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Specialisation in Universities.

IT is not the function of a university to make provision for teaching all the sciences; still less is it the function to confine its work to one narrow branch of specialised study. In one case, apart from the difficulties inherent in such an aggregation, the financial cost would be prohibitive; in the other, a limitation of such a nature would be wholly alien to the modern conception of a university, where, in place of the breadth and proportion of view which comes from the attrition of minds engaged in diverse studies and pursuits, would be found the narrowness and exclusiveness of intellectual segregation. We may therefore dismiss one extreme as impracticable and the other as undesirable.

The universities of to-day have many subjects of study in common. Happily the freedom to develop according to their own individualities, which has hitherto been their lot, has resulted in certain characteristic differences. It is devoutly to be hoped they may not lose these distinctions. The studies common to all universities form a broad humanistic and scientific foundation which is the basis of the intellectual life of the university. Superimposed upon this are the more highly specialised studies, which may in some cases cover a very narrow field, but not seldom form a department in the university linked up in innumerable ways with one or more branches of industrial or commercial life outside. This development has been gradual and, in general, continuous, and it is due to a variety of causes of which probably the two most effective may be defined as historical and regional or environmental. As matters now stand, some studies have already been specialised in certain of the universities and, until quite recently, largely by a process of natural development. To overlook or to underestimate the importance and bearing of this fact would be a mistake.

If the universities were self-supporting or mainly so, it is unlikely that the present system, which on the whole has worked well, would be challenged—it may yet prove to be the best in any circumstances—but since they are not self-supporting, and since they are coming to rely more and more upon assistance from State funds and local rates, they need not be surprised if a time comes when a critical eye is turned upon their activities. Such a time is with us now. The cry for economy, the reduction in the Government grant, the threat of lean years ahead, apart from other considerations, have brought to the forefront the question of the overlapping of university studies, and the possibility of better co-ordination and co-operation of the universities in the future, especially with regard to the ever-increasing expansion and development of technology and applied science.

With regard to the question of overlapping it should be remarked that at the recent conference in London of the Universities of Great Britain and Ireland, no statement was more generally applauded than that of Prof. Ripper, of Sheffield, who reminded the conference and the public that at present there was no unnecessary overlapping in university studies. Overlapping there may be, but whether this is unnecessary and wasteful is quite another question and one which cannot be answered by mere statistics. This is where co-operation would be most useful both now and in the future. The Minister of Education was on sound lines when, in addressing the conference, he advised the universities to take counsel with one another and husband their resources. Possible wastefulness due to overlapping ought not to be disregarded at any time and most certainly not at a time of financial stringency.

If, for example, each university were to attempt to cover all the main branches of technology, though perhaps the demand for university-trained technologists in a particular field did not reach a score annually, then disappointment and ineffective work must be the result. Obviously where the demand for trained technologists in a particular subject is limited to a comparatively small number, there is distinctly a case for specialising the study in one university. How far universities would attempt to compete with one another in such cases it is difficult to say. But it is worth recalling that, at the conference to which we have already alluded, Mr. Fisher directed attention to the public-spirited action of the University of Leeds a few years ago when glass technology was proposed as a subject for university research. It appears that either Leeds or Sheffield might have been the seat of the new department, but after a conference Leeds agreed to the new work being centred in Sheffield on the ground that the Yorkshire glass industry as a whole was more accessible from there than from Leeds. The method of procedure by conference should be noted.

Cases such as this are obviously cases for specialisation and are perhaps not difficult to settle. It would seem that the limited demand points to concentration and the "regional pull" to the particular university. On the other hand such highly specialised subjects as technical optics, oceanography, hydro-electrics cannot be said to have so localised a regional pull, nor Chinese, Assyriology, and a host of others. Again, departments of study connected with agriculture, forestry, leather industries, dyeing, textile industries, metallurgy, fuel and coal gas industries are already established in one or more of our universities. If, as is more than likely, any further specialisation of studies is to be made in these departments, especially if it involves considerable expense, obviously there would arise an occasion for co-operation among the various universities interested with the view of suitable distribution of the work.

So far we have been considering the subject of specialisation in universities from the point of view either of the more highly specialised studies or of technology or applied science generally, and have indicated our opinion that in these fields there will be ample scope and real necessity for co-ordination and co-operation. But there is another aspect of the problem which is apt to be overlooked or even in danger of being confused with the one just considered. It has relation to those basic humanistic and scientific studies which are the foundations of the intellectual life of the universities. Among them are included such subjects as the classics, English, history on one side, and mathematics, physics, chemistry on the other. They are found in all our universities, and rightly so, and so long as the university is conceived as "a spirit, a principle of life and energy, an influence . . . caring for the spirit and mind of man, regardless of considerations of utility," so long will they remain there. While, therefore, it is not disputed that the more fundamental of them should be taught in every university, it may be urged in the interests of a specious economy that the prosecution of research in them should be specialised in certain universities. This, we believe, would be a most dangerous principle to adopt, and would be quite contrary to the true spirit of the university. The effect upon the teaching would be little short of disastrous. In its Report of 1921 the University Grants Committee is clear that "sufficient leisure to pursue research is as essential as adequate remuneration," and that "no institution claiming university rank can rest content while it fails to provide opportunities for the advancement of knowledge, nor can junior teachers hope to rise in their profession or indeed carry out their teaching duties efficiently unless such opportunities are open to them." This extract amply confirms the general opinion expressed at the second Congress of the Universities of the Empire, 1921, regarding the great importance and value of research to a university teacher. Without research behind him a university teacher fails in the freshness, mastery, and inspiration required of a good teacher of university students. Whenever such fundamental studies are found in a university some opportunities for research in them should be provided. This may mean overlapping, but it is not overlapping involving wastefulness.

The case is almost equally strong for a subject which, while not absolutely fundamental in the sense indicated above, is necessarily included in the studies of a university for regional or local reasons. If it is argued that the undergraduates might travel to another university for the necessary instruction, it may be replied that in most cases it would be inconvenient and expensive and not seldom impossible. Assuming that the subject is taught in the university, the arguments adduced above show conclusively that opportunities for research are indispensable. A possible alternative would be to bring a teacher from another university to give a course of instruction in it. This is a plan which, though it has been adopted with good results in some universities, is not always possible or desirable. One can picture a case, in economics for example, where investigations into local conditions are absolutely necessary for the proper development of the teaching of the subject, and no substitute can adequately replace it.

While we are sensible of the need for economy and the avoidance of all unnecessary overlapping in our universities, we are also sensible of the wonderful developments which have taken place in higher and specialised studies in the few decades during which the modern universities have come into being and attained some degree of maturity. It may well be said that " not since the monastic period of the twelfth century, or the scholastic revolution of the sixteenth, has England known an educational movement so rich in romance, in courage, in devotion, and in promise." This extraordinary expansion and development, which has changed the whole face of education in England, is one of self-development untrammelled by vexatious restrictions. The modern university has developed under the wing of the State; it can no more dispense with Government assistance than it can with its students or staff. But if it is to fulfil its rightful destiny it must retain its freedom to develop from within. By all means let there be co-operation and co-ordination among the various universities, just as there are within the university itself. But if, unhappily, any attempt to lop or prune activities, hitherto self-determined, were to succeed, the measure of its success would be the measure of the nation's loss.

More Light on the Bantu Languages.

A Comparative Study of the Bantu and Semi-Bantu Languages. By Sir Harry H. Johnston. Vol. 2. Pp. xii+544. (Oxford: Clarendon Press, 1922.) *3l. 3s.*

AFTER numerous and vexatious delays, the second volume of this monumental work has at last seen the light. It contains " an analysis and comparison of the phonology and word-roots and a comparative examination of the syntax of the Bantu and Semi-Bantu languages, together with the conclusions to be derived from this evidence." In accordance with this plan we have, first, a review of the various groups of Bantu and Semi-Bantu languages, following the arrangement adopted in the first volume. (An alphabetical index of languages, by the bye, would greatly facilitate research, though the student is helped to a considerable extent by the table on pp. 2-13. In vol. 1, those not gifted with a remarkable memory for numbers had to turn over the pages till they found the particular language required.)

The classification adopted is open to some objections in detail—as was almost inevitable in the circumstances: but one had hoped to see some outstanding inaccuracies corrected in vol. 2, *e.g.* the treatment of the two distinct languages Lala and Lamba as one and the same. This, of course, is due to Madan, the only authority accessible when the vocabularies were prepared; but other sources of information have since become available. Again, there is some confusion (vol. 1, p. 281, vol. 2, p. 79) as to the languages entered under 70: Chopi, to adopt the ordinary orthography, is a distinct language from Tswa, and also, we believe, from Lenge, which, again, is not the same as Hlengwe. (See *e.g.* Junod's map in the " Grammaire Ronga." Sir Harry Johnston dissents from this writer's view, but it is supported by good recent authority.)

The paragraphs dealing with " Group T: the Zulu-Kafir languages " contain several points calling for discussion. It is surely by an oversight that the palatal click (*qc, ç*) is said to be " confined mainly to Zulu and Sesuto." It does not occur in Zulu, and only doubtfully in Xosa. (Bleek: " *Vide* Boyce-Davis, p. 4, where the *qc* is probably intended to indicate this sound.") The fact that it is found in Sesuto is interesting, as showing that it was probably borrowed direct from Hottentots or Bushmen—not, as usually assumed, from the Zulus. The same paragraph contains a somewhat perplexing assertion: " In Zulu the employment of clicks instead of diminishing is extending, through the same spirit of tribal self-assertion as may be met with in the Basuto. Whenever a present-day Zulu or even a Kafir " (why " even," seeing that click-words are more numerous in Xosa than in Zulu ?) " wishes to coin a new word—and they are doing this on an immense scale—he nearly always introduces a click into it. . . ."

It is difficult to check statements of this kind unless one is in constant touch with natives, but a rough test may be made by consulting the list of neologisms at the end of Colenso's Dictionary (edition of 1905, pp. 721-724). Among 236 words we find only three containing clicks, and two of these—*isigqoko* "hat" (adapted from *isigcogco* "head-ring"), and *uTixo* "God"—are not of very recent introduction. As, however, it may be objected that great linguistic changes may take place in seventeen years, we have examined a copy of the native newspaper, "Ilanga las' e Natal," dated February 17, 1922, and find, in two columns, averaging about 175 words each, 31 click-words, excluding repetitions and proper names. Of these, all, with the possible exception of three (two of which may be wrongly printed), are either to be found in Colenso's Dictionary, or are obvious derivatives of words there given.

It is strange to see *-gundu-* "rat" given as peculiar to the Swazi dialect, when *igundane* is very commonly used in Natal Zulu. Similarly, on p. 86, we have, *apropos* of the Sesuto *-liba* "(deep) water," the note, "This is a very interesting penetration far to the south of the Zambezi of a root which is very archaic (*-ndiba* or *-diba*), and particularly characteristic of the N.W. Bantu." But surely it is the same word as the Zulu *isi-ziba*, the Ronga *tiba*, the Swahili *ziwa*, etc.

This survey extends over five chapters and is followed by a similar review of the Semi-Bantu languages, after which we have a highly controversial chapter on phonetics and phonology. The note on p. 215 we may leave to be dealt with by scientific phoneticians, but must protest, in passing, against the dictum that "proficiency in speaking an African tongue exactly as it is pronounced . . . is *only* to be acquired by a parrot-like imitation of the natives." While "parrot-like imitation" can only be compassed by those possessed of a really good ear, a faultless pronunciation can often be acquired even by persons of inferior ear-capacity, by attending to the instructions of the phonetician. But this presupposes an analysis of the sounds carried out with that meticulous accuracy for which our author appears to entertain so great a contempt. Under the heading "Lingual-palatal-sibilant" (p. 217), no notice is taken of the fact that the symbols *c*, *j* cover at least two different sounds, one of which, the palatal plosive, is *not* a compound consonant "composed of a blending of *t* and *sh*." The difference is important, because sometimes, as in Chinyanja and Zanzibar Swahili, it serves to discriminate between otherwise similar words. Perhaps, however, this point is covered by what is said on p. 222 as to the palatalising of *d* and *t*. The final paragraph of this section (p. 219) fails to make clear the distinction between sentence-intonation and significant word-intonation.

Sir Harry Johnston seems inclined to agree with Prof. Meinhof as to the probable absence of vowel-roots in Proto-Bantu. "A comparison of all the recorded forms often leads to the deduction that the oldest root of two syllables commenced with a consonant, very often a guttural." This term is now disused as not sufficiently precise—it would cover velar, uvular, and faucal consonants. It is not quite accurate, however, to say that Meinhof in all cases "replaced the dubious or missing consonant by a gamma (γ)." He sometimes postulates *v̱* (bilabial *v*) and has left the question open for at least sixteen stems, where he was unable to decide what the primitive consonant could have been. It is not quite easy to see what is meant by the next sentence: "My own researches, however, lead me in restoring the missing consonant to greater definiteness; to a *g* instead of a γ, a *k* instead of an *x*, a labial instead of an aspirate." The fact that the form *γenda*, for instance, is found in a small group of languages (only Shambala and Pare-Gweno, so far as I am aware), while *genda*, *jenda*, and *enda* are common, coupled with the greater difficulty of pronunciation of the voiced velar fricative—a difficulty which seems to be felt very generally in Bantu—seem to indicate that Meinhof may be right here.

The chapter dealing with "Prefixes, Suffixes and Concords connected with the Noun" is of great interest. Sir Harry appears to show convincing reasons why the *fi-* or *pi-* diminutive class (Meinhof's 19th) should be identified with the 8th (*vi-*) instead of maintaining a separate existence. That it is singular while 8 is plural constitutes no objection, since we find 14 (*bu-*) fulfilling a similar double function—or rather being treated as plural in some cases (Luganda, Herero, etc.), while in itself it is, strictly speaking, neither singular nor plural. With this example in view, it seems to us that it would have been more logical to place *fi-*, etc. under 8 without creating for it the special subdivision of 8*a*. This prefix occurs in Karanga (as noticed on p. 75) in the form *swi-* (or rather *σi-*, with the peculiar "whistling *s*"),[1] with *v̱u-* corresponding to it as plural.

We should have thought it probable that the "honorific" prefix *ka-* belonged to a different class (now lost as such, but leaving traces, *e.g.* in Luganda, in such words as *Kabaka*, *Katonda*) from the diminutive (13). There are indications, in Konda, Lamba, and elsewhere, of a class of animals with the prefix *ka-*. Whether this was originally identical with the last-named, or had any connexion with the Chinyanja words beginning with *nanka-* (as *nankabai* "hawk"), is a problem which remains for solution.

It seems a pity to confuse the class of infinitives (verbal nouns) with the locatives in *ku-*, which should properly be Class 17, though no doubt the prefixes had originally the same origin. Words like *kuboko* "arm,"

[1] σ is the International Phonetic Association's symbol for this sound, which (or a similar one) is written by Meinhof ṣ and by Junod ŝ. Sir Harry Johnston has nowhere noticed it.

kutu "ear," etc., are locatives which have quite usurped the place of the original noun—usually of Class 5, which accounts for the plural in *ma-* (*maboko, matu*)—the locative, as such, having no plural. Similarly, the locative in *mu-* accounts for the appearance of parts of the body in Class 3. An interesting illustration of this is found in Swahili: the Mombasa dialect has preserved the old word for "foot," *guu* 5 (for *li-gulu*), pl. *maguu*, which, at Zanzibar, has become *m-guu* 3 (properly "in the foot"), pl. *miguu*.

It is a little difficult to accept in its entirety the following: "Class 18 [Meinhof's 20] implies 'hugeness,' something 'gigantic,' 'brutal' . . . augmentative in an ugly sense. And Class 19 (*Ga-*) is its plural in Luganda; otherwise the plural applied to *Gu-* is usually *Mi-*." As a matter of fact, the plural *mi-* really belongs to a distinct augmentative class, with the prefix *γi-* or *gi-*; still surviving in Swahili, though now practically indistinguishable from the 5th. The prefix is still traceable with monosyllabic roots, as in *jibwa* and *jitu*—elsewhere (by false analogy) it has been dropped, as in *dege*, augmentative of *ndege*. In Mombasa Swahili, the proper plural prefix of these augmentatives is *mi-*. But these two classes, the Depreciative ("augmentative in an ugly sense") and the Augmentative proper have become hopelessly confused—as shown by the Masaba example, *gumundu*, plural *gimindu*.

It is difficult to estimate duly the enormous amount of labour which has gone to the making of this volume, and not least to the collating and cross-indexing the word-roots grouped under the English equivalents, after having been enumerated separately under their several languages. With all criticisms that may be possible as to matters of detail (easily corrected if the criticisms are found valid), this work must remain for many years to come the standard guide to the subject. Nothing else that has yet been attempted gives the same comprehensive view of the whole Bantu family, and its possible relationships to the languages adjoining on the north-west. Perhaps the examination of these Semi-Bantu forms of speech is the most valuable part of the whole; and the discovery of the Homa and Bangminda languages (hitherto unsuspected forms of Bantu) in the Bahr-il-Ghazal may help to throw light on a difficult question.

A. WERNER.

Chemistry and Medicine.

Préparation des médicaments organiques. Par Ernest Fourneau. Pp. viii+350. (Paris: J. B. Baillière et Fils, 1921). 25 francs.

ONE of the minor effects of the late war has been the increased production of books on technical chemistry in the allied countries. Dealing with the manufacture of organic medicinal substances, hitherto very much a field of German activity, there recently appeared in this country a monograph by Barrowcliff and Carr, primarily concerned with industrial processes, plant, and patents. Prof. Fourneau, on the other hand, describes in the book under review the preparation of organic medicaments on a laboratory scale. Here are exact directions for all stages of the synthesis of phenacetine, stovaine, veronal, salvarsan, and many others, starting from common materials; for each step the yield is given, which in the author's experience can be obtained. A student of organic chemistry who has worked through these will have acquired quite as much manipulative skill as he usually obtains from Cohen's "Practical Organic Chemistry" or Gattermann's "Kochbuch," and he will have made more interesting substances.

The preparative directions constitute, however, little more than a quarter of the book under notice. Prof. Fourneau begins with a theoretical section, discussing such diverse matters as the relative costs of different processes of large-scale production, the pharmacological methods for testing antipyretics, the considerations which should govern the search for a new local anæsthetic, the chances of finding a useful organic compound of mercury. Like the practical section, the more theoretical one is excellent, and worthy of the discoverer of stovaine, but in a different way. The precision of the experimental part, with its homogeneity and wealth of detail, may recall to some readers that its author is a pupil of Willstätter. The more theoretical portion, less systematic than many German books, is, on the other hand, eminently readable. We feel that Prof. Fourneau has chosen for review just those topics in which he was really interested; thus we are given admirable accounts of adrenaline analogues, phosphatides and nucleic acids, in excess of their pharmacological importance, and in greater detail than his rapid review of alkaloidal chemistry.

The advice to beginners on the setting-up of apparatus gives an interesting glimpse of the author's personality. "Il faut toujours se préoccuper du montage soigneux et *élégant* des appareils et y consacrer le temps nécessaire; on le retrouve toujours." The laboratory should be kept like a drawing-room, and Moissan's ideal is quoted that the chemist should be able to work "sans se salir, en habit, en cravate blanche, en escarpins vernis, sur un parquet ciré."

However, the æsthetics of the laboratory do not extend to the printing-office, for Prof. Fourneau's book shows a Latin disregard for Teutonic spelling. Aronsohn (p. 22), Wärmestich (p. 23), Fränkel (pp. 57, 229), Fildes (p. 109), Laidlaw (p. 176), Rosenheim, Tebb, Thudichum (p. 187), Strecker (p. 188), Zeisel (pp. 219-221) are all spelt more or less inaccurately. We do not for a moment suggest that such trivial errors in typography constitute a serious blemish on an admirable work; we mention them rather in illustration of what we believe to be a national peculiarity. Chemical errors seem nearly all to have been collected in a list of errata, but the structural formulæ of quinine (p. 37) and of trypaflavine (p. 109) still require revision. It is perhaps open to discussion whether quinotoxine (p. 39) can be strictly described as the ketone corresponding to quinine, and whether, in French, phenyl potassium sulphate (p. 236) should really be an "éther sulfonique" (but here we may be getting on dangerous ground).

Prof. Fourneau's book should find a place wherever organic chemistry is taught to advanced students. It may be warmly recommended to the pharmacologist as a source of information on the chemistry of his subject. To recommend to technical chemists a book by the former director of the Poulenc laboratories seems superfluous. GEORGE BARGER.

The Hegelian Method and Modern Science.

The Ethical Theory of Hegel: A Study of the Philosophy of Right. By Prof. H. A. Reyburn. Pp. xx+271. (Oxford: Clarendon Press, 1921.) 8*s*. 6*d*. net.

THE "Rechtsphilosophie" was the last of the works published by Hegel in his lifetime. Originally it consisted of the rigorous, consecutively demonstrated, chain of numbered paragraphs, which he used as the framework of his courses of lectures. In the form in which we now know it in the collected edition published in 1833 two years after his death, the editors have added the notes and emendations, the celebrated *Zusätze*, with which Hegel was accustomed to elucidate his theory in lecturing.

Prof. Reyburn in this admirable study which he entitles Hegel's Ethical Theory, deals mainly with the "Rechtsphilosophie" but treats it as a general introduction to the whole philosophy of Hegel. It is doubtful if for the modern student he could have chosen a better way. Hegel had no ethical theory in the technical meaning of the term. His philosophy is ethical theory and his ethical theory is his philosophy. It cannot be otherwise if we once accept the view that the real is the rational and the rational is the real. If there be no realm of existence outside of and indifferent to value there is no need for a transcendental theory of morality like Kant's or a utilitarian principle like Bentham's.

The study of Hegel is of peculiar interest at the present time, and more especially to those who are conscious of the new methodology of science which is manifesting itself in the most modern mathematical and physical theories. So striking indeed is this that had Hegel's place in the history of philosophy been after instead of before the great scientific achievements of the end of the nineteenth and the opening of the twentieth centuries, it would have been impossible to resist the belief that the Hegelian dialectic had been suggested directly to its inventor by the discoveries of science. What finer illustration of identity in difference, of advance by negation, of the union of opposites in a higher synthesis, is to be found than that afforded by the electrical theory of matter? There have been repeated attempts since Hegel to reform philosophy by introducing into it what has been called scientific method, but the great reform which we are witnessing to-day is the introduction of philosophical method into science. Its keynote is that the concrete only is real. Science is discovering that there is no means of giving self-hood, consistency, independence, to the abstract, and this is the alpha and omega of the Hegelian philosophy.

Anyone who desires an easy introduction to the thought of this most powerful and yet most difficult philosopher of the modern period may be recommended to read Prof. Reyburn's book.

