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Educational Training for Overseas Life.

NOT the least significant feature of the third report of the Committee appointed by the British Association to consider the Educational Training of Boys and Girls for Overseas Life, presented at the Oxford meeting, is the emphasis which is laid upon the social importance of agricultural and other practical studies. The Committee rightly states that the intellectual and cultural aspects of practical studies are too often overlooked or regarded with contempt by educational authorities who fail to appreciate the clearer vision which accompanies contact with reality and the greater interest which practical work, even if vocational in aim, arouses in the pupils themselves. As Mr. H. W. Cousins aptly remarked, in the discussion on the report, the purpose of education should be to create an interest in doing things, not in merely talking about them, a sentiment which was warmly applauded by H.R.H. the Prince of Wales, who was present.

While it is true that the work of Prof. Nunn and other educationists is gradually modifying the attitude of teachers in schools towards practical work—not merely work in a chemical or physical laboratory—it is equally true that their efforts to combat 'education by book' are hampered and discouraged by most examining bodies. The capacity of the 'bookish' pupil is easier to assess than that of the pupil whose main interest lies in acquiring understanding of, and the capacity of participating in, the activities of his particular environment. A board of examiners sitting in one of the great centres of learning, however well intentioned, must find it exceedingly difficult catering for the needs of pupils in various environments, whose education is 'practical' and suited to the special environment, but of which the examiners themselves can know very little. Their difficulties would be increased if education authorities in those of our overseas territories, which are connected for examination purposes with English universities, desired to develop a schools curriculum based on the special needs of the countries they serve.

The point might well have been made by the Committee on Overseas Training that the education of boys and girls in our Dominions, Dependencies, and Crown Colonies is more 'bookish' and less adapted to make them capable of 'deliberate adjustment to their environment'—after all, the true purpose of education—than that which is given at home. There, those who are charged with the responsibility for the evolution of a system of education have generally accepted unreservedly the system evolved to suit a very different environment. Instead of basing their system upon the needs of the many, they have subordinated it to

the English examination system in order to cater for the needs of the very small number of pupils who may proceed to England to pursue their further studies. Certain education authorities in Ceylon, it is stated, send to a biological station in England for specimens of British marine and other material prescribed for study by one of our examining bodies. It would seem obviously the better course for the examining body to prescribe for study some of the specimens which abound in Ceylon.

Kenya Colony, the only East African territory where public provision is made for the education of European children, is an abject slave to the tyranny of the London Matriculation and the Oxford and Cambridge Local (so called) examinations. Most of the children educated in the State schools in Kenya will certainly never leave East Africa for a further course of study in Great Britain. The environment to which they have to adjust themselves is essentially agricultural; an environment which demands an understanding of the black races, and a sound knowledge of the elementary principles of social and personal hygiene, and human, animal, and plant diseases; in other words, an education where the bias should be agricultural and otherwise practical, where work in the field and workshop and laboratory should be the basis of the instruction in science and elementary anthropology the basis of the 'humanistic' studies. Nothing of the kind has been attempted. The syllabus of instruction is that prescribed for the 'literary' side of the English examinations; there are no workshops, there are no laboratories, there is no provision for practical work in the field. Where 'science' instruction is given at all it is 'out of the text-book.' What knowledge the children have of the native races is acquired in a school of experience which is calculated to breed contempt for them, and sow seeds of racial antagonism. Both the blacks who come within the sphere of influence of the State schools, and the Indian children, are being better educated than the children of the Europeans.

The most obvious commentary upon the type of instruction given in schools in Australia is the disproportionate size of its cities. Appeals for immigrants are made to compensate for the flight of colonial-born agriculturists from the land to the social amenities of towns, and the reluctance of Australia's urban unemployed to transfer to the land. Much the same problem faces all our self-governing dominions. This problem of education is of world-wide significance and of especial importance to the British nation, which bears a grave burden of responsibility for the development of so great a proportion of the world's natural resources and of the backward races. It is sufficiently important to command much of the attention of the statesmen of the Empire who will shortly be gathered together for another Imperial Conference. Education is not a subject remote in its bearings upon Imperial policy; it lies at the root of it. Upon the type of instruction which is given in our educational institutions at home will depend largely the character and outlook of the administrators of the scientific and technical experts in tropical possessions, and of the settlers in British dominions. Administrators could be produced whose training and educational achievements would be a guarantee that they would combine understanding of the problems inherent in the development of the natural resources of a country and the development of the soul of a people; and the scientific and technical services could be manned by those who combined knowledge of their craft with understanding of primitive crafts and a realisation of the social and political significance of the introduction of European ideas and processes among backward peoples.

If the needs of the better instructed elements among the Britons who proceed overseas are such as to demand considerable changes in the education which is given them as a preliminary training, the needs of the secondary school boys and girls destined for overseas work is greater. Whether they go to the tropics, where they must perforce have intimate contact with backward peoples, or to the self-governing dominions, there are certain obstacles which 'personality' alone cannot overcome, but 'character' based upon knowledge, capacity, and grit can. Prejudice against a newcomer wishing to introduce new methods into production is the commonest of diseases. But prejudice is not best overcome by pandering to the 'oldest inhabitants' fixed notions of what is right, but by proving the greater efficiency of the new. It is doubtless true, as Mr. Ormsby-Gore said at Oxford, that overseas farmers prefer to deal with 'raw' rather than instructed new settlers, that they prefer a man who has had no agricultural training in England to the man who has, because the methods overseas are vastly different from those at home. It does not follow, however, that the overseas man on the spot is sound in his prejudices. His methods may be thoroughly unsound. The home-trained man's methods, even applied in a new country, may be thoroughly sound in principle.

The most important aspect of the problem of land-settlement is the outlook of the settlers upon their work. Not the least significant feature of the flight from the land is the material sacrifices which those who are forsaking agriculture are prepared to make for the greater amenities of town life. The only apparent remedy lies in an education system which will bring greater contentment to the comparatively

isolated land worker. It is not easy to prescribe the exact form which this remedy must take, but it is fairly clear that it must depend upon the quickening interest of the workers in their vocation. No greater harm could be done to the cause of agriculture than by ceaseless reiteration of the material benefits arising from its pursuit. There is a limit to credulity and gullibility.

What is wanted is for the Imperial Conference to take an intelligent interest in this problem. It is more vital than tariffs; without even a partial solution much of the work of the politician and financier and trader will be wasted. An Imperial Education Committee is of more importance even than an Empire Marketing Board. It will not suffice to refer the problem of education to a committee of expert educationists; the responsible leaders among the statesmen of the various dominions and Crown colonies must be prepared to consider the whole problem with the experts and to make their own contribution to the discussions. They must let the educationists know what they hope from them: they must be prepared to fight for the necessary changes in educational policy in the countries for which they are responsible. Above all, they must assist the true educationist to rid himself of the examination blight. They must encourage a spirit of experimentation in educational method and realise that a stereotyped Prussian system of instruction, towards which we have been retrogressing while even the Prussians themselves have commenced to react against it, will kill the soul of any people.

The eminent persons who spoke at Oxford, ostensibly in support of the recommendations of the Overseas Training Committee, cannot be said to have laboured the essential features of the report. They gave the impression that a social veneer was a greater attribute to a man than social qualities. It cannot be overemphasised that the latter depend upon knowledge based upon a sound education system. According to one speaker, it was more important for a man proceeding overseas to have gone to the right type of school than it was for him to have acquired the right kind of knowledge, based upon an intensive technical training. It is a pity it is not more generally recognised that this curious snobbery is responsible for more of the defects in our administration system and our comparative failures in Imperial affairs than any other factor.

One other point which emerged in the discussion is of some interest, and this is the one which was raised by Mr. Ormsby-Gore in connexion with the staffing of the education and scientific services in the Crown Colonies. He stated that the Crown Colonies are in the greatest need of expert educationists and first-class scientific advisers. At present the demand exceeds the supply and it is impossible to fill many of the vacancies which existed. This he contrasted with the ease with which the late German administration in East Africa had built up its wonderful research institutions. It can only be hoped that this was not special pleading on the part of Mr. Ormsby-Gore to justify the chronic neglect of the British administration of once world famous institutions. The fact is that it is only within the last two years that the slightest appreciation has been displayed, either by the local governments of East Africa or by the Colonial Office, of the obvious fact that upon the education and scientific services the whole future of East Africa will depend. There would be no difficulty in obtaining the personnel for either of the services if the proper inducements were offered, and if the Colonial Office and the other governments would realise that it is not merely material inducements which will make the East African services attractive; conditions of service are just as important as salary, and the Colonial Office should realise that it is sometimes possible to offer a large salary without attracting candidates, because the acceptance of the post would rob the man appointed of all title to the respect of his fellows.

Indian Witchcraft and Primitive Forms of Belief.

Religion and Folklore of Northern India. By William Crooke. Prepared for the Press by R. E. Enthoven. Pp. iv.+471. (London: Oxford University Press, 1926.) 21*s.* net.

WHEN the history of the study of 'things Indian' is written, the name of the late William Crooke will rank high. His erudition was vast, and his range of reading immense, while his sanity of outlook and grasp of matters of fact guided him among the many pitfalls which have beset the paths of theory in Indian ethnology. It was these qualities which made him a particularly safe guide to the student and accounted largely for the high repute of the pioneer work in his little book "An Introduction to the Popular Religion and Folklore of Northern India," first published in 1894. It was reissued in 1896, and is now published posthumously in a third edition, but entirely rewritten in the light of further information.

It is scarcely necessary to stress the importance of Crooke's work in the study of the primitive religions of India. His contact with the village population in the course of his duties as an official of the Civil Service led him to the study of their beliefs and ritual. These he found represented a type very different from those of the priestly class and those described in the sacred books of the Brahmans. His investigations ranged

over the whole of northern India to the Nerbada River, and took in the population of the west coast and the Deccan. This area had been overrun by many waves of foreign incursions flowing over an indigenous population. Its inhabitants included primitive Mongoloids, represented by the tribes of the Assam frontier and the Kols and allied tribes, Dravidians such as the Gonds and Oraons, and in the Punjab, Indo-Aryans, Persians, Greeks, Sakas, Indo-Parthians, Huns, and Mongols.

The study of this medley of races revealed that the superficial uniformity of the widely adopted Hinduism embraced a variety of beliefs ranging from primitive animism to the worship of deities of the orthodox pantheon. In fact, Crooke's researches showed that while some conformed to Hinduism, owing to the rise in social status which followed the adoption of Brahmanism, and yet retained the cults of their tribal deities, others regularly resorted to the village, caste, or tribal godling in times of crisis, drought, famine, or pestilence. On the other hand, there went on *pari passu* a process of adoption of the godlings of the animistic peoples into the Hindu pantheon. Of such were the benign Devi, traced back to one of the manifestations of Dharti, the earth mother, Kali, a deified tigress, and on a lower scale not yet fully of orthodox rank, Hanuman the ape and Ganesa the rat. These latter are the Dvārāpalas, 'doorkeepers,' of the temple of the greater gods. The story of these local deities and of their development out of the strictly local cult into a more widely, or even generally, recognised object of worship is a pregnant chapter in the history of religion.

It is not without significance, and it is at the same time interesting to note, that among the many heroes who are objects of a cult appear the names of several Englishmen and an Englishwoman, whose tombs are treated with special reverence and to whose spirits offerings are made. The ghost of Capt. Cole, killed in 1804, is propitiated with offerings of wine and cigars; another, the spirit of a bibulous official, with beer and whisky; while the tomb of Col. W. Wallace of Sirur in Poona is worshipped on Thursdays and Sundays "in fulfilment of vows made for the cure of barrenness."

It would be difficult to single out any one topic as especially worthy of mention where so much is of interest and importance, whether in relation to the more primitive forms of belief among the Indian peoples themselves, or as affording material for comparative study. There is, however, one line of inquiry for which the religious, social, and racial conditions make northern India an especially promising field. Dr. Crooke's last chapter deals with the black art and witchcraft—a subject which offers occasion for many interesting questions. What, for example, is the relation between practitioners of white and black magic, and at what stage of development do they become differentiated? The Shaman, or medicine man, who may, and indeed often does, practise both forms of magic, develops on one hand into the orthodox magician or priest whose function is normally exercised to the advantage of his social group and its members, on the other into the witch whose action is malevolent and anti-social. The priest may still practise black magic, as do some Brahmans, with impunity. The Jackdaw of Rheims was cursed 'by book and by bell' as effectively as if he had been the victim of the blackest magic. The witch is destroyed or cast out.

The term 'witchcraft' is constantly used loosely in describing magical practices of primitive peoples, but it should imply more than the occasional use by any individual of magical practices for malevolent purposes. The witch of northern India as described by Dr. Crooke is one who performs harmful acts through the control of evil spirits. In European witchcraft, while the basis of the belief was purely magical, as can be seen even in the Bull of Innocent VIII., where the witch was said to blast crops, harm cattle, and bring disease and death to human beings—just as the Indian witch—yet the essential element in the legal and theological definition of a witch was the fact that she had entered into a compact with the devil from whom her power was derived. This no doubt goes back to the practice of the early Christian Church, which regarded backsliders into paganism as devil worshippers, and witchcraft was closely connected with heresy. But it is also significant that the Templars, who were reputed to have brought their alleged magical practices from the East, were accused of trafficking with and controlling evil spirits.

Indian witchcraft affords some curious and interesting parallels to the European belief. The witch is marked out by her appearance. Dhanwārs in the Central Provinces, for example, detect a witch by the sunken and gloomy appearance of the eye. Ovid mentions a double pupil as characterising a witch; in Wales she can be detected by the inversion of the image reflected in the eye. Unlike the European witch, almost invariably a hag, the Indian witch is beautiful. The witch acquires her art by a course of instruction. Among the Santals the novice, with a lamp in her hand and a broom tied to her waist—note the appearance of the broom—is taken to be married to one of the Bongas or spirits. The parallelism of the European methods of initiation is not exact but is sufficiently close. Again, Indian witches possess familiars, a cat or a tiger, and they themselves take on animal form. The use of a waxen image to harm an enemy, a practice which goes back to early Babylonia and Egypt, and is familiar in European witchcraft, is also noted. One of

the most remarkable feats of the Indian witch in this connexion is the 'abstraction of and eating a man's liver,' of course without his knowledge until he realises that he has been bewitched and in what manner. European witches sometimes 'extracted the heart' in much the same way. Finally, in both Europe and India a witch is detected by casting her into water to see if she will sink or float.

We may conclude with a much travelled story. Lona, an Indian witch noted in legend, performed an incantation for a young man over a hair supposed to belong to the object of his affections. Unfortunately for him, he had been deceived by a slave and the hair had been taken from a sieve which burst into the room immediately the magical rite had been performed. The same story is told of John Fian, the leader of the witches who conspired against James I.; but in his case the hair was that of a heifer, which incontinently pursued him, to his great embarrassment and confusion.

Storm and Stress.

(1) *Pleasure and Pain: a Theory of the Energic Foundation of Feeling.* By Paul Bousfield. Pp. x+114. (London: Kegan Paul and Co., Ltd.; New York: E. P. Dutton and Co., 1926.) 4*s.* 6*d.* net.

(2) *The Adolescent Girl: a Book for Parents and Teachers.* By Dr. Winifred Richmond. Pp. xv+212. (New York: The Macmillan Co., 1925.) 5*s.* net.

(3) *The Gang Age: a Study of the Preadolescent Boy and his Recreational Needs.* By Dr. Paul Hanly Furfey. Pp. xiv+189. (New York: The Macmillan Co., 1926.) 8*s.* 6*d.* net.

OF recent years, emotion as the driving and guiding principle, which shapes our lives and determines our behaviour, has occupied the attention of psychologists to a greater and greater extent. More particularly have they attempted to study from a scientific aspect that period of difficulty through which every boy and girl must pass as the simpler adjustments of the home give place to the wider emotional relationships of society. To the individual adolescent the period is still as stormy as it was to Goethe, and the adult is only groping his way to an understanding which will enable him to help. The question of what emotion is remains unsettled, and while all authorities regard the affective reactions of pleasure and pain as important constituents, they are by no means unanimous as to their exact relation to appetite, instinct, and emotion.

(1) Dr. Bousfield has approached the problem of pleasure and pain by attempting to explain the apparent paradox of the pleasure of enduring pain. First of all, he maintains that the fundamental disposition in all animals is a reaction to stimuli in such a way that tension will be reduced. Even such instincts as self-preservation and race preservation are not innately given, but the result of social influences in each generation. He demonstrates the rise and fall of tension by means of diagrams, and points out that pleasure does not exactly correspond to the fall of tension, since the maximum of pleasure depends rather on the rate than on the extent of the fall.

During life, tension is never completely relaxed, since there is always a degree of postural tone in all tissues. There may be no conscious awareness of this, but there may be an unconscious desire to retreat from this permanent tension (the death instinct of Freud).

With the advent of prospective imagination, pleasure may be induced by the prospect of relief of tension, and as a result a temporary slight diminution may ensue, although it still persists at a relatively high level. This may prolong and intensify pleasure, and with the alternations of prospective relief and actual imposition of tension the subject may even experience pleasure in painful situations.

(2) Without going into the abstruse question of the derivation of emotional reactions, Dr. Richmond, in "The Adolescent Girl," deals with the difficulty of adjustment of these reactions to the demands of society. A brief survey is undertaken of primitive cults and ceremonies in relation to the change in the girl's life, and a description is given of the physical and mental alterations incident to puberty. She points out that neurosis and delinquency easily arise out of the conflicts of this time, and that it is a matter of some wonder that the 'normal' girl does emerge from the welter of conflicting subjective impulses and objective influences. No attempt is made to discuss the root causes of troubles which arise, but sound advice is given to parents and teachers as to the upbringing of the adolescent, so that they may be alive to the possibilities of disaster and recognise the early signs of trouble, to the end that skilled assistance may be sought before it is too late.

(3) Similarly, Dr. Furfey deals with the preadolescent boy of ten to fourteen years, a period which he designates the gang age, since the child ceases to be individual and discursive in his interests, but concentrates his whole attention on the work of his activities in play. Dr. Furfey regards this phase as one of paramount importance in the normal development of the boy, and therefore one which ought to be supervised most carefully and skilfully. He quotes several case records to illustrate derivations from the normal at this time, and gives good advice as to the proper management of the child at this period of life. As he points out, the average child spends much more time in recreational

than in intellectual activities, and educationists may have neglected the former too much in favour of the latter. It may be advisable for the boy to be allowed a certain freedom to follow his individual bent in recreations, but during the gang age, when individualism is in abeyance, guidance is both wholesome and necessary. R. G. G.

Root Habits and Growth.

Root Development of Field Crops. By Prof. John E. Weaver. (McGraw-Hill Publications in the Agricultural and Botanical Sciences.) Pp. xii+291. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1926.) 15*s.* net.

FROM time immemorial observations and notes have been made on the aerial growth of crop plants under varying conditions of cultivation, and an extensive literature has arisen thereon. On the other hand, the subterranean growth has received little attention, and accurate information as to the relation between shoot and root growth is remarkably meagre. During recent years a few investigations have attempted to remedy this, the most notable contributions being those of Howard in India, and Prof. Weaver and other workers in America. The mechanical difficulties of root investigations *in situ* are such that satisfactory work can only be done where the soil and subsoil are of such a nature as to permit excavation without undue expenditure of time and labour and excessive danger of breaking the roots while their course is being traced. During the last twelve years Prof. Weaver has extensively developed the technique of root excavation by means of systems of trenches, and the volume under review aims at presenting the main American results which have been set forth in detail elsewhere.

The preliminary chapters deal briefly with soil characteristics as correlated with plant growth, and an excellent epitome is given of root structure and development, an elementary aspect of matters which is seldom lucidly explained. From the general point of view, one of the most important sections is that dealing with root habits in relation to crop production. Root growth is often extremely rapid, being so much as $\frac{1}{2}$ inch per day in grasses and 2-2$\frac{1}{2}$ inches per day in maize, the total root development being extraordinarily great as compared with the top growth, especially in the early stages. The ratio between the dry weight of shoot and root is often used as a standard of comparison between different plants, but scarcely represents the truth. The real measure of the functioning of a root lies in its absorbing surface, and a very finely branched root has a much greater surface and is far more active in working than a thick, heavy root with few branches.

Weaver opposes the idea, often stated in standard text-books, that crop plants in general are shallow-rooted and that only the top 6 or 8 inches of soil are suitable for growth. A consideration of the conditions under which root investigations have been carried out in various places, however, would lead one to suppose that the nature of the subsoil must play a most important part with regard to root penetration and the absorption of water and nutrients. In deep, easily worked soils and subsoils, such as apparently have been investigated in Nebraska, most crops are able to penetrate well, to develop an extensive root system, and so to commandeer larger stores of deep-seated water and food supplies. In other areas, where a comparatively shallow soil overlies a heavy intractable subsoil, many crops are unable to penetrate far and so gain a character for being shallow-rooted, while a few are able to go rather deeper in spite of the subsoil, and are therefore considered to be inherently deep-rooted. Further work under varying soil conditions will be needed to clear up many of the debatable points raised in the present volume. In humid regions the unproductiveness of the subsoil is recognised, whereas in arid regions this is not so. Greater root development occurs where plant food is plentiful, and this has an important relation to agricultural practice, influencing the depths of manuring, the type of fertiliser used, and the depth of ploughing, according to the crop grown. Tillage methods, as such, may not influence root habit directly, the changes in growth induced by tillering being really in response to differences brought about in the physical and chemical conditions of the soil and subsoil. Varying rooting habits may be turned to commercial advantage, for by growing mixed crops, which tap different soil layers for their water and nutrients, an increased total yield may be obtained. The reason that some weeds are more detrimental to certain crops than others may be because they absorb water and nutrients from the same level as the cultivated plants.

The root habits of native plants afford a useful indication as to soil conditions, and give some guide as to the crop plants that are most likely to succeed. This is specially the case in areas where the water content of the soil is the chief limiting factor to growth, the prevalence of scanty, short vegetation indicating conditions that are unfavourable or even hazardous for crop production. The detailed investigations on the root growth of individual crops not only bring out clearly the difference between one crop and another, but also the variation induced by different methods of cultivation, such as by spring and autumn sowing in wheat. In barley and sugar-beet, particularly, root penetration is much affected by the type of subsoil, as over a dry subsoil a mass of roots is formed in the

surface soil, whereas deep penetration is achieved under other conditions.

An outstanding feature of these investigations is the care and accuracy with which the illustrations have been prepared. Photographs and ordinary sketches proved unsatisfactory in field work, and a method has been evolved whereby each root, as it is traced, is mapped into position on a vertical scale, horizontal maps also being made for certain plants, such as pumpkins, maize or cacti, in which the roots spread widely. A description is given of the method of excavation which has proved so remarkably successful on the type of soil dealt with, and a good bibliography rounds off a volume which fills a definite gap in the annals of agricultural botany and suggests many starting-points for further investigations. W. E. B.

