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Language in the Service of Science

SEEKERS after truth in Nature have always been regarded as disturbers of the peace and associates of the Evil One. It is not surprising, therefore, that throwing stones at men of science is a practice dating from very early times; and it still continues, if in a somewhat different form. Since the powers of evil were let loose during the War, the earlier pebbles of theology have been largely replaced by the heavier stones of sociology, as expressed in a prize-epigram in the *Spectator*:

> Science finds out ingenious ways to kill
> Strong men, and keep alive the weak and ill—
> That these a sickly progeny may breed,
> Too poor to tax, too numerous to feed;

and more recently science has been indicted as a primary cause of unemployment. There is, however, an older missile that critics, chiefly literary men, never cease to hurl: the man of science, they say, cannot make himself intelligible to ordinary people; he abuses the English language, and has little or no literary feeling. Dr. Cyril Norwood, the headmaster of Harrow School, in a recent Friday evening discourse at the Royal Institution on "The Use of the English Language", allies himself with these critics, but his stones are so soft and so polished, and the material of them is so excellent, that, far from doing harm, they should do good, even if they only disturb the still waters of complacency.

In our rightful efforts to be natural, says Dr. Norwood, we easily become careless in the use of words and slip into colloquialisms, and even slang. Men of science labour under the further disadvantage, peculiar to themselves, that they have to use a highly technical vocabulary which, however intelligible it may be to students of the particular science, is frequently meaningless to ordinary men and women. "The use of technical terms may very easily lead writers to employ language as a set of symbols only, and they may lose all sense of living words." Technical language is a necessity, but its use is frequently overdone, and "men of science, even when writing for each other in scientific periodicals, would find that it would repay them to write as clearly and attractively as they can. They should regard technical and specially invented terms as a necessary evil, an instrument to be employed as sparingly as possible. For one of their main purposes must of necessity be the instruction of the general educated public who are not specialists in any

sense, and certainly in the propagation of ideas one who can explain himself in language which ordinary men and women can understand has a great advantage over one who has not this power".

Scientific workers will, we believe, agree generally with Dr. Norwood's moderately-worded statements, but it will be news to many that instruction of the general public is one of their main purposes. Perhaps it should be; but there are few signs that it is so now. The investigator who is inclined to assume the rôle of populariser believes that if he does so his colleagues will accuse him of being superficial and inaccurate. There is, further, a doubt whether, as a rule, he is qualified to act in this capacity; for good popular exposition demands qualities that have little or no connexion with those which make for success in scientific research. The populariser of knowledge must be able to woo or conquer his reader's attention by favour or by force; he must steer a clear course between academic phraseology and the jargon called 'journalese'; he requires imagination to see things as ordinary people see them; and, last but not least, he needs a sense of style. Ability to write or to speak plainly and pleasantly is seldom associated in the same individual with ability to do original work—there are, of course, some notable exceptions—and it would be well if this fact were recognised by the popular Press, which has lately gone to extremes in 'animating' objective description by over-emphasising the personal element. We all realise the advantage of hearing or reading the words of a discoverer or author as they flow hot from his mouth or fountain-pen, provided he is a capable exponent; but we also realise how wise was Johnson to have a Boswell, and how fortunate was Darwin to have a Huxley and a Ray Lankester as disciples.

The question of technical vocabulary is admittedly difficult. Although most would agree that in certain sciences there are words and expressions that almost or quite defy translation into ordinary language, yet in the great majority of sciences, pure and applied, it is possible to do so, if with some loss of precision, by using suitable devices, such as periphrasis and analogy. These, however, should be employed with caution, because periphrasis is the fruitful mother of jargon, and analogy, when false or faulty, has ever been an *ignis fatuus*, leading to wrong turns in science, religion and philosophy, and so blocking their progress. Men of science and technologists nearly always write and speak as if they are addressing one another, although the slang they use, like common slang, is concise, and often remarkably expressive—to themselves. These remarks, however, apply with equal force to other professional workers: lawyers, economists, stockbrokers, architects, musicians and other professional men, all use their own special jargon, which few laymen can properly understand. Language has been compared with a living organism: it grows by assimilating more material than it discards, but its general structure remains intact. The simpler words that make the backbone of a natural language stand fast against the accidents of time and the desecrations of the profane; they are and will remain the best for common use.

On the point of clear and attractive writing, it will be admitted that scientific men are, as a rule, far too engrossed in their special subjects to give much heed to style or method of presentation. A clear, brisk, and accurate style is, however, within the compass of all; but it requires effort. "All beautiful work," said Ruskin, "is the easy result of long and painful practice"; and if the man of science will not learn the rules of good writing and concentrate on applying them, he can only blame himself if he fails to make himself understood, and if another succeeds in reaping where he has sown.

The word 'style' has several meanings: it may mean personal idiosyncrasy in expression; or mere ornament; more often, and perhaps more correctly, it means the power of expressing lucidly a sequence of ideas; but however it be defined, fundamentally it consists in choosing the right words and arranging them properly. "Style is connexion; art is putting things in their places," said the Master of Balliol (Jowett); and though we may hold his definition of art to be inadequate, we cannot dispute that, fundamentally, style *is* connexion: the connecting of words, of clauses in a sentence, of sentences in a paragraph, and of paragraphs in a composition; and all with the object of attaining clear and precise expression.

The secret of a lucid style, as Dr. Norwood reminds us, is to simplify: cut out the redundant words, first the nouns and then the adjectives; avoid where possible the use of abstract nouns and long words; and beware of circumlocutions! Observance of these simple rules will go far to produce a good style; but a few more may be added, for example, prefer the active form of the verb to the passive; avoid the use of too many noun-adjectives; and study the use of hyphens.

The noun-adjective is often clumsy or ambiguous, and the rules or conventions for the proper use of hyphens (see Tract No. VI of the Society for Pure English) are honoured far more in the breach than in the observance in modern scientific literature.