H. W. C.

Soaps and Proteins.

Soaps and Proteins: Their Colloid Chemistry in Theory and Practice. By Prof. M. H. Fischer and others. Pp. ix+272. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1921.) 24*s*. net.

THE principal author of the volume under notice, who is a physiologist, states in his preface that he is principally interested in the colloid chemistry of the proteins, that this is too complex for direct analysis, and that therefore he turned to the soaps, as sufficiently analogous to the proteins in their colloidal behaviour to enable one "from the surer ground of the soaps . . . to step over into the more slippery one of the proteins." This view of the possibilities of reasoning by analogy will strike most people as decidedly light-hearted, even in cases where the results to be thus applied are unassailable, a condition which cannot be claimed for the author's views on the nature of soap-liquid systems.

The experimental work described consists in the preparation of a very large number of pure soaps (in the widest sense) and their examination under practically one aspect—their power to form gels with water and other solvents. The results are used to support the author's theory of the sol-gel transformation, which, according to him, is "a change from what is, at the higher temperature, essentially a solution of *soap in water* to that which is, at the lower temperature, a solution of *water in soap*." The methods of physical chemistry are held to be inapplicable to the latter type, and the author is thus relieved of the task of considering the fundamental work of McBain and his school. Various experiments are quoted in support of this gel theory, thus (p. 80): "A drop of phenolphthalein solution dropped upon a 10 per cent. sodium stearate water gel remains uncoloured. If, however, the gel is slightly squeezed (which breaks the encircling hydrated sodium stearate film and squeezes out the enclosed solution of soap-in-water), the spot turns bright red." If any one will take the trouble to put a drop of indicator on an acid or alkaline gelatin gel, he will see it turn without squeezing, so that the behaviour of soap gels is not, as the author claims, typical or universal, nor is it any clue to that of protein gels.

The chapters on proteins are trifling, and analogies like that drawn between the heat coagulation of albumin and the behaviour of a boiled solution of sodium palmitate can scarcely be taken seriously. The author almost throughout dismisses the work of other investigators in the airiest fashion; most strikingly, perhaps, in his chapters on emulsions and froths. Surface and interfacial tensions, adsorption and film-formation are all irrelevant: the decisive factor is a curious and novel physical property of the phases, their "breaking length." An extraordinary feature of the book are the illustrations—half-tones of more than 1300 tubes and bottles containing soap solutions which, at their worst, convey nothing and, at their best, no more than the text. They may in part account for the high price of the book, which is difficult to explain on any other grounds.

Commercial Metallurgy.

The Metallurgy of the Common Metals: Gold, Silver, Iron (and Steel), Copper, Lead, and Zinc. By L. S. Austin. Fifth edition, revised and enlarged. Pp. xviii+615. (New York: J. Wiley and Sons, Inc. London: Chapman and Hall, Ltd., 1921.) 42*s*. net.

THE first edition of Prof. Austin's book was published in 1907—it has now reached a fifth edition. In his preface the author states that since 1913, the date of the last edition, such radical changes and improvements have been made in the metallurgy of the common metals that the present book has been largely rewritten to bring it in accord with present-day practice. It is refreshing to come across a book which treats metallurgy as a whole and does not, as is so frequently the case, subdivide it into the so-called ferrous and non-ferrous metallurgy. The practice of differentiating the metallurgy of iron and its alloys from that of the other metals has its origin, of course, in the outstanding practical importance of these materials and the scale on which they are manufactured, but there is no scientific reason for making any distinction of this kind, and indeed, there is little doubt that if there were more interchange of opinion between those engaged in the various metal industries it would be of considerable benefit to all concerned.

The first ten chapters deal with general metallurgy under the headings (1) ores and metals, (2) fuels, (3) refractories, (4) the preparation of ores, (5) crushing, grinding, screening, and classifying, (6) metallurgical furnaces, (7) combustion, (8) metallurgical thermochemistry, (9) roasting, and (10) concentration of ores. Inasmuch as these aspects of metallurgy are compressed into 117 pages, the treatment is necessarily somewhat brief. The author, however, has economised space in not attempting to describe methods not now in use. Compactly as the subjects are dealt with, it would appear that terseness has been carried to an extreme in attempting to describe the concentration of ores by gravity, by concentrating tables, and by oil flotation in three pages, a considerable part of which is occupied with diagrams.

The remainder of the book treats of the metallurgy of gold, silver, iron, copper, lead, and zinc in so far as extraction and refining processes are concerned. No attempt, however, is made to deal with the mechanical treatment of metals, either in the hot or cold state, nor their working up into finished products. One of the characteristic features of American metallurgy is its emphasis on the efficient mechanical handling of the materials used in producing the metals and it is natural, therefore, to find this aspect of the subject well treated. The author's account of the metallurgy of gold, silver, copper, and lead is, on the whole, satisfactory. The metal iron, however, receives something less than its share of credit, for an attempt is made to describe the production of wrought iron in less than three pages. To try to deal with the manufacture of wrought iron without any account of the mechanical treatment necessary, except in the most perfunctory fashion, is certainly unusual. With regard to zinc, it is somewhat curious that, considering the importance of the present-day production of electrolytic zinc, very little more than one page is devoted to it.

The last two chapters give a brief account of plant and equipment and their cost and the business of metallurgy. A satisfactory feature of the book is the calculation of furnace charges in reference to typical metallurgical operations. As has been generally indicated, the book gives a good, if at times too brief, account of the principal operations involved in the metallurgy of the six metals discussed. It is well printed, particularly well illustrated, and bears evidence of careful and judicious preparation.

H. C. H. C.

Scientific Activities in the United States: A Biologist's View.

Universities and Scientific Life in the United States. By Prof. Maurice Caullery. Translated by James H. Woods and Emmet Russell. Pp. xvii+269. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1922.) 10*s.* 6*d.* net.

BEFORE the war inter-university exchange of professors was much in vogue as between Germany and America. More recently several exchanges of this kind have taken place between America and France, and Prof. Caullery's book is a result—a very useful result—of one of these exchanges. It gives a remarkably lucid and sympathetic interpretation of impressions received by the writer during a stay of five months in America in 1916, when he filled the post of exchange professor of biology at Harvard and visited many of the principal seats of learning in the United States.

The greater part of the book is devoted to the universities and colleges as centres of research and as providing the environment in which future workers are trained. These institutions have, in general, envisaged as their main task the training and equipment of their students for successful leadership in all branches of social activity; and they have come to recognise that with the incessant extension of the fields of application of science to social needs it concerns them to provide the best possible teaching in applied as well as in pure science. Thus the tendency is for science, as the basis of preparation for practical life, to inspire all the activity of the university.

It is sometimes asserted that the study of science in America is apt to be cramped by an excessively utilitarian bias, and such a bias has undoubtedly characterised the State universities, most of which originated in the "Colleges for Agriculture and Mechanic Arts" established under the Morrill Act of 1862. The policy inaugurated by this Act was one which Congress adopted owing to the refusal of the independent colleges to provide urgently needed teaching in technology. About the same time the growth of scientific knowledge led to the breaking down of the old uniform curriculum and its replacement by the elective system, and to the organisation of "Graduate Schools" by the more important colleges, which thus became full universities and began to cultivate a spirit of original research. Competition with the new State universities soon led to the abandonment of the attitude of aloofness in regard to applied science and proved beneficial to the interests of pure science, both because the broadening of the basis of studies in the old institutions brought them into closer touch with the nation at large and greatly increased their prosperity and resources, including laboratory equipment, and because the State universities have made, and continue to make, successful efforts towards rivalling the others in the cultivation of scientific research of all kinds.

In this connexion Prof. Caullery is able to elucidate and point his argument by reference to science progress in French institutions, where the Napoleonic system of public instruction has shown itself deficient in adaptability to changed conditions and faculties of science have few points of contact with schools of technology. In America adaptation to their environment is reflected in the remarkable growth shown by the universities and colleges during the past thirty years. The student population of the collegiate and graduate departments has twice doubled within this period, and shows, according to statistics summarised recently in NATURE of April 1, p. 425, no tendency towards abatement of this rate of progress. Buildings and equipment have more than kept pace, their value having increased from 108*l.* to 279*l.* per student, and this is due largely to the enormous development of laboratories which has taken place in all branches of science. Recent visitors to the United States are unanimous in admiring the wealth of material equipment for science teaching and research, and some even describe it as excessive. This development has been made possible by a belief, prevalent among all classes of the community, in the practical value of such work and, especially for the private universities, by the spirit of intense loyalty to the Alma Mater on the part of college graduates. The Harvard rule, that at the twenty-fifth anniversary of graduation each class gives the university a sum of 100,000 dollars, affords an example of the very practical forms in which this spirit manifests itself.

When the Graduate School movement began there arose a demand for facilities for scientific research, and, as this could not at the time be met in America, students resorted to Europe, and found that of European countries, Germany best suited their requirements.

A tradition of Germany's scientific supremacy became firmly established, and for forty years America's most promising young workers, coming under the spell of this tradition, became for life "intellectual subjects of Germany." A reaction had begun to set in before the war, and has acquired considerable force, but the German influence on American science has been profound and its effects will be lasting.

Scientific research is unanimously recognised by American intellectuals as an essential function of the university, but while the material requisites for it have been abundantly supplied, there exist certain other conditions less favourable to its development. Students come up to the university ill prepared as regards both acquisition of knowledge and intellectual discipline. Like many other observers, Prof. Caullery regards secondary school teaching as the weakest part of the American system of education. It is, he says, not merely that the college is burdened with the task of imparting knowledge which should have been acquired in the high school, but that the schools defer too much to the taste, or rather whim, of the pupil. "Americans try to compel the child as little as possible, to present life to it under its most smiling form, to spare it opposition, to make work appear to it under the form of pleasure rather than of duty . . .; they treat the schoolboy too much like a student, to the detriment of healthy intellectual discipline." The "spoon feeding" which is consequently resorted to in the college (where the student is apt to be treated too much like a schoolboy) is unfavourable to the development of capacity for original work. While this does not prevent the colleges from turning out graduates well qualified to achieve success in life, nor stifle the development of exceptionally gifted individuals, in the average case the college gives "a culture not sufficiently deep to be fertile."

The connexion between the college and the graduate school of the University, in which most of the advanced work in pure science is done, is very close. In all except a few of those universities (about thirty) in which a graduate school has been developed, it has no separate teaching staff: its professors are also those of the undergraduate college, although the work is organised quite separately, and is carried out under the superintendence of the Dean of the school. In most universities, moreover, the college tradition, with its emphasis on athletics and the social side of life, is still dominant. Some high authorities in America who believe that the destiny of the universities is to become primarily great schools of research have urged that the time has come to free the graduate school from this domination. Meanwhile there is a clear tendency to create special institutes for research within more or less narrow limits, some being established within, or in association with, the universities and others with no such connexion.

As regards the actual contributions to science of American universities, Prof. Caullery notes that in zoology and general biology, the sciences in which he is specially interested, they have produced of late years many very remarkable works. He instances those of Edmund Wilson (cytology), E. Conklin (cell-lineage), R. G. Harrison (experimental embryology), T. H. Morgan (Mendelian heredity and mutations in Drosophila), Calkins and Woodruff (Infusoria, senescence, etc.), and others.

Scientific activities outside the universities and colleges are dealt with by Prof. Caullery in a series of interesting sketches of the more important of the research institutes, the Carnegie and Rockefeller and other foundations for promoting research, the great museums, the Federal scientific services, and the scientific academies and societies. From the first category the Mellon Institute for Industrial Research may be selected as an example of an establishment for pure research attached to a university—Pittsburgh—but retaining a large measure of autonomy. A manufacturer having a problem to solve turns it over with a definite sum of money to the Institute, which proceeds to engage the services of a man of science and provides the requisite laboratories and equipment. The man of science, who is styled a fellow, conducts his researches in secrecy, and the results are the property of the donor of the subvention. The plan is reported to have worked very successfully.

For an indication of the scale on which scientific research is being fostered by these various bodies (except the Federal services) and by great industrial corporations, one may refer to a bulletin published last year by the National Research Council, now the chief agency for co-ordinating scientific research in America. This bulletin (noticed in NATURE of August 4 last) enumerated 170 bodies other than universities and colleges which provided funds for this purpose of the aggregate annual value in 1920 of more than 18 million dollars. The Government (Federal and State) grants for research in agriculture, engineering, and the industrial arts have been estimated to amount to 10 million dollars in 1921.

Our Bookshelf.

A Text-book of Wood. By Herbert Stone. Pp. vii + 240 + 41 Plates. (London: Rider and Son, Ltd., 1921.) 21s. net.

THIS book deals with the anatomy, physical and mechanical properties, anomalies, defects, and decay of wood. Although intended for "advanced students," it abounds in elementary errors as regards facts, botanical and mechanical. For example, the account of the production of wood by cambium is truly fantastic, while the implication is made that when dead wood is absorbing water and swelling, the cells of the medullary rays exert great pressure by reason of their turgidity. But quite inexcusable are misquotations of various scientific workers, including R. Hartig and Mathieu (who is made responsible for the statement that heartwood and sapwood are synonymous "expressions").

Errors as regards matters of fact are matched by the author's methods of reasoning and the conclusions that he draws. According to him the wood-vessels cannot have very important functions, "inasmuch as Conifers do without them." Or, again, he writes of a beam under transverse bending load that "the height may be reduced and yet the beam be stronger"; and in dealing with mechanical tests he not only "hopes and believes" that practical men do not "pay any attention to the figures so far supplied by physicists," but also advises the abolition of "all calculations whatsoever." A number of excellent photographs of wood-structure impart some value to the book.

Textile Design and Colour: Elementary Weaves and Figured Fabrics. By W. Watson. Second edition, with an Appendix on Standard Yarns, Weaves, and Fabrics. Pp. xi+436. (London: Longmans, Green and Co., 1921.) 21*s.* net.

THE comprehensiveness of Mr. Watson's training is reflected from the pages of this book. A student in the Textile Industries departments of the University of Leeds and the Bradford Technical College, and successively head of the Textile Departments at Salford and the Royal Technical College, Glasgow, Mr. Watson has naturally produced a volume which is both broad in outlook and sequential in treatment. In the maze of small weave effects, for example, it is so easy to degenerate into mere statement and illustration that any writer who can introduce a sequential and reasonable treatment leading to that imaginative insight, which is so much to be desired in the cloth constructor, is to be congratulated. In the future probably more conventional scientific treatment of the structures here referred to will be necessary, for not only do such matters as combinations and permutations appear, but, as was quite accidentally discovered at the meeting of the Mathematical Association last year, the problem of sateen cloth structure is the problem of atomic grouping in crystal structure.

Mr. Watson's treatment of the colour problems involved in textile designing is by no means so satisfactory: it largely resolves itself into "colour and weave" form. The technical treatment of figured fabrics is excellent, and the appendix upon Standard Fabric should prove very useful to all designers and manufacturers. A. F. B.

Principia Ethica. By Dr. George Edward Moore. Pp. xxvii+232. (Cambridge: At the University Press, 1922.) 15*s.* net.

THIS volume is the reprint of the famous and much-discussed treatise of Dr. G. E. Moore, the present Editor of *Mind,* which was first published in 1903. Readers will turn at once with interest to the brief note added to the preface in which the author tells us that he is still in agreement with its main tendency and conclusions. His thesis is that "good" is indefinable, but that "the good" can be defined. The good is the thing, simple or complex to any degree, to which the indefinable predicate good belongs. He illustrates his meaning by an extreme case. He asks us to imagine a world exceedingly beautiful, and then to imagine the ugliest world it is possible to conceive. We are asked, in comparing these worlds, to accept the limitation that "we are not entitled to imagine that any human being ever has, or ever, by any possibility, *can,* live in either." Is it irrational, he asks, to hold that it is better that the one should exist and not the other? To most students of ethics the limitation makes the question nonsense in the literal meaning of the term. It is interesting to find that Dr. Moore can still think it a rational question after the lapse of twenty years. Yet we must admit the force of his logic, for if value is to have any meaning at all to the realist, it can only be by finding some way of attaching it to the object and presenting it in complete abstraction from the subject, for the mind is limited in its activity to contemplation.

Rocks and Fossils and How to Identify Them. By J. H. Crabtree. Pp. 63. (London: The Epworth Press; J. Alfred Sharp, n.d.) 1*s.* 9*d.* net.

WE have here a book, very prettily illustrated by photographs; but the text is not in keeping with the author's daring statement that "geology is, of all concrete science studies, most exact in its observations and conclusions." The loss of land at Dunwich (p. 14) should not be ascribed to subsidence; faults (p. 18) do not imply that "the two parts are pitched at different angles"; limestones are said to be "generally combined with mineral matter"; Radiolaria are photographed in one of the admirable plates as "flinty shell remains of foraminifera"; and in another plate a very mixed assemblage of fossils, including halysites and Fenestella, is attributed to the Old Red Sandstone. "Interlocking teeth" are given as a characteristic of Labyrinthodon, and Tyrannosaurus is said to have preyed upon the mammoth. We must not dilate on the reappearance of Eozoon and the "Laurentian system," or on the "boreal climate" of the Trias (p. 56). If we interpret his remarks on "sauroid fishes" as referring to Sauripterus, the author has been diligent in his reading, and we must regret that he has shown so little regard for exactitude in "observations and conclusions." G. A. J. C.

The Mineral Resources of Burma. By N. M. Penzer. (Federation of British Industries: Intelligence Department.) Pp. viii+176. (London: G. Routledge and Sons, Ltd.; New York: E. P. Dutton and Co., 1922.) 31*s.* 6*d.* net.

MR. PENZER, on behalf of the Federation of British Industries, has undertaken with conspicuous success the task of summarising the information hitherto inconveniently scattered through various unrelated publications concerning the mineral resources of the province of Burma. He has taken care to secure the co-operation of recognised authorities with special local experience, such as Sir George Scott, Mr. La Touche, and Dr. Coggin Brown; and the result is a reference work of exceptional value to prospectors and commercial men. In addition to precise summaries of the recorded information regarding each mineral occurrence, the book contains a very useful sketch of the physical geography, geology, history, administrative systems and communications of Burma, a full index to the local vernacular names in common use, and a very full, conveniently classified bibliography.

The Statesman's Year-Book: Statistical and Historical Annual of the States of the World for the Year 1922. Edited by Sir John Scott Keltie and Dr. M. Epstein. 59th Annual Publication. Revised after Official Returns. Pp. xlvii + 1568. (London: Macmillan and Co., Ltd., 1922.) 20*s*. net.

THE new edition of the "Statesman's Year-Book," which appears earlier than usual this year, maintains all the features that have gained for it a unique place among volumes of reference. The number of independent states has now been increased by the addition of Egypt and Lithuania. Various secession states, the status of which is not yet fully recognised, are still grouped with their parent countries. The organisation of the Irish Free State, together with the full Treaty between Great Britain and Ireland, are given in the introductory pages, which also furnish information on the organisation of the League of Nations and the Imperial and Washington Conferences. While the whole volume has, as usual, been carefully revised, special attention has been devoted to Russia and China. We note some discrepancies in the figures for area and population of the countries detached from Russia, as given under the heading of Russia, and of those countries respectively; but the last census returns in this part of Europe were by no means complete. Two coloured maps show the division of Upper Silesia by the League of Nations and the Burgenland settlement between Austria and Hungary.

The Annual Register: A Review of Public Events at Home and Abroad for the Year 1921. Pp. xii + 332 + 180. (London: Longmans, Green and Co,. 1922.) 30*s*. net.

THE scope of the "Annual Register" is well indicated by its sub-title, and a truly remarkable amount of information is gathered together within the covers of the volume. Part 1 consists of some three hundred pages, of which about half are devoted to events of importance occurring in England during the past year: a large portion of this section deals with events in Ireland, culminating with the Peace Conference in London and the signature of the treaty of peace. The remainder of Part 1 is devoted to brief summaries of outstanding events in other countries of the world. Part 2 is of a more general nature and contains, among other items, a retrospect of science during the past year. The section is divided into two parts dealing with the biological and physical sciences respectively, and all outstanding events in the world of science appear to be mentioned.

To cover the ground, the articles are of necessity brief, but the whole is welded together so skilfully that the volume, besides serving as a comprehensive reference book for world affairs, provides an interesting and readable account of man's activities during the year 1921.

Cotton Spinning. By W. Scott Taggart. Vol. II. Sixth edition with Appendix. Pp. xv + 291. (London: Macmillan and Co., Ltd., 1921.) 8*s*. 6*d*. net.

IT is not surprising that Mr. Scott Taggart's work on "Cotton Spinning" should already be in its sixth edition. Books of this type arrange themselves under one of two heads—either they are "descriptive" or they are "demonstrative": rarely are they both. This work, although by no means void of the "why" and "wherefore" and the "for" and "against," is mainly descriptive. Thus in dealing with the distribution of drafts on pages 259 to 266, "fibre movement" does not seem to have been considered, with the result that even here Mr. Taggart is in difficulties in making theory fit with practice. But the treatment of each section of the subject throughout is so clear and concise that even the very limitations of the treatment stand out clearly and thus are not dangerous. This book should certainly be in the hands, not only of every cotton spinner, but of every spinner of materials of a like nature. A. F. B.

A History of the Association Psychology. By Prof. H. C. Warren. Pp. x + 328 + 1 chart. (London: Constable and Co., Ltd., 1921.) 16*s*.

THE volume under notice, by the well-known professor of Princeton University, contains a great deal of matter which cannot fail to be useful to the student, and it is presented in a serviceable form. It is not, however, as the title would lead us to expect, a history of the movement in mental science which followed the adoption of the empirical principles of Hume and explained knowledge by the laws of association,—a theory often described by its critics as psychological atomism. It is rather an attempt to show that an idea which has no history is to be discovered in all the historical systems of philosophy. It begins with the ancient philosophy of Greece and ends with an account of some of the psychological experiments now being conducted in college laboratories and reported in current journals.

Lubricating and Allied Oils. By E. A. Evans. Foreword by Sir Charles Cheers Wakefield. (The Directly-Useful Technical Series.) Pp. xv + 128. (London: Chapman and Hall, Ltd., 1921.) Price 9*s*. 6*d*. net.

THE greater part of this book is taken up with descriptions of the physical and chemical tests usually carried out on oils with the view of determining their commercial value. Sufficient is given to enable the chemist to carry out these tests in the orthodox manner and to reduce the results. The book should also be of value to the engineer, who must understand the meaning of the experimental results; his requirements are considered in later chapters on the selection of lubricants and oils employed in practice. Most of the existing works on lubrication and lubricants are too comprehensive and technical to be of much service to the user of oils, and the author of the present work is to be commended for the brief and clear account of the principal properties he has presented.

