G. Juvet: The equations of electromagnetism.—James Basset: An apparatus for carrying out physical or chemical experiments at varying temperatures and under pressures of 15,000 kilograms per square centimetre. The description is accompanied with photograph and sectional drawing of the apparatus.—B. Cabrera: The theory of paramagnetism.—Armand de Gramont: Monostatic telemetry during twilight.—R. de Mallemann and P. Gabiano: The circular dichroism of the alkaline cuprotartrates.—Lucien Mallet: The luminescence phenomena in the course of oxidising reactions in aqueous solutions. During the oxidation with alkaline hypochlorite of various organic substances (albumen, methylene blue, eosin, quinine, etc.) light is produced. The intensity is increased when the temperature is raised.—Eugène Delauney: A new method of quantitative analysis applicable to a mixture of rare earths. The method is based on the measurement of the thickness of an absorption band, as shown in a small Hilger spectrograph. Various examples of the use of the method are given.—W. Ipatieff and J. Andrewski: The precipitation of iridium and its solutions by hydrogen under pressure. At temperatures of 100° and 103° C. the proportion of iridium reduced by hydrogen has been studied for pressures between 1 and 10 atmospheres. The reduction increases with the dilution, with the pressure of the hydrogen and with the time of exposure. The general results are very similar to those previously obtained with platinum.—Dedebant: The field of instantaneous displacement of isobars.—Mlle. M. Gauthier: The French larvæ of Ephemerids referred to the genus Iron.—F. Mercier and Raymond-Hamet: The vaso-constrictive action of hydrastine.—Mme. L. Randoin and Mlle A. Michaux: The variations in the proportions of iron in the liver, the spleen, and the blood, under the influence of feeding in the complete absence of the antiscorbutic vitamin.—Raoul M. May: Microchemical studies on the nervous system. The proportion of sulphur and phosphorus in the cerebral hemispheres of the guinea-pig.—Charles Lebailly: The preventive and specific vaccination of dogs against distemper.

Aug. 8.—The president announced the death of Emile Schwoerer, correspondant for the section of mechanics.—Charles Nicolle and Charles Anderson: The transmission of the spirochæte of the shrew mouse by *Ornithodorus moubata* and the mechanism of the transmission of recurrent spirochætes by ticks.—S. Finikoff: Stratifiable congruences.—Pierre Dive: The most general internal movements of a heterogeneous fluid mass in rotation round an axis.—Louis de Broglie: The rôle of the continuous ψ waves in undulatory mechanics.—Maurice Lambrey: The absorption and emission spectrum of nitric oxide in the ultra-violet. Nitric oxide has been considered as completely transparent, but has now been found to have absorption bands in the ultra-violet. The same lines were found in the spectrum given by the gas in discharge without electrodes. Carbon monoxide was also found to give a fine absorption band in the same region.—René Dubrisay and Jean Bravard: The influence of absorbent materials on chemical equilibria in solution. In the reaction between ammonium chloride and calcium carbonate in aqueous solution, the equilibrium is displaced by the addition of absorbent substances, such as kieselguhr, sand, precipitated silica, clay, and kaolin.—Emile André and Mlle. Th. François: The study of oleilic alcohol and its derivatives. Preparation of oleicerine, elaidicerine, and stearolylic alcohol.—J. Dugué: Modifications of methods and of treatments resulting from the application of the theory of antioxygens. Discussion of the preparation of india-rubber from the point of view of the antioxygen theory.—R. Abrard, L. Joleaud, and Paul Lemoine: The conditions of the deposit of the Montian of Port-Marly (Seine-et-Oise).—E. Rothé, J. Lacoste, and Mlle Y. Dammann: Earthquakes in France in 1926. Fifteen well-characterised earthquakes were felt in France during 1926. The Pyrenees region and the Central Plateau were more stable than in preceding years; the most important phenomena affected Alsace and the Channel coasts.—Henri Humbert: A new Compositæ remarkable from the phylogenic point of view, *Tisserantia africana*.—A. Lebediantzef: The modifications of the solubility of the phosphoric acid and the biological properties of the soil observed in earth lying fallow and previously dried in the open air.—A. Th. Schlœsing: Remarks on the preceding communication.—Edouard Chatton and Mme. M. Chatton: The conditions necessary for determining experimentally the conjugation of the Infusoria *Glaucoma scintillans*.—F. Vlès and A. de Coulon: The experimental modifications of the receptivity

index of mice for grafts of tumours.—George F. Jaubert: The origin of the yellow colour of beeswax.—Weinberg and J. Barotte: Researches on antitoxic and antimicrobial sera.