The other main element in a good style is precision. "The chief aim in style," said Flaubert, "ought to be absolute precision. There is only one noun that can express your idea, only one verb that can set that idea in motion, and only one adjective that is the proper epithet for that noun." The chief obstacles to precise statement are want of clear thinking; bad choice of words; using too many abstract nouns, preposition-verbs, and circumlocutions; and faulty arrangement. Metaphors and analogies are useful in popular description, but find little place in rigidly scientific prose, as they often lack precision. Conciseness, first cousin to clarity, does not always make for precision, at least not for Flaubert's "absolute precision". It is possible to be too concise (as readers of many modern abstracts are aware) and to introduce ambiguity by cramming a maximum of meaning into a minimum of words. On the other hand, what is more tedious than reading a treatise by an author who leaves nothing to his reader's imagination, and disgorges the whole contents of his mind in sentences replete with qualifications and elaborations? The artist, it has been said, is known rather by what he omits. Can we not all emulate the artist in this respect?

Other hall-marks of a good style are variety and sobriety. Although often guilty of monotony, scientific writers of to-day can seldom be accused of want of sobriety; they err rather in the opposite direction, except when they make two or more words do the work of one. The populariser must, of course, be allowed some licence; he has to fix and maintain the attention of his audience; and if at times he tries to imitate authors like Shaw and Chesterton by immoderate use of hyperbole, paradox, parody, and alliteration, he may be forgiven on the ground that the end justifies the means. Nevertheless, the elements of style are essentially the same for popular scientific, purely scientific, and ordinary literary description. If the writer of science is to be as successful as the literary man in his appeal to the educated public, he must observe the 'rules of the game', and furthermore, he must cultivate that priceless possession of the true artist and the real man of science, the passion to excel, which is at the root of all the best work that is done in the world.

Metals and Civilisation

Man and Metals: a History of Mining in relation to the Development of Civilisation. By Dr. T. A. Rickard. Vol. 1. Pp. xiii+506. Vol. 2. Pp. v+507–1068. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1932.) 50*s*. net.

BUCKLE devoted six volumes to an introduction to the history of civilisation. Dr. T. A. Rickard gives us two bulky volumes on a single aspect of this subject, an aspect somewhat neglected by Mr. H. G. Wells, namely, the relation of mining and the use of metals to the development of civilisation.

It may reasonably be said that no man living is better qualified to write on this subject than Dr. Rickard. He was trained at the Royal School of Mines, London. Since his student days he has spent nearly fifty years as a mining engineer, mine manager and consultant in various parts of the world, but chiefly in the United States. He has been editor successively of three leading mining journals. He is also the author of several text-books on mining subjects.

In his introductory chapters, Dr. Rickard shows how man emerged from savagery by the aid of tools, first of wood and stone, then of metal. In the masterly review of the history of mining which follows these introductory chapters, the author shows how the search for metals has aided the spread of civilisation in ancient times, in the Middle Ages, and in our own era. Also how the use of metals for money, credit, machinery, transport, communication and war has been a fundamental factor in the development of our present world-wide civilisation.

The author also dwells on the perversity of mankind through which a blessing is often converted into a curse. In the earliest times "the sword was made before the ploughshare"; in the immediate future "shall we mend our ways or go with the Gadarene swine down the steep slope of perdition?" "The history of mining, like all other history, thunders a warning."

Dr. Rickard is a philosopher as well as a historian and an engineer; he is also a careful student. The dedication of his book "To the Librarians" indicates his appreciation of the work of others. The lengthy lists of references at the end of each chapter are evidence of the care with which he has studied his subject. Nevertheless, the treatment

in places seems to follow the preconceived methods of some mining geologists rather than the cautious following of the reef characteristic of the old-fashioned mining engineer. Dr. Rickard condemns rather thoroughly the legend of King Solomon's mines in Rhodesia and prefers the later theory that they are of recent Bantu origin. He offers no explanation of the destination of the very large amount of gold apparently taken from these workings, or of the workmanship of the gold ornaments, or of the finely made crucibles apparently used for assaying. These crucibles were turned on a wheel, not Bantu work, and may be found also around the ancient workings of Rouiberg and Blaubank in the Transvaal. These crucibles in *both* countries are characterised by a herring-bone pattern round the rims. The objections to South Africa not being regarded as a great centre for bronze and copper production are similar. The Middle Ages had no use for the million tons of copper estimated by Dr. P. A. Wagner to have been produced: nor is there any record of the thousands of tons of tin produced being shipped to Europe in the Middle Ages. In one district alone there are the remains of forty-six furnaces and enormous quantities of slag. The occurrence of nickel in ancient bronzes does not seem explicable from the limited Hungarian and Asiatic sources alone, but, as Dr. Rickard remarks, the chemical analysis of metallic relics has been sadly neglected. Many a "Green-stained piece of old metal" has been assumed to be bronze when often it was copper. He also, on geological grounds, denounces as fable the stories of the rapid submergence of Leonesse in November 1099.

Again, Dr. Rickard bases some important conclusions on the statement that the pre-Roman Britons only possessed tools of wood and deershorn. From "across the pond" we must remind him that Cæsar's world-victorious army was defeated again and again and finally driven from Britain in 55 B.C.—surely not with tools of wood and deershorn! The Romans did not finally conquer Britain for another hundred years although attempts were made.

In these days of specialised study, it is often easy to find fault with any book which deals with a very wide subject. Dr. Rickard's main conclusion is well and truly established; he has shown convincingly the intimate relation between the history of mining and the history of man's development from savagery, through barbarism to civilisation. B. W. H.

A Photogrammetric Survey in the Pamir

Wissenschaftliche Ergebnisse der Alai-Pamir Expedition 1928. Im Auftrage der Notgemeinschaft der Deutschen Wissenschaft. Herausgegeben von Dr. H. v. Ficker und Dr. W. R. Rickmers. Teil 1: *Geodätische, Topographische und Glaziologische Ergebnisse.* Von Dr. Richard Finsterwalder. Band 1: *Geodätischer und glaziologischer Teil.* Pp. x + 218 + 23 plates. Band 2: *Kartenbeilagen.* 12 maps. Teil 2: *Geologische Untersuchungen im nordwestlichen Pamir-Gebiet und mittleren Transalai.* Von Dr. Ludwig Nöth. Band 1: *Stratigraphie (ausschliesslich Quartär), Tektonik.* Pp. viii + 130 + 3 maps. Band 2: *Quartäre Ablagerungen, Morphologie.* Pp. v + 131–211 + 24 plates. Teil 3: *Beiträge zur Faunistik des Pamir-Gebietes.* Von Dr. W. F. Reinig. Band 1: *Ökologie und Tiergeographie.* Pp. viii + 195. Band 2: *Systematischer Teil.* Pp. iv + 196–312 + 6 plates. (Berlin: Dietrich Reimer (Ernest Vöhsen) A.-G., 1932.) 6 vols., 175 gold marks.