Our Bookshelf.

Animals of Land and Sea. By Austin H. Clark. (Library of Modern Sciences.) Pp. xxxiv+276. (New York: D. Van Nostrand Co.; London: Chapman and Hall, Ltd., 1925.) 15*s.* net.

THIS is a good book, but misses being a very good book. It is full of interesting facts, but they are not always well arranged. Mr. Clark's knowledge is extensive and often peculiar, but he has not digested it well: too many of the chapters read like the outpourings of a notebook, not free from unnecessary repetition. Finally, the numerous figures are so dispersed through the book that they can scarcely be said to illustrate the text: thus, opening at random, one finds thirty-four drawings of "biting and parasitic flies, and some maggots and pupae of flies" facing a page that deals with flying-fish. Biting flies were discussed some hundred pages earlier, but there was in the text no reference to these figures; for any further explanation of them one must hark back to the list of text-figures. Possibly the publishers are responsible for this lack of co-operation, for it is a too common fault in popular books written to order. None the less, the authors are to blame, and it is surprising to find a man of Mr. Clark's vigorous personality permitting this indignity.

Towards the end of the book the method improves. The chapter on animal flight is on the whole excellent: it works out certain ideas and subordinates the facts and observations—many of them original—to the main arguments. Yet even here some of the cargo might have been jettisoned with advantage. The chapters on "The Basis of Life in the Sea," "The Intermediate Foods of the Sea," and "The Ocean and the Land"—a contrast between their inhabitants—also puts the facts in a novel light that may reveal points of interest even to those who know them already, and may suggest fresh lines of inquiry. We are acquainted, in a sort of a way, with hundreds of facts that we do not realise; we must fit them into a scheme and see their mutual relations before our acquaintanceship matures into knowledge. It is because Mr. Clark has acted increasingly on this principle that his later chapters are more effective than his earlier. The penultimate chapter—"Life's Borderlands"—which brings together the extremes of temperature, pressure, and the like, under which life can exist, is remarkably interesting.

To write a book of this kind in such a way as to attract a large public is no easy task. The entire and not wholly inexplicable ignorance that most otherwise well-educated people display regarding their fellow-creatures, especially the inhabitants of the waters, presents an almost insuperable obstacle to the writer or speaker who wishes to interest the ordinary man in these aspects of life. We hope Mr. Clark will be found to have succeeded, for his aim, prudently kept in the background, is one with which readers of NATURE will sympathise.

Le Relief de la terre: ses origines, ses lois, son évolution; principes nouveaux de géographie physique. Par Paul Soulier. Pp. x+432+3 planches. (Paris: Félix Alcan, 1925.) 30 francs.

THIS interesting, if not very convincing book may be described as a fugue with the hypsographic curve as its principal theme; a hypothetical structural curve derived from it as the answering subject; the geochemical cycle of water, often repeated, as the counter subject; and a final *stretto* in which these and many related episodes are worked up into an all-embracing explanation of terrestrial relief. The author supposes the effects of denudation and deposition never to have taken place, and shows that the hypsographic curve is then transformed into a simple structural curve. He deduces from this that the structural relief of the earth's surface follows the statistical laws of chance, and therefore, ignoring the implications of isostasy, he rejects Wegener's well-known deduction from the hypsographic curve. Erosion has accentuated the upper concavity of the 'original' curve, and the continental plains and shelves have developed on the middle regions of the structural surface by the accumulation of sediments.

A summary of various theories of mountain building is given and all the existing hypotheses are rejected as inadequate. The author then suggests that water passes down through the surface rocks to an underlying "active orogenic zone," where it promotes aquo-igneous fusion and a general expansion of the materials there present by a process of hydration. The activities of the orogenic zone are made responsible for all the puzzling phenomena of vulcanism, compression, and tension, and for the surface relief of the moon and of Mars as well as of that of the earth. The gradual lowering of the surface of the oceans, due partly to the intensification of relief and partly to the internal absorption of water, leads to the conception of islands developing into continents by coalescence and the uplifting of peripheral mountain systems.

M. Soulier's theory of the earth is not likely to win acceptance, for it runs counter to the modern trend of geophysics. In particular it ignores the effects of radioactivity, and introduces instead a hydrothermal process that seems quite incompetent to produce the results ascribed to it. Nevertheless, the book is original in method and stimulating in thought, and it certainly deserves to be read by those interested in the evolution of the earth's surface features.

Geographie der Moose. Von Prof. Dr. Th. Herzog. Pp. xi+439+8 Tafeln. (Jena: Gustav Fischer, 1926.) 27 gold marks.

WHILE many writers have published works on the anatomy and taxonomy of mosses, Prof. Th. Herzog has struck out on a new line in his recently published volume and given an account of their geographical distribution together with that of the Hepaticæ. He has done for the mosses what Dr. H. Christ did for the ferns in his "Geographie der Farne." Unlike the older writers on plant distribution, he does not give his results in statistical tables but follows the examples of Prof. E. Warming in his "Oecology of Plants," and in the first 74 pages gives an interesting account of the factors, both internal and external, which influence the choice of a habitat, and distinguishes between distribution by spores and by asexual vegetative means. By this method it becomes easy to realise why some species have a wide range while others are confined to a restricted area.

The section dealing with the substratum upon which mosses grow is of special interest and contains lists of species which are confined to either acid, neutral or basic rocks, or to two of them, or (like *Brachythecium rutabulum*) will thrive equally well on any of the three. The epiphytic species are also dealt with in this section. This is followed by 136 pages, in which the distribution of the various families is discussed in detail.

The third section deals in a similar way with the geographical regions and gives numerous examples of the species characteristic of them. A few maps are inserted; that on p. 214 shows clearly the parallelism in distribution in widely separated areas of Gigaspermum and the genus Callitris belonging to the Cupressineæ, namely, north-west Africa, South Africa, and Australia. This Herzog terms "Disjunktionen." The book, which concludes with a classified bibliography and two indexes, one geographical, the other of genera and species, is illustrated with 151 text figures and 8 plates, Fig. 70 showing the various forms of thallus which occur in Aneura. The work should form a stimulating contribution to the literature of bryology.

C. H. W.

The Relation of Nature to Man in Aboriginal America. By Prof. Clark Wissler. Pp. xx+248. (New York and London: Oxford University Press, 1926.) 16*s.* net.

IN the text of this volume Dr. Clark Wissler follows closely a course of lectures at the Wagner Free Institute of Science, Philadelphia, which he delivered under the Richard Westbrook Free Lectureship Foundation. It is an admirably lucid exposition of the method of attacking anthropological problems by the study of distribution, and as such it is deserving of careful attention apart from the application of that method to the specific problems of aboriginal America to which the earlier chapters lead. The subjects reviewed are samples of the material culture, segregated distribution, social traits and somatic traits, and finally distribution form and its meaning.

The method is one of special importance in the study of American culture, where indeed there is a peculiarly favourable field for its employment. Its application to the somatic problem is especially instructive in view of the conclusion generally held by American anthropologists as to the homogeneity of the aboriginal population, notwithstanding differences such as that found in head-form. On the ecological side of the inquiry, Dr. Wissler's conclusion is that there is good ground for suspecting that the principle of concentric distribution is an ecological phenomenon universal to the more specialised form of plant and animal life, including man. Dr. Wissler's book is a most valuable and stimulating contribution to the method of anthropological study, but why will he, in common with many other scientific writers, especially in the United States, treat the words *fauna* and *flora* as if they were feminine singular nouns and endow them with an entirely superfluous plural in *æ*?

The Pedigree of the Human Race. By Prof. Harris Hawthorne Wilder. Pp. xiv+368. (New York: Henry Holt and Co., 1926.) 3.25 dollars.

IN spite of its title, Prof. Wilder's book refers to the races of mankind only in the last chapter. It is a compilation of a great deal of interesting information relating to the comparative anatomy of the Primates. But it scarcely fulfils the expectation the title suggests, for there is relatively little serious discussion of the pedigree. In a work dealing with man's ancestry, it is rather surprising to find no mention of Propliopithecus, perhaps the most interesting link in the chain, and an absence of reference to the leading works on the subject of the book.

The classification of the Primates is peculiar. The Tarsiidæ are included in the sub-order Anthropoidea. Though much might be urged in excuse of such a course, it can only create unnecessary confusion; and the student who critically studies the differential tables on pp. 25 and 26 will certainly be at a loss to discover why Tarsius is put under the heading Anthropoidea and not under Lemuroidea, seeing that it is cited as exceptional in respect of every feature enumerated and in most of these agrees with the Lemuroidea. Then again, alongside this ultra-modern treatment of Tarsius the antiquated idea with regard to Chiromys is retained. This specialised member of the Indrisinæ is removed from its own family and a special sub-order is made for its reception.

The book contains a large series of useful illustrations.

The Annual Register: a Review of Public Events at Home and Abroad for the Year 1925. Edited by Dr. M. Epstein. Pp. xiv+330+180. (London: Longmans, Green and Co., Ltd., 1926.) 30*s.* net.

THIS invaluable work of reference again gives a complete survey of the world's history during the past year in a small compass and a readable form. The customary arrangement is followed, of considerable sections devoted to Great Britain and the Empire, with smaller sections on other States. There are also surveys of the literature, science, art, drama and finance of the year, and a record of events. Appendices give the full text of the Locarno Treaties, the Irish Boundary Agreement, the Irish Bill 1925, and the Russo-Japanese Treaty. The work has now reached its 167th annual issue.

Letters to the Editor.

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

Microstructure of Mercury.

IN the course of investigations on dental alloys and amalgams, which we have carried out at the National Physical Laboratory on behalf of the Dental Investigation Committee, Department of Scientific and Industrial Research, we have thought it necessary, for the full study of the constitution of the amalgams, to undertake their microscopic examination. As mercury, and the amalgams rich in mercury, must be completely solidified for this purpose, it has been necessary to devise means for the preparation, etching, and photo-micrography of specimens at very low temperatures. Most of the work has been done by means of a paste of carbon dioxide snow and acetone.

FIG. 1.—Microstructure of pure mercury. Magnification: ×100.

Surfaces suitable for microscopic study have been prepared by allowing the metal to solidify in contact with glass, and such surfaces have been successfully etched by electrolysis in hydrochloric acid (sp. gr. 1·12 at 15° C.). It has also proved possible to polish the frozen specimens, but so far it has *not* been found possible to etch surfaces prepared in that way.

Special devices have been used for keeping the lenses of the microscope, etc., free from deposits of frost during examination and photography. Fig. 1 is a reproduction of a photograph showing the typical microstructure of solid mercury under a magnification of 100 diameters; we believe that this is the first time that such a structure has been recorded.

WALTER ROSENHAIN.
A. J. MURPHY.

The National Physical Laboratory,
Teddington, Middlesex,
July 30.

The Damping of Pendulous Jets.

IN a previous letter to NATURE (April 11, 1925, p. 530) the behaviour of liquid jets from a moving source was discussed theoretically, and supporting experimental data were presented. Dr. Julius Hartmann reviewed the subject in the issue of NATURE of June 6, 1925, p. 872, and arrived at confirmatory conclusions, though adopting a different mode of attack and manner of statement. Both of these communications treated the particles constituting the jet as though in free flight. The possibility of their being subject to viscous constraints while in flight was alluded to in the former paper, but Dr. Hartmann detected no such damping effects under his conditions of observation. Lately, Mr. Walter Thompson and I have examined the damping effect, and as the conclusions admit of concise statement they are presented herewith.

To recall the experimental conditions it may be stated that we have under consideration a jet of liquid issuing vertically downward, and that the container is subject to a linear, horizontal, oscillatory motion, and, in a particular case, a simple harmonic motion. The problem is the description of the horizontal motion of the jet at lower levels. It may be very simply shown that if the particles of the jet are acted upon during their fall by no force except gravity, and if the time of fall to the level considered is T, then the displacement of the jet from an arbitrary initial position will be $X = s + T\,ds/dt$. In this equation s represents the displacement of the container from its initial position at the instant of release of the particle observed. If damping forces, such as might be supplied by viscosity, are present, the particle, and hence the jet, will fall short of the displacement X defined above.

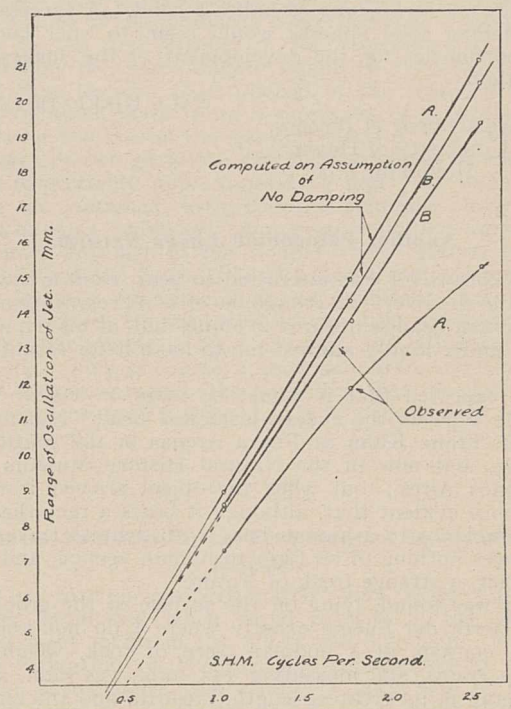

FIG. 1.—Effects of frequency and viscosity in diminishing the range of oscillation of jets. *B* curves are for a viscosity of 0·75 poises; *A* for 6·4 poises. Times of fall, about 0·75 seconds.

We experimented with six different oil mixtures, varying in viscosity from 0·75 to 6·45 poises, but otherwise physically similar. The specimen studied

was delivered from a cylindrical glass nozzle in the bottom of a container which executed horizontal simple harmonic motion of adjustable amplitude and period. Following the reasoning of the free-fall equation given above, one may readily compute the jet amplitudes to be expected, in the absence of damping, for any particular applied simple harmonic motion. Measuring jet amplitudes by a variety of methods, including photographic, we have compared actual with predicted values in several hundred cases.

It is learned that with low frequencies (one cycle per second or less) all of these liquids show amplitudes agreeing with the simple no-damping predictions, but that all of them, even the least viscous, show diminished amplitudes when the frequency is greater than two cycles per second. The more viscous the liquid the lower is the frequency at which this damping first appears. After its first appearance, damping always increases with increasing frequency, but at a slower rate with less viscous liquids. The variation of the damping threshold with viscosity is such as to indicate that only a liquid of zero viscosity would be entirely free from damping at high frequencies. Damping is very nearly independent of amplitude, though a slight increase with increasing amplitude may be observed.

The accompanying diagram (Fig. 1) illustrates the effects of both viscosity and frequency on the jet amplitudes.

These findings are of interest in connexion with the suggested use of recorded jet motions for the absolute measurement of seismic or other accelerations. The proposals are discussed in the communications to NATURE referred to above. It now appears impracticable to arrange a jet of any liquid which shall be sensibly undamped at frequencies so high as four cycles per second, and yet be viscous enough to fall unbroken for so long as half a second. A succession of falling solid spheres would seem to offer better opportunities for the development of the suggested method.

PAUL KIRKPATRICK.

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University of Hawaii,
Honolulu, T.H.

Another Patagonian *Lusus Naturæ*.

RECENTLY I was interested to hear, from a friend, of the discovery in Patagonia of a representation of a human head sculptured in stone, and, at his request, the finder kindly allowed me to have it for examination.

I expected that it would be more or less of the same type as the rudely fashioned head [1] found by Prof. Franz Kühn at Punta Arenas in the south of Chile, and now in the Natural History Museum of Buenos Aires; but when the object arrived it was at once evident that, although it bears a remarkable resemblance to a human head with definite features, it owes nothing of its form to human agency, and is, in fact, a strange freak of Nature.

It was found, lying on the surface of the ground, in Tierra del Fuego, exactly where I do not know, and consists of a nodular piece of rock, weighing 1750 grams, and measuring 155 mm., 115 mm., and 75 mm. in its greatest length, breadth, and thickness respectively (Fig. 1). The surface is covered with a greyish patina, except where rubbed off on the projecting parts, which are of a dark, metallic grey colour. In appearance the stone resembles basalt, and is very probably an altered rhyolitic rock, but its nature cannot be accurately determined without submitting a section to examination under the petrological microscope. At one end there is an ancient fracture, and when the stone is set up on this

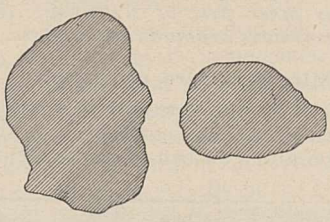

FIG. 1.—Vertical and horizontal profiles of the stone: scale ¼.

as a base, it has the appearance of a bearded head, as may be seen from the photograph (Fig. 2). The fact of the fracture occurring at what seems to be the neck serves to strengthen the illusion, giving the impression that it is a head which has been broken from a statue.

FIG. 2.—One side of the stone, from an untouched photograph: scale nearly ¼.

South America has gained an unenviable notoriety as the source of periodical announcements of sensational palæontological and archæological discoveries, which, when investigated, generally prove to have no foundation in fact. The affair of Paso Ibáñez, in which a lump of sandstone was put forward as a fossil human skull of Tertiary age,[2] will yet be fresh in the memories of many, and the purpose of this note is to prevent any misconceptions as to the true nature of the object described, should it ever figure in the daily Press either as yet another 'proof' of the existence of Tertiary man in South America, or as a remarkable example of stone carving by the prehistoric inhabitants of Patagonia.

G. A. GARDNER.

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Dwi-Manganese in Native Platinum.

CHEMICAL EXAMINATION.—Native platinum was long ago the subject of investigation and the search for elements not yet discovered. Kern, in the year 1877 (*Chem. News*, 36, 1877, and 37, 1878), A. Guyar

[1] This is figured by R. Hauthal, "Zwei bemerkenswerke Funde im südlichen Patagonien" (Congrès International des Américanistes. *Compte rendu* de la XXIe Session, deuxième partie, tenue à Göteborg en 1924, Fig. 6a, p. 518), Göteborg, 1925.

[2] The story of this extraordinary 'discovery' has been told by J. Imbelloni, "Nota sobre los supuestos descubrimientos del doctor J. G. Wolff en Patagonia" (*Revista de la Universidad de Buenos Aires*, vol. 51, pp. 39-51), Buenos Aires, 1923, and "L' uomo terziario fossile della Patagonia e la sua veridica istoria" (*Revista mensile del Touring Club Italiano, Le Vie d' Italia e dell' America Latina*), Milan, 1924.

(*Chem. News*, 40, 59, 1879), Kurtz (*Trans. Amer. Inst. Min. Eng.*, 33, 347, 1903), A. French (*Chem. News*, 104, 283, 1911) and many others claimed to have found new elements in native platinum. These 'discoveries,' however, have not been confirmed. In 1925 W. Noddak, I. Tacke and O. Berg (*Die Naturwissenschaften*, No. 26, pp. 167-174, 1925) published a paper stating that they found in native platinum from the Gorablogodatski region, Ural, an element of atomic number 75. The quantity of the discovered substance was, however, so small (about 1 mgm.) that it was not possible to carry out conclusive experiments.

We have tested the native platinum systematically for the presence in it of dwi-manganese (No. 75). The platinum (mixed) was treated chemically, and the final products were investigated Röntgenographically. Dwi-manganese would have been easily detected if it were present in the native platinum in quantities pointed out by Dr. Noddak, or even 10 or 100 times less than that. As a matter of fact, the Röntgenographs obtained prove with certainty the absence of dwi-manganese in native platinum in a quantity exceeding 0·0003 per cent.

Our investigation thus settles the question about the presence of manganese analogues in native platinum in the negative sense. It is also very likely that eka-manganese, a closer analogue of manganese and a rarer element in the earth's crust, is not present in native platinum. Druce (*Chem. News*, 131, 273, 1925) and Heyrovský (NATURE, November 28, 1925, p. 782) seem to have chosen a more trustworthy way, assuming that dwi-manganese is associated with manganese and not with platinum.

O. ZVJAGINSTSEV.

The Platinum Institute,
Academy of Sciences of U.S.S.R.,
May 1.

RÖNTGENOGRAPHICAL EXAMINATION.—The investigation of the spectra was carried out either with Siegbahn's vacuum spectograph or with Müller's spectrograph with Hadding's tube. In both cases the Röntgenographs were obtained with calcite crystal by the method of a fixed crystal. For the determination of the wave-lengths of unknown lines, the lines $K\alpha_1$Cu, $K\beta_1$Cu and $L\alpha_1$W were chosen for reference lines (the substance under investigation mixed with about 5 per cent. tungsten was deposited on the anticathode of copper). The wave-lengths of the unknown lines were calculated from the following formula:

$$Ctg\ (\theta_2 - \theta_x) = \frac{a_{1x}}{a_{2x}} \cdot \frac{a_{23}}{a_{13}} \cdot \frac{\sin(\theta_1 - \theta_3)}{\sin(\theta_2 - \theta_3)\sin(\theta_1 - \theta_2)} - Ctg\ (\theta_1 - \theta_2),$$

where θ_1, θ_2 and θ_3 denote the angles of deflexion for three given lines and a_{1x}, a_{2x}, a_{13} and a_{23} denote the mutual distances between the lines, measured with a comparator.

On Röntgenographs obtained with Müller's spectrograph, the doublet $K\alpha$Cu was well resolved (the width of the lines was 0·06 mm. with equal breadth of the slit).

The accuracy of measurements of wave-lengths was 0·4 X.U., but no lines were found in the region where the K lines of the element 75 would be expected.

M. KORSUNSKI.
N. SELJAKOW.

Physico-Technical Röntgenological Institute,
Leningrad, May 1.

Kaufmann's Experiment and the Spinning Electron.

IN a paper in a recent number of the *Zeitschr. für Physik*, Wentzel has published a calculation of the X-ray screening constants on the basis of the spinning electron. He obtains values of the screening constants which are much larger than those experimentally determined, so raising a difficulty in the way of the acceptance of the spinning electron. Wentzel introduces into the calculations a force $1/c(\mu[vX])$ (μ = magnetic moment of spinning electron, v = velocity, X = electric field) the exact analogy of the force $e[vH]$ on a moving electric charge in a magnetic field.

It can readily be shown that, if this force is accepted as having a real existence, Kaufmann's experiment is conclusive against the spinning electron. In this experiment the moving electrons are subjected to the action of parallel electric and magnetic fields. The deflexions of the electrons due to the actions of the fields are thus perpendicular to one another, and in the case of the spinning electron there will be an additional deflexion due to the force $1/c(\mu[vX])$. This deflexion will be in the same plane as that due to the magnetic field. Then, taking the simple theory of the experiment (as given, for example, in Richardson's "Electron Theory of Matter"), we have for the deflexion in the plane parallel to the condenser plates

$$x^1 = \frac{(He \pm X\mu/c)z'(z' - z_1)}{2mv},$$

the $\pm$ sign being required because of the spatial quantisation of the spinning electron in the magnetic field.