SYDNEY.

Royal Society of New South Wales, July 6.—J. W. Fielding: Observations on rodents and their parasites. The author examined 222 rats collected alive at Townsville, N. Queensland, for ectoparasites. On them he found 536 fleas, of which 493 were *Xenopsylla cheopis*, 33 *Ctenocephalus felis*, 8 *Ctenocephalus canis*, 1 *Pulex irritans*, and 1 *Ctenopsylla musculi*. Two were covered with an undetermined genus and species of mite. Data as to leprosy in rats, and also the presence of *Trypanosoma lewisi*, *Leptospera icterohæmorrhagica*, *Eimeria* sp. and worms were given.—The late Sydney Dodd: Swelled head in merino rams. Although the almost invariably fatal condition known among sheep-owners as 'swelled head' is generally regarded as affecting only young merino rams, it also occasionally affects older sheep. The condition has been ascribed from time to time to a number of different causes, including plant poisoning and streptococcic infection. A bacillus has been found in the œdematous fluid of the face, in the tissues of the affected muscles of the head and in the heart's blood during post-mortem examinations made immediately after death on typical cases. Experimental inoculation of pure cultures of this bacillus into the leg of a sheep produced lesions similar to those met with in cases naturally affected. The organism is anærobic and shows evidence of gas formation with dissociation of muscular tissue, but not particularly of a rancid nature.—W. F. Blakely: Descriptions of nine new species of Eucalyptus. Five of these belong to the Stringybark group, two to the Peppermint group, one is Ash, and one Bloodwood. Eight are indigenous to New South Wales, and one to the Northern Territory.—A. R. Penfold: The essential oil of *Eucalyptus Bakeri*. This pendulous willow-like tree of 30 ft.-50 ft. in height has a range from northern New South Wales to central Queensland. The principal constituents of its oil are cineol (70-77 per cent.), cymene, the aromatic aldehydes (cuminal, phellandral, cryptal), phloracetophenone-dimethyl ether and the esters (isobutyric, isovaleric, and formic) of cuminol and phellandrol. Australol (p-isopropyl phenol) d-a-pinene and sesquiterpene alcohol were also present in small quantities.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, Vol. 13, No. 6, June).—H. Walter Leavitt and John W. Gowen: Mineralogical content of Maine sands in relation to mortar strength. The percentage of granitic material in the sand plotted against the tensile strength after 7 days and 28 days setting, shows that strength decreases with increase of granitic material; thus quartz sand is not the best for making strong concrete. Increased strength goes with increased iron content and the latter with decreased granitic content, but there is also an independent effect of iron.—Dickinson W. Richards, Jr.: On the mechanics of blood flow, with special reference to the influence of change of posture. On changing from recumbancy to the standing posture, blood pressure increases and the volume of blood flow decreases in man. Applying Poisseuille's law of flow of a viscous liquid in a cylindrical tube, it is suggested that the changes are associated principally with arterial constriction.—Francis G. Benedict and Cornelia Golay Benedict: The nature of the insensible perspiration. The subject lies on the balance and breathes into a closed circuit respiratory apparatus also on the balance. Loss of weight then measures the loss through the skin (chiefly water), and it averages 50 per cent. of the total loss. The total insensible loss of a woman is 20 gm.-30 gm. per hour; that of a man is nearer 40 gm. per hour. Of this, about 45 per cent. is water from the skin, about 45 per cent. is water from the lungs, and 10 per cent. is the difference between oxygen intake and carbon dioxide output. The temperature of the environment and clothing make little difference. The total insensible loss is a good index of the total metabolism.—A. M. Showalter: Hermaphroditism in a dicœcious Hepatic.—Raoul M. May: Modifications of nerve centres due to the transplantation of the eye and olfactory organ in anuran embryos. The grafts develop synchronously with the corresponding organs of the host. There is at first marked affinity between the optic neuroblasts and those of the central nervous system (neuroblastotropism). The pia mater is only penetrated with difficulty by axons from the grafts.—Samuel F. Hildebrand and Charles Hatsel: On the growth, care, and behaviour of loggerhead turtles in captivity. The incubation period for the eggs appears to be 64 days, and the young remained at the surface of the water in the aquarium. Even when grown, they are sensitive to cold. Two specimens reared from eggs were kept for six years, their food being mainly fish, with occasional blue crabs and hard clams. Their weights when released were 55 lb. and 61 lb.—William Albert Noyes: (1) Magnetic hydrogen atoms and non-magnetic molecules. Suppose that under the catalytic effect of a metal, the orbits of the electrons of loosely joined hydrogen atoms are made to take opposite directions: the electrons are held by their nuclei but fall closer because there are now two nuclei instead of one. This might account for the dissipation of energy when the molecule forms. (2) The relation of the octet of electrons to ionisation. Close approach of atoms, molecules, or ions in solution involves strong repulsion between the external shells of electrons, leading to elastic collisions in which the components maintain their independent existence after collision.—Edison Pettit: Ultra-violet solar radiation. Two quartz cells, each consisting of a lens and plate, one silvered and the other gilded on the inner surfaces, are mounted at opposite ends of a diameter of a disc. The disc is carried by a spindle operated by an escapement so that an image of the sun formed by the silvered cell falls in turn on the junctions of a compensated thermocouple, after which the same procedure is carried out with the gilded cell. The galvanometer deflexions are recorded photographically and give the ratio of ultra-violet to green radiation every four minutes. The green radiation remains fairly constant, whereas the ultra-violet is zero for some time after sunrise and reaches a maximum at noon. The monthly mean of the ultra-violet radiation follows roughly the solar constant and the Mount Wilson daily sunspot numbers, but runs counter to the atmospheric ozone curve.—B. P. Gerasimovič and W. J. Luyten: On the distance of the sun from the galactic plane. The mean elevation of the sun above the galactic plane defined by the Cepheid variables, the O, B, and *c* and *ac* stars is +33 parsecs, with a mean error of not more than 3 parsecs.—Walter S. Adams and Alfred H. Joy: (1) The relationship of spectral type to period among variable stars. There is a practically linear correlation between spectral type and logarithm of period of light variation for the best known Cepheids. Long period variables and the mean for short period cluster type variables fall nearly on the Cepheid curve. (2) High-