Letters to the Editor.

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Interspecific Sterility.

THE implications of modern genetics have been so little considered by biologists in this country that the criticism of my address by Dr. Cunningham (NATURE, June 17), though in purpose destructive, is not unwelcome. Of the points he raises one chiefly calls for reply. I directed once more the attention of naturalists to the fact that we still await the production of an indubitably sterile hybrid from completely fertile parents which have arisen under critical observation from a single common origin. So far as our knowledge goes, all the domesticated races—for example, of dogs, of pigeons, of fowls among animals; and of cabbages, of peas, of *Primula sinensis*, and many more among plants—when intercrossed among themselves never produce this sterility in their mongrels, though the races are often distinct enough to pass for species. But if we begin crossing natural species, even those which on our reckoning must be very closely allied, we constantly find either that they will not interbreed, or that, if they can be crossed, the result is more or less sterile. Dr. Cunningham takes exception to my speaking of this interspecific sterility as the chief attribute of species, but he will not dispute that it is *a* chief attribute of species.

The races of fowls might, as he holds, on account of their enormous divergences, be without impropriety compared to natural species. They may also, as he thinks, all descend from *Gallus bankiva* (though I find that difficult to believe); but inasmuch as they do not show interspecific sterility they do not help us to understand how that peculiar property of species arose in evolution. In contemporary variation we witness the origin of many classes of differences, but not this; yet by hypothesis it must again and again have arisen in the course of evolution of species from a common ancestry. The difficulty is no new one; but I emphasised it because naturalists should take it more seriously than they have done hitherto. Especially now that a great deal of experimental breeding is in progress, watch should be kept for such an occurrence. I by no means declare that the event cannot happen, but, so far as I know, it has not been witnessed yet.

Dr. Cunningham tries to fill the gap by adducing two instances. The first is that of *Oenothera gigas*. Now I had not forgotten the tetraploids, which so often do not breed freely with diploids, but the applicability of that example is exceedingly doubtful. Interspecific sterility or incompatibility may well be a consequence of nuclear diversity, though we can scarcely regard an unresolved pair of twins, such as the tetraploid must be, as a specifically distinct organism.

His second illustration, if authentic, would be more nearly what is wanted. He says that "two mutants of Drosophila in Morgan's experiments are almost completely sterile with one another." The allusion is probably to a paper of Metz and Bridges (Proc. Nat. Acad. Sci., 1917, iii. p. 673), in which they claimed to have found two mutants of *D. virilis* which gave partially sterile hybrids when intercrossed. Dr. Cunningham is not perhaps aware that this claim was afterwards withdrawn (Metz, *ibid.*, 1920, vi. p. 421), inasmuch as one of the mutants was found to have been partially sterile. Metz and Bridges did adduce another example in *D. ampelophila*, but for a variety of reasons that, even if substantiated, would scarcely be to the point. As a matter of fact, however, in so far as opportunity of repeating the cross has occurred, complete fertility resulted. I know of no other example to which Dr. Cunningham can be referring.

Mr. Crowther (NATURE, June 17, p. 777) mistakes my meaning. It is, as he says, not difficult to "imagine" interspecific sterility produced by a gradual (or sudden) modification. That sterility may quite reasonably be supposed to be due to the inability of certain chromosomes to conjugate, and Mr. Crowther's simile of the sword and the scabbard may serve to depict the sort of thing we might expect to happen. But the difficulty is that we have never seen it happen to swords and scabbards which we know to have belonged originally to each other. On the contrary, they seem always to fit each other, whatever diversities they may have acquired.

W. BATESON.

July 2, 1922.

Geology and the Nebular Theory.

I DO not deserve the reproaches of Prof. Coleman (NATURE, June 17, p. 775). My molten earth did not, in point of fact, owe its thermal energy to primitive condensation, but to accumulated radioactive heat, as the concluding part of my lecture might have shown. I am committed neither to the nebular theory nor to the planetesimal theory.

Had I adopted the wider definition of the Archæan favoured by Prof. Coleman, I could not, of course, have described the Archæan sediments as scanty. I referred to an Archæan limited to the Keewatin, and to the Laurentian outpourings of granitic materials. The Keewatin is generally described as mainly volcanic in origin. The definition of Archæan and Algonkian favoured by Van Hise and Leith (Bulletin 360 of the United States Geol. Survey) would bear me out.

While many geologists would agree with Prof. Coleman as to his estimates of Archæan sediments, many, I think, will disagree with him in his contention that there was nothing exceptional in the thermal conditions attending the Laurentian revolution. Prof. Coleman's most interesting discovery of an ice age in Huronian times has, I submit, nothing to do with the matter. On the other hand, I think geologists in their interpretation of the Archæan should keep in mind the possibility (or probability) that the phenomena observed are due to paroxysmal thermal developments traceable to deep-seated radioactive substances: and that these developments, which appear to have been world-wide in extension, may have been sufficiently intense to have closed a biological era. So that, in fact, we have in the Archæan the almost obliterated record of a prior geological age.

J. JOLY.

Trinity College, Dublin.

I HAVE read with interest Prof. Coleman's timely reminder, in NATURE of June 17, p. 775, of the essentially intrusive relations of the Archæan and of the frequently made deduction that the oldest visible rocks of the earth's surface are sedimentary. Of course this deduction is perfectly sound, provided the age of an intrusive rock is taken, as has been the custom, to be that of its intrusion. We are entitled, however, to consider the previous history of the material composing these intrusive Archæan masses, and, in view of their predominantly banded structure, which marks them off as in some way different from later intrusive masses of similar composition, such consideration seems forced upon us.

Now the banded character of the Archæan gneiss suggests a partial derivation by melting from some stratiform materials such as sedimentary or volcanic rocks, or at any rate from rocks showing marked small-scale differentiation into basic and acid types. I do not think that stratiform differentiation during or previous to crystallisation can be seriously put forward as a cause of the banding, in view of the rarity of this phenomenon in more recent granites, and the fact that in them it is largely a marginal effect.

May we not then have in these Archæan gneisses the recrystallised remnants of still older sediments and lavas, and who is to say that they may not also embrace portions of the original surface on which water first settled, but so obscured by recrystallisation that the question of its molten or planetesimal origin is now unsolvable ?

The difference between the two views is simply that one regards the history of sedimentation on the earth as cut off sharply by intrusion, while the other sees it extending still further back into the mists of the past, beyond the point where human vision is any longer capable of discrimination. Where, on either view, is the decisive criterion between the nebular and planetesimal hypotheses ?

W. B. WRIGHT.

Manchester, June 27, 1922.

Wegener's Displacement Theory.

WEGENER'S speculations have attracted so much attention that there must be many who would be glad to find some simple means of testing his fittings and coincidences for themselves. Owing to the distortion present in all maps such tests must be carried out on a globe. Wegener himself uses tracing paper, which must be cut and slashed in order that it may even approximately fit the surface ; and any one who has tried it will admit that it is difficult to obtain satisfactory results. An easier plan is to roll out a lump of modelling wax or plasticine into a sheet of moderate thickness. The sheet may then be pressed upon the globe and cut to the required shape. According to my own experience, the best method is to cut the sheet a little smaller than the area that is to be represented, so that the actual margin appears all round it, and to build it outwards to this margin by the addition of small pieces of wax. Old plasticine which has become rather dry works very well and does not stick to the globe.

But much more precise tests can be carried out with the help of some form of triangular compasses. The three points of the compasses may be placed on three critical points of the globe and afterwards transferred, without altering their relative positions, to any other part of the globe that may be desired. The ordinary triangular compasses of the draughtsman are very little use upon a spherical surface, but a fairly convenient instrument can be constructed with an ordinary one-jointed two-foot rule as its basis. A point about an inch long is fixed near the joint, and each arm is provided with a sliding carrier. Each carrier bears a short sleeve through which a pointed rod, such as a knitting needle, slides rather stiffly. These rods form the other two points, and all three should stand approximately at right angles to the plane of the rule.

This is an easily constructed type, but much more convenient forms can be devised. If, for example, the arms are arcs of circles, of suitable diameter, so that they may stand concentric with the globe, the points may all be of fixed length, and the most troublesome of the adjustments required by the straight-armed form will be avoided.

This is not the place to discuss Wegener's views, but the use of triangular compasses seems to show that a rather high degree of plasticity is necessary in the masses of "Sial" in order to produce the coincidences on which he bases his calculation of the probability that his theory is correct.

PHILIP LAKE.

Sedgwick Museum,
Cambridge, June 21.

Opalescence Phenomena in Liquid Mixtures.

IT is well known that liquids which mix completely above a certain critical temperature, *e.g.* phenol and water, exhibit a strong and characteristic opalescence as the temperature of the mixture is lowered to a point slightly above that at which the components separate. A quantitative theory of this phenomenon was put forward by Einstein (*Annalen der Physik*, vol. 33, 1910) on the basis of thermodynamical reasoning, the spontaneous local fluctuations of *concentration* of the mixture being taken into account and the light-scattering due to the resulting fluctuations of refractive index being evaluated. He obtained as the expression for the light-scattering

$$\pi^2(M/N\lambda^4) \, . \, v\left(\frac{\partial \mu^2}{\partial \kappa}\right)^2 \bigg/ \frac{\partial (\log p)}{\partial \kappa} \text{ per unit volume,}$$

where μ is the refractive index of the mixture and $\partial(\log p)/\partial\kappa$ expresses the rate of change of the vapour pressure of one of the components with concentration, a quantity which becomes very large as the critical temperature and concentration are approached, thus giving rise to a marked opalescence. It should be pointed out, however, that Einstein's expression does not include the whole effect, for we have also to consider the result of *the fluctuation of density of either component taken separately*, and to add to Einstein's formula

$$(\pi^2/18)(RT/N\lambda^4)[\beta_1(\mu_1^2-1)^2(\mu_1^2+2)^2 + \beta_2(\mu_2^2-1)^2(\mu_2^2+2)^2],$$

where β_1, β_2, μ_1, μ_2 are respectively the compressibilities and refractive indices of the components. Further, the light-scattering due to the anisotropy and arbitrary orientation of the molecules of the components has also to be added.

The result of these corrections of Einstein's investigation may briefly be indicated. Very near the temperature at which the mixture separates into two phases, the fluctuations of *concentration* contribute by far the larger portion of the effect. But at higher and lower temperatures the effects of fluctuations of *density* and molecular anisotropy are no longer negligible, and when the temperature is sufficiently removed from the critical point they form a substantial part of the whole. Further, the increase in relative importance of the effect of molecular anisotropy in these circumstances should result in an increase in the proportion of *unpolarised* light in the transversely-scattered beam as we recede from the critical temperature.

The foregoing indications of theory have been confirmed generally in a series of experiments over a wide range of temperatures on light-scattering in phenol-water mixtures undertaken under the writer's direction by Mr. V. S. Tamma. It is found that the increased opalescence of the mixture over and above the effects due to the components taken separately can be traced at temperatures far higher than the critical point, and the indicated changes in the polarisation of the scattered light are also easily observed.

It is clear that the case of liquids which are completely miscible at ordinary temperatures stands on the same footing as that of imperfectly miscible liquids above the critical temperature, and the recent observations of W. H. Martin on this point (*Jour. Phy. Chem.*, Jan. 1922) agree with the indications of the theory outlined above.

I may take this opportunity of directing attention to a very important result observed in experiments on light-scattering in liquids conducted by Mr. Seshagiri Rao and the writer. It is found that the molecular anisotropy which results in a scattering of unpolarised light is noticeably *a function of the frequency of the incident light.* This indicates that the anisotropy is really due to the difference of the optical frequencies of the molecule in different directions, a conclusion which has a bearing on the recent interesting work of Havelock (Proc. Roy. Soc., May 1922). Debye and others have suggested that some molecules possess an appreciable permanent electric moment, and would thus exercise perceptible orienting influences on each other even in the gaseous and liquid states. Indications are already forthcoming that this may exercise an observable influence on the phenomena of molecular scattering of light.

Finally, it may be mentioned that a very carefully carried out series of experiments on the light-scattering in ether, benzene, and normal pentane, over a large range of temperatures above and below the critical temperature, has confirmed quantitatively the Einstein-Smoluchowski theory of molecular scattering of light. C. V. RAMAN.

210 Bowbazar Street,
Calcutta, May 25, 1922.

Transcription of Russian Names.

MR. DRUCE's letter in NATURE of June 17, p. 777, makes little of my typographical objection to a Czech transcription for the names of Russian men of science, by saying that NATURE and other journals already employ letters with diacritical marks. For my part, I venture to estimate that not one in twenty English newspapers has Czech type among its founts, or, if it had, would know how to use it in transcription. Are, then, Russian scientific names to be rendered on one system in NATURE and on another in almost every other newspaper—or even book? And are Russian scientific names to be rendered differently from Russian literary and musical names—or place-names?

Nobody questions that it is possible, and indeed easy, to transliterate Russian into Czech, all Slavonic tongues being closely akin. But is it more helpful to Britons to render ч by *č* than by *ch*, or ц by *c* than by *ts*, even though you save a letter by doing so? (I wonder how many Britons would pronounce this "c" correctly!) Czech journals naturally transcribe Russian names into Czech, but that seems to be no reason why journals in other languages should do so.

Mr. Druce, by the way, ignores my remark that Serbo-Croatian, with its ready-made official system of transliterating Cyrillic into Latin characters, has as good a claim as Czech, if a Slavonic language is to be used for this purpose.

Surely what is wanted in this country to replace the old conventional French and German (and hybrid) forms of Russian names is not a Croat nor a Czech system, but an intelligible British system of transcription, uniform for all Russian names alike: and this we have ready-made in the R.G.S. II. system (obtainable at any of the geographical booksellers, or at the Royal Geographical Society). Why not use it? EDWARD GLEICHEN.

Royal Geographical Society,
Kensington Gore,
London, S.W.7, June 23.

The Influence of Science.

THE defect of the disappearance of Greek from scientific education makes itself felt in the treatment of the history of science (NATURE, June 24, p. 801). The controversy between Galileo and the Inquisition was carried out with pretended hostility, but amicably in reality in the manners of good scientific society, as an academic university disputation on an agreed accepted thesis, taken from Plutarch's "Aetia Physica," the source of such disputations as "An detur vacuum?" or "de tempore," or whether the tide is due to the influence of the moon.

The Pythagoreans were prepared to maintain against all comers that the sun was the centre of our cosmos, in opposition to the Stoic philosophers; and so on for other subjects of disputation in the University of Athens.

Mr. Lones, of the Patent Office, has retrieved for us at last the passages in "De caelo" and elsewhere, of Aristotle that set Galileo to make a test by experiment, with the two weights dropped from the Campanile of Pisa, of density such as not to be affected appreciably by the resistance of the air. The weights struck the ground with one thud apparently; but if Galileo had thrown himself over after, his thud would have been distinctly later.

Because Aristotle was discussing the terminal velocity of rain and hailstones, or even a meteoric stone, from a height high up in the air, the ascent of a bubble in air, or else in water, compared with a stone sinking; he had no air-pump except his lungs, he could not be certain whether air was really a substance in Nature.

"Don'ts for Students in Science and History," compiled by G. S. Boulger (Tract 74, Catholic Truth Society), should be consulted before accepting the common version of many similar controversial stories. Huxley is quoted, writing to Prof. Mivart in 1885: "I gave some attention to the case of Galileo when I was in Italy, and I arrived at the conclusion the Pope and College of Cardinals had rather the best of it." And so the Inquisition was entitled to a parting shot of jubilation, as it would be again to-day on the doctrine of Relativity.

The rival theories of the Greek philosophers could serve as dialectical exercises till the crucial experiment of the "optic tube of Fiesole"; and here Galileo destroyed all previous uncertainty by his use of the telescope, the most powerful instrument in history for revolutionising the ideas of science. G. GREENHILL.

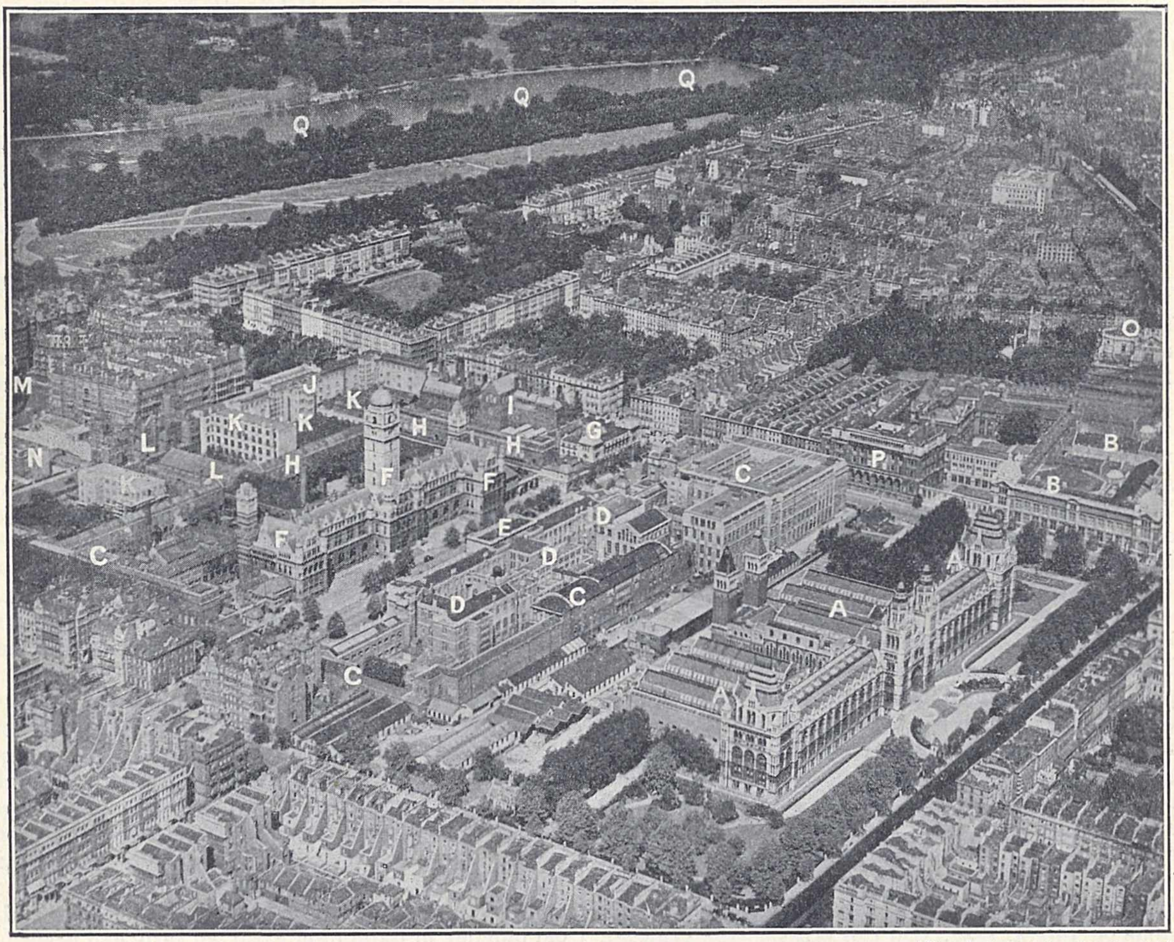
Staple Inn, June 27, 1922.

[Fortunately, inability to maintain a scientific thesis before philosophic or other authorities no longer involves such penalties as those to which Galileo was subjected. The whole purpose of the article to which Sir George Greenhill refers was to show that the freedom of experimental inquiry thus secured had far-reaching social and intellectual consequences, and we judge from his last paragraph that he agrees with this view.—EDITOR, NATURE.]

Science and Education at South Kensington.[1]

By T. Ll. Humberstone.

A LARGE part of the area shown in the accompanying photograph was at one time Brompton Park, a fine estate famous for its snipe-shooting and for its mild and salubrious air. In 1675 the park became a market-garden, the first of its kind in England. A short distance eastwards was Knightsbridge, an outlying hamlet of London, the scene of frequent skirmishes during the Civil War. Cromwell's association with the district—there is a tradition that he lived near what is now Queen's Gate—is preserved in the name Cromwell Road. Knightsbridge and Brompton maintained their sequestered character until comparatively recent times. It is recorded that until the middle of the nineteenth century, which must be well within the memory of the oldest inhabitant, people started from Hyde Park Corner at regular intervals in bands for mutual protection, and a bell was rung to warn pedestrians when the party was about to set out. Thus the effective history of the district for our purpose begins in 1851, when the great International Exhibition was opened in Hyde Park. Its initiation and success were largely due to the Prince Consort, and appropriately, therefore, the estate, which was purchased for the modest sum of 150,000*l.* from the profits of the Exhibition, is dominated on the northern and higher side by the Albert Memorial in Kensington Gardens and by the Royal Albert Hall. Would it be possible to find, in the whole educational history of the country, an example of money spent to greater advantage for the promotion of science and art? Sites have been provided for a splendid group of educational and public buildings and in addition a considerable annual income is received which is devoted to scientific purposes. The Exhibition of 1851 justified the hopes of its founders. It was to be for the nineteenth century



[*Photo by Central Aerophoto Co., Ltd.*]

A = Natural History Museum. B = Victoria and Albert Museum. C = Science Museum. D = Royal College of Science (New Building). E = Science Library. F = Imperial Institute and University of London. G = Royal School of Art Needlework. H = India Museum. I = City and Guilds Engineering College. J = Royal School of Mines. K = Imperial College. L = Royal College of Music. M = Royal Albert Hall. N = Royal College of Science (Botany) and Imperial College Union. O = Brompton Oratory. P = Royal College of Science (Old Building). Q = Serpentine in Hyde Park.

[1] It is fitting that Nature should take advantage of the method of obtaining "bird's-eye" views by means of aerial photography. Arrangements have been made for a short series of articles dealing with certain London areas of scientific interest illustrated by such photographs. The first of these, on South Kensington, is here printed. This will be followed by an article on Bloomsbury by the same contributor.

what the tournament had been in mediæval times—a challenge to every land, "not to the brightest dames and bravest lances as of yore," but to its best produce and happiest device "for the promotion of universal happiness and brotherhood." Happy days! Never perhaps was the spirit of the English people more buoyant, hopeful, confident. This was due in part to a growing appreciation of the benefits which science would confer on humanity.