Since now $X = ncH$, in which n is a factor of the order 1/2 in Kaufmann's experiment, and $\mu = 2eh/4\pi m$ or two Bohr magnetons, it can be seen on inserting the values of the constants concerned that the quantity in the first bracket in the expression for the deflexion is approximately equal to $He(1 \pm \frac{1}{2})$. It will thus be seen that, instead of the trace on the photographic plate being a single arc of a parabola, this, for the case of the spinning electron, will consist of arcs of two parabolæ, the x co-ordinates of which are respectively approximately $\frac{1}{2}$ and $\frac{3}{2}$ of those of the arc obtained with the non-spinning electron. Kaufmann's published photographs do not appear to show any sign of this double trace. Hence, provided that the force $1/c(\mu[vX])$ has a real existence, Kaufmann's experiment shows definitely that the free electron cannot possess any spin comparable with that required by Goudsmit and Uhlenbeck's theory. This, of course, applies only to free electrons, and does not preclude the possibility that the electron may possess such a spin when it is a constituent part of an atom.

L. C. JACKSON.

Liver Extracts in the Treatment of Malignant Disease.

THE liver is proportionately very large during early fœtal life when rapid growth is the most prominent factor in the life of the organism. Since the formation of bile has not commenced at this stage of existence, the relatively large size of this organ may be attributed to the probability that it exercises some influence on the growth of the body. This effect would be brought about presumably through the medium of an internal secretion. As malignant disease in its various forms is primarily a manifestation of abnormal cellular growth, I attempted to determine the presence of such an

active principle and to isolate it in a form suitable for therapeutic use.

The work was initiated in the laboratories of the Hamilton General Hospital with the co-operation of Dr. W. J. Deadman. Extracts of fœtal pig livers were used during the earlier stages of the work on animals. Later extracts of both fœtal and adult pig livers were employed in the clinical work. The preparations were first administered to mice in which Marsh tumour tissue had been transplanted, an equal number of transplanted animals being untreated and used as controls. It was noted that as compared with the controls the extension of the transplanted tissue was arrested in the mice under treatment, and with repeated injections distant from the site of the tumour, a total necrosis of the transplants occurred. The degeneration of the tumour tissue did not take place in the centre of the mass as normally occurs, but commenced at the periphery of the growth.

The work was afterwards transferred to the McGregor-Mowbray clinic of Hamilton, which has borne the entire expense of the earlier chemical investigation, and under the supervision of which all the clinical research has been carried out. The preparations which were originally employed contained relatively small quantities of the active principle. Recently the co-operation of Profs. A. Bruce Macallum and A. A. James, of the Department of Biochemistry of the University of Western Ontario, London, has been enlisted, and they have developed a preparation from beef livers which contains the active principle in a highly concentrated form and can be rapidly and economically prepared. These preparations effect no changes in the blood pressure.

The clinical results to date in those patients who have received the treatment may be summarised as follows: in one patient there was complete disappearance of the tumour mass; in others still under treatment a reduction in the size of the growth has been noted. In every case the progress of the disease has been arrested and the life of the patient prolonged beyond that of the prognosis given before treatment commenced. So far only inoperable and otherwise hopeless cases have been treated. No radical claims are advanced for this treatment, but the results obtained clinically have warranted a more extensive investigation which is now being carried out at the University of Western Ontario, London, and the McGregor-Mowbray Clinic, Hamilton.

This preliminary communication is made for the purpose of scientific record.

JOHN R. HOWITT.
Department of Biochemistry Medical School,
University of Western Ont.,
London, Ont.,
July 8.

Kammerer's Alytes.

As I was intimately connected with Dr. Kammerer's visit to England in 1923, and as his specimens were unpacked in my laboratory and examined there before being taken to Cambridge, perhaps I may be allowed to make some comments on Dr. Noble's communication to NATURE of August 7. As to the present condition of the Alytes, about which there has been so much controversy, I know nothing. Dr. Przibram's view that the specimen after its return to Vienna was allowed to fade and macerate and that then a clumsy attempt at 'faked' restoration was made, appears to me probable. But this specimen was demonstrated to a continuous stream of critical observers for a whole afternoon in the Zoological Laboratory at Cambridge by Dr. Kammerer, who removed it from its case and invited examination under a lens. We all saw the spines; it was these and not the colour which convinced us. Dr. Noble may set his mind quite at rest as to the former existence of nuptial asperities.

I possess a print of the photograph which shows them —it is not a question, as Dr. Noble imagines, of two or three spines but of a whole series of minute spines regularly spaced which can be clearly seen in profile along the edge of one of the fingers.

In the attack which he made on Dr. Kammerer at the meeting of the British Association last year, Dr. Noble laid great stress on the peculiar glands characteristic, as he said, of the nuptial pads, indeed, as he then stated, diagnostic of them, whilst the asperities were irrelevant. By his reference to Champy's paper in his present letter it is clear that he has since discovered his mistake. The glands found in these pads are merely the ordinary skin glands hypertrophied under the influence of the sexual hormone as the breeding period approaches. I have compared photographs of the sections through the normal skin of Alytes and through the 'pad.' The skin glands in the latter section are double the size of those in the former.

In conclusion, I may say that when Dr. Kammerer came to my laboratory in 1923 he brought other specimens about the existence of which I was sceptical until I saw them and which struck me as much more wonderful than Alytes. I refer to the large-eyed specimens of Proteus.

I suggest that Dr. Noble and his colleagues, instead of making aspersions on the good faith of a fellow-worker and the credulity of English scientists, would be better employed in endeavouring, as I have done, to repeat Kammerer's experiments, and when they have produced anything half as wonderful as the Proteus their comments will be listened to with more patience.

E. W. MACBRIDE.

The Birefringence of Crystalline Carbonates, Nitrates and Sulphates.

IN two very interesting papers (*Proc. Roy. Soc.*, vol. 105, p. 370, and vol. 106, p. 346, 1924) Prof. W. L. Bragg put forward an explanation of the strong birefringence exhibited by the crystalline carbonates and nitrates. Expressed very briefly, his theory is that in the carbonate and nitrate ions the oxygen atoms are situated in one plane around the central carbon or nitrogen atom, as the case may be, and that, as the result of this arrangement and of the mutual influence of the electric doublets induced in the atoms by the field of the light-waves, the refractivity of the group depends to a marked extent on the direction of the light-vector. The refractive indices of the crystal were successfully computed on this basis. The crystalline sulphates are known, on the other hand, to have a very weak birefringence, and the suggestion was made that very probably the oxygen atoms are arranged tetrahedrally round the sulphur atom in the sulphate ion group, thus making it optically isotropic.

Very interesting evidence regarding the birefringence of the nitrate and sulphate ions is furnished by some recent observations on the scattering of light by concentrated acids and their aqueous solutions made in the present writer's laboratory by Mr. S. Venkateswaran. The light scattered by dust-free nitric acid is found to be nearly unpolarised, indicating an extremely large anisotropy for the nitric acid molecule and for the nitrate ion. Concentrated sulphuric acid and its aqueous solutions, on the other hand, polarise the scattered light nearly completely, indicating that the sulphate ion is nearly isotropic optically. We

have thus a striking confirmation of Prof. Bragg's views.

Observations on the scattering of light by concentrated solutions of salts and by organic vapours containing the groups in question have been undertaken. One may venture confidently to predict the results to be expected. C. V. RAMAN.

210 Bowbazaar Street,
Calcutta, India,
June 10.

The Reduction of Carbonic Oxide.

EVEN politicians are attracted to this problem and see in it not red but the oils of to-morrow. If peers speculate in futures, why not we plebeian sciencers, who give our lives to such matters, not a princely two days or so? The victim of a pernicious complaint contracted in the service of the British Association in the granitic environment of Aberdeen, pursuing the vicious line of thought which has afflicted me since 1885, I have recently been led to make logical use of my singular views on the course of chemical change and apply them fully to this most remarkable, perhaps *the* most remarkable, of molecules—carbonic oxide. No other molecule has 'taken us in' so long. All my life I have been seeking to fathom its mysterious depths: even now I don't feel in safe soundings.

I have argued, before the Royal Society and at the recent Solvay Conference, that it is not directly oxidisable by oxygen: the potential of the circuit would be too low. Prof. Bone and I are duelling over this issue at the moment: the foils are to be without buttons.

If my line of thought regarding its oxidation be sound—I seem to see signs that the force of facts is beginning to tell in its favour, at the same time that trousers are no longer all built turned up, those who dabble in science being as unable as are ordinary mortals to follow one fashion for ever—the reverse operation, the direct reduction of the gas by hydrogen, should be equally impossible, catalyst or no catalyst. Some adjuvant action must intervene to effect reduction if the carbonic oxide-hydrogen potential be below the oxygen-hydrogen potential. F. Fischer's suggestion that the process is an indirect one is, therefore, of special interest. The modifications of the fundamental equation given by Messrs. Elvin and Nash (NATURE, July 31, p. 154) are no more likely than that equation is as an expression of the character of the chemical change. Metallic carbonyls are perhaps concerned in the transformations.

HENRY E. ARMSTRONG.

55 Granville Park,
Lewisham, S.E. 13.

Operation of Fog-Signals from a Distance.

IN the issue of NATURE for July 10, p. 58, reference is made to an installation for the operation of fog-signals from a distance. I wish to direct attention to two misstatements. The apparatus is not automatic in the strict sense of the term, as it requires to be started and stopped by human agency. The statement "These guns are the only automatic signals at present in use" may apply to the Clyde, but there are two lighthouses in the port of Dublin which are equipped with automatic fog-signalling apparatus, and these have been in operation there for almost two years. The system in Dublin depends on the interruption of a beam of light by fog. The light beam traverses the channel in an oblique direction over a distance of about half a mile, and the apparatus upon which the light acts is so arranged as to respond when the visibility falls to a dangerous degree. These lighthouses in Dublin were undoubtedly the first completely automatic lighthouses to be in operation. JOHN J. DOWLING.

University College,
Dublin, July 13.

I REGRET to have to confess ignorance about the two lighthouses in Dublin Bay. It would be of interest to know whether smoke from a passing steamer affecting the beam of light causes the 'guns' to act. I am well aware that engineers have often discussed the proper use of the word 'automatic.' Automatic telephony, for example, is not automatic in the strict sense of the term. It would take too long to discuss this fully, but personally I object to 'semi-automatic.'

THE WRITER OF THE NOTE.

Scientific Neglect of the Mas d'Azil.

L'ÉTAT d'abandon que l'illustre écrivain M. Wells signale pour la caverne du Mas d'Azil est réel et fort regrettable, bien que les conséquences en soient probablement moins graves qu'il ne pense. Elle appartient à l'état, mais la commune en a l'usage de temps immémorial. Le cantonnier chargé de l'entretien de la route départementale qui la traverse en est le gardien officiel; c'est lui qui fait visiter les galeries obscures, plus intéressantes par le pittoresque que pour la science préhistorique, bien que de rares dessins pariétaux s'y rencontrent, et, deci-delà, quelques menus vestiges de fréquentation humaine. Sur la rive droite, le point important était la salle du Foyer et sa galerie inférieur. La salle du Foyer a été fouillée depuis longtemps dans sa totalité par Piette, Ladavèze, Maury, etc., et en dernier lieu (1901–1902) par moi-même. Je doute qu'elle contienne actuellement autre chose que les déblais de ces fouilles, sauf son couloir inférieur, où existent quelques peintures étudiées par le Comte Bégouen et moi. Les couches archéologiques peu épaisses qui y subsistent vers le fond sont sans doute l'objet des grattages dont M. Wells nous entretient. Plus grave est le bouleversement réalisé l'année dernière dans cette région de la grotte par la municipalité pour y installer un théâtre. Mais je ne crois pas que les lieux de la caverne contenant encore du gisement, placés sur l'autre rive, aient été touchés récemment: une épaisse couche de pierrailles et de terre poudreuse les défend bien. H. BREUIL.

Preservation of Mammalian Spermatozoa.

IT may be of interest that experiments on the preservation 'in vitro' of mammalian spermatozoa show some prospect of successful application to the transport of semen to a distance; a problem of considerable importance in animal husbandry. Spermatozoa from a rabbit were sent by post from Cambridge to the Animal Breeding Research Department, University of Edinburgh. From 5 does inseminated, 46-49 hours after despatch, 3 produced litters of 8, 11, and 2 respectively. One doe died without diagnosis of pregnancy and one proved infertile.

Although the technique excludes the practical application of this particular method to the domesticated animals, further experiments are in progress, and it is hoped that these difficulties will be overcome.

ARTHUR WALTON.

Institute of Animal Nutrition,
Cambridge, July 29.

The Production of Single Crystals of Metals and some of their Properties.[1]

By Prof. H. C. H. CARPENTER, F.R.S.

THE problem of preparing a piece of metal in the form of a single crystal may be approached in one of two ways. As ordinarily prepared, metals and alloys consist of a large number of small crystals the size of which varies in the great majority of cases from about 100,000 to several million in a cubic inch. These result from the fact that when the metal or alloy freezes, crystallisation takes place at a large number of centres and the crystals grow until they meet one another. The boundaries, therefore, are produced by the meeting of these crystals and vary very much in shape. The net result is rather similar to that of a jig-saw puzzle, for the crystals are oriented quite at haphazard. The shapes and sizes of these crystals may be altered by working and heat-treatment, and the precise rearrangement may go so far as to result in the birth of new crystals, but the net result is always an aggregate of comparatively small crystals.

The properties of metals and alloys are the properties of these small crystals, and are due to two factors—(*a*) the crystal itself, and (*b*) the crystal boundary. In the crystal itself the atoms are arranged in a particular pattern corresponding to the symmetry of the metal. At the boundary, on the other hand, this condition does not obtain. For example, where two crystals are in contact atoms meet in two different directions, while at the place where three crystals touch, atoms meet in three different directions, and so on. It has been known for some time that the crystal boundary is stronger than the metal crystal, in the sense that normally when a metal is fractured it breaks through the crystal and not along the boundary, and the fracture of a metal test-piece is the summation of a large number of fractures running through small crystals. Hitherto it has been impossible, except in a very few isolated cases, to determine the properties of a metal crystal apart from those of the crystal boundary. The great and indeed fundamental interest of the problem of preparing a piece of metal in the form of a single crystal, therefore, is that its solution would enable the properties of the metal crystal to be determined.

SINGLE CRYSTALS FORMED DIRECT FROM THE LIQUID.

Evidence has been in existence for some time that, provided that the right conditions obtain, very large crystals can be grown from the liquid. The famous Tschernoff crystal dates back to about 1880. It was a large iron crystal, which he noticed in the 'riser' (head) of an ingot at the Vickers' works in Sheffield, and was upwards of 6 in. in length. Its shape was peculiar, and was what is called a 'crystal skeleton'—*i.e.* it had grown along the crystallographic axes to a greater extent than the filling-in process had occurred, and the net result was something which looked very like the branch of a pine-tree. Other instances of the accidental occurrence of large crystals have been noticed by Osmond and Cartaud, Moellendorff and Czochralski.

So far as I have been able to discover, the problem of preparing a single crystal direct from the liquid was first solved by Czochralski in 1918. He prepared long thin threads of crystals by drawing out a rod at a particular rate from the molten metal. As the rod was withdrawn the metal solidified and the resulting wire (0·5 mm. diameter) was found to consist of one crystal. Success was thus achieved with tin, lead, and antimony. Later Gomperz improved the technique of Czochralski's method. He used a silica rod on which to deposit the crystal growing from the melt and surrounded this with a neutral gas.

Quite recently (1923 and 1925) P. W. Bridgman has prepared much larger single crystals by melting the metal in a tube tapered at one end to a point and lowered through the furnace at a given rate. He found that if the lowering is at a speed less than the velocity of crystallisation and slow enough for the heat of solidification to be dissipated by conduction, then the metal will usually crystallise as one grain, provided that only one nucleus started at the bottom of the tube. In this way he prepared crystals of antimony, bismuth, cadmium, tellurium, tin, and zinc. It is particularly interesting to notice that this method also holds for metals having a polymorphic transition point (tin and antimony).

The melting was carried out *in vacuo*, and great stress is laid on the importance of freedom from dirt as an essential condition of success. At some little distance from the bottom the tube was constricted to a capillary, 0·1 mm. in diameter. It was found that one orientation of the crystals is usually more favourable for growth than others, so that even if crystallisation starts from more than one centre at the bottom, that crystal will eventually win through the capillary which is most favourably situated. Bridgman found that the most favourable orientation is, in almost all cases, when the plane of easiest cleavage or slip is parallel to the axis of the casting. In this way single crystal rods up to a diameter of 2·2 cm. were prepared. The same device was adopted by Obreimow and Schubnikow.

Valuable work on the single crystal wires produced by Czochralski's method and their distortion by mechanical stress has been carried out by Polanyi, Schmid, and Schouborn, while Bridgman has determined a number of physical properties of his single crystals of metals, which were purposely chosen because they did not possess the highest symmetry and therefore might be expected to give different values in different directions. This expectation was fulfilled.

SINGLE CRYSTAL TEST-PIECES FROM PRE-EXISTING CRYSTALS.

Here, again, a study of the literature showed it to contain a number of observations which indicated that, provided that the right conditions were obtained, success might be achieved in this direction, although the chances did not appear so good as that of preparing

[1] From the sixteenth May Lecture to the Institute of Metals, delivered on May 19.

a single crystal from the melt. Sauveur was, I think, the first investigator to show that, by carefully straining and afterwards heating metals, crystals of a much larger size than the normal could be produced, and stated that there was a critical stress which produced the largest crystals. Afterwards Ruder, Chappell, Jeffries, and Hanson showed that if a metal is locally deformed and then heated, exceptionally large crystals form at some distance from the point at which stress is the severest. If a tapered test-piece was used a 'strain gradient' was obtained, and it was found that the largest crystals always formed within the strained region, but farther from the area of greatest strain the higher the temperature. Seligman and Williams, working in my laboratory, stretched aluminium sheet, which had been previously heated, to various degrees, and found on heating that, up to a certain point, a small deformation had no effect. Beyond this, however, large crystals were formed, and as the deformation was further increased the crystal size was diminished. The crystals produced by these methods were very large compared with those in the original metal, some of them being 0·5 in. long.

In recent years wires have been produced, originally by accident, both of tungsten and molybdenum, in which crystals occupy the entire cross-section of the wire. This is done by drawing the metal through dies at a certain rate and temperature. Sykes, experimenting on molybdenum wire, obtained crystals 0·5 in. long, with an average diameter of 0·013 in.

Experiments on the production of single aluminium crystals were begun several years ago by Miss C. F. Elam, my research assistant, and myself. For many months we studied the structural changes produced in a crystal aggregate by deformation followed by heat, which may be summarised as follows: The first effects of strain are revealed by the presence of slip-bands, and in some cases of twin crystals. The former are completely, and the latter to some extent, removed by heating. No change is observed in the shape of the crystals. Somewhat greater deformation, however, followed by heat, produced actual crystal growth, and at this stage the boundaries of the crystals became active. This activity is shown in the capacity of the growing crystal to push forward its boundaries in certain directions, thus invading other crystals, upon which it imposes its orientation. A still greater deformation produces a change which appears to take place exclusively in the boundaries of the deformed crystals. It is here that new crystals are born, possessing a different orientation and a much smaller size. Accordingly, in this third stage there is a refining of the crystal structure. From the point of view, therefore, of producing large crystals from an aggregate of small ones, the intermediate degree of strain, just referred to, is the important one.

The increase in crystal size could be clearly followed in our experiments with an alloy of tin containing a little antimony, where the actual movement of the crystal boundary was observed and photographed. Our experiments further showed that in the absence of a change of phase neither crystal growth nor recrystallisation will take place in a metal unless it has been plastically deformed and afterwards heated to a certain minimum temperature for a certain minimum time. They also showed that there is no gradual increase in size from the original crystals up to the largest, but that the latter appear to form directly from them. It is clear therefore that, in the production of large metal crystals, the adjustment between mechanical strain and the temperature of heating is extremely important.

This point can be clearly illustrated in the case of the metal aluminium. Test-pieces, after preliminary heat-treatment to remove work hardness and render the crystals so far as possible equiaxed, were subjected to varying degrees of strain. After this they were all heated to 550° C. for 6 hours. Finally, they were etched in a 10 per cent. solution of caustic soda. Below the minimum strain required for growth, the crystal size remains unaltered. At the critical strain large crystals suddenly appear. Above this the size diminishes in proportion as the strain increases.

PRODUCTION OF SINGLE CRYSTALS IN SHEETS.

By this time we were ready to approach the problem itself, and our first experiments aimed at converting the crystals in the parallel portion of a test-piece 4·0 in. × 1·0 in. × 0·125 in. of aluminium into a single crystal. Calculation showed that the total number of crystals contained in the parallel portion of the test-piece was about 1,687,000.

After many months of work success was achieved in the following way: The test-piece must, in the first place, be accurately machined along the parallel portion. In order to convert this into a single crystal three treatments are necessary: the first thermal, the second mechanical, the third thermal. The first treatment is necessary to soften the metal completely and produce new equiaxed crystals of so far as possible uniform size, the average diameter being $\frac{1}{150}$ in. The second consists in straining these crystals to the required amount, and the third in heating the strained crystals to the requisite temperature, so that the potentiality of growth conferred by strain could be brought fully into operation.

The most suitable temperature of the first heating was found to be 550° C., and the time 6 hours. The precise degree of strain for the aluminium used was an elongation of 1·6 per cent. on 3 in. produced by a stress of 2·4 tons per sq. in. The final heat-treatment was begun at 450° C., and the temperature raised at about 25° C. per day up to 550° C. It was then brought finally up to 600° C. for one hour, in order to complete the absorption of small crystals on the surface, which persistently remained at lower temperatures. On an average, one test-piece in four is converted into a single crystal in this way. The boundary at each end extends in the form of an irregular line into the wide head of the test-piece. The time required for the single crystal to grow in this way is therefore about 100 hours.

The conditions laid down by us for the production of a single crystal were that every crystal in the complex should be strained a certain small amount, and that one of them should be strained rather more than all the rest. We were originally disposed to think that the crystal which grew and absorbed all the others was the one most highly energised by strain. Later investigations with X-ray analysis, however, have shown that

single crystals produced in this way are free from strain, and we have accordingly modified our view and consider that the most highly strained crystal deposits a nucleus free from strain upon which all the other crystals ultimately align themselves, thus producing an unstrained single crystal.