dispersion stellar spectra and some results of a study of γ Cygni. A spectrograph of 15 ft. focal length and 6 in. aperture has been installed with the 100 in. reflector at Mount Wilson; the linear scale of the spectrographs obtained is about 2·9 Å.U. to the millimetre at Hγ. Lines of rare earths have been identified in the spectra of γ Cygni and those of Ce^+ show a systematic displacement, possibly caused by relative upward motion of the gases where they originate.—M. S. **Knebelman**: Groups of collineations in a space of paths.—P. **Ehrenfest** and P. S. **Epstein**: Remarks on the quantum theory of diffraction.—Richard M. **Badger**: Absolute intensities in the hydrogen chloride rotation spectrum. The probabilities of transition from the initial to the final state with absorption of radiation are calculated from integral absorption coefficients, but the experimental results are not in agreement with the predicted values.—R. B. **Lindsay**: Note on 'pendulum' orbits in atomic models. The 'pendulum' orbit involves the notion of an electron penetrating the nucleus. This may be avoided by assuming a repulsive force in the neighbourhood of the nucleus. Assuming this obeys an inverse cube law, reasonable values of the effective radius of the nucleus are obtained.—Bergen **Davis** and Harris **Purks**: Measurement of the Mo *K* doublet distances by means of the double X-ray spectrometer. One crystal is mounted as usual on the spectrometer table and a second crystal is carried on a rotating arm; radiation is reflected from the first to the second and thence to the ionisation chamber. The angle through which the second crystal is turned is twice the difference between the angles for reflection of two radiations. The results are closely independent of horizontal slit width, so that it is possible to have sufficient intensity of radiation to permit accurate measurements.—J. C. **Slater**: The structure of the helium atom (1). A method is developed of obtaining an approximate solution to the problem of calculating the spectrum of helium from the wave equation of mechanics. It can also be applied to yield qualitative results with higher atoms and molecular structure.—Walter A. **MacNair**: The Zeeman effect of the hyperfine structure components of λ 2537 of mercury. Each of the five lines found by Wood has a triplet Zeeman pattern.—Paul S. **Epstein**: The dielectric constant of atomic hydrogen in undulatory mechanics. For the excited states of the atom, in weak fields the orientation is arbitrary; in strong fields this is not so. Owing to the complete symmetry of the atom in the normal state, the question of orientation is here without meaning.—Evelyn F. **Aylesworth**: The dielectric constant of atomic hydrogen from the point of view of Bohr's quantum theory. The calculations lead to results similar to those recorded in Epstein's paper above.—David L. **Webster**: Direct and indirect production of characteristic X-rays. Indirect rays will be produced at depths in the target averaging more than the mean depth of rays producing the continuous spectrum. With a target of silver 25 microns thick plated with copper, the majority of the *K*-radiation is direct when the cathode rays are driven by a steady voltage of 35 kv., d.c. Other targets used were blocks of cadmium with one or two sheets of silver foil 6 microns thick and a block of graphite plated with silver 3·5 microns thick. With 50 kv., the ratio of the direct to the indirect rays was 2·36.—Carl **Barus**: Mucronate electrode with micrometer.—Carl **Eckart**: The reflection of electrons from crystals. Electron reflection differs from X-ray reflection in that a single plane of atoms reflects an appreciable fraction of the electrons and that the wave-length of the electron wave inside the crystal differs from its wave-length in free space.—Edward Uhler **Condon**: (1) Coupling of electronic and nuclear motions in diatomic molecules. (2) Wave mechanics and the normal state of the hydrogen molecule. A discussion based on the quantum theory of the binding of atoms into molecules (valency forces) gives results in fair accord with experiment.—Gilbert N. **Lewis**: A new equation for the distribution of radiant energy.—C. F. **Richter**: The hydrogen atom with a spinning electron in wave mechanics. It is claimed that the fine structure of hydrogen-like spectra can be represented completely by the Schrödinger wave mechanics with the Uhlenbeck-Goudsmit spinning electron.