The Albert Hall was designed to carry out the Prince Consort's expressed ideas as forming "a central point of union where men of science and art could meet, where the results of their labours could be communicated and discussed, and where deputies from affiliated societies could occasionally confer with the metropolitan authorities." Public response to the appeal for the Prince Consort's memorial was less generous than was expected. The memorial in Kensington Gardens, which cost 130,000*l.* and took twenty years to complete, absorbed all the free-will offerings, including 50,000*l.* from Parliament, and it was therefore necessary to establish the Albert Hall on a commercial basis with the financial assistance of the 1851 Exhibition Commissioners, and even of the builders. A capital sum of 200,000*l.* was raised and seats were retailed (with a generous tenure of 999 years) for 100*l.* each. The foundation-stone was laid by Queen Victoria in 1867 and the Hall was opened in 1871. Those who, in view of the uses to which the Hall is occasionally put, may feel doubt as to the high ideals of its founders should read the inscription on the frieze, which asserts: "This Hall was erected for the advancement of the arts and sciences and for the works of industry of all nations, in fulfilment of the intentions of Albert, Prince Consort."

Not far south from the Albert Hall is the most beautiful building on the estate, and possibly in the kingdom, the Imperial Institute. This magnificent pile is the permanent memorial of the completion of the first fifty years of Queen Victoria's beneficent reign. Initiated by the Prince of Wales with the co-operation of the Lord Mayor of London, contributions to the fund poured in from all parts of the Empire. By 1892 a capital sum of 413,000*l.* had been obtained, including 236,862*l.* in private donations from Great Britain and 101,550*l.* from India, and a public grant of 20,000*l.* from Canada. Queen Victoria laid the foundation-stone on July 4, 1887. On this occasion the Prince of Wales expressed the hope that the Institute would hereafter exhibit not only the material resources of the Empire, but be "an emblem of that Imperial unity of purpose and action which we believe has gathered strength and reality with every year of your Majesty's reign." Mr. T. E. Collcutt was the architect, and the style is Italian Renaissance, with rich and abundant ornamentation. The central tower, 280 feet high, contains the Alexandra Peal of ten bells, given by an Australian lady.

Alas! the founders of the Imperial Institute gave more thought to raising the necessary capital than to sordid considerations of current income and expenditure. A somewhat fanciful scheme for electing Fellows, who were given certain club facilities and the right to use letters after their names, came to an untimely end. Call a building a white elephant and close its doors may be accepted as a paraphrase of a well-known proverb. In serious financial difficulties, the Institute sought the protection and assistance of the Government, which adopted the familiar expedient of taking in lodgers. Thus it came about that the University of London, which during the whole course of its existence had flitted like an embarrassed shade from one set of Government lodgings to another, including Somerset House, Marlborough House, and Burlington Gardens, obtained possession in 1900 of the larger part of the Imperial Institute for administrative purposes. In the remaining part of the building, the Imperial Institute continues its work of investigation and propaganda. Let us hope that in the near future the University may find its Canaan in Bloomsbury and this monumental building may again be wholly used for the noble purposes, sealed and sanctified by the War, for which it was originally founded; thus may Queen Victoria's earnest prayer at its inauguration in 1893 be fulfilled that the Institute might "never cease to flourish as a lasting emblem of the unity and loyalty of the Empire."

Reverting to the history of the Commissioners' estate, we find that at an early stage a large piece of ground, 12 acres in extent, was sold to the Government for the purposes of the Science and Art Department and its colleges and museums. This Department, originally founded in 1853 as a branch of the Board of Trade, became a few years later a distinct department of the Privy Council. It was moved westward from its quarters in Marlborough House in 1857 and drew up a programme of educational and scientific work which made "South Kensington" famous throughout the civilised world. The mere catalogue of the institutions which the Department administered is sufficiently impressive, including the South Kensington (now the Victoria and Albert) Museum, the Science Museum, the Science Library, the Royal College of Science, the Royal School of Mines, and the Royal College of Art. The Royal College of Science and Royal School of Mines claim descent from the Government "School of Mines and of Science applied to the Arts," established in Jermyn Street in 1851, and from the Royal College of Chemistry, originally established in Oxford Street, which combined with the School of Mines in 1853. The various departments were transferred to South Kensington between 1872 and 1880 to the old building in Exhibition Road, an early and beautiful example of building in terra-cotta. In 1905 the new chemical and physical laboratories, designed by Sir Aston Webb, were opened in the Imperial Institute Road, and, at about the same time, the new Victoria and Albert Museum, built to the designs of the same architect. The work of the Science and Art Department as a separate department came to an end under the Board of Education Act of 1899. It must be admitted that its adventures into the domain of secondary education were less happily inspired, and that there was need for co-ordination between secondary and technical education. In its day and generation, however, the Department did a great work, from which the impartial historian of national education will not withhold grateful appreciation and the historian of the late War may trace some of the silver threads of victory.

South Kensington was not only closely associated with the early history of general scientific education, but it recapitulates that history. A permanent memorial there to the technical education movement of the 'seventies and 'eighties is the City and Guilds of London Institute for the Advancement of Technical Education. The Institute was formed in 1878 by the Livery Companies of the City of London, one of its principal objects being the establishment of the Central Technical College to supply higher technical education to productive industry. It was designed originally as the coping-stone of a system of technical schools, and particularly for the training of technical teachers. The foundation-stone of the College was laid by the Prince of Wales in 1881, and the building was completed three years later. Its work is now confined to engineering education, and it is one of the largest and best-equipped schools for this subject in the country.

The next important movement, which had for its object the development of teaching and research in applied science, culminated in 1907 in the establishment of the Imperial College of Science and Technology, to which a Royal Charter was granted. The Board of Education transferred to the new governing body of the Imperial College the control of the Royal College of Science and the Royal School of Mines; and the Central Technical College, renamed the City and Guilds (Engineering) College, was also brought into the scheme of common administration. Remarkable progress has since been made in developing the resources of the colleges for teaching and research. A new building has been erected for the Royal School of Mines, and an extension (provided by the Goldsmiths' Company) of the City and Guilds College and others for botany, plant physiology and pathology, and chemical technology, while the social needs of the students have been met by the provision of a special building for the Imperial College Union.

The foregoing list by no means exhausts the buildings at South Kensington. The Natural History Museum (a branch of the British Museum) is in grey terra-cotta, built to the designs of Alfred Waterhouse, and was finished in 1880. It is both a museum and a centre for natural history study and research. The Royal College of Music, a less austere enterprise, was built by Sir Arthur Blomfield and opened in 1894; and the Royal School of Art Needlework and the headquarters of the Royal Geographical Society in Kensington Gore must also be mentioned.

Some final reflections. First and most obvious, the available space at South Kensington is now practically exhausted. Almost the only science which has not been practised at South Kensington is town planning, and there can be no doubt that the area might have been planned more economically. Much still remains to be done in providing new departments of pure and applied science. Under no possible reorganisation of higher education in the metropolis can South Kensington cease to be a most important centre for education and research in science and art. It has great resources in traditions, in men, in materials; and if, like Oxford, it is already the home of some lost causes, it has a marvellous power of adapting itself to new conditions.

Dark Nebulæ.[1]

By Prof. H. N. RUSSELL, Mount Wilson Observatory.

IT is now generally believed that many of the dark markings in the Milky Way, and dark starless regions in the sky, are produced by the interposition of huge obscuring clouds between us and the more remote stars. A long list of such dark markings has been given by Barnard,[2] who has done more than any one else to point out their importance and probable nature. In some cases, as in the Pleiades, Orion, and Ophiuchus, these "regions of obscuration" merge into faintly luminous nebulosity in the vicinity of certain stars, in such a way that there can be no doubt that they lie near these stars in space.

It thus appears that the obscuring masses or dark nebulæ in Ophiuchus and Scorpius are at a distance of 100 to 150 parsecs, those in Taurus at probably about the same distance, and those in Orion some 200 parsecs from us, while the dimensions of the individual clouds are themselves measured in parsecs.

The occurrence of these three great regions of obscuration within a distance which is so small compared with that of the galactic clouds indicates that such objects are probably of great cosmical temperature.

These dark nebulæ usually appear to be quite opaque. In some cases the stars can be seen faintly through them, apparently without much change in colour; but in some examples[3] stars imbedded in dense luminous nebulosity are abnormally red.

Of the various forms in which matter may be distributed in space, by far the most efficient in producing obscuration is fine dust, since this has the greatest superficial area per unit of mass. In a cloud composed of spherical particles of radius r and density ρ, distributed at random so that the average quantity of matter per unit volume is d, the extinction of a beam of light in passing through this cloud will be e stellar magnitudes per unit of distance, where $e = 0{\cdot}814\ qd/\rho r$. The numerical factor is independent of the physical units which are employed. The factor q is introduced to take account of the complications which occur when the size of the particle becomes comparable with the wave-lengths of light.[4] For particles more than two or three wave-lengths in diameter q is sensibly equal to unity. For smaller particles it increases and is a maximum, 2·56, when the circumference of the particle is 1·12 times the wave-length. It then rapidly diminishes and becomes nearly equal to $14/3 \times (2\pi r/\lambda)$ for particles of less than half this diameter.[5] The ratio

[1] Communication to the National Academy of Sciences, Washington, on March 14. Reprinted from the Proceedings of the Academy, vol. 8, No. 5, May 1922.

[2] Barnard, E. E., *Astrophys. Journ., Chicago*, 49, 1919 (1-23).

[3] Seares, F. H., and Hubble, E. P., *ibid.*, 52, 1920 (8-22); *Mt. Wilson Contr.*, No. 187.

[4] Schwarzschild, K., "Sitzungsberichte der K. B. Akad. der Wiss.," *Math.-Phys. Kl., München*, 31, 1901 (293-338); Proudman, *Monthly Not., R.A.S., London*, 73, 1913 (535-539).

[5] Barnard, E. E., *Astrophys. Journ., Chicago*, 38, 1913 (496-501).

q/r is a maximum, 2·42, when the circumference equals the wave-length.

For clouds of the same mean density d the opacity reaches a sharp maximum when the particles are of this size. At the same time the absorption changes from the non-selective type to the selective type, varying as λ^{-4}. For visual light the maximum opacity occurs when the radius is 0·086 ρ. A cloud of particles of this size, and of the density of rock (2·7), will exert an absorption of one magnitude if it contains only 1/86 of a milligram of matter per square centimetre of cross-section, regardless of its thickness. If the particles are of half this size, or smaller, the selective absorption is almost as complete as for a gas, but may be nearly 100 million times as great.

Obscuration of light in space, therefore, whether general or selective with respect to wave-length, will be produced mainly by dust particles a few millionths of an inch in diameter, unless such particles form a negligible proportion by weight of the obscuring cloud.

It is just these particles, however, which will be most influenced by the pressure of the radiation of the stars. Calculations from more accurate data confirm Schwarzschild's conclusion that for a particle of the optimum size and the density of water, the repulsive force of the sun's radiation is about ten times the gravitational attraction, and also show that for stars of the same brightness, but other spectral types, the radiation pressure will be about two-thirds as great for Class M and increase for the whiter stars, till for Class B it is fully ten times as great as for solar stars.

Dwarf stars will scarcely repel dust at all, but giant stars, and especially the very luminous one of Class B, will repel it very powerfully. Only the coarser particles can come near such a star—the finer ones being driven away. This selective removal, from the vicinity of bright stars, of the particles which are most efficient in cloud formation, may explain the fact that the luminous portions of these dark nebulæ, though centred upon stars, do not brighten up in their immediate neighbourhood so much as might have been anticipated.

The finest dust must continue to be repelled by the stars, whatever their distance. It may congregate to some degree in interstellar regions, where the repulsive forces from stars on opposite sides are nearly equal, but it can be in no true equilibrium there, and must escape ultimately to an indefinitely great distance.

Some force, however, operates to hold these dark clouds together, for their outlines are often sharp. This is probably the gravitational attraction of the cloud itself.

Taking a spherical cloud as an example we find that, if its mass is M times that of the sun, and its radius R parsecs, the velocity of escape at the surface is $0{\cdot}092\ M^{\frac{1}{2}}\ R^{-\frac{1}{2}}$ km./sec. The internal velocity of the nebular material is known only in the case of the Orion nebula, where the luminous gas shows irregular variations in radial velocity from point to point, amounting to about 5 km./sec. on each side of the mean.[6]

For a nebula 1 parsec in diameter (which may be taken as a rough representation of the small black, almost round spot about 15′ in diameter, discovered by Barnard [7] in Ophiuchus) the mass must be 60 times that of the sun, if the escape velocity is to be 1 km./sec.

If all this matter were in the form of particles of rock of the optimum size, the extinction for light passing centrally through the cloud would be 2000 magnitudes. An extinction of 10 magnitudes (quite sufficient for opacity) would be produced if the radii of the particles were 72 μ.

Though these numerical values are largely conjectural, it appears probable that the aggregate mass contained in one of these great obscuring clouds must be very considerable—probably sufficient to form hundreds of stars—and that a sensible fraction of the whole mass must be in the form of dust less than 0·1 mm. in diameter.

It can easily be shown that any dust cloud which is impervious to light must also be impervious to particles such as those of which it is composed (and to free-moving electrons as well) in the sense that such a particle could not traverse the cloud without a practical certainty of collision. These collisions may account for the existence of dust within the clouds, even if it was not a primitive constituent.

The transition from these dark nebulæ to luminous nebulæ in the vicinity of the stars appears to occur in two ways. The first is by simple reflection of the light of the stars: this appears to occur in the nebulosity surrounding the Pleiades, the star ρ Ophiuchi, and probably in many other cases. The second is by the excitation of gaseous emission, as in the Great Nebula of Orion, which is connected with one of the greatest known regions of obscuration and itself shows signs that obscuring masses lie in front of it.

Both theoretical considerations, as suggested by the writer [7] and the facts of observation collected by Hubble,[8] indicate that the luminosity of gaseous nebulæ is probably due to excitation of the individual atoms by radiations of some sort (aethereal or corpuscular) emanating from neighbouring stars of very high temperature. In the Orion nebula the stars of the Trapezium (θ Orionis) appear to be the source of excitation.

There is no reason to believe that the luminous gas forms the whole, or even any large part, of the matter present within the region—only that it is selectively sensitive to the incident excitation, and therefore gives out most of the light, just as the gases (carbon compounds and nitrogen) do in the coma and tail of a comet.

If the turbulent motions of the various parts of this nebula are of the same order of magnitude in the other two co-ordinates as in the radial direction, they must correspond to an average proper motion of 1·5 astronomical units per year, or about 0″·8 per century (with Kapteyn's parallax of 0″·0055). In a million years this would carry a nebulous wisp through 2°, which is more than the whole extent of the nebula.

It appears probable, therefore, that the aspect of the Orion nebula was entirely different a million years ago from what it is now, as regards its details. There is no reason, however, to suppose that the nebula was not there. We may rather imagine that wisps and clouds of dust, carrying gas with them, are slowly drifting about. Some of them pass through the field of excita-

6 "Publications of the Lick Observatory, Berkeley, Cal.," 13, 1918 (98).

7 Russell, H. N., *The Observatory*, London, 44, 1921 (72).

8 Hubble, E. P., "Annual Report of the Mount Wilson Observatory," 1921; "Year Book of the Carnegie Institution of Washington," 1921.

tion due to the radiations from the Trapezium stars, and, when in this field, the gas is set shining—faintly near its outskirts, and without excitation of the nebular lines; more strongly, and with the nebular lines, near the middle.

According to unpublished investigations by Hubble, it appears probable that the absorbing clouds in Orion, not far from the nebula, weaken the light of stars behind them by at least ten magnitudes. The exciting radiations probably penetrate to a relatively small depth into the mass and, even if they went deeper, little of the excited light could get out again. The Orion nebula, on this hypothesis, may be regarded almost as a superficial fluorescence of the gaseous portion of this vast dark cloud, in the limited region where it is stimulated by the influence of the exciting stars.

The Corrosion of Ferrous Metals.

THE fact that iron readily perishes when exposed to the forces of Nature must have been observed by man practically as long as the metal itself has been recognised. But it is only comparatively recently that the problem of the preservation of iron from corrosion has developed into one of such stupendous economic importance as at the present day. Sir Robert Hadfield estimates the wastage of the world's steel on account of rust alone to reach some 29 million tons for the year 1920. This, at an average figure of 20*l.* per ton, represents a loss to the community of at least 580,000,000*l.* One interesting feature of this calculation is that the annual increase in the world's total stock of iron and steel is only some 30 per cent. of the annual production, the remaining 70 per cent. being absorbed in replacing wastage consequent upon fair wear and tear and upon corrosion.

In a paper read before the North-East Coast Institution of Engineers and Shipbuilders in April last, Mr. A. Pickworth most opportunely directs the attention of marine engineers to this aspect of the subject. It is pointed out that the repairs necessary to counteract the ravages of rusting during ten years' service in the case of a single battleship have, for structural work alone, been known to cost some 150,000*l.* Any one, therefore, who can assist in combating this destructive plague to iron and steel merits the gratitude of the community.

It is now well recognised that, in addition to air, the presence of liquid water is essential to corrosion. Rise of temperature accentuates the evil, the rate of oxidation of iron immersed in water at 80° C. being more than seven times as great as that at 0° C. It is easy, therefore, to offer an explanation, as Mr. Pickworth points out, for the fact that corrosion assumes more serious proportions in the vicinity of boiler-room tanks on steamers than elsewhere. The tanks, whether used for ballast or feedwaters, are alternately filled and more or less completely emptied, but are rarely, if ever, thoroughly dry, for obvious reasons. The residual moisture, coupled with unequal distribution of waste heat from the boilers, and erratic cooling from the floor and shell plating in contact with the sea under the vessel, results in rapid corrosion. The steel work of the bunkers of a vessel frequently requires patching or renewing on account of corrosion. This is particularly the case with pocket bunkers at the sides of the boilers or 'tween-deck bunkers above the boilers. Not only does the heat from the boilers and the moisture in the coal tend to produce a corrosive atmosphere, but the abrasive action of the coal as it enters from the shoots and while it is settling as the lower layers are worked out all tend to accentuate the destruction of the metal. In practice it is found that the lower parts of the bunkers are the most seriously affected, and this is attributed to the accumulation of a mixture of small coal and mud which is rarely removed except at special surveys. Although in exceptional cases the outside surfaces of the shell plating of a ship may be seriously pitted and corroded, as, for example, when the vessel has been lying in very foul waters, the general rule appears to be for the wastage to be greater on the inside surfaces. This is due, in the main, to the extra cleaning and general attention received by the outside surfaces. Special care should be paid to those portions of the inside shell immediately under the sidelights, for the constant trickling of rain or water of condensation from the glass induces most serious corrosion, resulting at times in actual perforation of the plating.

As might be expected, the most serious external corrosion of the shell plating occurs in the neighbourhood of the wind and water line, the metal being alternately drenched and exposed to air. The surface water also is in motion relatively to the plates, and this tends to stimulate corrosion. One interesting point deserving of consideration is the fact that the external portions of a vessel above the water-line receive deposits of sodium chloride in consequence of the evaporation of sea spray. Owing to the hygroscopic character of the deposit, as well as to its chemical activity, corrosion is readily induced thereby.

It is difficult to obtain trustworthy comparative data on the relative efficiencies of different methods of avoiding corrosion. Early man frequently surrounded his iron with copper or bronze, so that his implements might possess the strength of the former combined with the incorrodibility of the latter metal. Modern developments of this process are galvanising, tinning, electroplating, and the like. The Bower-Barff process consists in coating the iron or steel with magnetic oxide, which is an excellent protection so long as it remains unbroken. The metal is cleaned, heated in a closed chamber by means of producer gas, and finally oxidised in a current of superheated steam for a couple of hours. If, however, the resulting coat of oxide should crack or chip off at any point, the layer of unprotected metal thereby exposed is rapidly attacked. The oxide functions as cathode and the metal as anode, so that deep pitting ensues. Mr. Pickworth mentions that a certain shipowner, relying on the protective action of mill scale, gave instructions for a ship to be built, the shell plates of which were to retain their mill scale as completely as possible. For a time all went well on service, but suddenly the vessel developed leaks and was almost lost. Upon docking it was found that many of the plates had been deeply pitted and even perforated in a number of places where the mill scale had been destroyed either during construction or through abrasion in service. It is now usual to remove scale by pickling, by weathering, or by some other suitable method, prior to painting, in order to avoid such disaster.

A second method of combating corrosion consists in alloying the iron with some other element that will render it incorrodible. This is the principle underlying the so-called "stainless steel," which contains some 12 to 14 per cent. of chromium, and is remarkably resistant to neutral corrosion, although acids dissolve it with ease. Unfortunately the cost is high, but once that difficulty is surmounted, a vast future lies in store for stainless metals. To realise this it is not essential that the price should fall to that of an ordinary carbon steel. To the writer's own knowledge the cost of painting the steel work in a certain large works recently averaged nearly 5*l.* per ton of steel painted. Assuming the paint will not require renewal within five years, the average annual cost is still 1*l.* per ton of steel. A firm could thus clearly afford to pay considerably extra in initial outlay if by so doing a really incorrodible structure could be obtained which would not require subsequent periodic treatment.

Yet a third method of reducing wastage by corrosion has been investigated, namely, the removal of the active corroding agent, dissolved oxygen, from waters in contact with the metal. The various means of doing this are discussed by Mr. Frank N. Speller[1] in an interesting paper entitled "Control of Corrosion by Deactivation of Water." The method has its limitations, but for hot-water heating systems it would appear to be particularly suitable. The oxygen may be removed either chemically or by purely physical means. A satisfactory plant was erected in Pittsburgh in 1915 in which the water is first made to flow through a "deactivator" which is a tank filled with a special type of expanded steel lathing. The steel rusts and thus deoxygenates the water, which then passes on to the heating system and is now non-corrosive. The principle is simple enough, but in practice it is necessary to pay great attention to the manner in which the deactivator is charged. Miscellaneous steel turnings usually rust together into a tight mass which offers serious resistance to the flow of the water. In a later form of deactivator installed in Boston in 1917 a filter was provided in order to remove all suspended hydroxide of iron.

Many types of mechanical de-aerators have been designed. The apparatus made by "Balke" in Germany appears to have given satisfactory results. The water at ordinary temperature is sprayed into a chamber carrying a 90 per cent. vacuum, and the released gases are pumped off into a condenser. The efficiency of mechanical de-aerators is of course limited by the solubility of the gases, the temperature, and the power of the vacuum. Normally, therefore, there will always remain a certain amount of unextracted oxygen which may be sufficient to induce gradually serious corrosion in the plant. On the other hand, chemical processes can remove all the dissolved oxygen under favourable conditions. Speller therefore suggests that where very large volumes of water require de-aeration, an economical type of apparatus would be one in which the bulk of the dissolved oxygen is first removed by some simple form of mechanical de-aerator, and the residual oxygen, say the last 5-10 per cent., by chemical treatment.

J. N. F.

[1] Journ. Franklin Institute, April 1922.