PRODUCTION OF SINGLE CRYSTALS IN BARS.

We next proceeded to apply these methods to the production of single crystals in round bars. We found that, provided that the same conditions as to accuracy of machining, correct crystal size, degree of straining, and final heat-treatment were maintained, single crystals could also be produced in round-bar test-pieces, both in diameters of 0·564 in. and 0·798 in. Single crystal test-pieces 9 in. long and 0·564 in. in diameter have been prepared in this way.

Deformation of these test-pieces under tensile stress is very remarkable. On one hand, the 'normal' bar, consisting of small crystals, drew down with a roughening of the surface, a cup and cone fracture, and the maintenance of a circular cross-section throughout. On the other hand, when a single crystal was pulled in this way it produced an ellipse. As the test proceeded the ellipse became narrower and narrower in one diameter, while the other diameter remained nearly constant. Presently a point was reached when a characteristic lens-shaped figure was formed. As the bar pulled apart this became smaller and smaller. Eventually fracture took place at each side and ultimately in the middle.

The final result was that the fractured surface of each half of the test-piece was a very acute ellipse or wedge, the metal being grooved in each case. Characteristic flow lines also made their appearance on the test-pieces, corresponding to the slipping of the metal in this remarkable and quite novel way. They may be called 'glide-ellipses.' Here, again, the properties varied considerably in different specimens, the tenacities ranging from 3·0 to 4·0 tons per sq. in. and the elongation from 57 to 85 per cent. In some of these experiments the volume of the single crystal exceeded 2 cu. in., which means that about 7,000,000 crystals had coalesced in their formation.

It has not been found possible to produce single crystal test-pieces of square bars. Owing to the shape, these fail to strain uniformly, and, on heating, crystals grow from the four corners and meet in a line in the middle of the four sides. Some of the crystals were from 2 in. to 3 in. long and were visible on two adjacent sides. Remarkable effects were obtained on breaking them. In some places the corners became rounded, while in others they were narrowed to a ridge of almost knife-edge thickness. The whole bar became very much twisted and distorted.

ANALYSIS OF THE DISTORTION OF SINGLE CRYSTAL BARS.

The distortions of the single crystal test-pieces produced both in sheet and bar forms were very remarkable, and clearly suggested that the crystal axes were not oriented in the same direction in each specimen. In discussing this matter with Mr. (now Prof.) G. I. Taylor, he thought that it would be a straightforward, though possibly laborious, task to determine the relationship between the orientation of the axes and the distortion produced in a tensile test, and that by examining a number of specimens some general results might be obtained about the forces necessary to produce distortions of this type. He kindly agreed to join us in the work of testing these matters. Before the test contemplated could be carried out, however, it was necessary to obtain the help of an expert in crystal analysis by X-rays. Dr. A Müller accepted our invitation, and succeeded in devising a satisfactory method of determining the orientation of the crystal axes in single crystal bars by means of X-rays.

For the purpose in hand it was necessary to work with a square bar. As already mentioned, single crystals cannot be grown in square bar form. We had, therefore, to produce a round single crystal test-bar and then to machine it down until its section was square. The method of investigation adopted was as follows: Each face was marked by a scratch parallel to the length of axis of the specimen and by cross scratches at 0·5 in. intervals. The faces were numbered 1, 2, 3, and 4, so that when the specimen was placed upright in the testing machine the faces appeared in this order when the observer moved round the machine in an anti-clockwise direction. At each successive stage of the test the extension between each pair of cross marks was measured on each face. At the same time the angles between the cross scratches and the longitudinal scratch were measured in each case. In addition, the thickness of the specimens between pairs of opposite faces and the angle between neighbouring faces were also measured. These suffice to determine the nature of the distortion.

Measurements showed that near the ends of the specimen, where it was held in the grips of the testing machine, the measurements were not quite the same as those near the middle, but that the central portion was nearly uniformly strained. There is a high degree of uniformity among the measurements of extension in the three middle compartments of each face, especially in the earlier stages of the test.

Measurements were made at extensions of 5, 10, 15, 20, 30, 40, 60, and 78 per cent., when the crystal broke. As the test proceeded the square section of the bar gradually disappeared, and the final result was a parallelepiped of remarkable form. The cross scratches, although remaining rectilinear, shifted by a definite angle which became markedly acute. When the specimen finally broke, it contained two very acute and two very obtuse angles.

Prof. Taylor and Miss Elam followed up this work with a paper published in 1925. In this they have described similar experiments made with several more specimens in order to find out whether the conclusions previously reached are general in their application and to settle several points which the previous experiments left in doubt. The chief result of their earlier work was to show that of the twelve crystallographically similar possible modes of shearing, the one for which the component of sheer-stress in the direction of shear was greatest was the one which actually occurred. The first object of the later work was to determine the orientation of the crystal axes of several specimens.

Assuming that the relationship outlined above holds in general, it is possible to predict the orientation of the plane on which slipping should occur. Three more single crystal test-pieces were stretched and their distortions analysed by the method already described. It was found that in each case the distortion was such as would be produced by shearing parallel to a single plane, and that this plane of slip was the one predicted. It was also found that the changes in orientation of the crystal axes relative to the axis of the specimen during the test were in good agreement with the prediction.

In the previous work it was not possible to make a detailed analysis of the deformation during the last stages of the stretching, but it was shown that the deformation ceased to be due to slipping on one crystal plane. Reasons were given for supposing that the deformation might be due to slipping on two crystal planes simultaneously, and it was shown that the crystal axis which formed the intersection of these two planes remained unstretched during the test, as it should if the distortion were in fact due to this cause. There are, however, a number of other types of distortion which might also leave this particular axis unstretched. In their later paper Taylor and Elam showed that for a small distortion the 'unstretched' cone passes through or very close to three other crystal axes, which, in fact, determine all the possible kinds of unstretched cone which can be produced by double slipping of the type contemplated. This completes the proof that the slipping in the last stages of the test is of this type.

When the crystal begins to slip on a second plane it seems likely that the rate of slip on each plane would be the same. In this way they would remain inclined at equal angles to the axis of the specimen, but it was impossible to verify this suggestion from the previous experiments. The second paper contains the test of this, and it is found that, although double slip does begin when two planes get to the position in which they make equal angles with the axes, the rate of slipping on the original slip plane is sometimes greater than it is on the new one. The two planes do not, therefore, necessarily remain at equal angles with the axis, but the process cannot be followed very far because the specimen usually breaks when only a comparatively small amount of double slipping has occurred.

A most interesting test described in this paper was that in which the authors distorted a single crystal test-piece, in which they predicted that from the original position of the crystal axes double slipping should begin at once. A specimen was found the axes of which corresponded very closely to this position, and it was found that double slipping did occur during nearly the whole extension. In this case it was found that the amount of slipping on the two planes was practically equal, and that the axis of the specimen remained very close to the (112) axis during the whole test.

A point of which Taylor and Elam made special mention was the extraordinary uniformity of the stretched specimens. They showed a photograph of specimen No. 68 which had been stretched to an extension of 70 per cent. To the eye it appears absolutely uniform. They gave numerical data as to the variations in extension of different parts of the specimen, and found that the average variation of ϵ was 0·0028 during the first 5 per cent. Up to 20 per cent. extension the variation did not exceed this figure; it then began to increase, until at the breaking point it rose to 4 parts in 100.

The chief conclusions drawn by the authors from the theory of fracture contained in their paper are—(1) that with a stress-strain curve of the type found by them, fracture of aluminium single crystals cannot occur by slipping on a single crystal plane, and (2) that the geometrical conditions alone imply that fracture takes place more easily when double slipping occurs than when all the slipping is confined to one plane.

Miss Elam and I have recently investigated the distortion of single crystal test-pieces of aluminium followed by subsequent heating. We have found that the crystals can be deformed so much as 7 per cent. without being destroyed on heating. Beyond this amount the metal recrystallises and breaks up into a number of smaller crystals the size of which depends on the amount of distortion. Near the fracture the crystals are smallest and they increase in size towards the shoulders of the test-piece. The recrystallised metal shows exceptionally straight crystal boundaries, and the crystals are frequently twinned.

We then made a detailed examination of the behaviour of two round single crystal test-pieces after successive increments of strain followed by heating. The orientation of the bar was first determined by means of X-rays, and the metal then extended 5 per cent. The position of the crystal axes was then determined, and it was found that the reflections on the photographic plate were not so well defined and were spread over a large reflecting angle. The crystal was then heated to 400°, 500°, and 600° C. and examined after various periods at these temperatures. No change appeared after this treatment. The nature of the X-ray reflections was unaltered, and there was no change in the position of the reflecting planes. After a second extension of 5 per cent. the positions of the reflecting planes were redetermined and the bar heated to 350° and 450° C. No change was observed. After heating at 550° C. the reflections that had been found previously had disappeared, but new ones were obtained in other positions.

A comparison of the reflecting planes from different parts of the bar, including opposite sides of the same reference plane, showed that it was still a single crystal, but that it possessed an entirely different orientation from that of the original. Moreover, the X-ray reflections now obtained were sharp and well defined as in the original crystal. Etching in caustic soda revealed a homogeneous structure. Further extension of 5 per cent. produced results similar to the first extension, and heating up to 600° C. produced no change. On heating after the fourth extension, however, the orientation was found to have changed once more, but the bar still remained a single crystal. The process was again repeated, and after the sixth extension a partial recrystallisation took place. Another single crystal test-piece was subjected to this treatment with exactly similar results. Here again the crystal moved successively into two new positions.

The Problem of the Origin of Species as it appeared to Darwin in 1859 and as it appears to us To-day.[1]

By Prof. HENRY FAIRFIELD OSBORN, For. Mem. R.S.

The first of these objects, that is, the establishment of a belief in descent with modification, was always held by my father to be the more important of the two; for I once heard him say, if a recollection of about fifty years' standing may be trusted, that "after all, evolution is the great thing, not natural selection."—LEONARD DARWIN, "Organic Evolution," pp. 1, 2.

NEARLY one hundred years ago Charles Darwin began to collect facts for "The Origin of Species," his immortal work, which was cautiously withheld from publication until 1859. There still prevailed the zoology of Linnæus and Buffon and the palæontology of Cuvier. In Lesson's "Mammalogie" (1827) the number of mammalian species is exactly 1124, as compared with the 13,450 species and subspecies of mammals known at the end of the year 1925. Birds increased from 3600 to 23,939; reptiles and amphibians from 543 to 9000; fishes from 3500 to 20,000. Darwin's species stood apart like isolated mountain peaks, whereas to-day living species and subspecies are often comparable to mountain chains composed of lesser peaks completely connected by ridges known as intergradations. It is not the number of species and subspecies which is significant, but the facts as to habit and habitat which are recorded with them. Similarly, it is not the number of fossil species now known as compared with those of Darwin's time, but the *linkage* of families, genera, species, subspecies, and even of 'ascending' and 'descending mutations' reaching back over hundreds of thousands, if not millions, of years.

This twenty- to one hundred-fold disparity in our knowledge simply intensifies our admiration for the courage of Darwin in boldly substituting a natural for a supernatural conception of the origin of species. It is true that Darwin's most influential authority was not the current zoology and palæontology of his day but Nature itself, whereby even in 1859 he absolutely established the Law of Evolution, as well as the directing and standardising principle of Natural Selection. It is, however, not this broader aspect of evolution, but the more concrete problem of the *modes* and *causes* of the origin of species which we are considering to-day.

Let us re-examine these causes in the light thrown by naturalists and observers on the invertebrates and vertebrates as distributed over the great continents of Europe and Asia, of North and South America, of Australia, considered not alone with their present boundaries but also with their former land connexions secured by elevation to the hundred fathom line. In this connexion I present a new zoogeographic and palæogeographic map of the world, prepared with the aid of Bartholomew of Edinburgh. We shall see that the results of zoological and palæontological research are entirely harmonious and concordant, but that zoology, while clearly teaching certain principles of the origin of species, leaves blank many gaps which are completely filled by palæontology.

Thus these two branches of biology are complementary in demonstrating that, through observations after the very naturalistic manner of Darwin in the voyage of the *Beagle* and through the very Lyell-Darwin methods by which the natural origin of species was originally discovered, *the problem of the origin of species has entirely changed in the last hundred years*. In fact, were the great naturalist living to-day, he would be foremost in modifying his own opinions, speculations and theories.

Greatly enhancing the value of the recent work of our field naturalists is the fact that the results reached in fishes, amphibians, reptiles, birds and mammals were recorded entirely independently of each other. Where the conclusions reached are harmonious or concordant they have the convincing value of entirely independent testimony. Also, these results are doubly valuable because they are for the most part assembled without biological purpose or intent, not to prove or to disprove any particular theory, but recorded simply as actual observations.

This is generally true of all field naturalists, who are more concerned about Nature than about the interpretation of Nature. The interpretations upon which our field naturalists do venture, such as the 'direct action of environment,' and 'Lamarckian inheritance,' are often lacking in real biological analysis. For such analysis, therefore, we must allude to five biological principles which have developed from laboratory experiments, and the generalisations growing out of them, beginning chiefly in the year 1880. These are as follows:

(1) Weismann's sharp distinction of the germ-plasm from the body plasm, from which follows the equally sharp distinction between truly germinal specific characters and bodily modifications by environment or habit; (2) the experimental failure of the inheritance effects of adaptive habit, known as Lamarckism; (3) the apparent failure of the environment to modify immediately the germ-plasm in creating adaptive specific characters; (4) the sharp limitations of the originative powers of Natural Selection as conceived by Darwin; (5) the sharp distinction between the continuous and discontinuous (or mutational) origin of specific characters.

In fact, the outstanding speculations of Darwin's and Herbert Spencer's time as to the causation of the origin of species have been pared down by laboratory analysis to a mere vestige of their former selves, and the overweening confidence of one school of causation after another has been displaced by diffidence, doubt, or even agnosticism, as expressed in the final address of William Bateson, whose recent death we lament at this meeting. To sum up, intensive laboratory and experimental research has added vastly to our knowledge of the functions of animals and of the heredity mechanism but has greatly increased the difficulties

[1] Read before Section D (Zoology) of the British Association, at the Oxford meeting, August 5, 1926. This is the fourth of a series of papers on the origin of species, the first having appeared in NATURE, June 13 and 20, 1925, under the title, "The Origin of Species as Revealed by Palæontology."

inherent in the problem of the origin of species. It is the *modes* and the *causes* of the onward progressive movement of the germ-plasm resulting in the consecutive origin of new adaptive specific forms which are rendered still more mysterious by the negative results of laboratory research.

DISTINCTION BETWEEN SPECIATION AND MUTATION.

So far as the *modes* of the origin of species are concerned, these negative results of the laboratory are more than offset by the positive results obtained by our field naturalists and explorers who are independently discovering a considerable number of species-in-the-making at the present time. In other words, we now understand the contemporary origin of species after modes and under conditions wholly unknown to Darwin in 1859. Geographic *isolation*, to which Darwin's attention was first directed by Wagner, with all the incidental influences of physical or chemical change, of enforced change of habit, of competition with a new life environment, perhaps of stimulus to the germinal energies themselves, seems to constitute the chief complex of causes in the origin of new species; this complex is summed up in the principles which Osborn terms *tetraplasy* and *tetrakinesis*. An extreme phase of isolation is *insulation*, where species are scattered among a number of islands. A like isolating mode among fishes is seen in the complete separation of rivers and streams formerly connected. In this complex of four coefficient causes, all involving energy, the specific germinal substance itself undergoes change, extremely slow but continuous, so that a new stage is very gradually reached, formerly known as a 'geographic variation' but now known as a 'subspecies.' Between subspecies living in islands and separated rivers there are naturally no *intergrades* or intermediate stages, but in a number of independent examples among fishes, amphibians, reptiles, birds and mammals, true intergradation has been observed linking one subspecific form with another in a continuous germinal life-chain. Such survival of intergrades may be instanced as proof of *complete continuity* between subspecies and, consequently, between species.

This appears to be the normal and natural mode of origin of the greater number of specific forms as observed in zoology; such mode has been termed 'speciation' by recent British and American authors. In exactly the same field of observation and by the same observers, apparently as an abnormal mode due to some irregular influence on the specific germ-plasm, is seen the discontinuous or sudden origin of new characters, ranked by some observers as specific, after the manner termed 'chance variation' by Darwin and 'mutation' by De Vries. *Mutation* thus appears to be a real phenomenon, but a relatively rare one; such mutational origins need to be protected by geographic or climatic isolation from interbreeding with normal species.

Thus *speciation* through continuity stands in contrast with *mutation* through discontinuity. There is no question as to germinal change in mutations, but may the same be said of subspecies? In answer to this doubt it has recently been shown by experiment (Sumner 1924) that many, if not all subspecific characters are *stable under changed conditions of environment*. Consequently, while under suspicion as to reality, often vexatious and unconvincing, and always annoying to the systematist, *well-authenticated subspecies are of priceless value to the biologist who seeks to ascertain the conditions under which new species arise.* It proves that many 'geographic variations' and 'subspecies' are really germinal transitions, intermediates and intergradations from 'species' to 'species' of the higher kind known to Darwin.

The above is a summary of principles gathered from a very large number of independent observers whose names will be fully recorded with the titles of their papers in the complete series of notes on which the present paper is based. Outstanding names are those of Adams in the gastropods, Jordan, Berg and Regan in the fishes, G. A. Boulenger in the amphibians, E. G. Boulenger in the reptiles, Chapman and Griscom in the birds, Osgood and Sumner in the mammals. The whole list of observers in the vertebrates alone comprises more than a hundred names. For the annotation of this extensive literature I am indebted to members of the corps of zoologists of the American and British Museums and of the Zoological Society of London.[2]

EXAMPLES OF GEOGRAPHIC ISOLATION AND SPECIATION.

It appears that speciation arises only where one or all of the energy coefficients of Osborn is changed. In amphibia especially, geographic isolation does not invariably result in the origin of new species, because all the conditions of the new habitat may be identical with those of the old. A most striking example of complete intergradation between 'species' is that of the molluscan genus Io of the Tennessee River, which now presents all the living intergrades between the smooth and the spinose forms as we pass downstream. In fishes, skeletal intergrades are observed as we pass from northern to southern waters (Berg) or from a colder to warmer marine habitats; these intergrades consist in the number of vertebræ, of fin rays and of scales, and in body form and colour, and Berg concludes that all the individuals of certain geographic areas simultaneously produce similar new specific characters.

Among amphibians the entire region around the Mediterranean affords G. A. Boulenger a series of subspecies of the edible frog, *Rana esculenta*, more or less connected by intergrading forms. Among reptiles E. G. Boulenger observes the speciation of the skink, *Chalcides ocellatus*, a species which, like the edible frog, surrounds the Mediterranean, in which the difference between two isolated subspecific forms is so great that *were it not for the wonderfully complete manner in which they are connected they could not be denied full specific rank.* As among fishes, intergradations are observed in all the skeletal characters, as well as in the colouring and the scales. Completely supporting these observations are those of many of the recent herpetologists who conservatively use the word 'variety' where other authors use the word 'subspecies,' who imply that intergradations occur wherever a sufficiently large number of specimens are examined. Chapman, with extensive collections of South American birds at his command, records exactly similar results:

[2] These data will be published in full in a sequel to the present paper, in the *American Naturalist*, No. 5, in the series on the origin of species.

The ornithologist finds large forms occupying colder areas, dark ones humid areas, and pale ones arid areas; and as the [environmental] conditions which obviously produce these variations in size and colour merge one with the other, so do the [specific and subspecific] forms themselves intergrade. That these variations are inherent [*i.e.* germinal, constitutional, hereditary] and not merely the temporary impress of physical environment on the individual, is apparently shown by the fact that they are often as well marked in the nestling as in the adult.

Chapman also observes a distinct case of 'mutation' within the genus Buarremon in the presence of a black pectoral feather-band, which is established as a specific character by isolation or geographic discontinuity. Like the single case with black dorsal band observed within the genus Troglodytes, the mutation does not intergrade and is thus recognised as of discontinuous or mutational origin. Stresemann finds partial melanism as well as albinism arising as not infrequent mutational characters, but fails to show that these are adaptive. Chapman and Griscom in their North and South American field work distinguish clearly between intergrading and non-intergrading kinds of birds. In a collection of 1500 specimens of the house wren, Troglodytes, these observers have noted a considerable number of cases of *complete* intergradation between subspecies, and those familiar with the marked physiography of South America, with (*a*) its cold and arid Pacific coastal belt, (*b*) its Andean Mountain chain subdivided by Chapman into numerous vertical life-zones each clearly demarcated until we reach the boreal summits, (*c*) its vast Amazonian forest plain, (*d*) its pampas and plains of the south-east, and (*e*) humid forests bordering the Straits, may anticipate wide speciation in other forms of animal life in this continent. It is noteworthy that these observers have discovered in Troglodytes only one example of mutation in the sense of De Vries. It cannot be questioned that isolation is the most important factor in the speciation of birds, especially in its extreme form of insulation. As an example of wide isolation without speciation, the house wren of Florida, *T. ædon ædon*, exhibits the same characters as those of Tierra del Fuego, but in the intermediate regions another species, *T. musculus*, exhibits a large amount of subspeciation and several complete intergradations.

Among mammals the great transverse geographic range from Scotland across Eurasia and North America to New Brunswick, Canada, of three species of the deer family, affords a striking example of geographic speciation; the stag (Cervus) yields twenty-three species and subspecies; the moose (Alces) yields eight subspecies; the reindeer (Rangifer) yields twenty-one subspecies. This is in wide contrast to the knowledge of Darwin (1837–1859), to whom were known only two species of stag, one species of moose, and one species of reindeer. Far more significant, however, are the observations of Osgood and Sumner on the deer-mice of the genus Peromyscus, which range through the temperate region of North America to the Pacific coast. From a collection of 30,000 specimens Osgood finds that a subspecies is characteristic of every distinct climatic region and sub-region. These subspecies listed by Merriam and Osgood have been accepted with great reluctance, especially by naturalists unfamiliar with the excessively sharp geographic and climatic barriers of the western United States. Our hesitation to accept these subspecies as of real germinal or genetic value has been entirely removed by the persistent observations and experiments of the biologist Sumner, largely in the identical collecting grounds of Osgood, and we must welcome these combined observations and experiments as the most convincing demonstration of the principle of *speciation continuity* thus far afforded. Between at least six of these subspecies complete intergradations occur. Classification becomes like dividing the lines of the spectrum. After eight years of transfer from an arid to a humid environment, or vice versa, these subspecies retain their original characters. Even profound change of environment does not yield a new subspecific form, nor are changes of habit inherited in eight years of experiment.