Official Publications Received.

BRITISH.

The North of Scotland College of Agriculture. Guide to Experiments and Demonstration Plots at Craibstone, 1927. Pp. xii+56. (Aberdeen.)

Memoirs of the Department of Agriculture in India. Botanical Series, Vol. 14, No. 4: Studies in Gujurat Cottons. Part iv: Hybrids between Broach-deshi and Goghari Varieties of Gossypium herbaceum. By Maganlal L. Patel and S. J. Patel. Pp. 131-176. (Calcutta: Government of India Central Publication Branch.) 14 annas; 1s. 6d.

Aeronautical Research Committee: Reports and Memoranda. No. 1079 (E. 24): Summary by the Secretary, Engine Sub-Committee, of a "Report on Anti-knock Investigations." By A. Egerton and S. F. Gates. (I.C.E. 561.) Pp. 13+13 plates. (London: H.M. Stationery Office.) 9d. net.

Royal Commission on Agriculture in India. Vol. 1, Part 2: Evidence of Officers serving under the Government of India. Pp. lxix+378+18 plates. (London: H.M. Stationery Office.) 6s. 3d. net.

The Journal of the Institute of Metals. No. 1, 1927. Vol. 37. Edited by G. Shaw Scott. Pp. xii+886+75 plates. (London: The Institute of Metals.) 31s. 6d. net.