Obituary.

Ernest Solvay.

On May 26 last, at the ripe age of eighty-five, there passed away, at his residence in Brussels, in the person of Ernest Solvay, one of the world's greatest industrial chemists. To Nicolas Leblanc belongs the credit of inventing the first successful process for manufacturing artificial soda; but it remained for the brothers Ernest and Alfred Solvay to provide the world with a pure and cheap product.

Ernest Solvay was born at Rebecq in Brabant, Belgium, on April 16, 1838. He was the son of Alexandre Solvay, a quarry proprietor and salt refiner. In 1838 two English chemists, Harrison Gray Dyar and John Hemming, patented a process for producing carbonate of soda by acting upon sodium chloride with ammonium bicarbonate and producing sodium bicarbonate and ammonium chloride. The sodium bicarbonate upon calcination yielded soda ash, and the ammonium chloride was decomposed by lime to free the ammonia for re-use. The patentees themselves, and several well-known chemists, erected works to manufacture by this process, but all proved failures, principally on account of the high loss of ammonia. The young Belgian chemist, Ernest Solvay, at the age of twenty-four, was attracted by the process, and, after two years of study and experiment, he devised such modifications as appeared to him to ensure its practicability, and embodied them in a patent in 1863.

Calling to his aid his brother Alfred, who had been trained for a commercial career at Antwerp and at Hull, they erected works at Couillet, near Brussels, as Solvay et Cie, with a capital of 5440*l.* With the starting of these works in 1865 the brothers met with most of the troubles and disasters that had daunted the earlier experimenters. Their experience is perhaps best described in Ernest Solvay's own words:

"With the starting of the works in 1865 began the everlasting struggle, the incessant need for improvements in apparatus, and the series of accidents inseparable from every new industry. This was the hill of Calvary which we had to climb, and its rough road might perhaps have stopped me if I had not been sustained by my confidence of success in the task that had to be accomplished, and above all by that devoted helper, my brother Alfred."

In the following year (1866) the works were producing only 1½ tons of soda ash per day, but by 1869 the process had proved so successful that the works were doubled in size. During these fateful four years, Solvay had encountered all the difficulties that had baffled his predecessors, both technical and financial; but, by his application of wonderful scientific skill and his tireless attention to work, he succeeded in evolving a remunerative process of manufacture. It was, however, far from perfect, and for the next fifty years Solvay ever strove to reach perfection, sparing neither time nor money to make it approach the ideal. At the time of his death, there are very few methods of manufacture that have so nearly reached the ideal as the Ammonia Soda process.

In 1873 Solvay granted a licence to John Brunner and Ludwig Mond to work the process in England, and Brunner, Mond and Co. started works at Winnington, Northwich, in that year. From this business connexion there sprang up a friendship among the three men that lasted as long as their lives, and it is difficult to decide whether Solvay or Mond effected thereafter the greater number of improvements in the process and apparatus.

In the same year Solvay and Co. erected their large works at Dombasle near Nancy, introducing all such improvements in plant as experience at Couillet had shown to be advisable.

From this time onwards to 1914 few years passed without some new works being erected to carry on the manufacture; in the United States in 1881, in Russia in 1881, in Germany and Austria in 1885, and later in Hungary, Spain, Italy, and Canada, until in 1914 there were scattered throughout the world twenty-three separate works engaged in the Solvay Ammonia Soda process, which were capable of producing nearly 2,000,000 tons of soda ash per year.

With the growth of the Ammonia Soda process, the production of alkali by the Leblanc method gradually declined, until it reached the point where it had to depend upon its chlorine products for its continued survival, and of late years even this monopoly has been seriously challenged by the electrolytic processes. In 1863 the world's production of soda, by the Leblanc process, was 300,000 tons a year. In 1913, the total production amounted to nearly 3,000,000 tons, of which almost two-thirds was made by the Solvay process, while the sale price had dropped to one-quarter. The essential raw materials for the Solvay process are salt, limestone, coke, coal, and ammonia, and in selecting sites for new works, Solvay was ever careful to choose them as near as possible to the source of supply of some of these.

In seeking for a cheap and plentiful supply of ammonia, Solvay was led to study the production of coke, and eventually, in conjunction with Mr. Semet-Solvay, he designed a bye-product coke oven which yielded ammonia through the scrubbing of the gas before its combustion for heating purposes. Many thousands of these Semet-Solvay ovens have been built in Belgium, France, England, Germany, the United States, Italy, and Japan, and in 1913 they were producing about 10 million tons of coke a year.

In the midst of his immense industrial activities Solvay was ever mindful of the welfare of his employees. Working a process that must of necessity be continuous, he was one of the first to reduce the hours of labour from 12 to 8-hour shifts. He insured his workmen against accidents, instituted savings-banks and retiring allowances, provided them with medical attention, built houses for them, and remitted the rent in cases of long service or distress, made free grants of land for culture, built schools and gave scholarships, and made grants in aid of higher education both in Belgium and abroad.

On the occasion of the company's fiftieth anniversary, a number of grants were made, among which were: 200,000 francs to the Université du Travail, Charleroi, 500,000 francs to provide prizes every fourth year for work on such contagious diseases as the poor are specially liable to suffer from, 500,000 francs to the University of Paris towards the Institute of Applied Chemistry, 500,000 francs to the University of Nancy to complete the Electrical Institute and found a chair of electro-chemistry. In addition, their workpeople received substantial concessions and bonuses. Ernest Solvay's sympathies and interests were not confined to his own workpeople, for he was absorbingly interested in the intellectual and social advancement of mankind in general. He published not only many treatises on these subjects, but also from his immense wealth financed or created numerous institutions for their study; *e.g.* the Solvay Society of Brussels and institutes of chemistry, physics, physiology, and sociology. In order to encourage the development of chemical and physical science, by providing funds for research workers and by holding conferences, he also inaugurated the Solvay International Institutes of Chemistry and of Physics, and endowed each with a capital of 1,000,000 francs.

During the war, Solvay elected to remain in Brussels in order that he might alleviate the suffering which he foresaw would be the lot of the poor. He devoted his energies and his fortune to this object throughout the whole of the German occupation, and the city will never forget his beneficence. Upon his return to the capital, King Albert personally expressed his thanks to him and created him a Minister of State. He was also the recipient of many other honours. He was a Grand Commander of the Order of Leopold, a Chevalier of the Legion of Honour, a Doctor of the University of Brussels, an honorary member of the Royal Institution of London, and of the German, French, American, and Dutch Chemical Societies, and a corresponding member of the French Academy of Sciences.

At the celebration of the fiftieth anniversary of the formation of his company, he was presented by Prof. Haller in the name of the French Institute with the gold Lavoisier Medal, and by Prof. Appell with the medal of the University of Paris.

In private life Ernest Solvay's tastes were simple, and he was ever happiest in his own family circle. He attracted to his side many men of exceptional ability and formed lasting friendships. By nature he was generally optimistic, and he had a very keen sense of humour. He was an ardent mountaineer, and regularly his summer holidays were spent among the Alps. He could climb vigorously at the age of seventy-five, and abandoned the sport only a few years prior to his death. JOHN I. WATTS.

THE HON. V. A. H. H. ONSLOW.

HUIA ONSLOW, son of the fourth Earl of Onslow, was born in New Zealand in 1890, where his father was Governor-General. Educated at Eton and Trinity College, Cambridge, he met with a calamitous accident at the close of his University career: an injury received in diving left him paralysed below the waist, with no hope of recovery. Though broken in body, his courage never left him, and with splendid bravery he devoted to scientific work such as remained to him of life. Special facilities for research led him to settle in Cambridge, where he turned one of the rooms of his house into a laboratory into which his couch could be wheeled. Here he became a pioneer in establishing contact between the two growing branches of biology—biochemistry and genetics. Genetical research had recently demonstrated the existence of two distinct kinds of white in the coat of certain animals—one dominant and the other recessive to colour. It had been surmised that in the former case the coat carried something which inhibited the production of colour, and that in the latter either the chromogen was absent, or else some substance which activated it. Onslow's chemical work took the question out of the realm of speculation, and placed it on a solid ground of fact—a notable contribution, which will be found in the Proc. Roy. Soc., 1915. At the same time he was carrying out extensive breeding-experiments with mice and rabbits, both at Cambridge and Pyrford, which helped materially in laying the foundation of a sound genetical knowledge of coat-colour. But it was the biochemical side that attracted him most, for he realised that the geneticist could not go very deep without the help of the chemist. He wished to approach the problem from both sides, and, with this end in view, started breeding-experiments with moths, concerning himself chiefly with melanic forms as likely to be of service for the chemical side of the inquiry. The results were published in a series of papers on the "Inheritance of Wing Colour in Lepidoptera," which appeared in the *Journal of Genetics*, 1919–21. Meanwhile, he became interested in the brilliant iridescent colours exhibited by many insects, and on this subject contributed last year an important paper to the Philosophical Transactions. Full of fresh and suggestive observations, it is pervaded by a critical power of thinking, and a knowledge of the physics involved, which must make it a landmark for future investigators of an intricate and fascinating series of problems.

And all this from an invalid couch, full of suffering, and stricken beyond hope of recovery. But fine as is the achievement, finer still was the way in which it was won. With life seemingly wrecked at the very start, his spirit rose above the physical crash, bravely accepted what had to be, and created out of the ruins a fresh life which was the wonder of those who knew him. What he did, and what he was, will assure him of that immortality that lives upon the lips of men; and with that we may

"Leave him still loftier than the world suspects,
Living and dying."

Dr. A. R. Willis.

Many students will regret the death of Dr. Ambrose Robinson Willis, at the age of seventy-two, on May 23 last. From 1872, when he entered the Royal School of Mines as a Royal Exhibitioner, until 1911, when he retired owing to ill-health from the Imperial College of Science and Technology, he had been continuously associated with the South Kensington institution.

In 1875 he obtained the A.R.S.M. in mining, metallurgy, and geology, the Duke of Cornwall's scholarship, the Murchison medal and prize, and the Edward Forbes medal and prize. The wide range of his studies is indicated by the facts that in 1876 he obtained first-class honours in zoology and chemistry at the London B.Sc.; in 1879, the London B.A.; in 1881 the M.A., and in 1883 the D.Sc. in mathematical physics. He was made assistant-professor in mathematics and mechanics at the Royal College of Science in 1884, being associated first with Goodeve and later with Perry. He also acted as examiner in mathematics for the Universities of London and Manchester.

It was as an instructor that Dr. Willis will be remembered, not only by old students of South Kensington, but by an enormously wider circle, in his capacity as an examiner in mathematics to the Science and Art Department and afterwards to the Board of Education. With his fellow-examiners Twisden and Wrigley, he exercised a tremendous influence for many years on students of mathematics and mechanics in all parts of the country. It was no small task virtually to direct the studies of an army of men, the majority with little time to spare from manual work, without means and often without a teacher, and whose only inspiration and incentive came from the desire to pass the various Board of Education examinations. That the duty was ably and wisely carried out will be readily admitted, and by none more than by those who, entering the Royal College of Science as exhibitioners or scholars, came into personal contact with the man who had done so much to direct their earlier studies.

Times have changed, and it is not so easy now to bring home the realisation of what it meant to men whose training had been on these lines, to attend Dr. Willis's lectures and listen to his extraordinarily clear, orderly, and inspiring exposition of mathematics. In his prime few can have equalled him in this respect—he radiated enthusiasm as he developed the argument, and his triumph as the full power of the attack made itself felt was delightful to see. Many hundreds of science teachers will still remember wistfully Dr. Willis's carefully prepared lectures in the short "summer courses" for teachers, which were arranged each year at South Kensington by the Board of Education.

Dr. Willis took a real personal interest in his students and possessed the faculty of making the shyest of men feel quite at ease with him. Many of his students can testify to innumerable kindnesses unobtrusively performed, and to his quiet support of any movement which would activate the social side of the College's work. His whole-hearted thoroughness, wide experience, geniality, North-country shrewdness, and sound common sense were greatly appreciated in university circles. His retirement in 1911 was made the occasion of a demonstration of affection and good-will from hundreds of old students, and he then voiced the great satisfaction that he felt to see so many of his old students playing prominent parts in the scientific world, not least in the development of aeronautics.

A. R. R.
G. W. C. K.

Current Topics and Events.

The portrait medallion of Sir Norman Lockyer, by Sir Hamo Thornycroft, which is to be erected at the Norman Lockyer Observatory, Salcombe Hill, Sidmouth, will be unveiled by Sir Frank Dyson, Astronomer Royal, on Saturday, July 22. Lt.-Col. F. K. McClean, a generous benefactor to the observatory, will present the medallion on behalf of the subscribers, and it will be received by Sir Richard Gregory, chairman of the council. The observatory was erected in 1912 upon a plateau 550 feet above sea level, and is unique of its kin in Great Britain, being vested in a registered corporation which possesses the whole of the property and controls the operations. It was founded by Sir Norman Lockyer, and was formerly called the Hill Observatory, but since that distinguished astronomer's death the name has been changed to the Norman Lockyer Observatory in honour to his memory. The director is Major W. J. S. Lockyer, and there is a research committee consisting of Sir Frank Dyson, Prof. A. S. Eddington, Prof. A. Fowler and Prof. H. H. Turner. The observatory possesses an equipment of the first rank for spectroscopic work, and photographs of stellar spectra taken in it are being used for the determination of the parallaxes of stars. The method used was first worked out at the Mount Wilson Observatory and it represents one of the most remarkable developments of astrophysics ever achieved. The gifts of Sir Norman and Lady Lockyer, Lt.-Col. McClean, Mr. Robert Mond, Capt. W. N. McClean and others, together with subscriptions of members, have been sufficient to establish and maintain the observatory hitherto, but additional funds will be required if the work is to be carried on efficiently. In the United States, generous donors to astronomy seem to be forthcoming whenever they are needed, with the result that the chief advances of astronomical science are being made there. The Norman Lockyer Observatory, on account of the elasticity of its constitution, offers similar benefactors in this country an excellent opportunity for emulating the example afforded by America, and we trust that one or more of them will provide the means to continue and extend the work to which a few devoted people have already contributed their full share.

Unusually heavy gales for the season of the year have occurred over England during the early part of July, especially during the night of July 5-6, and the tempestuous winds were accompanied by torrential rains. On the south-east coast of England the wind attained the velocity of about 60 miles an hour, and at Kew Observatory the velocity registered 53 miles an hour. London experienced considerable interruption to telephone communication, and in the open country much damage was done to the fruit crops. A renewal of the stormy conditions occurred on July 8-9.

Owing to the early breaking of the monsoon the attempt on Mount Everest planned for June 3 had to be abandoned. The *Times* announces that the members of the expedition are now returning to India. Col. Strutt, Dr. Longstaff, and Mr. Finch have already sailed for England. Mount Everest thus remains unconquered, at any rate for the present, the greatest altitude that was reached being 27,300 feet, or about 1700 feet below the summit. Col. Strutt believes that given favourable weather a future expedition should be able to reach the summit.

The *Quest* with the Shackleton-Rowett expedition has left Cape Town and arrived at Simonstown on July 7. After a few days there, according to the *Times*, she sails for home via South Trinidad and Rio de Janeiro. It is proposed to spend two days at South Trinidad, the uninhabited volcanic island in the South Atlantic. The island has been frequently visited, notably by the *Discovery* in 1901 and the *Valhalla* in 1905. At an earlier date it obtained fame by reason of several searches for buried treasure. The *Quest* may be expected at Plymouth about September 21.

According to the *Meteorological Magazine* of June, a new record height of 10,518 metres (34,500 feet) was attained by J. A. McCready in an aeroplane flight at Dayton on a Lepère machine, with a 400-h.p. Liberty engine, during September 1921. The previous record, by Major Schroeder, has been reduced by the authorities responsible for the official figures from 36,000 feet to 33,114 feet.

It is reported in the *Times* that Captain Amundsen, aboard the *Maud*, left Nome, Alaska, for Cape Barrow, on June 30. Early in August he proposes to make his flight across the Pole, either to Greenland or, more likely, to Spitsbergen. The route to Spitsbergen is the longer of the two, but Capt. Amundsen believes he can make the journey in eighteen hours. His aeroplane has been tested in a thirty-two hours flight. The Norwegian Government is taking steps to afford all possible assistance to Capt Amundsen in the event of his reaching Spitsbergen or Bear Island.

Invitations to serve on the Committee on Intellectual Co-operation of the League of Nations have been accepted by Mr. D. N. Banerji, Prof. Henri Bergson, Mlle. Bonnevie, Prof. A. de Castro, Mme. Curie, M. J. Destrée, Prof. A. Einstein, Prof. G. Gilbert Murray, M. G. de Reynold, Prof. F. Ruffini, M. L. de Torres Quevedo, and Dr. G. E. Hale. The committee, which will be entrusted with the examination of international questions regarding intellectual co-operation, will hold its first meeting in Geneva on August 1.

Since the eruption of 1906, Vesuvius has remained inactive on the whole until the early part of the present year. On February 26 the main cone, which had grown since 1906 to a height of about 230 feet, collapsed during an eruption, and shortly afterwards lava issued from several fissures; it has flowed ever since in amounts that are considerable, though not sufficient for it to escape from the crater. Since February, a new crater has been formed and has grown with great rapidity. Towards the end of June, a large fissure appeared in its western side, and from it there came a stream of lava about thirty feet wide. Owing to these recent flows and to the presence of sulphur fumes, it is difficult to reach the floor of the crater. In the *Times* for July 3 are reproduced, however, two photographs taken from within the crater, one of the new cone, and the other of the lava-stream issuing from it and showing very clearly the fluxion-structure of the lava.

MAY and June were both comparatively dry months this year at Greenwich Observatory, the rainfall in May being only 57 per cent. of the 100 year average, while June was 70 per cent. of the 100 year average for the corresponding month. In January, February, and April the rainfall was in excess of the average. In 1921, each of the first six months had a rainfall less than the normal. The total for the first half of the present year is 10·73 in., while in 1921 the total for the same period was only 5·97 in. The 100 year average for the six months is 10·47 in., and for the 35 year average, used by the Meteorological Office, 10·21 in., so that the period from January to June shows an excess on the normal. There was an absolute drought this year from May 26 to June 12, a period of 18 days, the only drought as yet registered in 1922. July bids fair to be a wet month; practically the average rainfall for the month in London fell in the first week.

THE Natural History Museum Staff Association held their summer scientific reunion in the board room of the Museum on July 5. There was a large attendance. Among other interesting exhibits were the following: specimen of the supposed gigantic Gastropod (*Dinocochlea ingens*) from the freshwater sandstones in the Wadhurst Clay, Hastings; the natural cast of a footprint of an Iguadon from the Wealden Beds, between Bexhill and St. Leonards; opalised Mollusca of Cretaceous age from New South Wales and South Australia; skin with scutes of a stegosaurian dinosaur from the Upper Cretaceous, Alberta, Canada; specimens from the collection of Swiss minerals bequeathed to the Museum by the late Rev. J. M. Gordon; one of the four meteoric stones which fell in the Strathmore district of Perthshire and Forfarshire on December 3, 1917; living specimens of a branchiopod crustacean (*Leptesheria dahalacensis*) hatched from eggs contained in dried mud from Bagdad; ammonites with the operculum preserved and associated fossils from the same bed in the Lias at Charmouth, Dorset; Horse Chestnut seedlings, illustrating three different methods of replacing the bud of the primary shoot; a very rare British orchid (*Orchis hircina*) recently found near Lewes; examples of the remarkably different, smooth and partly rough, skinned fruits borne on the same tree of the Khatta orange, North India; model of Commerson's dolphin (*Cephalorhynchus Commersoni*) from Port Stanley, Falkland Islands; and the model, enlarged 740 diameters, of the itch mite (*Sarcoptes Scabiei*) recently made for the Museum by Miss Grace Edwards. Messrs. R. and J. Beck exhibited their most recent forms of microscope, and Duroglass Ltd. showed examples of their glass-ware for preserving specimens in spirit and for use in chemical analysis.

AT a meeting of the Royal Society of Edinburgh on June 5, Dr. C. G. Knott, general secretary, gave an account of a correspondence between the Academy of Sciences of Paris and the Royal Society of Edinburgh, in which the Council of the latter Society directed attention to the fact that the "Cable Guide" system which was being accepted as the invention of M. Loth during the late war, was invented by Mr. C. A. Stevenson thirty years ago, and described in the Proceedings of the Royal Society of Edinburgh in 1893. In 1921 M. Loth was awarded an important prize for his valuable work in connexion with naval problems, and the report of Vice-Admiral Fournier, in recommending the award, referred pointedly to the method of the pilot cable for guiding ships by electrical signals into harbours during night or at times of fog. A comparison of this report with Mr. C. A. Stevenson's patent of 1893 showed that the two systems were fundamentally identical. Compared with M. Loth's beautiful devices, made possible in these days by the remarkable developments in methods for detecting electric and magnetic charges, Mr. Stevenson's early methods may appear crude, but that does not invalidate his claim as the originator and the first experimenter along these lines. Not only did he invent the pilot cable, but he was the first to demonstrate practically how it could be used in guiding vessels up estuaries and into harbours by means of electric signals from a sunken cable. It was a simple act of justice that these historical facts should be recognised and due credit given to Mr. Stevenson for his valuable pioneer work. A French translation of the statement prepared by the Council has been sent to the Academy of Sciences with the request that it be published in the *Comptes rendus*.

THE Paris correspondent of the *Times* states that the late Prince of Monaco has bequeathed sums of one million francs each to the Académie des Sciences, the Académie de Médecine, the Institut Océanographique, the Institut de Paléontologie Humaine de Paris, and the Musée Océanographique de Monaco.

THE Council of the Marine Biological Association of the United Kingdom has passed a resolution expressing "their respectful homage to the memory of His Highness the late Albert I., Sovereign Prince of Monaco, and their deep appreciation of the great services rendered by him to the advancement of the Science of the Ocean."

THE undermentioned Fellows of the Geological Society have been nominated as Delegates of the Society to the Brussels Geological Congress, 1922: Dr. J. W. Evans, Prof. E. J. Garwood, and Prof. W. W. Watts.

ACCORDING to the *Electrician* the posts of electrical adviser to the Government of India and chief engineer of the Hydro-Electric Survey of India, at present held by Mr. J. W. Meares, are shortly to be abolished.

LORD COLWYN will open the research laboratories of the Research Association of British Rubber and Tyre Manufacturers at 105-7 Lansdowne Road, Croydon, Surrey, on Wednesday, July 26, at 3 P.M.