THE Alai-Pamir expedition was a joint undertaking of the Notgemeinschaft der Deutschen Wissenschaft and the Academy of Sciences of the U.S.S.R., and its object was to explore the almost unknown north-western part of the Pamir. The sheet of the general map which accompanies these volumes extends from 72° E. to 73° 45′ E. and from 38° 30′ N. to 39° 40′ N., and most of this area was surveyed in greater or less detail. The actual survey reaches from the Kisil-su on the north to the southern border of the sheet, and from the Garmo Peak on the west to the Pamirski Post road on the east, stretching beyond that road in the Transalai and in the neighbourhood of Lake Karakul. The area covered by the survey is about 15,000 square kilometres.

The expedition entered this area at the north-east corner on June 27 and left at the north-west corner on Oct. 16, and the topographical map is a truly remarkable result for less than four months' work in so difficult a region. That so much was accomplished is due to the foresight with which the expedition was planned and to the fact that the survey was made by terrestrial photogrammetric methods and was plotted with the stereoautograph after the return to Europe. No previous expedition in unknown country has relied so entirely upon these methods, and the very practical account given by Dr. Finsterwalder should be valuable to workers in other areas. He deals not

only with the observations in the field but also with the subsequent preparation of the map, by the field observers themselves, with the help of the stereo-autograph. The chief instrument used in taking the photographs was the light photo-theodolite of Zeiss; but where the difficulties of access were too great, a still lighter photogrammeter, without theodolite and using smaller plates, was employed for supplementary observations. Other instruments were used for triangulation and for field astronomy, and the astronomical position of several points was accurately fixed by Belajeff, one of the Russian coadjutors, with a more complete astronomical equipment. Two stations of the Russian Pamir Triangulation were found and thus the survey was linked with previous work. Certain discrepancies between astronomical and geodetic positions indicate deflections of the plumb-line which deserve closer investigation.

The area examined varies greatly in character. Towards the south-east it is a dry plateau where rock-waste accumulates and the hills are low and tame. Towards the west and south-west the rainfall increases, snow gathers on the higher ground, and large glaciers flow out from extensive snowfields. The valleys here are deeply cut and the hills are rugged, especially near the Garmo Peak. On the north is the high chain of the Transalai, with smaller snowfields and glaciers, and beyond this lie the steppes of the Alai Valley, through which the Kisil-su flows from east to west.

The most interesting part of the region, from the morphological point of view, is the glaciated area of the west and south-west. The topographers spent some eight weeks here, the survey was made in considerable detail, and the rate of movement of two of the greatest glaciers was determined. The method by which this rate was measured shows some of the advantages of photogrammetry. From the ends of a measured base upon the bank photographs are taken with the photo-theodolite, looking across the glacier. After the lapse of a few days one at least of these photographs is repeated. With the stereo-autograph there is then no difficulty in determining with considerable precision the distance which any stone or other well-defined mark upon the glacier has moved during the interval. In sunny weather this interval must not be too long or some of the movement of a stone may be due to melting of the ice. One of the glaciers of which the rate was determined was the Fedchenko Glacier, the most remarkable of all. It flows from south to north, at right angles to the general trend of most of the main valleys. Its length is about seventy-four kilometres and Finsterwalder thinks that it is probably the longest glacier on the earth outside the polar regions.

A geologist can do nothing where the rocks are covered with snow, and accordingly Dr. Nöth devoted his attention chiefly to the north and east of the region. With the help of the observations of his colleagues he has produced a geological map of the whole area, but he is fully aware that such a map can be no more than an imperfect sketch. It will, however, be useful both to the reader and to any subsequent worker in the region.

By far the greater part of the north-western Pamir consists of Palæozoic and older rocks, with large intrusive masses. Lower Carboniferous beds have been definitely recognised, Middle Devonian and Permian beds with less certainty. The folding of these rocks was completed in the Permian period and the mass was raised above the sea. The Mesozoic era was a quiet time during which a surface of low relief was produced by erosion, the hills which rose above the general level being worn down, while in depressions below that level Mesozoic sediments were locally deposited. The Transalai range, on the northern border of these ancient rocks, is geologically distinct. Its northern slope consists of Cretaceous and Tertiary beds which have been strongly folded by a northward movement of the Pamir mass. This folding was completed in Miocene times and since then there has been no great change of form in any part of the region; but the valleys upon the western border have been deepened by ice and river erosion, while in the dry interior the rock-waste produced by weathering remains. Two glacial periods can be recognised, during the first of which the glaciated area was considerably more extensive than during the second.

Dr. Reinig, the zoologist of the German party, began to collect in the Fergana basin, before the expedition had reached its chief objective. He left the main party near Lake Karakul and travelled through the south part of the Pamir as far as Langar, near the border of Afghanistan. Accordingly, he deals with a much wider area than his colleagues. In the circumstances it was impossible to preserve or transport soft-bodied animals. Therefore he collected chiefly insects, paying special attention to bees and Tenebrionidæ, which, on account of their variability, might be

expected to yield the most valuable results. He gives a useful general account of the orography, climatology and vegetation of the whole region; but perhaps his most interesting chapter is that upon the origin of the Pamir fauna. Owing to its cold and dry climate the fauna of the High Pamir is much poorer, both in species and in individuals, than that of the milder and moister western valleys; but there are differences which cannot be due entirely to climate. During the first glacial period much of the Pamir was covered by ice, and animal life must have been greatly reduced. Most of the present fauna has entered the area since the ice retreated, and Dr. Reinig shows that there has been immigration both from the west and from the east. Another chapter, of special interest to zoologists, deals with variation in the Hymenoptera and Tenebrionidæ.