Straits Settlements. Annual Report on the Raffles Museum and Library for the Year 1926. By C. Boden Kloss. Pp. 14. (Singapore.)

Western Australia. Annual Progress Report of the Geological Survey for the Year 1926. Pp. 26+7 plates. (Perth: Fred. Wm. Simpson.)

Western Australia: Geological Survey. Bulletin No. 84: The Field Geology and Broader Mining Features of the Leonora-Duketon District, including parts of the North Coolgardie, Mt. Margaret and East Murchison Goldfields, and a Report on the Anaconda Copper Mine and Neighbourhood. By E. de C. Clarke. Pp. 66+4 plates. Bulletin No. 86: The Geology and Mineral Resources of the Yalgoo Goldfield. By E. de C. Clarke. Part 2: The Mining Centres of Rothesay and Goodingnow (Payne's Find). Pp. 41+3 plates. Bulletin No. 90: The Geology of a portion of the East Coolgardie and North-East Coolgardie Goldfields, including the Mining Centres of Monger and St. Ives. By E. de C. Clarke. Pp. 41+6 plates. (Perth: Fred. Wm. Simpson.)

Public Library, Museum and Art Gallery of South Australia. Records of the South Australian Museum. Vol. 3, No. 3. Pp. 219-341. (Adelaide.) 10s. 6d.

Indian Journal of Physics, Vol. 1, Part 4; and Proceedings of the Indian Association for the Cultivation of Science, Vol. 10, Part 4. Conducted by Prof. C. V. Raman. Pp. 329-456. (Calcutta: Indian Association for the Cultivation of Science.) 3 rupees; 4s.

Uganda Protectorate. Annual Report of the Geological Survey Department for the Year ended 31st December 1926. Pp. 43. (Entebbe: Government Printer.) 3s.

Memoirs of the Department of Agriculture in India. Chemical Series, Vol. 9, No. 3: Some Digestibility Trials on Indian Feeding Stuffs, II. By Dr. P. E. Lander and Pandit Lal Chand Dharmani. Pp. ii+63-83. 10 annas; 1s. Chemical Series, Vol. 9, No. 4: The Effect of Manuring a Crop on the Vegetative and Reproductive Capacity of the Seed. By B. Viswa Nath and M. Suryanarayana. With a Summary of the Results of certain Animal Nutrition Experiments carried out by Lt.-Col. R. McCarrison. Pp. ii+85-124. 14 annas; 1s. 6d. (Calcutta: Government of India Central Publication Branch.)

The Hundred and Fifth Report of the Commissioners of Crown Lands, in Obedience to the Acts 10 George IV. (Cap. 50) and 2 William IV. (Cap. 1), being the Seventy-Sixth Report under the Act of 14 and 15 Vict. (Cap. 42), dated 30th June 1927. Pp. 38. (London: H.M. Stationery Office.) 4s. net.

Aeronautical Research Committee: Reports and Memoranda. No. 1078 (Ae. 259): The Application of the Algebraic Formulæ of R. and M. 1056 to Problems of Aircraft Performance. By W. G. Jennings, N. E. Rowe and I. Bowen. (D.1. Special Technical Questions, 195 and a.—T. 2375 and a.) Pp. 11+11 plates. 9d. net. No. 1088 (Ae. 267); Preliminary Report on the Fitting of Slots and Flaps and Slot-and-Aileron Control to a Bristol Fighter. By H. L. Stevens. (A.2.b. Stability—Full Scale Experiments.—T.2420.) Pp. 3+2 plates. 4d. net. No. 1092 (Ae. 271): A Distant-Reading Instrument for the Measurement of Small Displacements. By E. F. Relf and L. F. G. Simmons. (C.1. Accessories—Instruments, 95.—T. 2429.) Pp. 4+1 plate. 4d. net. (London: H.M. Stationery Office.)