THE third report of the departmental Committee on Lighting in Factories and Workshops, just issued, deals mainly with the definition of "adequacy" of lighting, which it has already been recommended should be required by Statute and defined by Order of the Secretary of State for different industrial processes. The Committee considers that much work still remains to be done before the regulation of factory lighting can be established on a basis of definite legal minima for illumination. Ample proof is forthcoming of the relation between lighting and production and safety. It is therefore suggested that the chief industries should be invited to assume partial responsibility by sharing in further investigations into the lighting requirements of work in these industries. Meanwhile, as an indication of what is desirable, the Committee furnishes an appendix in which processes in the chief industries are classified as "fine work," requiring 3 foot-candles, and "very fine work," requiring 5 foot-candles. In other appendices values demanded in American codes on industrial lighting are given. It is gratifying to observe that there has already been a substantial improvement in industrial lighting since the Committee commenced its labours, and there is no doubt that the moderate course they recommend in regard to legal minima will meet with general approval.

MESSRS. GALLENKAMP AND CO., referring to the paragraph in NATURE, July 1, p. 19, on the efforts made by the Museums Association to get rectangular glass jars manufactured in this country, remind us that they are prepared to supply such jars. They have been exhibiting samples at the Museums Association Conference at Leicester this week; we understand that they were unable to make these jars when approached by the Association.

THE attention of archæologists may be directed to a lecture delivered by Mr. G. B. Gordon at the University Museum, Philadelphia, and published in the *Museum Journal* (vol. xii. No. 4), issued by that institution, in which he describes the walls and other antiquities of Constantinople. Mr. Gordon gives a graphic sketch of the history of the city in relation to the existing remains, and his lecture is illustrated by an admirable series of photographs.

A USEFUL list (No. 432) of publications on agriculture and gardening, including some rare herbals, has just been circulated by Mr. F. Edwards, 83 High Street, Marylebone, W.1. It is obtainable free, upon request, of the publisher.

Our Astronomical Column.

SKJELLERUP'S COMET.—This comet was photographed by Mr. Davidson at Greenwich on June 21 and July 3. The results show that a slight lengthening of the period (previously given as 4·72 years) is needed, and 5·1 years is probably near the truth. This is not unfavourable to the suggested identity with Grigg's Comet 1902 II. Dividing the interval by 4, 4·96 years is obtained as the mean period since 1902, and 5·1 years is quite within the limit of change that might have been produced by Jupiter-perturbations. These would have been considerable early in 1905, and sensible in 1915. The new period is much the same as that of Tempel's Comet, for which the value 5·16 years was found in 1920. This has hitherto been reckoned the second shortest cometary period.

Profs. Crawford and Meyer of Berkeley Observatory, California, find the period 5·53 years for Skjellerup's Comet, but this appears to be somewhat too great, judging by recent observations.

PERIODICAL COMETS.—An investigation has recently been completed by Miss J. M. Young, instructor of mathematics at the University of California, "on the causes which have prevented certain periodical comets being redetected on their predicted returns."

She has brought a number of interesting facts together, with regard to Barnard's Comet of 1884 and Denning's Comet of 1881, and concludes that the most probable period for the former is 5·39 years, and for the latter 8·84 years. Neither of the comets alluded to have been redetected since the years of their discovery, but at certain returns the conditions have been very unfavourable. Miss Young concludes that periodic comets often escape observation owing to the fact that they have not been searched for over a sufficiently large extent of the heavens.

It is to be hoped that greater efforts will be made to rediscover some of the numerous comets of short period which have only been observed at one return. Denning's Comet of 1881 is due in 1925, when the conditions may be favourable; but there is considerable uncertainty as to the date of perihelion.

ROCHE'S LIMIT FOR SATELLITES.—It is not always remembered that the limit assigned by Roche as the minimum-distance of a satellite from its primary (depending on the density of the latter, but of the order of $2\frac{1}{2}$ times its radius) takes no account of the force of cohesion in keeping the satellite particles together. In the case of bodies of the size of the earth or moon, the disruptive forces would be so large that the force of cohesion might be neglected compared with them; but the case is different when we consider little bodies like Phobos, the inner satellite of Mars. Prof. George Darwin, in his well-known work on the tides, etc., suggested that Phobos was so near Roche's limit that future astronomers might witness its disintegration. Dr. E. O. Fountain gives some useful calculations on the subject in the Journal of the British Astronomical Association for May. He assumes as the tenacity of the material forming Phobos about 300 lbs. per square inch, the figure for brick and cement. On this basis he finds that Phobos would still hold together even close to the surface of Mars, while in its present situation a satellite of 200 miles diameter could exist without destruction. He also finds that bodies some 200 miles in diameter could exist without destruction at the inner edge of Saturn's ring, so that the doctrine of Roche's limit can scarcely be invoked to explain the disintegration of the matter of the ring into such tiny fragments as those which appear to constitute the ring particles.

Research Items.

English Gypsy Christian Names.—In the second part of vol. i. of the *Journal of the Gypsy Lore Society*, which has been revived under promising auspices, is a contribution by Mr. E. O. Winstedt on English Gypsy Christian names. This question has hitherto been inadequately treated, and in this branch of Gypsy lore, as in others, there has been a tendency to confine attention too exclusively to Gypsies, and to regard them as more peculiar than they really are. But recent research tends to show that many of their customs, superstitions, folk-tales, and peculiarities of dress are borrowed from the Gorgios among whom they have lived. It is only by foraging among parish registers and similar documents that the remarkable examples collected by Mr. Winstedt can be discovered. Many are certainly of foreign origin, having been brought with them by gypsies as a relic of their travels, and the frequency of Greek names indicates a survival of their sojourn in Greek-speaking countries. Others, again, seem to be English names extensively modified by settlers in this country. These have been traced with much research and ingenuity, and the interest of Mr. Winstedt's paper to philologists and ethnologists is obvious.

Social Economics in the Philippine Islands.—The relation of religious beliefs and economics to the environment is well illustrated by an important memoir on the Ifugao, who inhabit one of the most isolated districts in the Philippines. They have practically no foreign market for their products, and for their imports they must pay middlemen's profits three or four times over as well as high transport charges. They live in a series of mountain valleys, and this isolation leads to hostility between the groups. The country is fertile, but the climate most uncertain, the latter directly affecting crops and health, and indirectly, it has been a factor which the writer (Mr. R. F. Barton, University of California Publications on Archæology and Ethnology, vol. xv. No. 5) calls " one of the richest religions in the world," for in order to obtain the favour of good weather and consequent good crops, the Ifugao performs a round of religious feasts, the provision of animals for which is the principal economic motive in his life. The uncertainty of the climate causes much disease, and expensive religious feasts must be given to relieve sickness. " The wealth of the religion has arisen from the variation of climate and the rough and dangerous nature of the mountains, and the perils of the torrents and the landslides. Religion is a great factor, the greatest by far in the commercial activities of the tribe and in the economic activities of the male Ifugao." This survey of an isolated tribe living under special conditions which promote isolation and superstition, is most instructive.

Parasitology in S. Africa.—In the *South African Journal of Science*, vol. xviii., 1921, among the reports of papers read at the South African Association for the Advancement of Science, we note Dr. A. Porter's abstract on the life-histories of some trematodes, including the two African species of Bilharzia infecting man and the liver fluke of sheep, the intermediate hosts of which in S. Africa have been ascertained. Prof. H. B. Fantham records observations on parasitic protozoa in S. Africa, including an Entamœba—believed to be new—from the horse.

Myriapoda.—The attention of workers on this class may be directed to two recently published papers—one by Mr. H. W. Brolemann in Proc. R. Soc. Edinburgh, vol. 42, 1922, on material collected by Capt. W. E. Evans during the Mesopotamia campaign, comprising 17 species, and by Mr. R. V. Chamberlin, in Proc. U.S. Nat. Mus., vol. 60, art. 7, 1921, on the centipedes of Central America.

Cretaceous Fossil Reptiles in India.—Dr. C. A. Matley, whose services were lent to the Military Accounts Department in India during the later stages of the war, took the opportunity of mapping in detail around the cantonment of Jubbulpore the cretaceous formations locally known as the Lameta beds, which are found underlying the great spread of trap-flows in the Central Provinces. In a paper published in the Records of the Geological Survey of India (vol. liii., Part 2), Dr. Matley shows that in this area the Lametas and trap-flows follow in conformable succession above the so-called Jubbulpore group of the Gondwana system of freshwater beds. Accepting for the Lametas an age of albian to cenomanian, based on correlation with the marine cretaceous beds of western India, the lowest trap-flows are probably not younger than middle cretaceous, while the Jubbulpore group, which was regarded by Feistmantel on palæo-botanical evidence as middle jurassic, should now be included in the cretaceous system. Dr. Matley's work thus tends to restrict the stratigraphical range previously accepted for these associated formations, and his observations, which were necessarily hurried in places through official duties of an entirely different sort, indicate the desirability of making a detailed re-examination of the strata immediately below and intercalated with the Deccan trap-flows in the Central Provinces of India. The Lameta beds are famous as having yielded the fossil bones on which Lydekker founded the dinosaurian genus Titanosaurus. Dr. Matley, in the course of his work, collected further vertebrate remains from previously known localities and discovered some new occurrences. The locality from which General Sleeman, the famous suppressor of " thuggy," first obtained fossil bones in 1828 has been explored systematically with the help of officers lent by the Geological Survey of India, and a large quantity of fresh material has now been obtained, including about 5000 scutes as well as some hundreds of bones, which will certainly yield results on critical examination of the greatest palæontological interest.

The Structure of Rockall.—In June last year Dr. J. B. Charcot, cruising in the *Pourquoi Pas ?*, visited the little-known island of Rockall, which lies some 200 miles west of the Hebrides. One of his chief aims was to obtain rock samples in the hope of throwing further light on the origin of this curious rock. In this Dr. Charcot was successful, and to an account of his experiences in *La Geographie* for May 1922, is added M. A. Lacroix's report on the geological collections. The prevailing rock of the island is a coarse-grained aegirine granite of a somewhat unusual but not unique type. The so-called rockallite which was described by Prof. J. W. Judd some twenty-five years ago, turns out to be relatively rare. It is a fine grained rock with more aegirine than the normal granite, and it occurs only in patches. Previous to Dr. Charcot's visit the only rock specimens from the island were rockallite. All the rocks contain elpidite, which is known also in certain beds in Greenland. Dredgings in the vicinity of Rockall brought to light basaltic rocks, probably the remains of a submerged plateau of basalt, as was suggested some years ago by Prof. G. A. J. Cole. There can be little doubt that Rockall is the last remnant of a former extensive land surface.

THE GEOLOGICAL MAPPING OF THE GLOBE.—In these columns attention has been directed from time to time to the maps issued in connexion with regional memoirs, such as those on Australian states, Sinai, and Mesopotamia. We may now add Lange Koch's geological map of Palæozoic strata in north-west Greenland, 1 : 2,000,000, attached to his paper on "The Stratigraphy of North-west Greenland" (*Meddelelser fro Dansk. geol. Foren.*, vol. v., No. 17, 1920—foreword dated May 1921). In this memoir the earlier Palæozoic systems are shown to have been involved in the Caledonian folding, which is thus for the first time traced across the Atlantic interval. R. C. Wilson, in "The Geology of the Western Railway" (Geol. Surv. Nigeria, Bull. 2, 1922, price 17*s.* 6*d.*), includes a coloured map of country north of Lagos, scale 1 : 250,000, and records Eocene beds near the coast, followed by areas in which composite gneiss is prominent. An immense amount of information as to geological knowledge of the countries bordering the Pacific has been brought together in the Proceedings of the First Pan-Pacific Conference, part 3, published at the office of the Honolulu Star Bulletin, 1921. M. Emm. de Margerie (*Annales de Géographie*, vol. xxxi., p. 109, 1922), in criticising, with a query, "Une nouvelle carte géologique du monde?" points out that the production of such a map is beyond the powers of any one geologist. While indicating defects in a recent publication, he provides valuable notes on material not yet utilised. Hence his essay usefully records a number of publications on regions recently explored.

GLAZE STORM IN AMERICA.—The great glaze storm of February 21-23 in the Upper Lake region of the United States of America is discussed by Prof. A. J. Henry and Messrs. J. E. Lockwood and D. A. Seeley of the U.S. Weather Bureau, and is published in the U.S. *Monthly Weather Review* for February. A large amount of damage was done to overhead telegraph, telephone, and other transmission lines in the upper Mississippi Valley and in the States of Wisconsin and Michigan. A serious loss was sustained by shade and ornamental trees and orchards, a loss which cannot be replaced within the lifetime of the present generation. The storm, in common with others of a similar nature, had a cold surface air current which was overrun by a warmer current, the rain which was condensed in the upper current falling upon objects having a temperature some degrees below 32° F. was frozen as it reached them. The diameter of the ice-covered wires varied from a few tenths of an inch to 2·5 in. or more, forming a rod of ice as thick as a man's wrist, and added to this was the weight of icicles which formed along the wires, often very close together, and varying in length from 3 to 12 inches. Often 2 or 3 miles of telephone wires went down at one time. At Oshkosh a small piece of ice-covered branch weighed 2 pounds; without the ice it weighed 2 ounces. In Michigan the ice, sleet, and snowstorm was one of the heaviest on record. Millions of dollars worth of property was destroyed. In many orchards, 25-75 per cent. of the older trees were broken off entirely. At Arcadia a short twig weighing 1 ounce had an ice coating of 2 pounds. Several observers reported the ice coating to weigh 20 to 40 times as much as the supporting branch or wire.

NEW THEORY OF CYCLONES.—During the last twenty years our knowledge of the actual movement of the air in a cyclone has increased materially, and it has become more and more difficult to reconcile it with the theory of cyclone formation advanced by Ferrel 60 years ago. It is only recently that the work of meteorologists in this country and abroad has led to a more satisfactory theory, which has been given a precise form by V. Bjerknes and his son J. Bjerknes, in a series of papers dating from 1917 to 1921. A thoroughly readable account of the present state of the theory will be found in an article by Dr. E. Kuhlbrodt in the issue of *Die Wissenschaften* for May 26. According to Dr. Kuhlbrodt the north polar regions are covered by a cap of cold air which thins out as it extends downwards into temperate latitudes and ends in general about latitude 40°, but may disappear at latitude 50° over a few degrees of longitude. Above the cold cap is a considerable thickness of warm air derived from the south and having a motion to the east. Where the surface of separation of warm and cold air comes down to the earth's surface at an unusually high latitude a cyclone is produced, which is carried to the east by the movement of the warm air. The distribution of wind and weather to be expected in such a region is shown to be in agreement with observation.

WEATHER AT BLUE HILL, U.S.—Meteorological observations made at the Blue Hill Observatory, under the direction of Prof. Alexander McAdie, during 1921, are published in the Annals of the Astronomical Observatory of Harvard College. The observational data complete an unbroken period of thirty-six years, 1886–1921, and include pressure, temperature, wind direction and velocity, humidity, sunshine, cloudiness, and precipitation. It is estimated that the series should extend over at least fifty years for the establishment of proper normals. A table is given showing advance of the seasons for thirty-six years, 1886–1921. It is interesting to note that the earliest autumn frost for the whole period occurred on August 21 in 1908, and in this year the first snowfall in autumn occurred on December 7, which is the latest of the whole period, an anomaly which would scarcely be expected. The rainfall table giving the monthly amounts for the several years shows a large and varying range of measurement in all months. The average annual rainfall is 46·59 in., ranging from 4·7 in. for March to 3·20 in. for June.

A DIFFERENTIAL REFRACTOMETER.—Messrs. Bellingham and Stanley, Ltd., has constructed a differential refractometer for measuring very small differences between the refractive index of two liquids. The design of the instrument is based on the method described by Hallwachs. The liquids are contained in a glass cell and are separated by a thin glass plate. Light from the source is admitted to the liquid of lower refractive index at grazing incidence on the separating glass plate, which it traverses and then passes through the second liquid at a small angle to the glass plate, the magnitude of this angle depending on the difference between the refractive indices of the two liquids. By means of an observation telescope the axis of which is approximately in the plane of the separating glass plate, the limiting position of the emergent ray from the cell can be observed and the position measured by the screw motion which rotates the cell with its supporting table. In the case of liquids having indices approximating to that of water a difference in index of 0·00001 corresponds to an angle of emergence of about $\frac{1}{3}$ of a degree. The instrument can thus be made extremely sensitive, and is particularly valuable for the detection of small quantities of impurities in liquids.

Annual Visitation of the National Physical Laboratory.

A LARGE number of visitors were present at the National Physical Laboratory on the occasion of the Annual Visitation on June 27. The guests were received by Sir Charles Sherrington, president of the Royal Society and chairman of the General Board; and Sir Joseph Petavel, Director of the Laboratory. As is usual on such occasions, the various departments were thrown open and an interesting series of exhibits was arranged, illustrative of the work carried on in the institution.

In the Department of Aerodynamics, exhibits were shown in most of the six wind tunnels. In the largest of these, which has a cross section of 14 ft. × 7 ft., an aerofoil model was set up showing the methods of measuring the lift and drag. The section of the aerofoil under test was on a scale approximately one-fifth of full size. In another channel were shown additions made to the standard type of balance, whereby for one setting of the model the component forces and moments in three directions can be determined. This represents a considerable saving of time in the process of testing. The discontinuous flow of air past a barrier was demonstrated in an effective manner by means of smoke released into the stream of air before it reached the obstacle. Other exhibits included an aeroplane model showing the method of obtaining the distribution of pressure over the wing, an apparatus used for determining the thrust and torque of model propellers, and an ingenious wind direction finder.

The additions to the Engineering Department, consisting of a large experimental shop and a set of offices, have been completed during the year and have much relieved the congestion. Among the exhibits were two machines for testing the efficiency of spur gears and chain drives. In both of these machines the regenerative principle is made use of, so that the power consumption is only that absorbed by the element under test. Thus, to determine the losses corresponding to an actual transmission of 100 h.p., a power of the order of 5 h.p. suffices. The efficiencies can be measured to an accuracy of 0·1 per cent. A new machine for testing reinforced concrete slabs and columns was also shown. The slab specimens can be tested in sizes up to 16 ft. × 6 ft. and 14 inches in thickness, and the columns from 8 to 20 feet in length; the maximum load is 60 tons. It was interesting to note that it was found possible to support the columns by means of knife-edge pivots. During the year, a plant has been completed for the production of asphalt road carpets. This enables the constituents to be mixed accurately in the proper proportions, prior to laying and testing in the standard road-testing machine. Other exhibits in this department included apparatus designed for the measurement of the temperature and pressure of the oil film in lubricated journals, the investigation of heat losses through pipe covers, the determination of the fatigue ranges of stress in materials by the strain method, and for the investigation of the detonation of a mixture of air and liquid fuels in closed vessels.

In the Metallurgical Department, a much-needed extension of space has been provided during the year by the addition of an extra floor on the Wernher building. Considerable attention has been devoted in this Department during recent years to the study of aluminium and its alloys, and examples were shown of an alloy developed at the Laboratory which is specially suitable for aeroplane engines. Pistons and piston rings of this material were on view. A specimen of aluminium was exhibited which had been submitted many times to an alternate treatment of rolling and melting without any effect on its tensile strength. A very effective experiment was shown on specimens of an aluminium-zinc alloy, which were heated in a furnace at a temperature of 370° C. and then quenched by immersion in water. Within a period of five minutes, a considerable generation of heat occurred—due to the breakdown of an unstable solid phase—which rendered the specimen almost too hot to be held in the hand. An interesting series of micro-photographs, taken during this period, showed the structural changes occurring, which are accompanied by great variation in hardness.

In the section of the department dealing with refractory materials, a new recuperative gas furnace, working under natural draught, and intended for glass melting, was running, while in the section of aeronautical chemistry the viscosity method for characterising deterioration of fabrics was demonstrated. Other exhibits in the Metallurgical Department were a high temperature thermostat arranged for obtaining very slow rates of cooling, and an ingenious relay for controlling furnace currents.

In the Heat Division of the Physics Department, various methods for the measurement of thermal conductivity were demonstrated. These included a new apparatus for dealing with thin sheets of material and for studying the effects of pressure on the thermal conductivity, a large scale apparatus for experiments on insulators for cold storage purposes, and a similar apparatus which has been used for measuring the conductivity of a series of building materials. A method for investigating the convection of heat in transformer oils was shown and also a device for the automatic operation of a ventilating valve with small changes of temperature of the air inside and outside a room. Various types of hygrometers were also exhibited.

In the Thermometry Division a new type of resistance bridge was shown with dials reading to 0·001° C., with a platinum thermometer of 10 ohms fundamental interval.

In the Radiology Division apparatus designed for the X-ray spectroscopic investigation of structure of materials, the measurement of radium salts, the standardising of barium platino-cyanide pastilles, the investigation of protective values of X-ray materials, and the X-ray examination of metals were exhibited.

In the Optics Division, various types of apparatus for measurement and specification of colour were shown. These included a Nutting monochromatic colorimeter, a Lovibond tintometer, a Bawtree colorimeter, and a trichromatic colorimeter for standardisation purposes designed and constructed at the Laboratory. In the latter instrument the mixing of the three primary colours is accomplished by rotating a periscopic prism which passes rapidly in front of three sectorial openings of variable angles in which the coloured filters are placed. Among the exhibits in this division was also a differential refractometer for liquids having nearly the same refractive index, while a new immersion method for measuring the internal bore of a glass tube was also demonstrated.

The Metrology Department (Glass Testing Section) showed a new equipment designed for the accurate calibration of hydrometers against a hydrostatic balance. The liquid in which the hydrometer is immersed is surrounded by a water bath controlled by a thermostat. The whole of this apparatus can be moved under a special balance from the scale pans of which are suspended two plummets of the same mass but differing in volume by 100 c.c. The density of the liquid is thus obtained directly by weighing and is compared with the hydrometer under investigation. The balance is of special construction and is provided with inertia bobs at the ends of the arms to counteract the damping due to the movement of the plummets through the liquid. Other exhibits in the Metrology Department included a series of instruments for the precision measurement of engineers' gauges and a vertical interference apparatus for testing the flatness of surfaces, line standards and comparators.

In the Froude National Tank experiments to determine the resistance of a ship form in artificially created waves, and the method of taking continuous records of resistance, pitching angle and pitching period were demonstrated. The object of this work is to obtain data as to the loss of speed of different designs of ships under service conditions. It is interesting to note in this connexion that observations of full size ships have been taken by members of the staff in voyages across the Atlantic in three types of vessels, liners, cargo steamers, and oil tankers. Apparatus was also shown for determining forces on a ship's rudder, the manœuvring power of a ship's form, and the resistance of a seaplane model on the surface of the water.