The whole work is beautifully produced and the volumes are very convenient to handle and read. The paper is thick and strong but very light, and the print is clear. The numerous photographic views and panoramas are well reproduced and the maps and sections leave nothing further to be desired. Besides the general topographic map on the scale of 1 : 200,000 and the geological map upon the same scale, there is another with the contours in blue and the trigonometrical nets in red, and a transparent sheet showing the photogrammetric lines. There are also special maps of the greater glaciers on a larger scale, sections of two of them showing the rate of movement, and a sheet of geological sections. PHILIP LAKE.

The Play of Thought in Progress

Adventures of Ideas. By Prof. Alfred North Whitehead. Pp. xii+392. (Cambridge: At the University Press, 1933.) 12*s.* 6*d.* net.

THIS is a book so rich in thought and covering so many fields of human experience that it is quite impossible to summarise or render an adequate account of it within the limits of a review. It is emphatically a book to be bought, read, re-read, and pondered. Not everyone will agree with the author's views, which are the expression of a highly individual philosophy, a particular attitude towards the problems of existence, but no one can read the book without receiving help and stimulus from the wisdom that permeates it and flashes into brilliance in many pregnant phrases.

The book is complementary to "Science and the Modern World" and "Process and Reality", but is complete in itself, and can be read without previous acquaintance with Whitehead's philosophy. There are four sections. The first deals with the influence exerted by Platonic, Roman, and Christian ideas upon the development of Western civilisation.

In a few vivid chapters, Whitehead traces the growth of the humanitarian ideas which originated first as the intuitions of genius, and slowly made their way in the world, as the world ripened to receive them. Thus "at the close of the Dark Ages Europe started upon its second effort after civilization with three main advantages: its Christian ethics: its instinct for legal organization transcending local boundaries, derived from the Church and the reminiscence of the Empire: and thirdly its wider inheritance of antecedent thought, gradually disclosing itself as Hebrew, Greek, and Roman literatures. The total effect was the increased sense of the dignity of man, as man. There has been a growth, slow and wavering, of respect for the preciousness of human life. This is the humanitarian spirit, gradually emerging in the slow sunrise of a thousand years" (p. 105). This is what Whitehead means by the adventure of ideas in the history of the human race—their influence in promoting "the slow drift of mankind towards civilization".

There is, too, in all great thought an element of adventurousness—fresh ideas represent something novel, untested, unsafe: they are a leap in the dark. It is of the essence of life itself that it is a striving after expansion and novelty. It is "an offensive, directed against the repetitious mechanism of the Universe. . . . Life can only be understood as an aim at that perfection which the conditions of its environment allow. But the aim is always beyond the attained fact" (p. 102).

A civilisation which has become static, which rests content with accepted ideas and customs, which puts safety first and refuses the adventure of ideas, is a civilisation about to decay. It can be rescued and transformed only by the influence of fresh ideas, new ends to pursue. "The foundation of all understanding of sociological theory—that is to say, of all understanding of human life—is that no static maintenance of perfection is possible. This axiom is rooted in the nature of things. Advance or Decadence are the only choices offered to mankind. The pure conservative is fighting against the essence of the Universe'

(p. 353). Our present civilisation has reached a period of stagnation and is doomed to slow decline unless some fresh and revivifying creative ideal emerges. Let us hope, with Whitehead, that "our present epoch is to be viewed as a period of change to a new direction of civilization".

In the second section of the book, Whitehead deals in similar fashion with the influence of scientific ideas upon European culture. Here again we meet with a rich tangle of thought to which a reviewer can do but poor justice. There is a valuable discussion of the main doctrines concerning the laws of Nature, of which Whitehead distinguishes four—the doctrine of law as immanent, the doctrine of law as imposed, the doctrine of law as mere description, and the more modern doctrine of law as conventional interpretation. The influence of these varied conceptions of natural law upon scientific cosmologies is traced out historically.

Linked with this general discussion is a brilliant treatment of the interplay of "speculation" and "scholarship"—another facet of the adventure of ideas. Their contrast is exemplified by the Greeks of the classic period and the later Alexandrians. "The note of Hellenism is delight, speculation, discoursive literature: the note of Hellenistic Alexandria is concentration, thoroughness, investigation of the special types of order appertaining to special topics". Both are necessary for the advance of knowledge and understanding, but their proper balance is rarely achieved.

Nowadays, according to Whitehead, the balance has tipped too far in the direction of "scholarship". "Modern scholarship and modern science reproduce the same limitations as dominated the bygone Hellenistic epoch, and the bygone Scholastic epoch. They canalize thought and observation within predetermined limits, based upon inadequate metaphysical assumptions dogmatically assumed. The modern assumptions differ from older assumptions, not wholly for the better. They exclude from rationalistic thought more of the final values of existence. The intimate timidity of professionalized scholarship circumscribes reason by reducing its topics to triviality, for example to bare sensa and to tautologies. It then frees itself from criticism by dogmatically handing over the remainder of experience to an animal faith or a religious mysticism, incapable of rationalization" (p. 151). New directions of thought are required, and they will come through flashes of intuition, commencing as "sheer ventures of rash speculation", which will be tested, criticised, exemplified, extended, by the patient work of scholarship and research.

The third part of the book is headed "Philosophical" and it contains a condensed account of Whitehead's own system of philosophy. It is extremely hard reading, and is likely to be refractory to any but the professional metaphysician. For this reason, no attempt will be made here to expound it.

The last section deals with truth, beauty, art, adventure, peace, as qualities which should characterise a civilised society. The last two chapters are particularly fine; in them Whitehead frees his thought from its often difficult and obscure expression and writes vividly and clearly. It is in these chapters that one can best grasp the purport of the book, and share the vision of reality which our great poet-philosopher offers us.

I conclude with one further quotation, which gives some notion of what Whitehead means by "Peace". "The vigour of civilized societies", he writes, "is preserved by the widespread sense that high aims are worth while. Vigorous societies harbour a certain extravagance of objectives, so that men wander beyond the safe provision of personal gratifications. All strong interests easily become impersonal, the love of a good job well done. There is a sense of harmony about such an accomplishment, the Peace brought by something worth while" (p. 371). E. S. R.