(1) The summary of eight years' experiment proves the comparative stability of subspecies of the Deer-mice (Peromyscus) under very marked new environmental physical conditions. (2) Merriam-Osgood subspecies are proved to be stable under changed conditions of environment, by transplantation experiments; *i.e.* a desert subspecies, *P. m. sonoriensis*, reared for eight years in a humid environment, is entirely unmodified in the direction of the humid subspecies *P. m. gambeli*. (3) This doubly proves (*a*) that characters of the desert *P. m. sonoriensis* are germinal, not environmental; (*b*) that humid environment makes no modification whatever toward increased depth of colour in eight years and in seven to twelve generations. (4) Similar results from transplantation of *P. m. rubidus* and *P. m. sonoriensis* are obtained: reared in an entirely new environment, they do not converge toward each other but toward local humid species *P. m. gambeli*.

Speciation a Secular Phenomenon.

Whereas an inheritable mutation may be produced by a single experiment, 40,000 years, the lapse of time since the last glaciation, is a moderate estimate of the time required to produce a subspecies. In the case of all the genera cited above—Cervus, Alces, Rangifer, Rana, Chalcides, Troglodytes, Peromyscus—we are observing subspecies arising in a region which was profoundly affected by the fourth glaciation with its pluvial climate, a region in which new subspecies have arisen *pari passu* with the modern demarcations of habitat and of habit. That speciation is an incredibly slow process is attested by the case of the newly discovered Pliohippus of Leidy, which early in Pliocene time assumed all the characters of the modern Equus. The entire speciation process of plants and animals has been going on perhaps for a thousand million years, as estimated on purely physical grounds, and in a recent conversation with Sir Ernest Rutherford it was agreed that another thousand years of research may be required for an understanding of the highly complex physico-chemical basis of life.

Concordant Observations in Zoology and Palæontology.

As distinguished from the speciation observed in zoology, in palæontology we deal with secular speciation, in which, quoting from the first of Osborn's series of

papers on the origin of species, we observe the adaptive action and reaction of the heredity germ over long periods of time. We also observe the secular action of natural selection (Darwin's selection factor), the secular direct reaction to environment (Buffon's factor), the secular adaptive action of habit (Lamarck's factor), the secular adaptive reaction to the living environment (Darwin's factor). We sharply separate Darwin's factor of selection, which has no energy content, from the above four energetic forces of evolution, namely, heredity, physical environment, living environment, and individual development or ontogeny. This is the principle of tetraplasy and tetrakinesis.

This momentary lapse into speculative as distinguished from purely observational consideration of the problem of the origin of species may clarify the transition from zoology to palæontology.

In palæontology an entirely new series of principles is discovered in speciation which are quite beyond the eye of the zoologist. Chief among these new principles is that dimly perceived by Darwin in the words 'analogous variation'; it is that of germinal or evolutionary trend in a definite direction, the 'mutations richtung' of Neumayr. Out of this springs Osborn's principle of *rectigradation* observed in the rise of adaptive characters from the germ-plasm, that is, new specific characters which pass continuously from the most rudimentary and inefficient into the most efficient and highly developed stages. It may be a matter of interest to members of the British Association to recall that this principle was presented to the Association in 1889 by the present speaker. Through unbroken observation during the intervening thirty-seven years this rectigradation principle has been confirmed in four great orders of hoofed mammals, namely, the horses, the rhinoceroses, the titanotheres, and the proboscideans. Research on the two latter groups fills two great monographs aggregating nearly a million words and covering, in the case of the Proboscidea, the analysis of the mode of origin of more than 350 species and, in the case of the titanotheres, the chief stages of specific development extending from Lower Eocene through Lower Oligocene time, when these animals suddenly disappear.

An epitome of these observations is presented in three diagrams in which the three outstanding principles discovered in palæontology are observed: First, the unbroken continuity of speciation, which becomes absolute as the gaps are filled by discovery. Second, the constitutional predisposition to speciate in certain predetermined directions which must be inherent in the germ-plasm of ancestral forms. Third, that these constitutional predispositions are not released except through adaptive reaction to new conditions of life; they are not, therefore, of the nature of inherent perfecting tendency, but, rather, of the nature of a *potentiality* to appear when the need for them arises. For example, the rhinoceroses have the potentiality of developing two horns, an anterior horn on the nasal bone and a posterior horn on the frontal bone. But in the fourteen branches into which this great subfamily subdivides in its migrations to all parts of the earth, this double potentiality is seldom availed of, sometimes not availed of at all.

Conclusions.

We seem to have reached an entirely new era in research on the problem of the origin of species, marked by the decline and death of speculations and theories advanced upon the very limited knowledge of the first half of the nineteenth century. Through zoology and palæontology we have reached a solution of the least difficult half of the problem with which Charles Darwin was confronted: we know the *modes* by which subspecies and species originate; in fact, there is little more on this point to be known. But this very knowledge renders the problem of *causes* infinitely more difficult than it appeared to Darwin. The causes of 'variation,' to use the term he employed for the evolutionary process, lie in the way before us. They may be resolved or they may prove to be beyond human solution. We must resolutely face these alternatives, and in the meantime continue our synthesis over every field of biologic research.

The Geographical Distribution of Magnetic Observatories.

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

THE provision for observational work in terrestrial magnetism is different in kind in different countries, and in some countries—Great Britain, for example—the provision made is of more than one kind. The object in view may be purely utilitarian, or purely scientific, or partly both. Originally the provision of information necessary for the use of the compass was the one utilitarian object generally recognised. To secure this object to the best advantage, the natural course is to make a single department responsible for the running of magnetic observatories, the taking of field observations and the preparation of charts. Thus, in the United States the Coast and Geodetic Survey controls the whole of official terrestrial magnetism. The number and position of the observatories—Sitka, Cheltenham, Tucson, Vieques (Porto Rico), and Honolulu—is determined primarily by survey considerations. The same idea prevailed to a certain extent in India, but the oldest magnetic observatory, Alibag—regarded as the continuation of Colaba, Bombay—represents a more usual form of development.

In most countries terrestrial magnetism has not been an independent plant, but from the point of view of astronomers and meteorologists has been a parasitical growth on astronomy or meteorology. Greenwich may perhaps be regarded as an example of this. At present most magnetic observatories are under the meteorological service of the country, and one of the two international associations concerned with the subject is the Magnetic Commission of the International Meteorological Committee. It is under its auspices that a selection of international quiet and disturbed days is made at De Bilt, Netherlands. The other international association, the Section of Terrestrial Magnetism and Electricity of the International

Union of Geodesy and Geophysics, represents the more distinctly scientific aspects of the subject. Its existence distinct from the Section of Meteorology is largely due to the independent position assigned to terrestrial magnetism in the United States and some other countries.

In France—as is still the case in Germany, Denmark, Holland, Belgium, and Portugal—terrestrial magnetism used to be in the main a branch of meteorology, but it now comes under the Institute of Geophysics, presided over by Prof. Maurain, of Paris. In Italy there was once an observatory at Rome under the Meteorological Office. But Rome—like Kew of later years—suffered from artificial disturbance and had to be given up, and Italy remained for many years without a continuously recording magnetic observatory. It succeeded after the War to the observatory maintained at Pola by the Austrian Admiralty, which is now controlled by the Italian Hydrographic Office.

Of the observatories independent of State control, the most important are those of the Jesuit Order and of the Carnegie Institution of Washington. The former group includes Stonyhurst—one of the oldest magnetic observatories now existing—Ebro (Tortosa) and Lukiapang (successor to Zi-ka-wei) in China. The Carnegie observatories at Watheroo (Western Australia) and Huancayo (Peru) are of recent creation.

In Bulletin, No. 5, 1924, of the International Section of Terrestrial Magnetism and Electricity, 66 magnetic observatories are included in the list on pp. 146-148, but some of these had not been active for some years, and a few, for example Kew, are now extinct. The number may seem large, but it means only one observatory per three million square miles of the earth's surface, while the diversity in the phenomena to be recorded is very great. Further, the distribution is very irregular. Of the 66 observatories mentioned above some 30 were in Europe, and only 13 were in the southern hemisphere. Only three were north of 60° N., and only two were south of 40° S. The regions of the globe in which observatories are particularly scarce call for our special consideration.

Until a few years ago Pavlovsk (59° 41′ N.) was the most northerly regular station provided with magnetographs. No publications from it or other Russian observatories for years after the commencement of the War were available until comparatively recently. But it would seem that unbroken records were obtained at Pavlovsk and Kasan in Russia, and at Ekaterinburg in Siberia. Records were also obtained at Irkutsk, or at Zuya in its neighbourhood, down to 1920. The Russians have also established a new station at Matochkin Shar (73° 15′ N.), in Nova Zembla, a neighbourhood where Prof. Birkeland had a temporary station in 1902–3. This is the most northerly station on the international list. From information recently supplied we learn that it is equipped with Eschenhagen magnetographs recording D, H, and V (declination, horizontal force and vertical force), the sensitiveness of these instruments being respectively 1′·0, 22·6γ and 5·7γ per mm. More suitable values for a station where H is very low and disturbance large, would be 2′ or 3′ per mm. for D, and 10γ for H and V. The magnetograph room itself seems to be of wood, but the instruments stand on a concrete and brick foundation. This foundation should be satisfactory if it is non-magnetic, a property, however, which is rather unusual in brick. Further, Russian observatories seem also in contemplation at Taschkent and in Eastern Siberia, a part of the world unrepresented at present.

Of the two other observatories on the international list north of 60° N., one, Sodankylä (67° 22′ N.), is run by the Finnish Government, which of late years has also been active in survey work. The third of the new high latitude stations, Lerwick (60° 9′ N.), in the Shetland Islands, was instituted by the Meteorological Office, and magnetographs were in operation in 1923. Another high latitude station of comparatively recent origin calling for notice is Meanook (54° 37′ N.) in Canada. This was only partially equipped in 1924, and one of the resolutions passed by the Section of Terrestrial Magnetism and Electricity at its meeting in that year at Madrid emphasised the importance of full equipment. Meanook is one of the nearest stations to the north magnetic pole. Yet another high latitude observatory is being instituted by the Danish Government at Godhavn (69° 15′ N., 53° 14′ W.) in western Greenland. Pavilions for absolute observations and for magnetographs connected by a corridor form a single building. An important feature is that the equipment includes two complete sets of magnetographs, one of low sensitiveness, so as to make provision for large disturbances.

Observatories in high magnetic latitudes (that is, latitudes where dip is high) have special difficulties to contend with. Magnetic disturbance is large, and H being small, changes in D are enormous, rendering ordinary D magnetographs unsuitable. On the other hand, small changes of dip represent such large changes of V that ordinary dip instruments are unequal to the satisfactory determination of base line values for V curves. It is thus a matter of general interest that the National Physical Laboratory has under construction an instrument for measuring V directly. The desirability of such an instrument was also the subject of a resolution at Madrid. High latitude stations are of special importance, not merely because they record magnetic disturbances in the regions where these are most developed, but also on account of the light they may throw on the relation between magnetic and auroral phenomena. The importance of this relation has been increased by the development of radio, and the evidence that has recently been obtained as to the influence on radio of a 'conducting layer' at about the height which Prof. Störmer has found for the lower level of aurora. So far at least as latitude is concerned, Lerwick should be favourably situated for combined observations on terrestrial magnetism and aurora. But the full utilisation of the opportunities presented by such a station calls not merely for special knowledge and equipment, but also for an ample and vigorous staff, as a lot of night work is involved under probably severe climatic conditions.

Another region where magnetic observatories have hitherto been sparse includes the geographical equator. The international list contains no station between Buitenzorg (Batavia, 6° 11′ S.) and Kodaikanal (10° 14′ N.), and a footnote supplies the regrettable information that Kodaikanal stopped recording in

1923. This will leave more than 20° of latitude unrepresented between Batavia and Antipolo (14° 36′ N.). Kodaikanal was one of the stations supported by the Indian Survey, which has also closed down observatories at Barrackpore (22° 46′ N.) and Toungoo (18° 56′ N.), thus leaving only two magnetic observatories, Alibag and Dehra Dun, in the whole Indian empire. The fact that, as compared with pre-War times, magnetic observatories have fared worse in India than in Russia seems to afford food for reflection. If Kodaikanal is an unsuitable site, as is rather suggested by remarks in some of the Indian Survey publications, the resuscitation of Trivandrum, memorable for the work of J. A. Broun, would provide a station nearer to the equator than any existing observatory in the northern hemisphere.

Other areas within the British Empire where magnetism is somewhat poorly represented are South Africa and Australia. There was once a magnetic observatory at Cape Town, and a new observatory somewhere else in South Africa has been talked about, but at present the Royal Alfred Observatory in Mauritius seems to be the only one in that part of the world. Melbourne was once the site of a magnetic observatory, but has long been unsuitable for that purpose. Recently an observatory has been set agoing at Toolangi in Victoria, but that seems the only observatory in Australia, with the exception of Watheroo, which belongs to the Carnegie Institution of Washington.

New Zealand has a magnetic observatory at Christchurch, and with assistance from the Admiralty and the Carnegie Institution is also maintaining what was originally a German observatory at Apia, Samoa. It is scarcely necessary to say, in view of the scarcity of magnetic observatories in or near the Pacific Ocean, that the stoppage of Apia observatory would have been a great misfortune.

The latest observatory of the Carnegie Institution, Huancayo (12° 3′ S.), is in a way unique from its proximity to the magnetic equator. Dip there at present is less than 1°, and its measurement must present unusual features. Huancayo is situated, moreover, in a continent, South America, where additional magnetic observatories are badly wanted.

Obituary.

SIR WILLIAM RIDGEWAY.

WILLIAM RIDGEWAY, a son of the Rev. J. H. Ridgeway, of Ballydermot, King's County, was born in 1853; he had a brilliant career in Trinity College, Dublin, and later at Gonville and Caius College, Cambridge, graduating as fifth Classic in 1880, and was elected a fellow of his College. In 1883 he was appointed to the chair of Greek in Queen's College, Cork, and while holding that appointment he resided for five months each year in Cambridge. In 1892 he was elected to the Disney professorship of archæology in Cambridge, and shortly afterwards resigned his chair at Cork. He was re-elected a fellow of his College, and had also been Brereton reader in classics since 1907. He was Gifford lecturer in natural religion, University of Aberdeen, in 1909–11; Stokes lecturer in Irish archæology, Dublin, 1909; and Hermione lecturer in art, Dublin, 1911. He was president of the Royal Anthropological Institute, 1908–10; of the Anthropological Section of the British Association, 1908; and had been president of the Cambridge Philological, Antiquarian, Classical and Anthropological Societies. He was elected a fellow of the British Academy in 1904, and was a foreign member of various learned societies in Europe. His learning was recognised by other universities, and he had conferred on him Hon. D.Litt. Dublin, 1902; Hon. D.Litt. Manchester, 1906; Hon. LL.D. Aberdeen, 1908; and gained the Sc.D. of Cambridge for his work on the horse. He was knighted in 1919. He wrote numerous contributions to classical, philological, anthropological, zoological and other journals, and the following books: "Origin of Metallic Currency and Weight Standards," 1892; "The Early Age of Greece," 1901; "The Origin and Influence of the Thoroughbred Horse," 1905; "The Origin of Tragedy," 1910.

This bare enumeration of the academic distinctions and of the writings of Sir William Ridgeway will serve to show the wide extent of his erudition and the great range of his interests. These were constantly exhibited when he joined in discussions at classical and scientific societies, in which he usually gave a free rein to his sense of humour, and also to caustic criticism. His strong personality and the definite views he expressed vividly in speech and writing, combined with his love of controversy, sometimes strained the forbearance of many friends, even occasionally to the breaking point. He was a man of pronounced likes and dislikes, and it was often a moot point whether he was not as dangerous to the causes he espoused and to his friends as to his enemies, for he was liable through friendly enthusiasm to overstate the case at issue. He entered wholeheartedly into a fray, whether it was Irish education, the Irish and English Anglican Church, or University politics, as those can testify who remember the discussions on the degrees for women and on compulsory Greek in the University of Cambridge.

Sir William was emphatically a driving force in the University, and spared no pains in furthering the well-being of the institutions to which he belonged, to take but two examples: the Cambridge Antiquarian Society and the Museum of Archæology and Ethnology. It was due to his energy that a lectureship in ethnology was instituted, and again largely to him that nine years later it was converted into a readership; in this and other ways he was instrumental in founding the Cambridge School of Anthropology. He very early recognised the value of ethnology in elucidating obscure points in classics and archæology; in some respects he was a pioneer in these comparative studies, and he delighted to recall how his heterodox views later gained acceptance from more conservative scholars.

Sir William stimulated very many students, naturally mainly in classical archæology, of whom a considerable proportion have gained great eminence, and he was careful to keep in frequent correspondence with them; but he also had a large number of correspondents throughout the world on an amazing variety of

subjects, from Asiatic ritual dances to currency and zebras.

Those who were privileged to see Sir William's family life gained another view of this very remarkable man. His love for his wife was as apparent as it was deserved, for Lady Ridgeway devoted her life to her brilliant husband, and no one will ever know what he owed to her. She was his prop for very many years as his eyesight increasingly failed, and she dispensed gracious hospitality to his friends in their charming home at Fen Ditton. Her sudden death at the end of May was a terrible blow, and though he gallantly tried to overcome his desolation and to take up the threads of his old life, he was a broken man until death mercifully took him in his sleep during the night of August 11: a peaceful ending for a strenuous and militant life. A. C. HADDON.

WE regret to announce the following deaths:

Mr. William Fawcett, lately Director of Public Gardens and Plantations, Jamaica, on August 14, aged seventy-five years.

Prof. Robert Gnehm, professor of technical chemistry, and afterwards director of the Technical High School, Zurich, who was known for his investigations on dyeing processes and dyestuffs, aged seventy-four years.

Dr. J. F. Hall-Edwards, president of the British Electro-Therapeutic Society, and a pioneer in the field of medical radiology, on August 15, aged sixty-seven years.

News and Views.

THE meeting of the British Association at Oxford which ended on August 11 has been memorable in many ways; and not least for the specially interesting character of the proceedings at the concluding gathering held at the Examination Schools. The message received from the Prince of Wales as president summed up in felicitous language the aims and prospects of the cause of science, the advancement of which it is the object of the Association to promote. The message also conveyed, in graceful terms, the president's appreciation of, and thanks for, the efforts made by all concerned to render the Oxford meeting of 1926 one of the most successful in the records of the Association. The reply read by Sir Oliver Lodge as chairman gave due expression to the gratitude felt by the members assembled at Oxford for the keen personal interest and sympathy shown by the Prince in the work of the Association, notably in his inaugural address.

THE speech delivered by Sir Oliver Lodge bore eloquent testimony to the world-wide charm exercised by Oxford over all who can be touched by the long history of western civilisation and culture. The well-known eulogy by Matthew Arnold, marked by graceful fancy and poetic feeling, and not without a light suggestion of penetrating humour, came with especial force and acceptance from one so capable of giving it its full effect as Sir Oliver Lodge. The significance of the presence of guests from overseas and from foreign countries had been emphasised by the Prince in his message, and was driven further home by the chairman of the meeting. The speeches of Prof. M'Murrich and Prof. Osborn, the latter of which concluded the meeting, showed that they too, as visitors and guests from overseas and abroad, fully appreciated the claim of science for international co-operation and fellowship. The final meeting at the schools was especially well attended, and formed an excellent conclusion to a very successful gathering.

AMONG several interesting papers presented to the Chemistry Section of the British Association at Oxford was a contribution by Mr. J. J. Manley on "The Union of Mercury and Helium." Judging by a lengthy report of Mr. Manley's paper in the *Times* for August 11, the author does not appear to have carried his investigations beyond the stage described in his letter to NATURE of April 24 last, except that he now believes that only one helide—HgHe—is formed, whereas in the letter he stated that he had obtained experimental evidence of the existence of two—$HgHe_{10}$ and HgHe. The evidence for union appears to be based upon the disappearance of free helium when it is submitted to the action of the electric glow discharge in contact with purified mercury, and upon a slight increase in refractive index as the action proceeds. The presumed compound is apparently decomposed by heat, so that its composition could be deduced from the difference in weight of 'uncombined' mercury before and after the experiment. As this difference is exceedingly small—of the order of 236 millionths of a gram—it is clear that Mr. Manley is encountering very great experimental difficulties; and bearing in mind the somewhat similar work of Miethe and Stammreich on the alleged transmutation of mercury into gold (NATURE, May 29, 1926), it is obvious that further investigation is required to dissipate or confirm the doubts that are held concerning the author's conclusions. Should those doubts be dissipated, Mr. Manley's work will constitute a discovery of very great importance.

IN the issue of the *Times* referred to, a leader-writer refers to Mr. Manley's contribution as a "startling announcement," as if it were novel, but actually the claim was first announced by Mr. Manley in these columns more than twenty months ago (NATURE, December 13, 1924). It is perhaps asking too much to expect a leader-writer, even in the *Times*, to be conversant with all that appears in our correspondence columns, but the incident directs attention once more to the need of adequate scientific representation on the staffs of our leading newspapers, and it also testifies to the value of the work done by the British Association in affording opportunity for lay writers to proclaim from the house-tops matters

of scientific importance that otherwise may be lost in the pages of scientific periodicals. The opinion is frequently heard that announcements of great discoveries at meetings of the British Association are less frequent than of yore, and although there is little more valid evidence for this opinion than for that concerning the diminished severity of our winters compared with those of, say, fifty years ago, the belief is probably to some extent responsible for the unbridled romance with which the popular writer is apt to invest his accounts of scientific achievements. The first duty of the newspaper man is to make a 'story,' and to this end he gives free rein to his unscientific imagination by supplying or suggesting sensation where it is not called for, or by elaborating relatively unimportant details at the expense of the main issue; he is also peculiarly susceptible to the temptation of treating the new as of necessity true, and occasionally, as in the present instance, of treating the true as necessarily new.

A STRONG earthquake was felt in the midland and western counties of England and in Wales at 3.58 A.M. (G.M.T.) on Sunday, August 15. From the accounts so far received it appears that the shock was felt over a nearly circular area 225 miles in diameter, and containing, therefore, about 40,000 square miles. The centre of this area lies a few miles to the south-east of Hereford, and it is worthy of notice that the shock was strongest in this city and Ludlow and in some of the villages between. A few chimneys fell at some of these places, but damage so slight would not entitle the earthquake to a higher degree of intensity than 7 of the Rossi-Forel scale. During the last forty years British earthquakes of the same intensity have disturbed areas ranging from 25,000 to 63,000 square miles. The position of the roughly determined centre suggests that the recent earthquake may be connected with the twin-centres in a northwest-southeast line near Hereford and Ross, which gave rise to the strong earthquakes of 1863, 1868, and 1896. These disturbed areas of about 85,000, 41,000, and 98,000 square miles respectively. As regards intensity and disturbed area, the recent earthquake closely resembles that of 1868, and it is not impossible that, as in that year, the Ross focus was mainly responsible for the disturbance. The much slighter shock of January 26, 1924, was not directly connected with the others, for the axis of its disturbed area runs in a northeast-southwest direction through or near the Hereford focus.