The British Research Association for the Woollen and Worsted Industries. Publication No. 78: An Outline of the Activities. By S. G. Barker and Arnold Frobisher. Published on the Occasion of the Leeds Meeting of the British Association for the Advancement of Science, August 31st–September 7th, 1927. Pp. 48+4 plates. (Leeds.)

Report of the Progress of the Ordnance Survey for the Financial Year 1st April 1926 to 31st March 1927. Pp. 9+5 plates. (London: H.M. Stationery Office.) 9d. net.

London County Council. Lectures and Classes for Teachers: Handbook for the Session 1927-28. Pp. 78. (London: London County Council.)

FOREIGN.

Skogsförsöksanstaltens Exkurzionsledare. 12: Geologie, Jordmån och, Vegetation inom Siljansfors Försökspark i Dalarna. By Karl Lundblad. Pp. 112+3 maps. (Stockholm: Centraltryckeriet.)

Meddelanden från Statens Skogsförsöksanstalt. Hälfte 23, 1926-27. Pp. 639+2 plates. (Stockholm: Centraltryckeriet.) 10 kr.

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 553: Further Radiometric Measurements and Temperature Estimates of the Planet Mars, 1926. By W. W. Coblentz and C. O. Lampland. Pp. 236-276. (Washington, D.C.: Government Printing Office.) 15 cents.

Journal of the College of Agriculture. Hokkaido Imperial University, Sapporo, Japan. Vol. 19, Part 1: New Species and Subspecies of Moths from the Japanese Empire. By Prof. Dr. S. Matsumura. Pp. 96+5 plates. Vol. 20, Part 2: Die Hydrolyse des Leders, von Prof. Dr. G. Grasser; Einfluss der Deduktions-methoden auf die Ausflockungszahl, von Prof. Dr. G. Grasser und Dr. S. Sawayama. Pp. 49-78. (Sapporo.)

The Science Reports of the Tôhohu Imperial University, Sendai, Japan. Second Series (Geology), Vol. 10, No. 3: On *Bison exguus* Matsumoto and its Ancestry, by Hikoshishirô Matsumoto; On a new Fossil Race of the Asiatic Elephant in Japan, by Hikoshishirô Matsumoto. Pp. 51-62+4 plates. (Tôkyô and Sendai: Maruzen Co. Ltd.)

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 71: Investigations on Raw Cotton; Deterioration of Cotton during Damp Storage. By Alan Chamley Burns. Pp. xiv+92+13 plates. (Cairo: Government Publications Office.) 10 P.T.

Koninklijk Nederlandsch Meteorologisch Instituut. No. 113: Rapport de la Réunion de la Commission Internationale de Météorologie Maritime à Zurich 14-17 Septembre 1926. Pp. 21+1 planche. ('s-Gravenhage: Algemeene Landsdrukkerij.) 0.30 fl.

Department of the Interior: Bureau of Education. Bulletin, 1927, No. 14: Physical Education in American Colleges and Universities. By Marie M. Ready. Pp. vi+51. (Washington, D.C.: Government Printing Office.) 10 cents.

Bulletin géodésique: Organe de la Section de Géodésie de l'Union Géodésique et Géophysique Internationale. Année 1925, No. 8, Octobre-novembre-décembre 1925. Pp. 597-722. Année 1926, No. 10, Avril-mai-juin 1926. Pp. 81-154. Année 1926, No. 11, Juillet-août-septembre 1926. Pp. 155-186. (Toulouse: Édouard Privat; Paris: J. Hermann.)

The Metabolism of the Fasting Steer. By Francis G. Benedict and Prof. Ernest G. Ritzman. (Publication No. 377.) Pp. viii+246. (Washington, D.C.: Carnegie Institution.)

Department of the Interior: U.S. Geological Survey. Water-Supply Paper 549: Surface Water Supply of the United States, 1922. Part 9: Colorado River Basin. Pp. v+175+2 plates. 25 cents. Water-Supply Paper 551; Surface Water Supply of the United States, 1922. Part 11: Pacific Slope Basins in California. Pp. viii+405+2 plates. 50 cents. Water-Supply Paper 575: Surface Water Supply of Hawaii, July 1, 1922, to June 30, 1923. Pp. iv+173. 25 cents. (Washington, D.C.: Government Printing Office.)