Short Reviews

Strahlenoptik. Von Dr. M. Herzberger. (Die Grundlehren der mathematischen Wissenschaften in Einzeldarstellungen mit besonderer Berücksichtigung der Anwendungsgebiete, herausgegeben von R. Courant, Band 35.) Pp. xiii+196. (Berlin: Julius Springer, 1931.) 19.40 gold marks.

THIS volume, which is not a textbook, embodies recent work by the author and other workers, carrying this further in an attempt to give a unified exposition of erstwhile geometrical optics, not by the usual devious routes but rather by consistent application of the original method of Hamilton. The author goes far towards achieving this, although finding himself compelled to resort to conventional methods when considering the limitation of rays. The subject, still in essence geometrical optics, gains considerably in perspicuity by reason of the inherent advantages of the

method and the conciseness of Herzberger's treatment. The author's additions to the terminology are not such obvious gains.

As befits one of a well-known series of mathematical monographs, the treatment most appropriate to the subject has been employed. This assumes substantial acquaintance with the properties of matrices and the vector method, such as rather to limit the appeal of the work among average students.

The book, consisting of eight parts, may be considered in two divisions. In Parts 1–4, after a brief general consideration of systems in anisotropic media, the basis is laid for the subsequent treatment, ray-tracing formulæ being given incidentally. The chapter on Gaussian optics includes consideration of the general case with references to Gullstrand.

In Parts 5–8, devoted to the theory of aberrations, a system of first order aberrations is worked out without applications, and generalities are given for finite aperture and field. The author follows T. Smith closely, the last part being confined entirely to work by this writer.

Adequate bibliographical reference is for the most part given, although one misses mention of certain names which suggest themselves in places (for example, Rayleigh, Schwarzschild).

Handbuch der physikalischen und technischen Mechanik. Herausgegeben von Prof. Dr. F. Auerbach und Prof. Dr. W. Hort. Band 3: *Statik und Dynamik elastischer Körper nebst Anwendungsgebieten, zum Gebrauch für Ingenieure, Physiker und Mathematiker.* Pp. ix+468. 32 gold marks. Band 4, Hälfte 1: *Statik und Dynamik elastischer Körper nebst Anwendungsgebieten, zum Gebrauch für Ingenieure, Physiker und Mathematiker.* Lief. 1. Pp. vi+198. 16 gold marks. Lief. 2. Pp. xiv+199–636. 72 gold marks. Band 4, Hälfte 2: *Technische Physik der festen Körper, zum Gebrauch für Ingenieure, Physiker und Mathematiker.* Pp. xiii+614. 75 gold marks. (Leipzig: Johann Ambrosius Barth, 1927–1931.)

THIS monumental handbook in seven volumes now nears completion, the only outstanding parts to be published being the conclusion of vol. 5 (on the mechanics of fluids) and the complete index for the whole work. Of the volumes here noticed, the first (vol. 3), besides covering familiar ground in elasticity, includes an article on earthquakes and seismic waves, by Gutenberg. Vol. 4 ranges over a wide field of technical elasticity and the properties of matter, and summarises much work that is not otherwise easily accessible in collected form. Among the articles may be mentioned several on crystal structure (including one on polycrystals and their investigation by X-rays), two on the growth- and deformation-texture of organic substances and of metals, and one on workshop testing of materials. A regrettable feature of the publication is the very high price (particularly in sterling) of the last published, vol. 4.

Methods of Social Study. By Sidney and Beatrice Webb. Pp. vii+263. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1932.) 8*s.* 6*d.* net.

THIS excellent work gives the prolegomena to an applied science of society. The authors think that sociology has reached the stage occupied by the physical sciences a century ago; and that scientific method can be strictly applied to help the theoretical and practical progress of sociology. Such developments as the adoption of an official audit in public administration, the recruitment of civil servants and the organisation of trade unions, are not merely the outcome of blind forces hazily understood by the trial and error method, but the result of hypotheses actually arrived at by social workers and philanthropists working along the lines of scientific method. The authors of this work then discuss questions relating to the mental equipment of the social investigator, to the study and compiling of social facts and to the use of statistics. The great difference between social and physical sciences is given by their object: "Treasure your exceptions" should be the motto of the first; "scrap your exceptions" seems to be the physicist's point of view. Hence the social problem is not to find out how to get men and women to fit into society, but how to make a society into which will fit the men and women with all their differences and peculiarities of character, health and occupation. T. G.

Zoologie der Madagascar. Par G. Grandidier et G. Petit. Pp. 258+48 plates. (Paris: Société d'Éditions Géographiques, Maritimes et Coloniales, 1932.)

THIS is the first of a series of useful semi-popular volumes dealing with the land of the lemurs. It is admirably illustrated and fulfils its purpose well. One of the authors clearly has an intimate personal knowledge of the mammals, the account of which occupies nearly half the work and is illustrated by 27 plates. The invertebrates are treated very briefly, for as yet they are little known. The bibliography is particularly valuable. The French know how to write such books; they select the form in which they might lecture, bringing in all necessary scientific facts, but no others, in an attractive manner.

Elementary Physics: for Medical, First Year University Science Students and General Use in Schools. By G. Stead. Fourth edition. Pp. xiv+457. (London: J. and A. Churchill, 1933.) 10*s.* 6*d.*

IN this, the fourth edition of the book, very few changes have been made but some additional matter has been introduced, notably in the sections on X-rays and radioactivity. Both of these, although brief, appear to be somewhat too advanced for so elementary a work. The book should be of use to medical students, for whose benefit the mathematical work has been reduced to a minimum.

Structure of Alloys*

By PROF. W. L. BRAGG, O.B.E., F.R.S.