AFTER a busy professional life of forty-three years, Prof. T. Turner is retiring on September 30 from the Feeney chair of metallurgy in the University of Birmingham. Taking the Associateship of the Royal School of Mines with the De la Beche medal in 1883, Prof. Turner was appointed demonstrator in chemistry at Mason College. A few years later he became lecturer in metallurgy, and when the chair of metallurgy was instituted in the University, he was appointed professor and has held the position for nearly a quarter of a century. Prof. Turner's own research work has dealt with silicon in cast iron, the production of wrought iron and steel, the hardness of metals; volatility, density and other properties of metals and alloys. He is a past president of the Institute of Metals, having also served as treasurer. He is a member of council and Bessemer Gold Medallist of the Iron and Steel Institute. He is an honorary member of various metallurgical societies in the Dominions, the United States, and on the continent. In his own University, a gold medal has been instituted to commemorate his services to metallurgy. His best known book is the "Metallurgy of Iron," which has passed through several editions.

THE School of Research in Metallurgy at the University of Birmingham, under the able guidance of Prof. Turner, has done much original work, and has contributed in no small degree to the amazing progress in metallurgical science which has taken place during the present century. The past and present students and friends of the metallurgical department of the University and of its retiring professor, have decided to make a presentation to him in the immediate future. The subscription list is open to all who feel inclined to associate themselves with the movement; members of the local section of the Institute of Metals and of the Birmingham Metallurgical Society are supporting the scheme. Several local firms have also intimated their desire to subscribe. Further information and subscription forms may be obtained on application to Dr. T. B. Crow, hon. sec. to the testimonial committee, at the University, Edgbaston, Birmingham. Prof. Turner is proposing to reside at Leatherhead, Surrey, in order to keep in close touch with his interests in London, and in extending to him and Mrs. Turner our best wishes for further years of health and happiness, we will be voicing the sentiments of his very large circle of friends.

ALL true lovers of plant-life will be interested to hear of the exceptionally well thought-out scheme propounded by Dr. L. Cockayne, the doyen of New Zealand botanists, for the setting apart of the Wilton's Bush Reserve, about three miles from the capital city of Wellington, N.Z., as an "open-air museum for plants native to New Zealand." The New Zealand flora is unique, not only in the beauty of its forests, its ferns and its alpine associations, but also in certain aspects of the lines of evolution which it has undergone, such as, for example, the replacement of a xerophytic type of foliage in the young plants of a number of species by a mesophytic type when well grown, this being exactly the opposite to what happens in the well-known case of the Australian phyllodineous wattles. Dr. Cockayne propounds a scheme with four main points in it, as follows:—(1) A well-grown collection of all possible species from the flora of New Zealand, the Kermadecs, Stewart Island, Chatham Islands and the subantarctic islands, so far as the limitations of the soil and climate of the proposed site will allow. (2) Representations of the leading plant-associations found in the Dominion, just as they existed in primeval New Zealand. Many of these associations are now either almost extinct or very inaccessible for study, and this scheme would

bring them within reach of students in the capital city. (3) Illustrations of the horticultural use that can be made of New Zealand plants, by the planting out of small gardens, alpine rockeries, etc. (4) Restoration of the present forest area of Wilton's Bush to its primeval condition. The area is already much modified and invaded by exotic weeds, but could speedily be brought back to its original state by scientific treatment.

DR. COCKAYNE suggests that the plan should be put into operation gradually over a number of years, and that a start could be made at once by procuring from all parts of the Dominion the plants required to build up the complete collection of the flora, and in particular by concentrating on the formation of an alpine garden along the sides of the mountain stream which flows through the bush. He also suggests the transformation of one of the fine cliffs in the gully into a representation of the typical cliff flora of Eastern Marlborough, which is one of the most striking plant associations known in New Zealand. After that the planting of a small kauri forest could be taken in hand, and so, from year to year, one new effect after another could be added until the scheme was completed. The scheme as outlined (*vide* the *Dominion*, Wellington, June 15) appears to us to be a very fine one, and will certainly meet with the cordial support and approval of botanists throughout the world. We hope that the Wellington City Council will take a wide view of the problem and not allow considerations of finance to stunt a plan which, if carried out in a broad and generous spirit, will add greatly to the fame of a capital which at present is perhaps too much renowned for its windiness and too little known for its wonderful beauty.

A PUBLIC demonstration of the potato trials carried out by the National Institute of Agricultural Botany at its Potato-Testing Station at Ormskirk took place on August 11. Research into the resistance of potatoes to wart disease (*Synchitrium endobioticum*), undertaken by the Institute on behalf of the Ministry of Agriculture, forms a large part of the work. Wart disease is fortunately not spreading, but there is an urgent demand from infected districts for improved immune varieties. New productions of breeders are grown by the Institute at Ormskirk in highly infected soil to determine their reaction to the disease. A variety is only certified as immune if it has been grown for at least two years at Ormskirk without showing any trace of disease. Dry seasons do not afford a good test, and therefore occasionally three or even four seasons are required. This year 97 stocks are being tested for the first time, 45 for the second, and 9 for the third. There are also 626 stocks of from two to ten tubers each, which are grown both to inform breeders at the earliest possible date which of their seedlings are susceptible, and to assist genetical studies on the inheritance of immunity. It is of interest to note that it is theoretically possible to find an immune variety as a parent which will produce 100 per cent. immune seedlings, no matter what the other parent is. Research is also made on the methods of transmission of virus diseases, such as leaf-roll and mosaic, which are a serious menace to English potato crops. There appears to be some correlation between the health of the crop from which the seed-tubers are taken and the incidence of these diseases in the following year. On the other hand, the diseases apparently cannot be transmitted through the soil or by mere contact of foliage. Trials are also being made both of the chief main crop varieties and of the best new immunes to determine their yielding capacity and the time taken to mature. The improvement of the methods of testing these characters is also under investigation. Finally, all stocks sent to Ormskirk as new are examined by the Institute's Potato Synonym Committee; 1533 stocks were reviewed between 1920 and 1925. In 1920 72 per cent. proved to be 'synonymous,' but by 1925 this unsatisfactory proportion had been reduced to 16 per cent. of the entries, the remaining 84 per cent. being distinct varieties.

A FOURTH edition of the handbook entitled "Particulars of Meteorological Reports issued by Wireless Telegraphy in Great Britain and the Countries of Europe and North Africa" (M.O. 252) has been issued by the Meteorological Office, Air Ministry (London: H.M. Stationery Office, price 4*s*. net). It contains full particulars of the meteorological bulletins issued by the various countries. These bulletins are normally issued at least three times a day, and include ordinary ground observations of weather, wind, temperature, humidity, and height of the barometer for a number of places. They also include information about conditions in the upper air, reports from and to ships at sea, and weather forecasts. Full particulars are given of the various codes in use for summarising this information. The area dealt with extends westwards to America, eastwards to Siberia, northwards to Spitsbergen, and southwards to northern Africa. Greenland is also now included. Changes constantly occur in the weather reports issued by radio from different countries, and in order to keep those interested informed of such changes, supplements to this handbook are issued from time to time. This revised fourth edition embodies all supplements issued since the previous edition. The area covered by the weather charts prepared from these messages is shown in a frontispiece. Most of the issues can be received in the British Isles by the use of quite modest receiving apparatus. Purchasers of this work will be informed when amending notices are issued and when a new edition is ready if they notify the Director of the Meteorological Office of their desire to receive this information.

No one can work in the vast field of economic and political science or be engaged in business or trade, without continually feeling the need of some work which will supply in a handy form statistical and other information on any of the numerous topics that go to make up the complexity of modern life.

It is well known that such works—encyclopædias, year-books, professional and trade directories, commercial returns, biographies, and so on—are published in large numbers in all parts of the world and relating to diverse subjects, but it is not always so easy to obtain definite information of their exact nature or to make the most suitable selection to meet any particular want. Dr. Paul Heile has now set out to provide a guide to this wealth of material in his "Nachschlagebuch der Nachschlagewerke für die Wirtschaftspraxis" (Hamburg: Verlag Wirtschaftsdienst G.m.b.H., 5 marks), which he has compiled, using as a basis the collection of the Welt-Wirtschafts-Archiv at Hamburg after a special attempt had been made to make this as representative as possible. The work is comprehensive and is divided into the following sections: general, geographical, commercial substances, directories (again subdivided geographically and by subject), dictionaries, and biography. German works predominate, as is natural, but the other countries are well represented, as a glance at the geographical section shows, and the value of the work is enhanced by annotations where the title is not self-explanatory and by analysis of those entries which cover more than one subject. It is a drawback to its use as a reference book that such details as place of publication and publisher's names have not been given, but it will nevertheless be a valuable guide for business firms in Great Britain and for our growing commercial libraries. The volume contains also a classified list of the 1000 or so current trade and commercial periodicals taken by the library at Hamburg, together with a history of the Institute. The receipt of the work makes us hope that the promised catalogue of the Library of the London School of Economics will not long be delayed.

THE Annual Report of the Mines Branch (Canadian Department of Mines), for 1924 contains a section on investigation of fuels and fuel testing, which throws light on the fuel problem as it occurs in Canada. Experiments are recorded on the production of coke from the coal of the Maritime Provinces. The coke is intended to make Canada independent of imported anthracite. Tests of friability of coke have been worked out. Reports are made of lubricating oils and gasoline marketed in Canada. The distillation of lignite and sub-bituminous coal and oil shale is considered, evidently an anticipation of the time when supplies of liquid fuel will have to be produced at home.

A BIBLIOGRAPHY of meteorological literature prepared by the Royal Meteorological Society with the collaboration of the Meteorological Office (No. 9, January-June 1925) has recently been issued by the Royal Meteorological Society. Since October 1920 the bibliography which previously had been given in the Society's *Quarterly Journal* has been issued as a separate publication in six-monthly parts (price to non-fellows, 2*s*. 6*d*.). A symbol is attached to the title of the work to show in which library the publication has been received. The divisions of the bibliography deal with general meteorology and with various branches of the work, such as temperature, rainfall, and terrestrial magnetism. The publication is helpful to meteorologists in different parts of the world.

THE annual report of the Physical Department of the Ministry of Public Works, Egypt, for 1923–24, has been issued. Dr. H. E. Hurst, the controller, reports continued progress in all departments. In the hydrological service observations are now obtained from 286 rainfall stations, an increase of five on the previous year, and from 82 gauging stations extending from Egypt to Uganda, Kenya and Abyssinia. The daily weather report continues to be published, based on the data from 28 stations in Egypt and the Sudan, five in Europe and two in Palestine. A daily broadcast message is sent out from Abu Zabal at 09·55 G.M.T. Upper-air investigations by pilot balloons from Helwan Observatory continue. Arrears of meteorological publications which accumulated during the War are being fast overtaken, the annual reports up to 1921 being nearly ready. The report contains a full list of the publications of the department.

VOLUME 17 of contributions from the Jefferson and the Cruft Laboratories of Harvard University consists of reprints of thirty-nine papers on physical subjects which have been published in scientific periodicals during the years 1924–5. Nine of these emanate from the X-ray laboratory of Prof. Duane, six from that of Prof. Bridgman, four deal with radio circuits and their properties, and twelve with spectroscopy. In the last group is a paper by Messrs. H. N. Russell and F. A. Saunders directing attention to certain new regularities in the spectra of calcium, strontium, and barium. Almost the whole of the lines of the first two are now identified by the help of new spectroscopic terms comparable in importance with the older terms, but some of them negative. The authors characterise the present notation of spectroscopy as chaotic, and as the result of discussion with other workers suggest that in future the *series* be denoted by Roman capitals, the *system* by an index at the upper left hand giving the multiplicity, and the *component* of a multiple term by a subscript on the right giving the inner quantum number.

READERS interested in early printing should obtain from Messrs. Bowes and Bowes, 1 Trinity Street, Cambridge, a copy of their Catalogue (No. 435) of books printed from 1477 to 1600. The list comprises some 548 titles, to which are added many helpful notes.

THE British Science Guild will publish shortly a Supplement to its Catalogue of British Scientific and Technical Books. The Supplement has been compiled by Miss Daphne Shaw from the monthly lists published in NATURE, and it will contain 2258 titles of books issued in 1925, classified alphabetically from agriculture to zoology, as well as an author index.

MESSRS. Chapman and Hall, Ltd., ask us to state that they have had in active preparation "The Theory and Practice of Radiology," by Dr. B. Leggett, but

that in consequence of a fire at their printers the whole work, almost completed, was destroyed, and it is therefore necessary to recommence production and there will be a delay of some months in the publication of the volume.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A junior inspector of mines in the Mines Inspectorate of the Government of India—The Secretary to the High Commissioner for India, 42 Grosvenor Gardens, S.W.1 (August 30). Assistant masters for, respectively, physics and mathematics and chemistry, and physiology and biology at the Lawrence College, Ghora Gall (Murrer Hills), India—The Principal, St. Luke's College, Exeter (August 31). An adviser in dairy bacteriology at Armstrong College, Newcastle-upon-Tyne—The Registrar (September 2). An assistant bacteriologist in the Department of Pathology and Bacteriology of the University of Sheffield—The Registrar (September 11). A lecturer in plant physiology in the University of Aberdeen—The Secretary (September 14). A senior metallurgist under the British Cast Iron Research Association—The Director, 75 New Street, Birmingham (September 15). A professor of philosophy in the University of Sydney—The Agent-General for New South Wales, Australia House, Strand, W.C.2 (September 15). A professor of psychiatry in the University of Sydney—The Agent-General for New South Wales, Australia House, Strand, W.C.2 (September 15). A research bio-chemist at the Walter and Eliza Hall Institute of Research, Melbourne—The Agent-General for Victoria, Victoria House, Melbourne Place, Strand, W.C.2 (September 30). An adviser in agricultural chemistry at Armstrong College, Newcastle-upon-Tyne—The Registrar (October 1). A lecturer in mathematics and physics in the Government College for Indian Women, Lahore—Miss G. Harrison, The Poplars, Buckingham.

Our Astronomical Column.

THE AUGUST PERSEIDS OF 1926.—Mr. W. F. Denning writes that "a series of very clear nights during the first eleven days of August enabled these meteors to be well traced as they gradually increased to a maximum on the morning of August 12. On August 7 the shower was strikingly evident by some fine, flashing meteors. The hourly number observed was about twenty-five from all radiants, of which the proportion from Perseus was sixteen. On August 10, after rain and clouds had prevailed in the early part of the night, the sky became very clear and 60 meteors were seen by an assistant during a watch maintained for 2½ hours. The great majority of these were Perseids and were fairly bright with the normal features of swiftness and afterglows, the latter being strongly marked in several cases where the heads were unusually lustrous. On August 11 clouds and rain again affected the conditions, but soon after 22^h G.M.T. the sky became clear and the ensuing morning presented an ideal aspect for astronomical purposes. A look-out was maintained for 4½ hours and 180 meteors were counted. About 145 of these were Perseids and included a fair proportion of conspicuous objects with long paths and a rapidity of movement which called for celerity on the part of the observer in accurately recording their flights. The maximum of the shower occurred between 2^h and 3^h G.M.T., August 12, when 60 meteors appeared. On the whole, however, the display may be regarded as only of moderate intensity and not nearly so rich in number as those of 1871, 1874, 1877, 1921 or some other years."

SOLAR RADIATION.—Special attention is directed by the Scientific News Service of the Smithsonian Institution to a recent issue of the *Monthly Weather Review* of the U.S. Weather Bureau, which is said to contain a further corroboration by Dr. Abbot of the reality of the variability of the sun's radiation. From a series of observations made at Mt. Wilson by himself and Mr. L. B. Aldrich during the years 1910–1920, a selection has been made of the days on which the atmospheric conditions were as nearly identical as possible, these being divided into comparable groups. Observations made throughout 1912 and 1913 were discarded on account of the Mt. Katmai eruption. When the mean values of the solar radiation readings for these selected days, grouped for a month at a time (the mean value for July of each year from 1910–1920 is given as an example), are plotted, together with the solar constant values already published by the Smithsonian Institution and the sunspot numbers for the same epochs, a close degree of parallelism is shown between the three sets of observations. It is also claimed that short interval changes within the individual months are verified. It is not stated, however, whether the data for other months or periods of the year give as close agreement as that shown for July. The full details of Dr. Abbot's communication will be awaited with interest.

THE SYSTEM OF CASTOR.—This beautiful system became still more interesting when Adams and Joy found in 1920 that the distant companion *C* (about 1″ distant from the bright pair) was itself a spectroscopic binary. The period was at first given as 4 days, corrected later to 0·815 days. *C* is of magnitude 9·03; as the two spectra are of equal intensity, each component is of mag. 9·78; taking the parallax as 0·0747″, this corresponds to absolute mag. 9·15.

Mr. H. van Gent, of Leyden Observatory, examined *C* for variability and found that it is an eclipsing binary. He has determined the light curve from photographs taken with the Leyden 33 cm. refractor. He discusses the observations in *Bull. Astr. Inst. Netherlands*, vol. 3, No. 97. The radius of each component is 406,000 km.; the mass of each is 0·518 sun and density 2·60 sun; the distance apart 2,581,000 km. and inclination 86°.

The surface brightness of each component is 3·31 mag. fainter than that of the sun. The effective temperature is deduced as 3500°, agreeing well with the spectral type *M*. These exact details concerning a red dwarf star are of great interest.

It is noted that Castor *C* has the greatest parallax and proper motion so far known among eclipsing variable stars, and that the components of 61 Cygni have similar absolute magnitude and colour.

Research Items.

THE HUNGARIAN BRONZE AGE.—In *Man* for August, Dr. Lajos Zoltai describes two bronze hoards from Hajdusámson, near Debreczen. The finest examples of the Hungarian bronze industry come from the region known as the Nyirség in the north-east bend of the Tisza, which would appear to have been densely populated and a centre of culture in the Bronze Age. The hoards here described are now in the City Museum of Debreczen. The first consists of a sword and twelve axes found in an orderly grouping which suggests a votive deposit. The leaf-shaped sword is only 53·2 cm. long and has a pommel of which the button consists of closely fitting superimposed rhombs, diminishing in area from the base, the smallest being pointed. Such a pommel is unique in Hungary but is met in Scandinavian swords. Analogous forms of sword are figured by Montelius from north Germany and north Italy. The scroll decoration of the blade is peculiar to Hungary. Three of the axes are similarly decorated. Hajdusámson lies near the centre of the region in which axes ornamented with this scroll pattern are found. It may be described as the centre of the area of fabrication. The second hoard consisted of a number of bronze vessels of which the peculiarity lay in the double handles and their mode of attachment. Mr. Gordon Childe, in an appended note discussing the chronology of the finds, points out that they illustrate two periods of the Hungarian Bronze Age. The leaf-shaped sword belongs to the earliest variety and, being stamped clearly with marks of local manufacture, supplies a link missing in Peake's argument for the Hungarian origin of the type.

PHYSICAL CHARACTERS OF THE FRANKS.—A detailed study of skeletal remains from a Franco-Merovingian cemetery at Baye (Marne) by M. H. V. Vallois in Fasc. 4-5-6, Vol. 6, VII^{e} Série of the *Bull. Soc. d'Anthropologie de Paris*, concludes with a comparative study of such material relating to these invaders of France as is available. The typical Franks would appear to be comparable to the tall dolichocephals of the *Reihengräber*. The type is found with some frequency in Flanders, but in France it rapidly merges into the rest of the population. Thus the Frankish cemeteries of the centre and east of France show a fairly homogenous population in which the skeletal characters agree, generally, with those of the Franks of Belgium, in being dolicho- or sub-dolichocephalic, mesoseme, mesorrhine, or leptorrhine, to some extent prognathous and with a marked protuberance of the occiput. But in the south of Belgium and the more central parts of France these characters rapidly undergo progressive modification, dolichocephaly becomes sub-dolichocephaly, leptorrhiny, mesorrhiny, and the effect of crossing with the Gallo-Roman populations is more and more marked as the distance from the Frankish centre of origin increases. The decrease in stature is considerable, and the measurements given here, 1·64-1·67 m. (males), 1·53-1·58 m. (females), while higher than those of the neolithic peoples, do not exceed those of the Gauls or medieval or modern Parisians. It is noted that while the early crania are predominantly dolichocephalic, and brachycephals are rare, the face being long and narrow of the typical Nordic character, in the cemeteries of Normandy by Merovingian times the dolichocephals are becoming more rare and are mixed with brachycephals, and by the tenth and eleventh centuries the brachycephals are almost the only type, showing that by then the original Gallo-Roman population had resumed preponderance. Yet it is remarkable that while the tall stature and leptorrhiny disappeared almost at once, dolichocephaly, prognathism and the protuberance in the occipital region persist for a much greater length of time.

MODERN WHEAT BREEDING.—The aim and present position of modern wheat breeding is outlined by Sir Rowland Biffen and F. L. Engledow in *Research Monograph* No. 4 of the Ministry of Agriculture and Fisheries. So far as possible the account is couched in non-technical language to render it intelligible to farmers and other non-academic readers, and it presents a clear and concise picture of the methods adopted and the results attained. After a general statement of the problem the principles of heredity and various theories bearing thereon are discussed, together with the complications associated with linkage, chromosomes, races and species. Breeding may be for increased yield or better quality of grain, for greater resistance to disease or for straw less liable to lodging, and in each case specific methods have to be adopted. Increased strength of straw is a most important point, as in many cases farmers are afraid to cultivate in such a way as to obtain the maximum possible yield, for fear lest the crop should lodge and the expense of the extra cultivation and manuring be lost without adequate return. The process of breeding new cereals is necessarily slow, since, owing to the rigid tests that are needed for purity for milling and baking, about ten years must elapse before any promising new variety can be placed on the market. The need in British farming is for a strong wheat with good yielding capacity, and in 1916, Yeoman wheat was introduced to meet these demands so far as possible. After several years' further experiments a still better wheat has been produced, known as Yeoman II., and it now remains to be seen whether this will fulfil its promise under ordinary methods of general cultivation.