Many interesting exhibits were on view in the various sections of the Electricity Department. The Photometry Division showed a method of determining the spectral distribution of energy in arcs having cores of different materials, and of measuring the transmission ratios of coloured glasses intended as standards for ships' navigation lights.

The Alternating Current Section demonstrated the speed regulation of a D.C. motor by means of a relatively small phonic motor directly coupled to it. The Direct Current Section showed apparatus for experiments on moulded insulators and other insulating materials, tests on buried cables and on energy losses in a 3-core cable with three-phase current.

In the Standards Section, an air gap for dielectric tests on mica and thin sheet materials was shown. This consists of very accurately flat steel plates 12 cms. in diameter, separated by distance pieces of quartz, so as to give an accurately parallel gap. The apparatus can be taken apart and the gap reproduced to within 0·0001 mm. In connexion with the abovementioned apparatus, a machine of the optical lever type has been evolved for measuring the thickness from point to point of sheets of mica or other thin material.

A standard multivibrator apparatus for radio-frequencies was shown by the same section. In this apparatus a wave with a sharp peak is produced, having a frequency of 1000 per sec. From this, by the help of a highly resonant circuit, every harmonic up to the hundredth may be picked out, thus providing a series of accurately spaced radio-frequencies. The fundamental is kept constant to 1 part in 100,000 by a tuning-fork control. A second multivibrator, which can be controlled from the first one, has a fundamental of 30,000 per second and gives a further series up to 1,000,000 per second.

In the Wireless Section, directional measurements of spark and continuous wave stations were shown, the photographic reception of signals on a string galvanometer, and a new type of thermo-junction ammeter for high frequency.

Agricultural Research in Great Britain.

THE "assistant principal" at the Ministry of Agriculture, Mr. V. E. Wilkins, has prepared a valuable pamphlet,[1] which gives a useful account of the various forms of agricultural research that are being supported financially by the State. As is well known, the Ministry decided to concentrate research at definite institutions; Rothamsted is concerned with plant nutrition, soil problems, and plant pathology; Cambridge has entrusted to it plant and animal breeding, and animal nutrition; Long Ashton, a branch of the University of Bristol, deals with fruit growing and preserving; plant physiology is dealt with at the research institute attached to the Imperial College of Science; dairying at Reading; animal pathology at the Royal Veterinary College; agricultural zoology at Birmingham; helminthology at the London School of Tropical Medicine; agricultural economics in Oxford; plant breeding, with particular reference to Wales, at Aberystwyth; fruit growing and hops at East Malling; and nursery and market gardening at Cheshunt. Besides these research institutes and stations the Ministry has set up a system of advisory centres from which information in respect of specific subjects is disseminated by advisory officers who also, in many cases, undertake a certain amount of research.

(*a*) *The Soil and its Effect on Plant Growth.*—This fundamental subject has been entrusted to the Rothamsted Experimental Station, which is concerned, among other things, with the examination of the soil in its relation to bacteria and protozoa, and an account is given of the arduous nature of the research along these lines. The nitrification of organic nitrogen alone has demanded the services of eight research workers, who in many cases have worked night- and day-shifts. An interesting form of investigation undertaken at this station is concerned with the production of artificial farmyard manure. During the later stages of the war, and subsequently, until the agricultural policy of the Government was altered, there was a prospect of a superabundance of straw, more, in fact, than could be dealt with as food and litter by farm animals. The Rothamsted investigators set about devising a means of converting this straw directly into farmyard manure, and the results are most encouraging, although now, with the reduced area of tillage land, the necessity for such conversion is no longer pressing.

At the same station much work has been done on the influence of colloids on the water-content of soil, and on the mechanical operations concerned with tillage. Most ingenious electrical methods are also being exploited to determine the relation between soil acidity and crop production, and the list of publications that have been issued from Rothamsted during 1920 and 1921 shows the extraordinarily varied character of the work being conducted at this famous station.

(*b*) *Plant Breeding.*—The problems that are being investigated along this line are concerned with the baking qualities or strength of English wheat, with the production of cereals possessed of a straw stiff enough to stand up under adverse circumstances, with immunity to disease, with the increase of the number of grains in the ear, with the production of hardier varieties of winter oats, with the relationship of nitrogen in barley grain to the quality of the produce, and with the production of potatoes immune to wart disease. These problems are being dealt

[1] "Ministry of Agriculture and Fisheries. Agricultural Research and the Farmer: A Record of Recent Achievement." By V. E. Wilkins. Pp. 168. (London: H.M. Stationery Office, 1922.) 2*s*. 6*d*. net.

with chiefly at Cambridge; while Aberystwyth, the Welsh plant-breeding station, is concerned principally with the discovery of the production of new and improved herbage plants which must be so important in the West of England from the point of view of pasture and meadows.

(c) *Plant Physiology*.—The chapter on this subject opens with a suggestive discussion on the fundamental principles involved in crop production. These principles are concerned with the causes that determine heavy cropping and light cropping, resistance to disease, and the formation of flower-buds on fruit-trees. The electrical treatment of crops is also receiving attention at Rothamsted, the Harper Adams Agricultural College, and on a station near Dumfries. To quote from the report, " There is no doubt that electrical discharge will increase plant growth, and it is hoped that it will be found possible to continue the patient experimental work that has been going on for some years, for it seems certain sooner or later that electricity must play an important part on the farm in increasing crop production."

(d) *Fruit-growing and Preserving*.—Fruit problems are being dealt with mainly at the horticultural station at Long Ashton and at East Malling in Kent. Much suggestive work has been done on the problem of fruit stocks, a subject that has hitherto been very confused and unsatisfactory. The Paradise stock, for instance, has been proved to be a mixture of several varieties, and it would appear that even the crab stock may be graded into several classes, each of which has a distinct influence on the scion that is grafted or budded on to it. This subject is inseparably connected with the development of the root system, a line of research to which the late Mr. Pickering gave much attention, showing that it was quite unnceessary to give the amount of attention that is usually bestowed upon planting. This unexpected result appears to have been confirmed at Long Ashton, the original root system playing practically no further part in the growth of the transplanted tree, which seems to develop a new root system independent of the old. Work on ringing, pruning, disbudding, etc., also promises to have an influence on commercial production, while much light is being thrown upon the problem of manuring of fruit. This station has also contributed largely to our knowledge of the factors that determine the production of high-grade cider and perry.

(e) *Plant Diseases*.—In no department of the Ministry's scheme has more activity been shown than in the direction of plant diseases. At the School of Botany in Cambridge special attention has been given to the silver leaf disease, a trouble that is increasing markedly in this country, and is now no longer confined to plums, but has spread to apples and other fruit-trees. How destructive the disease may be is proved by the fact that an apple-orchard of about 6 acres, near Wisbech, showed more than 1000 trees attacked by this disease, the cause being attributed to carelessness in pruning and the neglect to protect the wounds thus caused.

Space does not permit of the publication of details in the departments of animal husbandry, animal breeding, dairying, animal diseases, and agricultural economics, but enough has probably been said to show what an enormous change has come over the country in respect of the provision for agricultural research under the enlightened policy pursued by the Ministry of Agriculture.

The Magnetic Work of the Carnegie Institution.[1]

By Dr. C. CHREE, F.R.S.

THE primary object of the volume referred to below is to chronicle the results of observations made on land by members of the Department of Terrestrial Magnetism of the Carnegie Institution, Washington, from 1914 to 1920. During that period 1747 stations were occupied, bringing up to 4028 the number of land stations occupied since the world survey began in 1905. Even the general reader will find much to interest him in the field observers' reports on pp. 98-222. Mr. F. Brown, for instance, who travelled over large areas in China, Mongolia, Manchuria, Upper Burma, the Cameroons, and French Equatorial Africa, and who crossed Central Africa from Angola to Mozambique, relates adventures with brigands, lions, witch doctors, and native kings.

There is also a general account of the land instruments employed, references being made to earlier volumes for constructional details. Plate 2 gives illustrations of the instruments supplied by the Department to Captain Roald Amundsen's *Maud* expedition. On p. 9 there is an explanation of the two standards which have been used, the earlier denoted by C.I.W. (Carnegie Institution, Washington), the later by I.M.S. (International magnetic standards). The use of the latter term for standards which have not received international sanction is somewhat open to criticism.

The observational results occupy some 67 pages, and later in the volume there is a detailed description of the stations. Some of the more picturesque places visited are illustrated in seven plates.

[1] Researches of the Department of Terrestrial Magnetism, vol. iv.: Land Magnetic Observations 1914–1920. By Dr. L. A. Bauer and others; and Special Reports. (Publication 175). Pp. vi+475+9 plates. (Washington: Carnegie Institution, 1921.)

Mr. J. A. Fleming describes the construction at the headquarters of the department, at Washington, of a new non-magnetic building for experimental work. It is of considerable size, 28 ft. × 53 ft. ground area, of double-walled concrete. Provision is made for the supply of water, gas, compressed air, and electric circuits for direct and alternating current. The cost, exclusive of the internal equipment, was 8500 dollars. A magnetic survey made after the completion of the building showed differences of 2′ in dip and 25γ in horizontal force between the north and south ends.

Mr. H. W. Fisk discusses errors arising from minute pivot defects in dip needles. He advocates the use of at least four needles at each station, so as to recognise with certainty when an individual needle becomes faulty.

A description by Mr. S. J. Barnett of a new sine galvanometer for determining H (horizontal force) is of special interest at the present moment. The construction of similar instruments has been simultaneously in progress in America, Japan, and England. The instrument described by Mr. Barnett is much smaller than that recently described to the Royal Society by Mr. F. E. Smith. Its coils, of approximately 30 cms. diameter, are wound on Carrara marble. An approximation is made to the Helmholtz arrangement, but the coils are really spirals. It is hoped to measure H with an error less than 1 in 10,000. A preliminary comparison with the I.M.S. standard mentioned above gave a discrepancy of only 0·7γ, or 1 part in 25,000, but the constants of the instrument are as yet to some extent provisional.

Mr. J. A. Fleming also deals with the results of comparisons, direct and indirect, between Carnegie Institution instruments and the standard instruments in use at a number of observatories. He claims that the results show, first, that the Carnegie Institution standards are in every way satisfactory, and second, that "the absolute precision obtainable with carefully designed magnetometers and (dip) inductors, provided instruments are carefully used and comparisons are made with reliable standards at least every two or three years, is of the order 0'·2 in declination and inclination and of the order 0·00015H (*i.e.* 3γ in England) in horizontal intensity." If this be true, the gain in accuracy to be hoped for from coil instruments is not great. If, however, as stated on p. 468, a complete observation of H with the coil instrument occupies only 2 minutes, its use at an observatory would represent a great economy of time, always provided little time is spent on keeping the apparatus up to the mark.

However this may be, what is really more wanted is a coil instrument for measuring V (vertical force). Base line values of V curves are at present dependent on dip circles or inductors. Even if the accuracy claimed by Mr. Fleming for dip inductors be conceded, it must be remembered that an error of 0'·2 in the dip at a place where the value of H is only 0·03 (the approximate value at the base station of the Australasian Antarctic Expedition 1912–13) leads to an error of about 90γ in V. Thus a coil instrument which could give V directly, to within ±5γ even, would be an immense improvement on a dip inductor for use in high latitudes.

New Social Coleoptera.[1]

By Dr. A. D. Imms.

If we regard as truly social only those insects in which the parent, or parents, live with their offspring, protecting and feeding them, there have been known hitherto but three groups of beetles which come into this category, namely, the Platypodidæ, Scolytidæ, and Passalidæ. Prof. W. M. Wheeler has recently added to the list two genera of Silvanid beetles belonging to the family Cucujidæ, discovered by him in British Guiana. The beetles in question are *Coccidotrophus socialis* and *Eunausibius wheeleri* both of Schwartz and Barber. The bulk of his observations concern the first-mentioned insect, the other species being apparently rare. The beetles enter the hollow petioles of a Leguminous tree Tachigalia and either bore their way in, or gain admittance through perforations previously made by other insects. They enter either as a single pair, or one beetle enters and is very soon joined by an individual of the opposite sex. Upon taking possession of their future habitation the beetles remove any loose pith, or the remains of previous tenants, by pushing this debris into the pointed ends of the cavity by means of their flattened heads. This behaviour brings the insects into contact with the outermost layer of pith adhering to the walls of the cavity, and certain strips of nutritive parenchyma. The latter tissue forms the food of the beetles, and is also shared by young Coccidæ of the species *Pseudococcus bromeliæ*, which soon begin to enter the petiole-cavity. By means of the feeding action of the beetles, the strips become converted into grooves, the coccids stationing themselves in a row in each groove. The beetles carefully avoid soiling their food material and store their frass in the areas between the grooves. They lay their eggs along the frass ridges, and the larvæ which hatch out feed upon the same nutritive parenchyma as their parents. When mature, they construct brown cocoons within which pupation occurs. The beetles emerging from the latter remain in the petiole with the original pair; they mate and produce eggs and larvæ in turn, thus leading to the climax stage of the colony, which may eventually consist of several dozens of beetles of both sexes, and many larvæ and pupæ in all stages of development. The Coccidæ also increase in number, so that the cavity of the petiole sometimes becomes crowded with inmates. In the meantime, the old and exhausted beetles die off, and their bodies are consigned to the refuse accumulations already mentioned. When this crowded condition is reached, beetles begin to leave the colony either singly or in pairs and, seeking other petioles, thus found new colonies.

Both the larvæ and imagines of the *Coccidotrophus* solicit honey dew from the coccids by "stroking" the latter by means of the antennæ. The relations of the beetle to the coccids, moreover, are physiologically similar to those of symphile beetles to host ants that supply them with regurgitated liquids. *Coccidotrophus*, like the symphiles, has specially modified antennæ and labium, such modifications occurring in both the larvæ and adults. This type of relationship with Coccidæ has not been noted hitherto in any Coleoptera and, apart from ants, very few insects are known to have developed the ability to solicit honey dew from among the Homoptera.

It appears that the Sylvanids have a more primitive social life than any of the three families of beetles previously alluded to, but there is no definite preparation of larval food by the parents. Their colonies represent a stage in social development intermediate between the families mentioned and the merely gregarious species of Cucujidæ. For further details, and many interesting observations on the numerous and heterogeneous "biocœnose" of other insects associated with the plant Tachigalia, the reader is referred to Prof. Wheeler's original paper.

[1] W. M. Wheeler, "A Study of some Social Beetles in British Guiana and of their Relations to the Ant-Plant Tachigalia," *Zoologica*, New York, vol. iii. Nos. 3-11, Dec. 24, 1921.

Spectroscopic Studies of Stellar Velocities.[1]

By Dr. William J. S. Lockyer.

In order to determine the distribution and motion of stars in space it is necessary to know four important facts about each star. The first is its position, known as its Right Ascension and Declination; the second is its proper motion, *i.e.* the movement at right angles to the line of sight; the third is the radial velocity or movement towards or away from the earth; and lastly, the parallax or distance of the star from the earth.

During the last few years the accumulation of a large amount of such data, extending over many years, has led astronomers to the important problem of investigating the systematic motions of the stars

[1] "The Radial Velocities of 594 Stars," Publications of the Dominion Astrophysical Observatory, Victoria, B.C. (vol. 2, No. 1), by J. S. Plaskett, W. E. Harper, R. K. Young, H. H. Plaskett (Ottawa, 1921).

and their distances, thus leading to our knowledge of the distribution of stars in space, and finally to the structure of the universe.

At the present time, however, data are most lacking regarding stellar radial velocities, and any attempt to increase our knowledge in this respect deserves particular attention. It is, therefore, very satisfactory to know that, when planning the equipment of the Dominion Astrophysical Observatory of Victoria, B.C., the first consideration was given to its suitability for this class of work, which it is proposed to make the great feature of the new institution. Quite recently the first volume of measures has been published, and this comprises the determination of the radial velocities of 594 stars between the fifth and eighth magnitudes, the velocities of which have not been measured before.

The work was commenced in May 1918 by the Director of the Observatory, Dr. J. S. Plaskett, and Dr. R. K. Young. In the following year Mr. W. E. Harper and Mr. H. H. Plaskett joined the staff, so that this volume is the outcome of the endeavours of these four observers, who together made the observations, the measurements and the reductions of the spectrograms, as no computing assistance was available.

The introduction to the volume describes briefly the telescope, the spectrograph, the observing arrangements, measuring machines, wave-lengths of spectral lines employed, etc. The telescope was the large 72-inch reflector, and the spectroscope was used with the Cassegrain combination of the telescope. The regulation and control of the temperature in the spectrograph was at first attained by the use of a mercury contact thermometer actuating a special relay, but this was replaced later by the installation of a Callendar recorder. Considerable attention was devoted to the wave-lengths of the lines employed in the reduction of the spectrograms, and the system eventually adopted was one developed by Dr. Young, which is to some extent a compromise of different methods and systems used by various observers. Tables showing the standard wave-lengths employed are given, and they indicate the wave-lengths used for B-type stars and for A- to F-type stars, together with a list of iron comparison lines.

The work accomplished may be briefly summarised by referring to the results of the measures which are brought together in various tables. The first contains the mean velocities, with their probable errors, of all stars, 537 in number, assigned to be of constant velocity, including their positions, magnitudes, spectral types, etc. Next follows a summary table of the velocities of the systems of all spectroscopic binaries, the orbits of which have been determined at the Victoria Observatory. Table IV. gives complete information as regards the details of all the 3287 radial velocity plates of the 537 constant velocity stars, an average of 6·1 plates per star. This information is concise, compact, and in a convenient form, and will be valuable for detail reference when required. Similar detailed information is given in Table V. with respect to 206 plates of 35 probably binary stars.

It is interesting to make a short reference to the accuracy of the determinations of the radial velocities, because this accuracy depends to a very great extent on the definition of the lines in the star's spectrum under examination. Thus, some spectra have clean-cut lines which render their measurement easy, while others exhibit fuzzy lines, making measurements difficult. The authors have, therefore, divided the probable errors into three classes. The first includes stars of spectral types between Fo and M (excluding some early F stars) which give the most trustworthy values; the probable errors for these range between ±0·1 and ±1·0 kms. for the mean velocity obtained from all plates, and between ±0·2 and ±2·5 kms. for a single plate. The second main class includes about one-fourth of the A-type, about two-thirds of the B-type, and the early F-type mentioned above. The probable errors for this group are given as ranging from ±0·5 to ±1·5 kms. for the mean velocity, and from ±1·2 to ±3·5 kms. for a single plate.

The last group embraces mostly A-type stars with the addition of a few B- and O-type, the lines of which are diffuse, broad, and frequently weak. For these the probable errors range from ±1·0 to ±3·8 kms. for the mean and from ±2·5 to ±10·0 kms. for a single plate.

The original programme as to the number of photographs of the spectrum of each star to be secured, namely, six plates for each star with well-defined lines and eight or ten plates with poor lines, was almost carried out; the whole system of velocities here deduced is therefore homogeneous and a high grade of accuracy has been maintained. The radial velocity values are the result of a great amount of painstaking care, and their early publication is evidence of the industry that has been displayed in all stages of the research.

Geology of Antarctic Lands.

A USEFUL reference to recent summaries of the geological features of Antarctica occurs in the Proceedings of the first Pacific Conference, part iii. p. 644 (1921). It is unfortunate that the various researches based on the results of different British expeditions have not been carried out in a common clearing-house and published as an interlocking series. At present three sets of quarto publications are appearing in our libraries, two of them under the auspices of the Royal Society of Edinburgh, and one under those of the Trustees of the British Museum. Mr. J. M. Wordie's observations on the Weddell Sea area (Shackleton expedition, 1914–17) have been already noticed (NATURE, vol. 109, p. 218). The geological results of the expedition from the Falkland Islands in 1913, financed by Messrs. Salvesen of Leith, are now described by the leader, Mr. D. Ferguson ("Geological Observations in the South Shetlands, the Palmer Archipelago, and Graham Land," Trans. Roy. Soc. Edin., vol. liii. p. 29, 1921). The unrest in the earth's crust in Oligocene and Miocene times is illustrated by great outpourings of basalt in the South Shetland Islands. The later lavas of the series are notably columnar, and are correlated with similar rocks in Patagonia. Volcanic activity continued almost down to recent times, and there is a series of andesitic tuffs and lavas that go back to Jurassic or early Cretaceous age. The photographic landscapes in this memoir are of unusual excellence. The rocks collected abundantly by its author are described by G. W. Tyrrell in a separate memoir (*ibid.* p. 57). They include the varied intrusive masses of Graham Land and its group of islands, and the red adamellite of Mount Theodore, "the most imposing natural feature" of the district. Mr. Tyrrell regards these older igneous rocks as distinctly Andean in type.

Dr. H. H. Thomas (*ibid.* p. 81) deals with the rocks and minerals collected from islands of the same region by Mr. Innes Wilson, of the Falkland Islands, in

1916–17, including a high-grade copper ore from a boulder near Port Lockroy on the Neumayer Channel. The description of the varied lavas of Deception Island in both this and Mr. Tyrrell's paper is surely an argument in favour of collation and co-operation.

The reports of the British Antarctic ("Terra Nova") Expedition of 1910, published by the British Museum, are concerned, however, with another quadrant of the antarctic region. In the geological series, Nos. 3 and 4, recent and older sedimentary deposits are described by Mr. F. Debenham, from his personal observations as geologist to the expedition. Metamorphic rocks are dealt with in No. 5; but their relationships in the field are as yet but little known. Dr. A. Smith Woodward's account (No. 2) of "Fish remains from the Upper Old Red Sandstone of Granite Harbour," including Bothriolepis, provides more definite information. The remoteness and perils of the district excuse the uncorrelated nature of the results, and no doubt also explain the handsome method of their presentation in the year 1921–22.

G. A. J. C.

Durability of Optical Glass.

By Dr. JAMES WEIR FRENCH.

IT is the custom of optical glass manufacturers to issue long lists of types characterised by their optical constants, without much regard to their qualities of durability, which are only occasionally indicated. To the practical computer these lengthy lists are not imposing. Experience has taught him that the number of sufficiently trustworthy types is really very limited, and that only in exceptional circumstances, that fortunately do not frequently arise, may an extension of his list be justified. But while the possibility remains that glass of an unstable kind may be used in the construction of his instruments, the optician has cause for anxiety in the knowledge that his reputation as well as the glass may become tarnished.

The British Scientific Instrument Research Association, the function of which is to provide for the industry the leaven of science, has been charged with the investigation of the durability of glass. According to the admirable report[1] that has recently been issued, "the object of the Research was to determine how far it was possible to establish simple tests by which the durability of different types and varieties of optical glass could be quickly ascertained without awaiting the results of experience by actual use over an extended period." To what extent this object has been attained may be realised from the frank confession at the conclusion of the report, that "it is not possible to recommend any simple test by which the durability of an optical glass can be determined, with such reliability as to avoid the chance of misleading users of the glass in some one or other application of it." With this pessimistic conclusion it is difficult to agree, as the object has already been attained in the workshop, if it is agreed that it is the reflecting or transmitting qualities of the surface with which the optician is concerned.