WHEN one metal is alloyed with another, in a series of varying relative proportions, generally several new alloy structures (phases) appear which are different from each other and from the structures of either pure metal. In the usual type of diagram, the composition of the alloy is represented along a horizontal scale starting with the pure metal *A* on the left side and ending with the pure metal *B* on the right side: temperatures are plotted vertically. In a typical case, the addition of small quantities of the metal *B* to the metal *A* does not alter its characteristic structure, the atoms remaining in the same relative arrangement. Atoms of *B* replace a corresponding number of atoms of *A* in an apparently random manner, and the only observable change is a uniform contraction or expansion of the *A* lattice. There is thus a more or less extended single phase region on the left of the diagram. As the proportion of *B* is increased, a limit is reached at which the *A* structure can no longer absorb *B* atoms in this way, and beyond this point a new phase appears. The new phase, which is richer in the *B* constituent, has a different atomic arrangement, as has been confirmed by X-ray analysis. Throughout a certain range of composition the two phases co-exist and each is constant in composition, the amount of the first phase decreasing and of the second phase increasing in passing through the two-phase region from left to right. The first phase finally disappears, and a new region of single phase is entered, to be succeeded by two-phase regions and single phase regions alternately. The last single phase region on the right hand side includes as a limiting case the pure metal *B*.

Such phase diagrams have been worked out for many alloys by metallurgical methods. The boundaries between single phase and two-phase regions are determined by examining polished and etched surfaces under the microscope, and thermal and electrical measurements aid in outlining the diagram. The single phase regions are bounded on each side by lines of which the departure from the vertical shows that the extent of the phase is, to some extent, dependent upon temperature. The liquidus and solidus boundaries above each phase region show at what temperatures solidification from the melt begins and ends.

In recent years, X-ray methods have played an important part in the construction of phase diagrams, the 'powder method' being particularly suitable for this purpose. Westgren's name will always be associated with this field of inquiry, in which he was a pioneer. Several methods differing in their experimental detail have been used. In one method the alloy in the form of a fine powder is placed in a Debye-Scherrer camera, and irradiated with monochromatic X-rays of suitable wave-length. The diffracted beams form a pattern of lines upon a strip of photographic film, which is in the form of a cylinder with the powder at its axis. The pattern is characteristic of the alloy structure, and if not too complex, the structure can be completely analysed by studying the pattern it produces. In a single phase region the character of this pattern remains the same throughout the range of composition, the only change being a shift in the positions of the lines due to the expansion or contraction of the lattice. When the boundary of the single phase region is passed and the two-phase region is entered, the photographs show the pattern of both constituent phases superimposed. The lines of one become fainter, and of the other stronger, as the region is traversed. Since in this region each phase is constant in composition, the lines, though altering in intensity, do not shift their positions. If the lattice dimensions of a phase as determined by the powder photograph are plotted against composition, a sloping line is obtained in the single phase region and a horizontal line in the two-phase region. The composition at which the two lines intersect is a highly accurate index of the position of the phase boundary.

X-RAY TECHNIQUE

The wave-length of the radiation used in making the photographs must be adapted to the alloy which is being examined. It must not be absorbed too heavily by the alloy powder, both because the diffracted lines are then weak, and because the absorption implies a re-scattering of radiation in all directions with consequent darkening of the background. For example, cobalt, iron and chromium $K\alpha$ radiations are excellent for examining iron alloys, since they are of lower frequency than the iron 'absorption edge' and hence are little absorbed. A cobalt radiation gives a large absorption of cobalt $K\beta$ rays in the specimen if these waves have not previously been filtered out. Copper radiation is extremely inefficient owing to the very large absorption, which produces a blackened film on which scarcely any lines are discernible.

It is possible to obtain powder photographs which at the same time give the pattern of lines throughout the complete circle, and enable the lattice dimensions to be worked out with high accuracy. The latter are most useful indices in elaborating the phase diagram. A recent design of camera by Bradley, combined with an ingenious method of evaluating the results, enables spacings to be compared with an accuracy approaching 1/50,000 when the crystalline material is suitable,

* Friday evening discourse delivered at the Royal Institution on March 17.

while at the same time the camera is of the ordinary circular type utilising short exposures and including the complete pattern. All 'precision methods' of measuring spacing depend upon the useful feature that rays diffracted backwards through nearly 180° enable a very accurate comparison of spacing with wave-length to be made. The particular feature of the method referred to above is the way in which errors due to incorrect placing of the specimen, absorption in the specimen, film shrinkage, and uncertainty as to camera-radius, are automatically eliminated.

Powder cameras must be calibrated by taking in each camera a photograph of a crystal with known spacings. Quartz is very suitable for this purpose. It is constant in composition, has a small temperature coefficient, and gives a large number of very clear lines. The quartz photograph may become as important in X-ray work as the comparison iron spectrum in spectroscopy.

Nature of a 'Phase'

The determination of phase boundaries by X-rays is merely the application of a new method to a problem already dealt with by well-established metallurgical technique. The particular contribution of X-ray analysis is its determination of the atomic arrangement in the alloy. It is found that each phase has a characteristic geometrical pattern of atomic positions. This is in accord with the findings of analysis in other crystalline bodies such as inorganic and organic compounds, but there is a new feature in alloy structures which is peculiar to them. The phase is an absolutely definite arrangement of 'sites' for atoms, if one may put it in that way, but in many cases the way in which the atoms are distributed amongst these sites turns out to be of secondary importance, and may vary widely. Such a feature is foreign to the typical inorganic or organic compound, where the atoms of various kinds have each their appointed positions.

An example of this peculiar feature is given by the structures of two closely related alloys the compositions of which approach the ideal formulæ Cu_5Zn_8 and Cu_5Cd_8. These alloys, which appear as phases in the copper-zinc and copper-cadmium systems, are obviously similar in nature. They are hard and brittle with a characteristic fracture and sheen. X-ray analysis by Bradley has determined their complex structure, in which there are 52 atoms in the unit cube, the 'γ structure'. From the similarity in atomic ratio and the correspondence in chemical properties of zinc and cadmium, it would be expected that the arrangement of zinc atoms in one and of cadmium atoms in the other would precisely correspond. The sites for atoms in the two alloys are indeed almost identical, but Bradley has been able to show that the distribution of zinc atoms amongst these sites in the one alloy is entirely different from the arrangement of cadmium atoms in the other. Clearly the peculiar complex γ structure is determined by something apart from the distribution of the atoms; the latter is a secondary feature influenced by the relative sizes of zinc and cadmium atoms.