HERRING, MACKEREL, AND PLANKTON. — Many naturalists have expressed the belief that movements or occurrences of herring and mackerel at certain seasons are influenced by the presence or absence of certain planktonic organisms. If this is so, then fishermen might benefit greatly by an instrument which would give them a quick indication of the state of the water in which they were proposing to fish. An instrument for use on commercial fishing craft must, however, be simple, strong, easily handled and rapid to use. In his paper, entitled "The Herring in Relation to its Animate Environment," Part 2 (Min. Agric. and Fish., Fishery Investigations, Ser. 2, Vol. 8, No. 7. London, H.M.S.O., 1925), Mr. A. C. Hardy describes trials of his 'plankton recorder,' which consists essentially of a cylinder carrying a white gauze filtering-disc. When the instrument is towed end-on through the water, plankton is deposited on the disc, imparting to the latter a distinctive colour which is dependent on the nature and number of the plankton organisms present. Discs used from commercial drifters in 1922 and 1923 during the herring fishery in the North Sea, and the south-west mackerel fishery from Newlyn, strongly suggested that poor fishing occurred in waters which gave a green disc (due to the predominance of Diatomacea or Phaeocystis). On the other hand, no very convincing correlation could be demonstrated between the number of copepods (red, pink or yellowish-pink disc) and the quantity of fish caught. Confirmation of the results of these preliminary trials is needed, and much interesting and useful information may be expected from an extensive use of this plankton recorder.

FISHERIES INVESTIGATIONS IN DENMARK.—The report of the Danish Biological Station for 1925 covers a wide range of work. Dr. Petersen, in a short discussion on the influence of fishing upon the stock of plaice in the Baltic, gives figures, based on official statistics of landings, which show that since the War there has been a steady decrease in the annual yield of plaice in that region. He suggests that the time has come for a suitable protection of plaice in the Belt sea, and, if possible, by the aid of international legislation, also in the Kattegat and certain parts of the Baltic. A report on the estimation of the density of oyster-population in the Limfjord gives instructive data of collections made by divers. In 1907 the density was estimated to be 1 oyster for each 3·2 square metres, but in 1924 it had dropped to only 1 oyster for each 38 square metres—a reduction to $\frac{1}{12}$. In addition to living oysters, the diver collected the shells of dead individuals. The shells of oysters which had died since the previous summer were easily recognisable, and thus an estimate could be made of the mortality during the season 1923–1924. An alarmingly heavy death-rate of 71 per cent. of the stock was indicated for the hard bottom area in the western parts of the Broad of Livo. Dr. Blegvad gives an account of his continued studies on the quantity of fish-food in the sea bottom, by means of the Petersen bottom sampler, and the detailed examination of the stomach contents of fishes. He attributes the considerable variations in quantity of food for fishes, from year to year, to (1) good brood years of the chief food species, alternating with bad years; (2) the consumption by fishes and other predatory animals, although the effect of the consumption by fishes has probably been exaggerated; (3) physical reasons, such as cold and lack of oxygen, which often kill off large numbers of food animals, especially during the winter.

FERTILITY IN THE DOMESTIC FOWL.—Dr. F. A. E. Crew gives (*Proc. R. Soc. Edin.*, vol. 46, pt. 2, 1926) the results of a series of experiments designed to determine the time of the onset of fertility in the domestic hen after the introduction of the male and the duration of fertility after his removal. He found that fertile eggs can be expected within 24-48 hours after the introduction of the male, though the onset of fertility varies with different matings. The length of life of the sperm within the body of the female is 15-20 days, but the eggs laid after the first week commonly fail to complete their development. If after the removal of the male a second male is introduced, the influence of the first sire is removed by the seventh-tenth day and there appears to be a relation between the general vigour of the male and the fertilising power of the sperm it produces. These results have an important practical bearing for the poultry farmer.

THE ANATOMY OF THE ELEPHANT.—Dr. N. B. Eales has made a careful and detailed dissection of the head of a fœtal elephant and has given an account of her results (*Trans. R. Soc. Edin.*, vol. 54, pt. 3, 1926) illustrated by twelve plates of beautifully clear and well-executed drawings. The work amplifies and corrects that of earlier workers and, as the specimen is unique, Dr. Eales has made the fullest possible use of it. The most interesting result obtained by the author is the evidence of ancestral history revealed by the characters of the lower jaw. The upper part of the skull is essentially like that of the adult and of all modern elephants, the differences being due to fœtal characters entirely. But the lower jaw exhibits the *longirostris* phase of the modern elephant's ancestry. It is relatively longer than in the adult, and the change to the adult condition is accompanied by a definite metamorphosis involving a relative shortening of the anterior part of the mandible. This interesting observation is of the utmost importance as corroborative evidence supporting the accepted facts of palæontology. Dr. Eales is to be congratulated on the completion of a distinguished piece of work.

CULTIVATION OF DROSOPHILA FOR LABORATORY PURPOSES.—Drosophila is now widely used as a laboratory animal especially in genetic investigations, and there is no reason why it should not be used extensively for class purposes to demonstrate the most important results of modern research in genetics, provided it can be kept successfully in the laboratory. With this end in view Prof. Raymond Pearl has investigated the possibilities of making a satisfactory synthetic food medium, free from the uncertainties of the standard banana medium now in use, which would give the required degree of quantitative precision desirable in genetical work. Such a medium is described in a recent paper by Prof. Pearl (*Journ. Gen. Physiol.*, March 1926, vol. 9, No. 4). It is an entirely artificial medium, containing no natural fruit juice and with a higher degree of acidity than the banana medium. On account of its high acidity there is practically never any contamination of the cultures by troublesome bacteria. Experiments with this medium have shown that it is greatly superior to the banana medium in respect of both the fertility and the mortality of the flies kept on it. These results should be of great service to laboratory workers and teachers who may wish to keep Drosophila for class purposes.

YIELD AND POSITION OF FIELD CROPS.—The effect of outside rows on the yields of kafir and milo crops has been determined by J. S. Cole and A. L. Hallsted in the United States over a period of eight years (*Jour. Agric. Research*, 32, 10). The outside rows of 10-row plots gave heavier yields than the inside rows except in 1915, a year of unusually low temperature and heavy rainfall. The increase was much greater in the yield of grain than of stover. On an 8-year average, the acre yield of kafir grain from the outside rows was 30 per cent. higher than that from the inside rows, but the stover was only 7·5 per cent. higher. With milo the figures were 43 per cent. excess grain and 8 per cent. excess stover in favour of the outside rows. The increased yield of grain from the latter proved to be roughly proportionate to the increased area of soil available to them. The relationship between the yields from all ten rows and the inside eight rows of each plot proved to be linear, the correlation being very nearly perfect, and consequently the relative merits of the methods represented could be equally well determined by either including or rejecting the outside rows. The yields determined from the entire 10-row plots were, however, subject to a systematic error arising from the fact that the effective areas of the plots were somewhat greater than the conventional areas assigned to them in converting the plot yields to acre yields.

A NEW SPHYGMO-MANOMETER.—Messrs. Hawksley and Sons, Ltd., 83 Wigmore Street, London, W. 1, have submitted to us for inspection a specimen of the 'Baumanometer' devised by Messrs. W. A. Baum and Co. Inc., New York, for the measurement of arterial blood pressure. The instrument is a modified form of the well-known mercury sphygmo-manometer. To justify the introduction of still another instrument

for measuring blood pressure the booklet supplied with the instrument finds two faults with the existing U-tube manometer, namely, the smallness and variability in the bore of the tube. It states that errors so great as 20 mm. may occur with the old pattern. We are not aware that such an error could be possible, especially as we know in Great Britain that the pressure depends merely on the difference in level in the two limbs of the U-tube, the capillarity effects being negligible. This head of pressure is independent of the shape and course of the intervening tube, and the exhortation by the makers to the physician "to admit his shortcomings on the mechanical side and review his elementary physics" might well be reciprocated. The desk-model submitted to us has a good appearance and is a well-finished instrument. The U-tube consists of a tubular left limb (bore ≏ 0·5 cm.) and a much wider right limb (bore ≏ 2 cm.). The change of zero is compensated for by graduating the left limb in 'calibrated millimetres.' The shift and disregard of the right limb reading also necessitates the bore of the left tube being taken into account, which we find has been done. The instrument possesses two definite advantages which will be appreciated by the busy clinician, namely (1) the wider left bore prevents air pockets and (2) the scale divisions (≏ 0·9 mm.) are easier to read and only the left limb has to be read. It must be pointed out, however, that the scale calibration stressed in this instrument has become necessary owing to the makers' deviation from the usual simple manometer with uniform bore and double reading. Further, the great increase in size of the bore of the tube involves a corresponding increase in the inertia of the moving mercury and consequent damping of oscillations.

MAGNETIC ALLOYS.—Mr. P. E. Billinghurst, writing from Camp Mizine, Salween River, Burma (c/o Messrs. Thomas Cook and Son, Rangoon), points out that if the atomic weight of each constituent of Heusler's alloy is multiplied by the fraction by weight of the element present and the sum taken, it is equal very nearly to the atomic weight of iron. He states that he has produced a number of similar magnetic alloys containing gold, bismuth, tin, silver, copper, and zinc, and found that the above relation holds for them equally well. Owing to the loss of his records by fire he is unable to give the actual figures.

LENGTHENED CHAIN COMPOUNDS OF SULPHUR.—We have received the advance proof of a paper on lengthened chain compounds of sulphur by P. C. Rây and K. C. Bose-Rây which is to be published in the *Journal of the Indian Chemical Society*, vol. 3, No. 2. According to V. Meyer, dithioethylene glycol reacts with ethylene bromide to give a mixture of 1 : 4 dithian and its polymer, the product varying according to the conditions. The polymer has been investigated by the authors and found to consist of a mixture of brominated long-chain compounds, including the substance $BrC_2H_4(S \cdot C_2H_4)_{48}Br$, which is the first example of an organic sulphur compound with a molecular weight so high as 3068.

CADMIUM PHOTO-ELECTRIC CELL.—A cadmium photo-electric cell has been designed by Messrs. H. D. Griffiths and John S. Taylor to measure ultra-violet radiation of the range of wave-lengths which are of therapeutic importance. It consists of the cell itself, in which cadmium forms the active element, and a simple electroscope. The cadmium is deposited by distillation on a plate in front of which is a grid insulated from the plate. The radiation is admitted through a quartz plate and the cell is filled with hydrogen at a low pressure. In use, the grid is charged positively and thus attracts the electrons released from the illuminated plate. The instrument was found very sensitive to unscreened radiation from a quartz mercury lamp. By the use of various filters, it was found that visible and ultra-violet radiation of a wave-length longer than 3500 ft. had no appreciable effect on the instrument. There was no fatigue to be detected during a prolonged exposure. The instrument is sold by Messrs. Watson and Son, Ltd.

WAVE-LENGTH AND THE PHOTO-ELECTRIC BEHAVIOUR OF CRYSTALS.—In the *Zeitschrift für Physik* of July 12, Messrs. B. Gudden and R. Pohl direct attention to the apparent antagonism between the action of long and short wave-lengths when photo-electric absorption of light takes place in solid bodies. They show that it is not due to any real difference between the specific behaviour of the different waves. The essential effect of all wave-lengths is to split off electrons from the atoms, and the observed phenomena can be explained by assuming, in agreement with the experimental results, that a space element of the lattice is only able to support a definite maximum disturbance due to the photo-electric splitting off of electrons, the value of this maximum depending on the temperature. When the maximum is reached, a kind of breakdown takes place and the excited centres go back to their original unexcited state. The disturbances cause a widening of the spectrum on the long wave-length side, similar to that caused by thermal movements or lattice defects. The disturbances vanish as soon as the extra long wave-length light absorbed owing to the above widening has split off enough electrons to increase them above the critical limit.

RESISTANT STEELS.—A paper communicated to the recent Congress of Chemists in London by Messrs. T. G. Elliot and G. B. Willey, dealt with various types of steel now produced commercially by Messrs. Hadfields, Ltd., having great resistance to high and to low temperatures and to attack by chemical agents. The steels are of the austenitic type, and are characterised by high ductility, and by a tensile strength which is retained at high temperatures, one of them giving a value of 31 tons per sq. in. at 700° C. The creep test is even more important than the ordinary tensile test, as it indicates the stress at which a heated mass of the metal could stand for an indefinite time without change of form. The steel in question has a creep stress of so much as 11 tons per sq. in. at 700°. Alloy steels of this class also resist both scaling and warping when heated for long periods in air and subjected to rapid heating and cooling, so that they find a wide application as furnace fittings, hardening boxes, recuperator tubes, etc. Another variety, apparently differing somewhat in composition, is used for turbine blading. A third is used in low-temperature plant, retaining its ductility even in liquid air. For example, a Frémont shock test figure of 50 kg.m. has been obtained at −195°, mild steel only giving 3 kg.m. The paper contains numerous figures relating to mechanical tests, and records of performance in use, including resistance to acids and other corrosive substances, a field in which so much progress has been made in recent years by the introduction of steels highly alloyed with nickel and chromium. The greater initial expense of such steels, and the greater difficulty of working them, are offset by the very greatly increased durability under the conditions to which the steels are exposed in chemical works and elsewhere.

The International Geological Congress at Madrid.

THE fourteenth session of the International Geological Congress was held in Madrid towards the end of May last. It was presided over by Señor D. César Rubio y Muñoz, under the honorary presidency of His Majesty King Alfonso. Señor Rubio is the President of the Board of Mines and was formerly President of the Geological Institute, entrusted with the preparation of the geological map of Spain. His successor, Señor D. Domingo de Orneta, who was to have taken an active part in the meeting, died shortly before it was held.

The Geological Congress is almost the sole survivor of the scientific congresses which formerly played such an important rôle in international scientific comity. It is still open to men of science of all nations, a distinction to which the scientific unions constituted under the International Research Council can lay no claim.

After a preliminary meeting of the Government delegates on the previous day, the congress was formally inaugurated by the King on Monday, May 24. The total number of members was more than a thousand. Many of these had already taken part in excursions to the Canary Islands and Morocco, or to Huelva, famous for its cupriferous pyrites, or other places of geological interest in the south of Spain. Toledo, Aranjuez, Almaden with its mines of mercury, and the Guadarrama mountains that separate Old from New Castile were visited during the meeting, and afterwards there were other excursions to the Balearic Islands, the potash deposits in Catalonia, the Pyrenees, the important coalfield of Asturias, and the iron ores in the neighbourhood of Bilbao.

The Spanish Government and the municipalities of Madrid and of the towns that were visited in the excursions extended splendid hospitality to the members of the Congress. There was a Royal reception at the Palace, a gala theatrical performance, a municipal garden party, and a banquet at which the speeches, twenty-seven in number, commenced with the fish course. This was followed by a charming exhibition of national costumes, dances, and singing, in which the performers were all amateurs.

In spite of these attractions, time was found in the different sections of the Congress for valuable discussions on matters of current geological interest.

There were a number of contributions on recent physical methods of studying the configuration and economic possibilities of the rocks of particular areas by electric, magnetic, and gravimetric methods, and observation of the propagation in the earth's crust of artificially produced vibrations.

The pyritic deposits of the south of Spain, to which reference has already been made, were the subject of important papers, and the greater part of two days was devoted to the discussion of the question as to whether they were formed by replacement or owed their origin to magmatic or pneumatolytic intrusion or deposition. Considerable attention was also given to the part played by Hercynian and Alpine movements in mountain building, more especially in Spain.

Perhaps, however, what was of the greatest interest to the British representatives was the consideration of questions of African geology in connexion with the proposed international geological map of Africa on a scale of one in five million, which was resolved on at the previous Congress at Brussels in 1922. A number of representatives of British African surveys were present as well as those of France, Belgium, Spain, Portugal, Italy, and Egypt. It was gratifying to note the progress that has been made in the interval. A geological map of the whole of South Africa has been recently published on a scale of one in one million, and one of Egypt on a scale of one in two million, and of South-West Africa on the same scale. Maps of the Anglo-Egyptian Sudan and Somaliland on a scale of one in three million, of the Gold Coast on one in one million five hundred thousand, and Gambia on one in five hundred thousand, and of all the remaining British African colonies or mandated territories, Nigeria, Uganda, Kenya, Tanganyika, Nyasaland, British Bechuanaland, and Northern Rhodesia, as well as of Southern Rhodesia, on a scale of one in two million, have been prepared, and work on other parts of Africa is well advanced. The map of the whole of Africa on the scale of one in five million will be prepared under the auspices of the Belgian Government as soon as all the materials are ready.

Of permanent value as a conspectus of the geology of Spain are the excellent guides, some nineteen in number, to the excursions. Many of them are published not only in Spanish but also in French, English, or German, or more than one of these languages. At the same time the Municipality of Madrid presented the members of the Congress with a well-illustrated volume on the Quaternary rocks of the Manzanares Valley by José Péres de Barradas.

The greatest achievement of the Congress, however, was the re-creation among geologists from all parts of the world of the atmosphere of friendliness and cordiality that prevailed in the days, which now seem so remote, 'before the War.'

Cancer Causation: Importance of Cell Physiology.

IN an interesting paper read before the German Chemical Society, at the meeting recently held at Kiel, Dr. Otto Warburg said that the attempts made artificially to produce carcinoma by tar-painting or by X-ray radiation showed that the normal tissues contain cells in which carcinoma may begin without help from any outside cells or micro-organisms. There is no cancer bacillus, just as there is no diabetes or arteriosclerosis bacillus. The cancer problem is a problem of cell physiology in the narrow sense, and limited to the physiology of the body cells.

Since cancerous tissue grows differently from normal tissue, that is to say, irregularly and to excess, it follows that the metabolism of the cancer cell differs from that of the normal cell. Since, on the other hand, the carcinoma cell as an actual body cell originates from normal cells, it becomes necessary to correlate carcinoma metabolism with normal metabolism. Like normal organs, the tumour consumes oxygen and gives off carbon dioxide; the veins of the tumour contain less oxygen and more carbon dioxide than the arteries. Like normal organs the tumour requires glucose, and its veins contain less glucose than the arteries. But, unlike the normal organs, the tumour produces lactic acid which is passed into the blood, a portion of this acid being obtained from the blood sugar, which the tumour to a certain extent oxidises in the same way as normal organs, but for the most part splits into lactic acid. Careful research has shown that there is lactic fermentation of the glucose, and in fact there are a large number of different kinds of malignant tumours, for example, transplanted rat

carcinomata and sarcomata, the Peyton Rous chicken sarcoma, tar carcinoma in rabbits, and all kinds of human cancers, which qualitatively and almost quantitatively show the same result. We have here, therefore, a general characteristic of carcinoma and sarcoma cells which is entirely independent of any particular kind of irritation or of the nature of the normal tissue in which the tumours originate.

If, now, it be asked in what manner tumour metabolism arises out of normal cellular metabolism, it is necessary to inquire first of all under what conditions normal cells split glucose into lactic acid. Normal body cells produce lactic acid when their respiration is inhibited, either by cutting off the supply of oxygen or by poisoning. The production of lactic acid from glucose is, therefore, no peculiar property newly acquired when tumours first form, but is a property common to all body cells. But whilst in normal cells lactic fermentation is only set up by absence of oxygen, tumour cells always produce lactic acid, even when they are fully supplied with oxygen.

The results of these investigations may therefore be summed up in the statement that the tumour, so far as its metabolism is concerned, always behaves as a normal growing cell in a state of asphyxia. If normal growing cells be deprived of oxygen, then we have the reaction of a carcinoma cell. Since by deprivation of oxygen respiration is inhibited, fermentation cannot be masked or prevented, and the asphyxiated cells continue to produce lactic acid in excess, even when the oxygen supply is restored. Most of the cells so treated die because they are unable to live at the expense of energy of fermentation. Only a small number of them remain alive, and in their nature, magnitude and action they are indistinguishable from carcinoma cells.

Dr. Warburg then considered the question whether the asphyxia of normal growing cells sufficed to bring about the cancerous state, or whether other unknown factors also played a part. Reference was made in this connexion to the recent experiments of Carrel, Dresel and Wind, in which the attempt was made to discover whether carcinoma cells can not only exist without breathing, through energy of fermentation, but can also grow. The general conclusion was that tumour cells, like yeast, cannot live their full period without oxygen, but that both kinds of cells are able to grow for a time without oxygen, by the energy of fermentation, and that the asphyxiation of normal growing cells is sufficient to produce the cancerous state

Hæmoglobin.

HÆMOGLOBIN, the oxygen-carrier in the blood of vertebrates, upon which life depends, is a substance of great interest and importance, the investigation of which has received considerable attention from research workers. Prof. J. Barcroft, whose lecture on hæmoglobin, delivered before the Chemical Society on February 11, 1926, has been published in the Society's journal for May 1926, gives an account of recent investigations on the subject.

The old idea that hæmoglobin is a compound of two bodies, called *hæmatin* (containing iron) and a protein, *globin*, is not altogether untrue. The well-defined crystalline substance *hæmin* is obtained by the action of glacial acetic acid on dried blood. When hæmin is oxidised in the presence of alkali, hæmatin is obtained. Alkaline reduction of hæmin yields *hæm*, a substance having an ill-defined spectrum. Nicotine, pyridine, globin, etc., when added to hæm, produce a class of substances with well-defined and similar spectra, called *hæmochromogens*. Of these it appears that the globin compound alone can form a hæmoglobin by regulation of the hydrogen-ion concentration. Cytochrome, another substance well known to the biochemist, has been proved by examination of the absorption spectrum to consist of three hæmochromogens.

The determination of the equilibrium constant K for hæmoglobin and oxygen and for hæmoglobin and carbon monoxide by the ordinary methods of gas analyses is exceedingly difficult on account of the low pressures of the gases involved, and methods have been worked out which involve spectroscopic measurements. The velocity constants, k and k', for these reactions have been obtained by an ingenious form of apparatus which overcomes the difficulties due to the high order of velocity by very rapid mixing of the components. For the reaction $HbO_2 \longrightarrow Hb + O_2$, k' is relatively small, whereas the constant for the formation of the oxide is very large and is also comparatively independent of the temperature and hydrogen-ion concentration. It follows that the equilibrium constant, $K = k'/k$, must be a measure of the effect of the reduction phase. Parallel observations with carbon monoxide show that the slow-reduction phase in the case of oxygen is peculiar.

There is a shift towards the blue in the position of the important α-band in the absorption spectrum when the hæmoglobin is treated with carbon monoxide. This shift, measured in Ångström units, is called the 'span,' and a nearly linear relation is obtained between $\log K$ and the span of hæmoglobins from various sources, where $K[HbO_2] \times [CO] = [HbCO][O_2]$. This is supposed to indicate that "there are a limited number of hæmoglobins, say two, which in different animals are mixed together in different proportions." The difficulties encountered in the measurement of osmotic pressures are also considered and in conclusion attempts are made to reconcile the equation, $Hb_4 + 4O_2 \rightleftharpoons Hb_4O_8$, which these measurements indicate, with the shape of the equilibrium curves previously obtained.

Contact Catalysis.[1]

THE Committee on Contact Catalysis under the chairmanship of W. D. Bancroft has performed an excellent piece of work in collecting together and commenting upon the interesting peculiarities of surfaces in affecting the rates of chemical change of reactants at, or in close proximity to, those surfaces. Whilst certain purists may object to the term 'contact' in connexion with reactions the velocities of which are accelerated by the presence of substances which, although taking part in the chemical change, are not present either in the reactants or products in stoichiometric quantities; yet the word possesses advantages in differentiating homogeneous reactions from reactions heterogeneously accelerated.