From the report it appears that numerous tests of Continental and British types of optical glass have been examined by the iodoeosin test of Mylius, the autoclave water and steam tests at four and two atmospheres of pressure, and the "dimming" test evolved by the Royal Arsenal Directorate of Chemical Inspection, which co-operated in the research. This dimming test is really an elaboration of the Zschimmer test. The three tests as applied indicate merely to what extent alkali can be dissolved from the surface, and, as is to be expected, the flint glass types appear more durable than the crown types—a conclusion that is misleading, as the report rightly indicates. Our industrial atmosphere unfortunately contains sulphuretted hydrogen, and if in the dimming test an atmosphere more representative of reality had been employed, the flint types would have been placed more nearly in the order accorded to them by Faraday.

The report confirms the interesting fact, already known in the workshop, that in the glass-polishing process alkali is dissolved from the surface layer, which, with a few exceptions, becomes more durable. Workshop experience shows that a new cloth polisher tested with litmus will usually be found to be slightly acid; after a few hours of working it will be neutral; and thereafter it becomes strongly alkaline. A pitch polisher reacts similarly, but it does not retain the dissolved alkali to the same extent.

The optician is concerned in practice not so much with those so-called optical glasses that are visually affected by the tests referred to, as with those that are labelled as being durable and unaffected. If a well-polished specimen of the most durable crown glass be boiled in water at atmospheric pressure for two hours and its reflecting power be then tested by means of a multi-reflection photometer, a loss of ¼ per cent. per reflection may be detected. After boiling for eight hours, the loss will be about 2 per cent., but thereafter the rate diminishes.

The drastic autoclave tests adopted in the research are not necessary to demonstrate how many of the types included in the optical glass-makers' lists are vitreous substances of but little value and a source of danger to the unwary.

[1] Report of an Investigation on the Determination of the Durability of Optical Glass carried out by T. Haigh. Pp. 51+10 plates. (British Scientific Instrument Research Association, 26 Russell Square, W.C.1.) 7s. 6d.

Volcanic Activity in Nigeria.

REPORTS have been received by the Governor from Mr. A. A. Reading, of the Bibundi Estate, of a recent volcanic eruption in the Cameroons Mountain, near the coast of Nigeria. Repeated earthquake shocks commencing on February 3 last were followed by an eruption at an altitude of about 4000 feet on the north-west side of the mountain, giving rise to a lava stream which flowed down in the direction of the Bibundi Estate, and entered the plantation area on March 3. The lava extended, roughly, one-third of a mile out to sea, and huge columns of steam were continually ascending. Attempts to photograph the scene failed on account of the dense smoke and ashes. The centre of the group of craters was estimated to be distant 9900 yards from the house at Bibundi Beach on a magnetic bearing of 128°, and the height above sea-level was believed to be about 4150 feet.

In May the northern stream was still advancing, and threatened to reach the sea along the water-courses on each side of Dollmanshohe. Sometimes there was a loud noise resembling that of a blast furnace; at other times there was a series of explosions that sounded like big guns firing. On some days there were showers of ashes, which were so heavy that they broke the leaves of the palm trees.

When on open ground the lava stream came along like a wall of red-hot rock 30 or 40 feet high, which kept falling away in front as it advanced, but when it came down the deep ravine between Wernerfelde and Retzlaffelde, it flowed like a red-hot river moving at the rate of about 2 feet a minute. Mr. Reading threw a big stone on it to see if it would make a splash, but although it was moving and looked liquid, the stone bounded off just as if the lava were solid rock.

Since the outbreak of the volcano no severe earthquake shocks have been experienced, though the house was frequently felt to be shaking and two or three slight shocks were noticed.

Mr. Reading went round the edge of the lava in a canoe where it projected into the sea. He could not approach nearer than about 300 yards on account of the heat. At that distance the sea was so hot that he could not put his hand into it, and dead fish abound.

University and Educational Intelligence.

BIRMINGHAM.—Applications are invited from graduates in medicine of the University, of not more than five years' standing, for the Walter Myers travelling studentship (value 300*l*. for one year) for research in any branch of medicine or pathology approved by the selection committee. The studentship is tenable at any university, laboratory, or other approved institution, and the holder must devote his whole time to research. Full information is obtainable from the Registrar of the University.

LEEDS.—A Gas Research Fellowship, value 200*l*. per annum, established by the Institution of Gas Engineers at the University of Leeds for the prosecution of post-graduate research in gas chemistry, has been awarded to Mr. S. Pexton. For the last two years Mr. Pexton has worked in the department of coal gas and fuel industries of the University.

LONDON.—Applications are invited for the William Julius Mickle fellowship, which is of the value of at least 200*l*., and awarded annually to the man or woman resident in London and a graduate of the University, who, in the opinion of the Senate, has done most to advance medical art or science during the preceding five years. Particulars respecting the appointment may be obtained from the principal officer of the University. All applications for the fellowship must reach him by, at latest, October 2.

ST. ANDREWS.—The honorary degree of LL.D. will be conferred on the Prince of Wales on the occasion of his contemplated visit at the end of September. There will be no public graduation ceremony.

THE Commissioners of the Exhibition of 1851 announce that Senior Studentships for 1922 have been awarded to the following: Mr. J. S. Buck (Liverpool), research student in chemistry, of the University of Liverpool; Mr. G. T. R. Hill (London), research student in aeronautics, of the University of London, University College, late experimental engineer and pilot to Handley Page, Ltd.; Mr. A. E. Ingham (Cambridge), research student in mathematics, of the University of Cambridge; Mr. J. E. Jones (Victoria), lecturer in mathematics, of the University of Manchester; and Mr. C. E. Tilley (Adelaide and Sydney), research student in geology, of the University of Cambridge. Science Research Scholarships (Overseas) have been awarded, on the nomination of the institution mentioned, as follows: Mr. J. M. Luck (University of Toronto), for biology; Mr. W. H. McCurdy (Dalhousie University), for physics; Mr. D. F. Stedman (University of British Columbia), for physical chemistry; Miss Marie Bentivoglio (University of Sydney), for crystallography; Mr. J. S. Rogers (University of Melbourne), for physics; Mr. J. C. Smith (University of New Zealand), for chemistry; and Mr. I. Low (University of Stellenbosch), for meteorology.

DR. W. D. HENDERSON, professor of zoology in the University of Bristol, has been appointed Ray Lankester Investigator at the Marine Biological Laboratory, Plymouth.

THE *Chemiker Zeitung* announces that the Society of Friends of the University of Jena has at its first annual meeting granted a sum of 700,000 marks for scientific purposes and 200,000 marks for the assistance of students. Of the first sum, 200,000 marks is for the Chemical Institute.

AN appointment is to be made by a committee of the Royal College of Physicians of London and of the Royal College of Surgeons of England of a Streatfeild research scholar. The scholarship was founded for the promotion of research in medicine and surgery and is of the annual value of about 250*l*., tenable at the discretion of the committee for three years. Applications, marked "Streatfeild Scholarship," and stating the nature of the proposed research and where it will be carried out, should reach the Registrar of the Royal College of Physicians of London, Pall Mall East, S.W.1, on or before October 2.

STATISTICS for 1920–21 of 93 State Universities and State Colleges have been published by the United States Bureau of Education (Bulletin, 1921, No. 53), under the heads—teaching force, student enrolment, and property and income. Most of these institutions were originally "Colleges for Agriculture and Mechanic Arts," and their agricultural and engineering schools are still far larger than all their other professional departments put together; but nearly all of them have departments of arts and sciences, and seventeen have graduate departments with not less than 50 students each. The largest teaching staffs are maintained in the following universities: California (1016), Cornell (905), Minnesota (837), Illinois (780), Wisconsin (731), Ohio (569), and Michigan (543). Thirty-four other institutions have more than 100 teachers. Of the total number of teachers (about 15,000) one-sixth are women. Salaries of presidents (most of whom are provided with free quarters in addition) range in general between 5000 and 12,000 dollars; those of professors between 2000 and 6000. The student (regular term) enrolments in the seven large universities named above were: 14,445, 5771, 11,282, 8739, 7573, 7584, and 9611. Forty-two other institutions have enrolments exceeding 1000. Women students constitute nearly a third of the total. Besides the regular term students there are some 60,000 summer school students, of whom nearly two-thirds are women. Almost every one of the State universities and State colleges holds a summer school. Endowments exceeding, in each case, five million dollars, are possessed by the Massachusetts Institute of Technology, Cornell University, and the universities of Texas, California, and Washington. It is remarkable that in no less than five States the private benefactions received by the State universities and State colleges during the year amounted to one-fifth or more of their total incomes.

Calendar of Industrial Pioneers.

July 16, 1824. Simone Stratico died.—An Italian engineer and mathematician, Stratico held professorships at Padua and Pavia, where he assisted Volta in his physical work, while under the rule of Napoleon he became an inspector of roads and bridges. He was also the author of works on hydraulics.

July 17, 1794. John Roebuck died.—The friend of Joseph Black and Watt, Roebuck was trained as a doctor and practised for a time at Birmingham. Turning his attention to chemical manufacture, he was successful in introducing leaden chambers in place of glass ones in the manufacture of sulphuric acid. In 1760 he founded the famous Carron Iron Works on the river Carron in Stirlingshire, but though a sound metallurgist, his business operations failed financially.

July 17, 1857. Pierre Louis Frederic Sauvage died.—Remembered as one of the independent inventors of the screw propeller, Sauvage was well known as an ingenious mechanician, and had works in the neighbourhood of Boulogne. He patented the propeller in 1832, but reaped no benefit from it; and though granted a pension by Louis Philippe, the failure of his scheme affected his mind and he died in an asylum. A statue of him was erected at Boulogne in 1881.

July 17, 1886. David Stevenson died.—A member of the well-known Scottish family of lighthouse engineers, Stevenson was trained as a mechanic, made surveys, wrote scientific papers, and with his brother Thomas (1818–1887) designed and built 28 beacons and 30 lighthouses in various parts of the world. He also took a leading part in the introduction of paraffin in place of colza oil.

July 17, 1891. Willoughby Smith died.—Entering the service of the Gutta-Percha Company in 1848, Smith superintended the making and assisted in the laying of the first submarine cables, and became chief electrician and manager of the Telegraph Construction and Maintenance Company. He made experiments on coating wire with gutta-percha, introduced improvements in cable manufacture, and was connected with the various Atlantic cable enterprises. In 1882 he served as president of the Society of Telegraph Engineers, now the Institution of Electrical Engineers.

July 19, 1879. Louis Favre died.—The son of a Swiss carpenter, Favre learned his father's trade and afterwards became noted as a builder of railways in the south of France and in Switzerland. In 1872 he became the engineer of the St. Gothard's tunnel, in the construction of which he made use of compressed air as suggested by Colladon. This tunnel is 14,900 metres in length. Favre's death occurred suddenly in the tunnel a short time before its completion.

July 22, 1869. John Augustus Roebling died.—One of the greatest bridge builders of last century, Roebling was a native of Germany, being born on June 12, 1806, at Mulhausen, Thuringia. He graduated from the Polytechnic School at Berlin, and in 1831 emigrated to the United States, where, after experience in canal and railway engineering, he founded a wire-rope manufactory. He constructed a wire-rope suspension aqueduct and a bridge over the Monongahela River, and suspension bridges over the Niagara Falls and the Ohio River, the latter having a span of 1057 feet. The success of his work led to the acceptance of his design for a great bridge over the East River to connect New York and Brooklyn, and it was while superintending the laying out of one of the towers of this bridge that he received the injury from the effects of which he died. E. C. S.

Societies and Academies.

LONDON.

Royal Microscopical Society, June 21.—Prof. F. J. Cheshire, president, in the chair.—A. Chaston **Chapman**: The use of the microscope in the brewing industry. The use of the microscope for research and control purposes has been directly responsible for greater technical advances and, indirectly, for more far-reaching discoveries in brewing than in any other industry. The larger breweries have laboratories in which both chemical and biological tests are carried out and much time is devoted to the examination of yeast, to the forcing of beers as a test of stability, to the testing of the efficiency of the air-filters, etc. The successful conduct of brewing operations depends almost entirely on such control work. The introduction of the microscope into the brewery as the result, chiefly, of Pasteur's investigations. has been responsible for the replacement of empirical methods by processes based on scientific knowledge.—J. **Strachan**: The microscope in paper-making. The microscope was introduced into the industry by amateur microscopists more than a century ago, and during the past twenty-five years, which have witnessed the application of exact scientific methods to paper-making, the technologist found the microscope already in common use. The microscope is used in the paper-mill chiefly for the analysis of paper and of its raw materials and in controlling the blending and preparation of these substances. It has also been applied to the beating process, which is largely a matter of colloid physics, and to sizing, dyeing, impurities in air and water, the valuation of new raw materials, etc. In spite of recent research work, which indicates that the cellulose basis of plants is of a uniform chemical composition, and that X-ray spectrographic methods have proved this substance to be of definite crystalline character, the constitution of cellulose remains unsettled. No important work had been done on its refractive index (about 1·555). Microscopic work on this matter and the application of the polariscope and ultra-microscope would probably yield important evidence.

Mineralogical Society, June 27.—Dr. A. Hutchinson, president, in the chair.—A. **Brammall** and H. F. **Harwood**: The Dartmoor granite; its accessory minerals and petrology. Minerals of general occurrence: tourmaline, ilmenite, magnetite, apatite, monazite, garnet, zircon [(1) in water-clear, small crystals, (2) in tawny, zoned, larger, and more abundant crystals], pyrites and pyrrhotine. More restricted: fluor (colourless, blue, and purple), topaz, cassiterite, andalusite, sphene, anatase, barytes. Biotite is abundant; muscovite is scanty. Streams have yielded, in addition, rutile, brookite, and blue-green anatase. Analyses are given of granite types (bulk), biotite, porphyritic felspars (baryta-bearing), and some accessory minerals. In the tor area (Haytor-Widecombe), the granite occurs as successive sheets or flows, differing appreciably in chemical composition. The texture becomes coarser, porphyritic felspars become more abundant and richer in plagioclase content, and the percentage of biotite and accessories increases with vertical descent in a flow. The relationship of topography to pseudo-bedding, jointing, veining, and probable faulting is discussed.—W. F. P. **McLintock** and F. R. **Ennos**: On the structure and composition of the Strathmore meteorite. From microscopical examination of thin sections of this meteorite, stones of which fell in Perthshire and Forfarshire on December 3, 1917, the structure is that of the intermediate chondrite group (Ci). An apatite-like mineral is present. Detailed chemical analyses of the magnetic and non-magnetic portions agree closely with the Baroti group.—H. F. **Collins**: On some crystallised sulphates from the province of Huelva, Spain. Analyses are given of pisanite, chalcanthite, coquimbite, copiapite, voltaite, roemerite, etc., from various pyrites mines. Experiments were made to determine the range of miscibility of iron sulphate and copper sulphate in mixed crystals of pisanite ($R''SO_4 . 7H_2O$) and chalcanthite ($R''SO_4 . 5H_2O$).—H. **Hilton**: The graphical construction of the constants of a shear. A graphical construction, based on the gnomonic projection, is given for obtaining the two circular planes of a shear, when the initial and final positions of two crystal-poles or edges are known.—H. **Hilton**: A note on crystallographic notation. A notation is suggested for the 32 crystal-classes and the 230 groups of movements, which is easy to write and print, and is based on the fundamental principles of structure-theory.—A. F. **Hallimond** and E. G. **Radley**: On glauconite from the Greensand near Lewes, Sussex; the constitution of glauconite. A boring through 325 feet of gault at Iford Manor yielded glauconite sand. A discussion of the analysis of this material and of some previously published analyses leads to the formula $R_2O . (4R_2O_3, RO) . 10SiO_2 . nH_2O$.—L. J. **Spencer**: Ninth list of new mineral names.

DUBLIN.

Royal Irish Academy, June 12.—Prof. Sydney Young, president, in the chair.—G. H. **Carpenter** and Miss K. C. J. **Phillips**: The Collembola of Spitsbergen and Bear Island. The collections made by the Oxford University Expedition of 1921 include ten species of Collembola, one of which—*Folsomia sexoculata*—is an addition to the known fauna of Spitsbergen, while another—an Isotoma closely allied to the common *I. viridis*—taken on Bear Island is new to science. Twenty species of these insects have now been recorded from Spitsbergen; seven of these have been found also on Bear Island, which possesses, in addition, four species not yet detected on Spitsbergen. Sixteen members of this arctic fauna are represented in Great Britain and Ireland, while thirteen occur in Greenland and North America. Such distributional facts suggest paths of migration to the north of the Atlantic.

EDINBURGH.

Royal Society, June 19.—Prof. F. O. Bower, president, in the chair.—J. **Stephenson**: On the pharyngeal glands of the Microdrili (Oligochaeta). The chromophil cells in the anterior segments of the body of the Microdrili have, contrary to the usual view, no direct communication with the alimentary canal, and are not cells of the alimentary lining which have retreated from the epithelial layer while still retaining their connexion with it by means of a long thin neck which acts as a ductule. They are mesoblastic in origin; in the enchytraeids (where they form the septal glands) their secretion reaches the pharynx by percolating along special strands of tissue; in all other cases special channels are wanting and the products of the cells simply mix with the coelomic fluid; their secretion is thus an internal secretion.—W. **Peddie**: On self light, fatigue, inhibition, and recurrent visual images. Formal development of the trichromatic hypothesis is made beyond the stage at which it was left at the time of Helmholtz's death. Phenomena of contrast and after images, steadily decaying or oscillatory, and phenomena of fatigue and inhibition, are treated. The trichromatic theory of colour vision is founded securely on fact.—R. A. **Fisher**: On the dominance ratio. The "dominance ratio" upon which the relationship correlations depend, when inheritance follows the Mendelian scheme, has a numerical value for certain human measurements, very near to one-third. This value presents a difficulty to the Mendelian interpretation of the human relationship correlations, in that it could occur only if the frequency ratio of the several factors were unsymmetrically distributed, in such a way that the dominant phase was commonly more numerous than the recessive phase. When, however, the effects of selection are taken into account the distribution of the frequency ratio may be calculated; the distribution obtained is unsymmetrical in the manner required, and the dominance ratio is exactly one-third. The distribution produced by selection also explains the occurrence among the non-recessives of the harmful character sometimes brought out by inbreeding.—A. P. **Laurie**: Chemical combination and Sir Alfred Ewing's magnetic atom. Sir Alfred Ewing's paper on hysteresis of iron has profound significance for the chemist, for it shows that it is possible to devise an atom of fixed and rotating magnets free from polarity, and that on the approach of another atom the rotating unit can be swung into an unstable position and then fall into a new stable position with evolution of heat. If we assume the electrons to be moving in the tiny orbits but arranged in space round a positive nucleus, the results obtained by Sir Alfred Ewing can be applied to chemical combination, ionisation, and catalytic action.

Official Publications Received.

Royal Botanic Gardens, Kew. Bulletin of Miscellaneous Information, 1921. Pp. 4+415+42. (London: H.M. Stationery Office.) 10*s.* net.

Department of the Interior: United States Geological Survey. Water-Supply Paper 487: The Arkansas River Flood of June 3-5, 1921. By R. Follansbee and E. E. Jones. Pp. 44. Water-Supply Paper 477: Surface Water Supply of the United States, 1918. Part 7: Lower Mississippi River Basin. Pp. 38. (Washington: Government Printing Office.)

Memoirs of the Department of Agriculture in India. Botanical Series, Vol. 11, No. 7: Correlation of Colour Characters in Rice. By G. P. Hector. Pp. 153-183. (Calcutta: Thacker, Spink and Co.; London: Thacker and Co.) 1.4 rupees; 1*s.* 8*d.*

Smithsonian Miscellaneous Collections, Vol. 72, No. 15: Explorations and Field-Work of the Smithsonian Institution in 1921. (Publication 2669.) Pp. 128. (Washington: Smithsonian Institution.)

Survey of India. General Report, 1920-21, from 1st October 1920 to 30th September 1921. Pp. vi+48+8 maps. (Calcutta: Surveyor-General's Office.) 2 rupees; 4*s.*

Botanical Survey of South Africa. Memoir No. 4: A Guide to Botanical Survey Work. Pp. 89. (Pretoria: Department of Agriculture.) 1*s.* 6*d.*

Southern Rhodesia. Geological Survey Bulletin No. 8: (1) The Geology of the Diamond-bearing Gravels of the Somabula Forest, by A. M. Macgregor, with Notes by the late A. E. V. Zealley; (2) On a Collection of Fossil Plants from Southern Rhodesia, by Dr. A. C. Seward and R. E. Holttum. Pp. 48+12 plates. (Salisbury: Geological Survey.)

Board of Scientific Advice for India. Annual Report for the Year 1920-21. Pp. vii+64. (Calcutta: Government Printing Office.) 12 annas.

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, Grenada, January-December 1921. Pp. iv+15. (Barbados.) 6*d.*

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, Montserrat, 1920-21. Pp. iii+33. (Barbados.) 6*d.*

Diary of Societies.

FRIDAY, JULY 14.

INTERNATIONAL NEO-MALTHUSIAN AND BIRTH CONTROL CONFERENCE (at Kingsway Hall, Kingsway, W.C.2), at 10.—Dr. C. K. Millard: Birth Control and the Medical Profession.—Dr. A. Nyström: The Necessity for abolishing Laws against Preventive Measures.—Dr. H. Rohleder: Neo-Malthusianism from the Medical Standpoint.—N. Haire: Sterilisation of the Unfit.—Dr. D. R. Hooker: Effect of X-rays upon Reproduction in the Rat.

INTERNATIONAL CONFERENCE OF SETTLEMENTS (at Toynbee Hall, 28 Commercial Street, E.1), at 10 and 2.15.—A. Greenwood, Miss E. M. McDowell, F. J. Marquis, J. J. Mallon, and others: Settlements and Industry.

SATURDAY, JULY 15.

INTERNATIONAL CONFERENCE OF SETTLEMENTS (at Toynbee Hall, 28 Commercial Street, E.1), at 10.—H. R. Aldridge, T. Adams, Capt. Reiss, Rev. D. MacFadyn, and others: The Relation of Settlements to Health and Housing Reform.

WEDNESDAY, JULY 19.

FELLOWSHIP OF MEDICINE (at 1 Wimpole Street, W.1), at 5.—V. Bonney: Myomectomy as opposed to Hysterectomy.