We find similar phases, or arrangements of atomic sites, in different alloys. For example, the alloys of copper, silver, gold with metals of the *B* subgroups such as zinc, cadmium, aluminium, gallium, tin form an α face-centred cubic phase like that of copper, silver, gold themselves, a body-centred β phase, and a complex γ phase with 52 atoms in the unit cell. All γ phases have similar physical characteristics such as their extreme hardness. Since the geometrical arrangement of atomic sites in each phase appears to be quite definite, while at the same time independent of the atomic distribution, by what is it determined?

Hume-Rothery's Law

The answer to this question is provided by a brilliant hypothesis which we owe to Hume Rothery, the truth of which has now been verified by a large number of examples. Hume-Rothery's law states that each phase appears when the ratio of valency electrons to atoms has a value characteristic of that phase. For example, the β phase, which is body-centred cubic, is found when there are three valency electrons to every two atoms, examples being the alloys CuZn, Cu_3Al, Cu_5Sn. Assigning one valency electron to copper, two valency electrons to zinc, three to aluminium, and four to tin, it will be seen that in the first of these compounds there are three electrons to two atoms, in the second six electrons to four atoms, and in the third nine electrons to six atoms. An even more striking example is found amongst the γ structures to which reference has already been made. Here the electron-atom ratio is 21 : 13, examples being Cu_5Zn_8, Cu_9Al_4, $Cu_{31}Sn_8$. A hexagonal, close-packed ε structure which appears in many of the alloy systems has a ratio 7 : 4, as evidenced by $CuZn_3$, Cu_3Sn, $AgZn_3$, Ag_5Al_3, $AuCd_3$. A very large number of alloys obeying this law is now known, and it will no doubt be added to as other systems are examined.

There are exceptions to the rule. It must further be borne in mind that an alloy phase is not definite in composition but extends over a range in the phase diagram which may be broad or narrow. The composition which gives one of the above ideal electron-atom ratios may be towards one side of the single phase region, or even just outside it. It is justifiable to say, however, that the electron-atom ratio is a main factor in determining the arrangement of atomic sites in the phase. The range of the phase is modified by other factors, which make it broad or narrow and displace it one way or the other, but they are of secondary importance. Starting with copper, silver, or gold and alloying them with other metals, we run through a similar series of phases. The higher the valency of the second metal, the smaller is the amount of it which has to be added in order to produce each new phase. Quantitatively this may

be expressed by saying that its contribution is to be reckoned in terms of added valency electrons, according to Hume-Rothery's law.

It is an interesting feature that the metals of the triads iron, cobalt, nickel; ruthenium, rhodium, palladium; osmium, iridium, platinum; form similar phases of the β and γ types. In these alloys the valency *zero* must be assigned to the transition metals; for example,

3 : 2 phase FeAl, CoAl, NiAl
21 : 13 phase Fe_5Zn_{21}, Co_5Zn_{21}, Ni_5Zn_{21}, Rh_5Zn_{21}, Pt_5Zn_{21}.

To sum up, the arrangement of atomic sites in an alloy phase appears to be due not to the interaction between the metals of one kind and those of another kind, but to the interaction between all the metal atoms on one hand, and the common electronic structure, to which they join in contributing their valency electrons, on the other hand. The metal atoms can be shuffled about between the phase-sites without a profound alteration of the nature of the phase, as if the structure were almost indifferent to the nature of the atoms in the various sites so long as they provided the quota of valency electrons. It has been shown by Bradley, for example, that ternary alloys and presumably alloys of any complexity assume the γ phase if the total electron-atom ratio is 21 : 13.

Segregation of Atoms into Phase-Sites

Two aspects of the problem of alloy structure may thus be distinguished. The first concerns the geometrical arrangement of the sites for atoms, characteristic of each type of phase. Its elucidation must be sought for in the electron-atom interaction as part of the problem of metallic structure in general. The second concerns the way in which the atoms distribute themselves amongst these sites. It has been known for some time that this distribution may vary in a given phase. On one hand, atoms of each kind may segregate into certain positions in a symmetrical way, so as to build a crystal structure of definite pattern like those found in inorganic and organic compounds. In some of the γ alloys, for example, similar atoms occupy certain sets of the sites which are related by the crystal symmetry, and the other atoms occupy the remainder.

Alternatively, we may find the formation of a *super-lattice*. In a simple β structure of the body-centred cubic type, for example, there are two atomic positions in each unit cubic cell, at corners and centres, which are crystallographically identical. In such structures as CuZn, or FeAl, one atom occupies the corners and the other the centres. In β alloys of more complex composition, however, the unit of pattern repeats in a larger distance, so that it is necessary to stack several cubes together and select symmetrically certain positions from the large unit for one of the atoms, in order to represent the unit of pattern. An X-ray photograph of such an alloy shows as a primary feature the lines due to the body-centred cubic arrangement characteristic of all β phases. In addition, subsidiary lines due to the super-lattice appear, which indicate that the unit of pattern is upon a larger scale. The segregation of the atoms into preferred positions may be followed by studying these lines.

As opposed to the formation of a super-lattice or of a regular crystalline segregation, we find in other cases that the X-ray diagram indicates merely the arrangement of the atomic sites, as if the atoms were arranged in an absolutely random manner amongst these sites. Such a random arrangement would affect the X-ray diffraction pattern as if each site were occupied by an identical unit of mean composition. Many examples might be quoted, a very striking one being given by Westgren. The alloy Cu_5Si has a complex structure in which there are twenty atoms in the unit cube. This β′ structure is assumed instead of the simple β structure by certain alloys with a 3 : 2 electron ratio, and is similar to one form of the element manganese, the β-manganese structure. An X-ray photograph of Cu_5Si gives lines identical in arrangement and relation in intensity with those of β-manganese, in which, of course, all atoms have the same scattering power, so that the scattering by each atomic site must be that of a mean effective atom. Further, it may be noted that the six atoms of Cu_5Si cannot be distributed in any regular way between twenty atomic positions, since 6 is not a factor of 20. Structures which give such an effect are said to be structures of *random replacement*.