In the United States, Dr. H. S. Taylor himself has been largely instrumental in stimulating interest in problems in this field, which during the last decade has attracted an increasing number of research students in all countries, and from which a remarkable crop of new technical industries, not without economic value, has already been harvested.

In 1917 Langmuir showed that chemical reaction

[1] Fourth Report of the Committee on Contact Catalysis. By Hugh S. Taylor. *Jour. Phys. Chem.*, xxx, 145, 171, Feb. 1926.

was probably restricted to the molecules of the reactants actually in contact with the surface. Whilst the experiments of Bone and others at high temperatures indicate that this generalisation may not be always true, yet in a large number of reactions such appears to be the case. Even in combustion at hot surfaces, reaction chains may start from, or, electrons or ions which in turn effect reaction may be emitted from the surface. Four years later it was shown simultaneously in England and the United States that the whole of a surface could not be equally uniform in affecting the rate of chemical action, certain portions of the surface being more active than others. Data both on the quantities and heats of adsorption of gases and vapours as well as the effect of poisons on the rate of catalytic action have amply confirmed the theory of active patches, as is shown in the present report.

It is clear that the existence of active patches is due to the fact that the surface of the catalyst is not uniform, but composite, consisting of various planes, corners and edges of minute crystals in addition to atoms isolated on planes and edges as well as atoms in the planes and edges. The work of Born and Lennard Jones on the surface energies of heteropolar compounds leads us to hope that the surface energies of the various portions of a composite metal surface may in time be computed. Only in the case of certain charcoals and of nickel do we possess any definite information on the extents and specific activities of various patches of different activities, but further information on this subject as well as the variation in relative areas will doubtless be forthcoming.

When we are in possession of data on the variation of the surface forces with chemical reaction rate taking place at the surface, some clue may be given to the mechanism of chemical activation, the elucidation of which is stimulating at the present time a renewed interest in the study of photochemistry.

It is to be hoped that such reports may be continued although the labour involved may render their appearance less frequent in future. Both the committee and Dr. Taylor are to be congratulated on this successor to the three reports already published.

ERIC K. RIDEAL.

University and Educational Intelligence.

CAMBRIDGE.—Mr. C. P. T. Winckworth, Christ's College, has been elected Eric Yarrow lecturer in Assyriology. Dr. C. L. Withycombe has been elected University lecturer in advanced and economic entomology. Prof. B. M. Jones has been nominated as a member of the Advisory Committee on Aeronautical Education. Dr. J. L. Witts, University of Manchester, and Mr. J. O. W. Bland, Jesus College, have been elected John Lucas Walker students in pathology. A grant of 100*l.* has been made from the Balfour Fund to Dr. H. Scott, Trinity College, towards the expenses of an expedition to Abyssinia. Mr. H. G. Cannon, Christ's College, and Miss S. M. Manton, Girton College, have been appointed to the University's table at the laboratory of the Marine Biological Association at Plymouth. An industrial bursary has been awarded by the Royal Commissioners for the Exhibition of 1851 to C. Salter, St. Catherine's College.

An interesting report has been published by the Appointments Committee giving a list of all the teaching appointments made under the new statutes and the grants made to the different faculties and departments from the Government grant. The total amount of new grants already thus allotted is 18,710*l.*, out of 20,000*l.* available for the purpose.

The following have been elected to research studentships: W. J. Dann at Trinity College; B. C. Saunders at Pembroke College; W. A. Waters (chemistry), R. V. Thomas (chemistry), E. G. Jones (economics), J. G. Adshead (mathematics), H. Stayt (anthropology), T. E. Allibone (physics), and W. R. Wooldridge (biochemistry) at Gonville and Caius College; G. H. Aston, A. Caress, O. H. Wansbrough-Jones and B. J. Wood at Trinity Hall; J. Hilton at Christ's College; J. H. Ratcliffe at Sidney Sussex College; G. E. Watts has been elected Charles Kingsley bye-fellow at Magdalene College.

Further details are now available of the will of the late Dr. J. E. Bles, whose bequests to the University of Cambridge have already been referred to in these columns. He left all his scientific instruments, scientific books, and the fittings and contents of his private laboratory to the University of Cambridge, and he empowered his trustees to expend a sum, not exceeding 500*l.*, in completing any researches made by him and publishing the results of any researches not published at the time of his decease. The value of his estate was 42,677*l.*; failing issue, and subject to his widow's life interest and after certain bequests, he left the residue of his property to the University upon trust for a professorship of animal embryology to be called the Charles Darwin professorship, for research and teaching in the subject from a purely scientific aspect; apart from economic, technical, or medical aspects, and subject thereto upon similar terms for a professorship of bio-physics. In the event of these chairs being already constituted, the legacy would have been devoted to the promotion of biological science and subject to a board consisting of the professors of biological subjects, which is also to examine the position of the fund every twenty-five years.

THE Calcutta University Poverty Problem lecturer, Captain Petavel, has for several years been carrying on a campaign of advocacy of a scheme for establishing near Calcutta a co-operative colony of middle-class 'home-crofters,' and in connexion therewith a school of which the pupils would "be systematically organised to produce their food by their own labour, the work being made instructive for them." In his magazine *Bread and Freedom* for July, he announces that a Mr. K. K. Dutta, a well-known Calcutta attorney, has placed at the disposal of his organising committee a village and farm, while another member of the committee has promised to contribute a sum of 10,000 rupees towards a fund for putting the scheme into operation "on business lines." A somewhat similar scheme was recently advocated by Prof. J. W. Scott, of University College, Cardiff.

FROM Loughborough College, Leicestershire, we have received a calendar for 1926–27, giving very fully detailed and illustrated descriptions of the College laboratories and courses in engineering and in pure and applied science including chemical technology. The College has also a Department of Administration and Economics, an Extra-Mural Department, a school of Industrial and Fine Art, and a secondary school for boys. The Faculty of Engineering is noteworthy for its system of concurrent theoretical and practical training, made possible by the large scale of the workshops, half the student's time being spent in productive work. The governors award annually five scholarships in the Faculty of Engineering, each of the value of 75*l.* per annum, open to British subjects in any part of the Empire. Candidates resident outside Great Britain can be examined at local centres.

Contemporary Birthdays.

August 20, 1860. Sir William Henry Ellis, G.B.E.
August 21, 1866. Sir Gerald P. Lenox-Conyngham, F.R.S.
August 21, 1858. Mr. Charles T. Heycock, F.R.S.
August 23, 1875. Prof. W. H. Eccles, F.R.S.
August 25, 1851. Sir John A. F. Aspinall.
August 25, 1844. Sir Thomas Muir, F.R.S.
August 26, 1863. Mr. Edward Heawood.
August 26, 1873. Prof. William A. Osborne.
August 26, 1860. Sir Thomas Ranken Lyle, F.R.S.

Sir WILLIAM ELLIS is president of the Institution of Civil Engineers, and a past president of the Iron and Steel Institute. He was master cutler of Sheffield from 1914 until 1917.

Sir GERALD LENOX-CONYNGHAM, reader in geodesy in the University of Cambridge, was educated at Edinburgh Academy, afterwards entering the Royal Engineers branch of the army. He was superintendent of the Trigonometrical Survey of India from 1912 until 1921. Sir Gerald is a member of the National Committee for Geodesy and Geophysics of the International Research Council.

Mr. HEYCOCK, mathematician and metallurgist, is a fellow of, and lecturer in natural science in, King's College, Cambridge. He was president of Section B (Chemistry) at the Cardiff meeting of the British Association in 1920. Mr. Heycock was awarded the Royal Society's Davy medal in that year on the ground of his researches in physical chemistry, more especially on the composition and constitution of alloys. While his work added to theoretical conceptions, it proved of importance also to industrial metallurgy.

Prof. ECCLES was born at Ulverston, Lancashire. He was the last dean and professor of applied physics in the City and Guilds of London Technical College, which was recently closed. Lately president of the Radio Society of Great Britain, he was, last month, elected president of the Institution of Electrical Engineers.

Sir JOHN ASPINALL was born at Liverpool. He was chief mechanical engineer of the Lancashire and Yorkshire Railway from 1886 until 1899. In 1919 he was appointed consulting mechanical engineer to the Ministry of Transport. Sir John is a past president of the Institution of Mechanical Engineers and of the Institution of Civil Engineers.

Sir THOMAS MUIR, for a long period—1892 until 1915—superintendent-general of education in Cape Colony, was born in Scotland. A graduate of the University of Glasgow, he was, early in his career, assistant professor of mathematics there. In 1883 the Royal Society of Edinburgh awarded him the Keith gold medal for his researches into the theory of determinants and allied questions. The unusual course was taken of allotting the medal again in 1897 for continued work in the same field, and once more in 1916 to mark the completion of the series down to 1915, all the memoirs having been published by the Society. Sir Thomas remains faithful to residence in Cape Colony.

Mr. EDWARD HEAWOOD is known to a wide circle as the accomplished librarian of the Royal Geographical Society, a post he has filled since 1901. Born at Newport, Shropshire, he was educated at Queen Elizabeth's Grammar School, Ipswich, graduating at Gonville and Caius College, Cambridge.

Sir THOMAS LYLE was born at Coleraine, Ireland. He graduated at the University of Dublin. From 1889 until 1915 Sir Thomas was professor of natural philosophy in the University of Melbourne.

Societies and Academies.

ROME.

Royal Academy of the Lincei, June 3.—Leonida **Tonelli**: The quadrature of surfaces.—A. **Bemporad**: The astrographic catalogue of Catania.—Ferruccio **Zambonini**: The presence in the products of the present-day activity of Vesuvius of a cæsiferous variety of potassium fluoborate. For a crystalline sublimate from Vesuvius, consisting of potassium and cæsium fluoborates in isomorphous mixture, the name 'avogadrite' is proposed.—Luisa **Pelosi**: Certain geometrical maxima and minima.—Mauro **Picone**: The singularity of harmonic functions.—Oscar **Zariski**: The impossibility of resolving parametrically by radicals an algebraic equation $f(xy)=0$ of the genus $p>6$ with general moduli.—Umberto **Crudeli**: Models of the helium atom.—R. **Mazet**: Oscillations of a liquid in connected vessels.—Vasco **Ronchi**: The limit of resolution of spectroscopic apparatus. The expression 'resolving power' of a prism, grating, etc., is shown to be inaccurate, since such apparatus is characterised only by dispersion. The resolution depends on the means by which it is examined and, when diffraction images are observed, is only one-half as great as when interference images are employed.—Mario **Picotti**: The results of the physico-chemical researches carried out on the Royal Italian cruiser *Marsigli* in the Straits of Messina. Observations on the temperature and salinity of the water are described.—Fausta **Bertolini**: Conformation of the stomach of the Teleostei in relation to the nutrition.—M. **Sella**: The migration of the tunny studied by means of fish-hooks.

SYDNEY.

Royal Society of New South Wales, June 2.—M. S. **Benjamin**: A note on the rate of decomposition of commercial calcium cyanide. Decomposition was effected in a large closed glass container, and the percentage of hydrocyanic acid evolved was determined. The curves obtained indicate that carbon dioxide considerably accelerates the rate of change and factors other than the cyanogen content of the material affect the efficiency of a given dose of the material in practical fumigation.—G. **Harker** and R. K. **Newman**: Reactions depending upon the vapour at the interface of two immiscible liquids. The reaction between amyl acetate and acidulated water has been studied. The hydrolytic effect of liquid amyl acetate and of the mixed saturated vapour of amyl acetate and water at 100°, upon a surface of given area of dilute mineral acid, revealed a close agreement in the rate of hydrolysis. Taken in conjunction with the results previously obtained for benzyl chloride, it is therefore evident that at the interface of the two liquids the mixed saturated vapours of both liquids must be present. This is in agreement with the view of Van der Waals that there exists a continuous transition from the liquid to the vapour state at the boundary of any liquid.—A. R. **Penfold**: Notes on the essential oils from some cultivated Eucalypts. The specimens were grown from seed at Ashfield, near Sydney. The trees examined varied from three to eight years of age, and consisted of *E. Australiana*, *E. Macarthuri*, *E. citriodora* and *E. radiata* (*numerosa*). The *E. Australiana* was grown from seed collected at Wyndham, N.S.W., a place which yielded oils possessing a lævo-rotation of about $-3{\cdot}6$ and containing phellandrene in small quantity, and as it would not meet the requirements of the various pharmacopœias the district had to be abandoned. The oils obtained from material grown

at Ashfield possessed an optical rotation of +2·5° to 3·2° and were free from phellandrene. *E. Macarthuri* gave remarkable yields, varying from 0·5 to 0·74 per cent., as compared with 0·2 per cent. yield from the ordinary native material, whilst the geranyl acetate varied from 62 per cent. to 75 per cent., thus showing the influence of ecological conditions. *E. citriodora* yielded oils from 0·5 per cent. to 1 per cent., containing from 90 to 98 per cent. citronellal, and it would appear as if there were separate races existing within this species.—Miss P. Nicol: An investigation of the optical properties of selenium in the conducting form. Methods of preparing mirrors of selenium are described. The method gives values of γ_0 generally correct to within about 3 per cent. and of κ_0 to within 5 per cent. The values obtained vary within fairly wide limits, depending on the method of preparation (casting on glass, polishing, grinding, etc.). The results obtained are:

λ= 6470-4170	ν_0=2·7 -3·36	κ_0=0·45-0·9
λ= 5890-5896	ν_0=2·75-3·06	κ_0=0·77-1·07
λ=21900-8100	ν_0=2·59-3·02	κ_0=0·90-1·18
λ= 4400-4800	ν_0=2·74-3·04	κ_0=1·05-1·27

Some rough measures in the near infra red indicated $\kappa_0 < 0{\cdot}1$ and ν_0 about 2·6. There was no definite indication of any relation between the temperature of transformation to the conducting form and the optical properties, nor was there any variation with the length of exposure to light or with the age of the specimen.

VIENNA.

Academy of Sciences, July 1.—F. Hemmelmayr and J. Strehly: Contributions to our knowledge of skoparin. Apparently this substance contains seven hydroxyl groups, and its formula is $C_{22}H_{22}O_{11}$ rather than $C_{20}H_{20}O_{10}$.—L. Schmidt and R. Stöhr: Two substances similar to stearine from *Asclepias syriaca*. A monovalent unsaturated alcohol $C_{31}H_{52}O$ and a divalent unsaturated alcohol $C_{45}H_{74}O_2$ have been obtained.—L. Waldmann: Petrographic description of the stones collected by L. Kober in the northern Hegas and in the Taurus.

Official Publications Received.

International Hydrographic Bureau. Special Publication No. 12: Investigation of Harmonic Constants, Prediction of Tide and Current, and their Description by Means of these Constants. By Rear-Admiral Phaff. Pp. 80+6 plates. 5 Swiss francs. Supplement to Special Publication No. 12: Tables for the Calculation of Tides by Means of Harmonic Constants. Pp. 136. (Monaco.)

Straits Settlements. Annual Report on the Raffles Museum and Library for the Year 1925. By C. Boden Kloss. Pp. 14. (Singapore: Government Printing Office.)

Union of South Africa: Department of Agriculture. Reprint No. 4, 1925: Weeds of South Africa, Part 3. By K. A. Lansdell. Pp. 34+5 plates. (Pretoria: Government Printing and Stationery Office.) 3*d*.

The National University of Ireland. Calendar for the Year 1926. Pp. viii+329+431+156. (Dublin.)

Department of Scientific and Industrial Research. Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for the Year 1925; with Report of the Geological Survey Board and Report of the Director. Pp. vi+211+12 plates. (London: H.M. Stationery Office; Southampton: Ordnance Survey Office.) 4*s*. 6*d*. net.

University of Bristol. The Annual Report of the Agricultural and Horticultural Research Station (The National Fruit and Cider Institute), Long Ashton, Bristol, 1925. Pp. 152+11 plates. (Bristol.)

Report of the Imperial Institute of Veterinary Research, Muktesar, for the Year ending 31st March 1925. Pp. ii+59. (Calcutta: Government of India Central Publication Branch.) 1.14 rupees; 3*s*. 3*d*.

Records of the Geological Survey of India. Vol. 59, Part 1: General Report for 1925, by Dr. E. H. Pascoe; The Zonal Distribution and Description of the larger Foraminifera of the Middle and Lower Kirthar Series (Middle Eocene) and parts of Western India, by W. L. F. Nuttall. Pp. 164+8 plates. (Calcutta: Government of India Central Publication Branch.) 2.12 rupees; 5*s*.

Ceylon Journal of Science. Section A: Botany. Annals of the Royal Botanic Gardens, Peradeniya. Edited by A. H. G. Alston. Vol. 10, Part 1, June 15th. Pp. 144+2 plates. (Peradeniya: Director of Agriculture; London: Dulau and Co., Ltd.) 3 rupees.

The Scientific Proceedings of the Royal Dublin Society. Vol. 18 (N.S.), No. 22: The Downy Mildew of Onions (Perenospora Schleideni), with particular reference to the Hibernation of the Parasite. By Dr. Paul A. Murphy and Robert M'Kay. Pp. 237-261+plates 12-15. 4*s*. Vol. 18 (N.S.), No. 23: A simple Method of Temperature Control for use with Refractometers and Polarimeters. By Michael T. Casey. Pp. 263-264. 6*d*. Vol. 18 (N.S.), No. 24: The Dehydration Rates of Conifer Leaves in relation to Pentosan Content. By Joseph Doyle and Phyllis Clinch. Pp. 265-275. 1*s*. (Dublin.)

Forestry Commission. Sixth Annual Report of the Forestry Commissioners, Year ending September 30th, 1925. Pp. 32. (London: H.M. Stationery Office.) 9*d*. net.

Jamaica. Annual Report of the Department of Agriculture for the Year ended 31st December 1925. Pp. 23. (Jamaica, B.W.I.)

Diary of Societies.

SATURDAY, AUGUST 21.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Annual Meeting) (at Newcastle-upon-Tyne), at 2.30.

CONGRESSES.

AUGUST 27 AND 28.

IRON AND STEEL INSTITUTE (Autumn Meeting) (at Stockholm).—F. Adcock: The Effect of Nitrogen on Chromium and some Iron Chromium Alloys (Alloys of Iron Research, Part IV.).—J. H. Andrew and H. A. Dickie: A Physical Investigation into the Cause of Temper Brittleness.—Prof. C. Benedicks, H. Bäckström, and P. Sederholm: Anomalies in Heat Conduction, with some Determinations of Thermal Conductivity in Iron and Carbon Steels.—Prof. C. Benedicks and R. Sundberg: Electrochemical Potentials of Carbon and Chromium Steels.—G. F. Comstock: The Treatment of Steel with Ferro Carbon-Titanium.—G. A. Hankins, D. Hanson, and Miss G. W. Ford: The Mechanical Properties of Four Heat-Treated Spring Steels.—Prof. K. Honda: Is the Direct Change from Austenite to Troostite Possible?—A. Johansson and R. Von Seth: The Carburisation and Decarburisation of Iron and Some Investigations on the Surface Decarburisation of Steel.—A. Johansson and A. Wahlberg: The Development of the Swedish Iron and Steel Industry during the last thirty years.—E. Kinander: Notes on Jernkontoret.—A. Lundgren: The Testing of Hardened Steel.—W. Petersson: Notes on the Development of the Swedish Mining Industry during the last twenty-five years.—G. Phragmen: The Constitution of the Iron-Silicon Alloys.

AUGUST 29 TO SEPTEMBER 1.

SOCIÉTÉ HELVÉTIQUE DES SCIENCES NATURELLES (at Fribourg).—In Sections devoted to Mathematics, Physics, Geophysics, Meteorology and Astronomy, Chemistry, Geology, Mineralogy and Petrography, General Botany, Special Botany and Geographical Botany, Zoology, Entomology, Anthropology and Ethnology, Palæontology, Medical Biology, History of Medicine and Natural Science.

AUGUST 31 TO SEPTEMBER 8.

WORLD POWER CONFERENCE (at Basle), Technical Programme of Sectional Meeting:

Utilisation of Water Power, and Inland Navigation.
Exchange of Electrical Energy between Countries.
The Economic Relation between Electrical Energy Produced Hydraulically and Electrical Energy Produced Thermally: Conditions under which the two systems can work together with advantage.
Electricity in Agriculture.
Railway Electrification.

SEPTEMBER 1 TO 4.

INSTITUTE OF METALS (Autumn Meeting) (at Liége) (September 1, at 8).—Dr. W. Rosenhain: Ancient Industries and Modern Metallurgy) (Autumn Lecture).—Dr. C. J. Smithells, H. P. Rooksby, and W. R. Pitkin: The Deformation of Tungsten Crystals.—Prof. K. Honda: A Comparison of Static and Dynamic Tensile and Notched-Bar Tests.—C. H. M. Jenkins: The Constitution and the Physical Properties of the Alloys of Cadmium and Zinc.—H. J. Gough, S. J. Wright, and Dr. D. Hanson: Some Further Experiments on the Behaviour of Single Crystals of Aluminium under Reversed Torsional Stresses.—B. Ôtani: Silumin and its Structure.—G. B. Phillips: The Primitive Copper Industry of America. Part II.—Kathleen E. Bingham: The Constitution and Age-Hardening of Some Ternary and Quaternary Alloys of Aluminium containing Nickel.—Dr. A. G. C. Gwyer and H. W. L. Phillips: The Constitution and Structure of the Commercial Aluminium-Silicon Alloys. With an Appendix upon The Properties of the Modified Aluminium-Silicon Alloys, by Dr. D. Stockdale and I. Wilkinson.—J. D. Grogan: Some Mechanical Properties of Silicon-Aluminium Alloys.—Dr. C. S. Smith and Prof. C. R. Hayward: The Action of Hydrogen on Hot Solid Copper.—Capt. F. R. Barton: The Development of the Use of Nickel in Coinage.—A. Pinkerton and W. H. Tait: Season-Cracking in Arsenical Copper Tubes.—Prof. P. Chevenard: Thermal Anomalies of Certain Solid Solutions.—W. T. Cook and W. R. D. Jones: Preliminary Experiments on the Copper-Magnesium Alloys.—F. W. Rowe: Bronze Worm Gear Blanks produced by Centrifugal Casting.—L. Boscheron: An Account of the Non-Ferrous Metals Industry in the Liége District.

SEPTEMBER 6 TO 11.

AMERICAN CHEMICAL SOCIETY (at Philadelphia).—In eighteen Divisional Gatherings, dealing with various branches of Pure and Applied Chemistry.

SEPTEMBER 13 TO 17.

INTERNATIONAL CONGRESS OF PHILOSOPHY (at Harvard University, Cambridge, Mass.).