Department of the Interior: U.S. Geological Survey. Bulletin 789: The Iniskin-Chinitna Peninsula and the Snug Harbor District, Alaska, By Fred H. Moffit. Pp. iv+71+11 plates. 50 cents. Bulletin 791: Geology of the Upper Matanuska Valley, Alaska. By Stephen R. Capps. With a Section on the Igneous Rocks, by J. B. Mertie, Jr. Pp. viii +92+16 plates. 30 cents. (Washington, D.C.: Government Printing Office.)

Proceedings of the United States National Museum. Vol. 71, Art. 13: A Revision of the Cottoid Fishes of the Genus Artediellus. By Peter Schmidt. (No. 2685.) Pp. 10. (Washington, D.C.: Government Printing Office.)

Field Museum of Natural History. Anthropology Leaflet No. 22: Insect-Musicians and Cricket Champions of China. By Berthold Laufer. Pp. 27+12 plates. (Chicago, Ill.) 50 cents.

Publikationer fra det Danske Meteorologiske Institut. Communications magnétiques. No. 1: Sur l'erreur moyenne des moyennes mensuelles des éléments magnétiques observées à l'Observatoire de Rude Skov, par D. la Cour; No. 2: Direct Determination of Scale Values at the Magnetic Observatory at Godhavn, by Johannes Olsen. Pp. 33+7. (København: G. E. C. Gad.)

Institut de Géophysique et de Météorologie de l'Université de Lwów. Communications, Vol. 2, Nos. 19 à 30, des résultats des recherches de Henryk Arctowski et de ses collaborateurs MM. Henryk Orkisz, Edward Stenz, Stanislaw Zych, Wincenty Przepiórski et Jan Moniak, faites à la Société des Naturalistes Polonais et publiées dan la revue *Kosmos*, Vols. 51 et 52. Pp. viii+167+234. (Lwów.)

Société des Nations: League of Nations. Bulletins de l'Institut International de Coopération Intellectuelle: Bulletin des Relations scientifiques. 2me année, No. 3, Août. Pp. 309-401. (Paris: Les Presses universitaires de France.) 8 francs.

CATALOGUE.

Instrumentos de precisión Cambridge para aplicaciones industriales. Catálogo No. 907S. Pp. 40. (London: Cambridge Instrument Co., Ltd.)

Diary of Societies.

SATURDAY, SEPTEMBER 10.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Eastern District Meeting) (at Town Hall, Lowestoft), at 11 A.M.

TUESDAY, SEPTEMBER 13.

INSTITUTE OF MARINE ENGINEERS (at 85 The Minories, E.1), at 6.30.—Eng.-Capt. W. Onyon: Presidential Address.

CONGRESSES.

SEPTEMBER 11–17.

INTERNATIONAL CONGRESS OF PHYSICS IN COMMEMORATION OF THE CENTENARY OF VOLTA (at Como).

SEPTEMBER 11–18.

INTERNATIONAL CONGRESS OF GENETICS (at Berlin). In three sections: General Genetics and Cytology, Heredity in Man and Eugenics, Animal and Plant Breeding.

SEPTEMBER 12–14.

INTERNATIONAL SOCIETY OF LEATHER TRADES' CHEMISTS (Bi-Annual Conference) (at Leathersellers' Hall, St. Helen's Place, E.C.3.)

SEPTEMBER 12–15.

INSTITUTION OF PUBLIC LIGHTING ENGINEERS (Annual Meeting and Conference) (at Brighton).

SEPTEMBER 12–16.

BRITISH MYCOLOGICAL SOCIETY (Annual Meeting) (at Aviemore).

Monday, September 12.—Excursion.

At 8.45 P.M.—Council Meeting: Exhibits.

Tuesday, September 13.—Excursion.

At 8.45 P.M.—Dr. E. J. Butler: Presidential Address.

Wednesday, September 14.—Excursion.

At 8.45 P.M.—Annual General Meeting.

Thursday, September 15.—Excursion.

At 8.45 P.M.—Dr. M. Wilson: Life-History of Milesina Kriegeriana and its Occurrence in Britain.—Dr. G. G. Hahn: Species of Phomopsis occurring on Conifers and their Distinction in Culture.

Friday, September 16.—Excursion.

At 8.45 P.M.—Miss M. Wilson: The Dutch Elm Disease.—C. Rea: Remarks on Fungi found during the Foray.

SEPTEMBER 12–17.

INTERNATIONAL CONGRESS FOR TESTING MATERIALS (at Amsterdam).

SEPTEMBER 15–17.

ANNUAL CONFERENCE OF WOMEN ENGINEERS (at Shipping, Engineering and Machinery Exhibition).

Thursday, September 15, at 8 P.M.—Presidential Address at Olympia.

Friday, September 16, at 2.45.—Discussion on the Relative Importance of Commercial and Technical Engineering under Present-day Conditions. Commercial Side: Miss E. M. Kennedy; Technical Side: Miss Norah M. Jeans.

Saturday, September 17, at 2.15 (at Crosby Hall).—Miss Iris Cummins: Water Power and the Electrification of the Irish Free State.

SEPTEMBER 18–OCTOBER 3.

INTERNATIONAL CONGRESS OF THEORETICAL AND APPLIED LIMNOLOGY (at Rome). In four sections: Physics and Chemistry, Geology and Hydrography, Biology, and Applied Limnology.

SEPTEMBER 20–22.

IRON AND STEEL INSTITUTE (Autumn Meeting) (at Royal Technical College, Glasgow), at 10 A.M.—*Papers to be submitted*:—D. F. Campbell: High-Frequency Induction Melting.—H. A. Dickie: Magnetic and other Changes concerned in the Temper-Brittleness of Nickel-Chromium Steels.—Prof. C. A. Edwards and K. Kuwada: The Influence of Cold-Rolling and Subsequent Annealing on the Hardness of Mild Steel.—A. B. Everest, T. H. Turner, and D. Hanson: The Influence of Nickel and Silicon on an Iron-Carbon Alloy.—C. S. Gill: The Effect of Varying Ash in the Coke on Blast-Furnace Working.—D. Hanson: The Constitution of Silicon-Carbon-Iron Alloys, and a New Theory of the Cast Irons.—E. G. Herbert: The Work-Hardening of Steel by Abrasion.—K. Honda and K. Takahasi: On the Quantitative Measurement of the Cutting Power of Cutlery.—E. H. Lewis: The Use of Silica Gel as a Medium for Drying Blast.—T. Matsushita and K. Nagasawa: The Mechanism of Tempering of Steels.—T. W. Robinson: The Economic and Social Development of the American Iron and Steel Industry.—Dr. W. Rosenhain and D. Hanson: The Behaviour of Mild Steel under Prolonged Stress at 300° C.—J. H. Smith and F. V. Warnock: A Testing Machine for Repeated Impact, and a Preliminary Investigation on the Effects of Repeated Impact on Lowmoor Iron.—J. H. Whiteley: The Solution of Carbon in α-Iron and its Precipitation.—F. Wüst: A Contribution to the Theory of the Blast-Furnace Process.

SEPTEMBER 23–26.

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX (at Trinity College, Cambridge).—Subjects for discussion: Report of the Public Libraries Committee of the Board of Education (A. E. Twentyman and Lieut.-Col. L. Newcombe); Recent Developments in connexion with the Science Library, South Kensington (Sir Henry Lyons); Information, Organisation, and Statistics in Industry (Major L. Urwick, S. J. Nightingale, H. Quigley, W. Wallace, A. E. Overton, F. W. Tattersall); Patent Classification (A. R. Wright, A. Gomme); Problems of the Information Bureau (A. F. Ridley, P. K. Turner, Dr. J. C. Withers); Photographic Reproduction of Printed and MS. Material (N. Parley, Sir William Schooling, R. H. New); Standards of Book Selection in Science and Technology (Sir Richard Gregory).