The transition between the two extremes of regular and random replacement may be observed in one and the same alloy. Alloys at high temperatures or which have been rapidly quenched from high temperatures show random arrangement, whereas alloys subjected to prolonged annealing have a regular or super-lattice structure. The potential energy of the symmetrical structure must be less than that of the disordered structure, and hence it is the stable structure at low temperatures. At high temperatures, however, the thermal movements are causing the atoms constantly to change places, a disordered arrangement having a higher entropy than an ordered arrangement.

The study of these changes in arrangement is of great interest and importance, because they affect the physical properties of the alloy. It is to be emphasised that we are not concerned here with a phase change, since the phase remains the same throughout. We are dealing with continuous changes from order to disorder within the same phase structure.

The segregation of atoms into regular positions was surmised by Tammann in 1919 as an explanation of the changes in resistance of annealed alloys. One of the most fully examined cases is that of the gold copper alloy AuCu studied by Johannson and Linde. In this case we are dealing not only with regular and irregular distribution of atoms,

but also with an alteration of crystalline form. The alloy of perfect arrangement is tetragonal in symmetry, and the symmetry passes by change of axial ratio into the cubic type as the temperature is raised. A similar but simpler case will be discussed here, where the arrangement of the atomic sites remains the same throughout. This is the case in the iron aluminium alloys examined in detail by Bradley.

The alloy of composition FeAl is a structure of the β type, with iron atoms and aluminium atoms at corners and centres of the unit cube. Iron has itself a body-centred cubic structure, and it is found that, when aluminium is dissolved in iron, there is a very wide continuous range of this body centred cubic phase extending from pure iron to FeAl. The added aluminium atoms simply replace iron atoms. Two types of super-lattice are built up. When the composition is FeAl, iron atoms at the centres of the cubes are entirely replaced by aluminium atoms, so that the structure is of the type known as a 'CsCl' structure. It may be noted that there is no crystallographic distinction between corners and centres, so that we might equally well describe the arrangement as one of aluminium atoms at corners and iron atoms at centres. When the composition is Fe_3Al, and the alloy is carefully annealed, one half of the cube centres chosen in a symmetrical way are occupied by aluminium and the other half remain iron atoms.

By observing the super-lattice lines in the photographs, Bradley has been able to follow out the process of replacement at all compositions between pure iron and FeAl. Taking first annealed alloys, the first aluminium atoms to enter the structure replace iron atoms at random. At a certain concentration, the aluminium atoms desert cube corners and one set of cube centres, and tend to concentrate in the remaining set of cube centres, finally at Fe_3Al occupying it entirely. Past this point, since one set of cube centres is now full, the further aluminium atoms start filling up the remaining set of cube centres. At a certain point, in order to equalise the distribution between the two sets of centres, these two share the available aluminium until finally at FeAl they are completely filled. The quenched alloys show a curious phenomenon. Up to 25 per cent atomic aluminium they have apparently random replacement. Past that point, within less than 1 per cent change in composition, they change over into a distribution in which all corners are occupied by iron, and centres by a random replacement of iron by aluminium.

Random Replacement

When an X-ray photograph shows an apparently random replacement, are we to interpret this as meaning that the atomic sites are occupied by iron and aluminium as if they were the 'black and white balls' of a problem in probabilities? On physical grounds this is not to be expected. The Fe_3Al and FeAl structures show us that aluminium atoms under conditions of ideal equilibrium tend in the first place to avoid being nearest neighbours by segregating into cube centres, leaving the corners for iron, and further to avoid being in cubes which are side by side (Fe_3Al structure). We must postulate a slight increase in potential energy when aluminium atoms are at centres of contiguous cubes, and a larger increase when two find themselves at a corner and centre of the same cube. I am indebted to Dr. Williams for calculations concerned with this effect. If we suppose a small increase V of potential energy to be produced by one of these undesirable contacts, it is then possible to calculate the proportion of atoms in 'disorder' as opposed to 'order' at a series of temperatures.

The calculation shows that it is impossible to account for the whole range between complete order (which we know to exist by the evidence of super-lattice lines) and complete disorder, in any range of temperature experimentally available. The difference between annealing and quenching could at the most produce a slight disorder. The conditions we have set are, however, not true to actualities. As the structure becomes more disordered, the contrast between the ordered position and disordered position for a given atom becomes less, and so V must be supposed to diminish, until finally one can picture a state where no criterion is possible—the atom is completely demoralised by the corrupt state of society in which it finds itself.

It is possible, however, that what appears to be random replacement is not really a purely fortuitous distribution. We may suppose that within each small crystallite of the metal there is for the most part an ordered distribution, but that this ordered distribution is frequently getting 'out of step'. To take a simple case of a linear row, we may suppose an alternation Al-Fe-Al-Fe to take place for a part of the row, and that then owing to an excess of iron, two iron atoms follow, so that when the alternation recommences, aluminium and iron atoms have changed places. This process may be frequently repeated. Since the effects of all atoms in crystal planes are summed when the X-rays are diffracted by the crystallite as a whole, the result as regards diffraction would be an apparently random replacement of iron by aluminium. A kind of structural twinning within the crystal, which does not alter the orientation of its axes but only the succession of its atomic planes, is possible.

The behaviour of the quenched iron aluminium alloys suggests some such explanation. So long as aluminium is present in quantities less than 25 per cent in atomic proportions, there is apparent random replacement. Beyond this point the segregation suddenly appears by which aluminium goes into cube centres alone. May not this be because below 25 per cent the excess of iron causes the structure to get 'out of step', two successive layers of iron atoms causing a part of the crystallite with aluminium at centres of cubes

to continue as a pattern in which the same atoms go to corners? Beyond 25 per cent aluminium, each cube must have contiguous cubes containing aluminium at centres, so that there is no question as to what is a centre and what is a corner. The plan of iron at corners and aluminium at centres is therefore carried out throughout the crystallite.

Though so many problems of alloy constitution are still to be solved, an important step forward has been made by the recognition that the arrangement of atomic sites and the segregation of atoms into these sites are separate problems, and by the discovery of similar phase-structures in alloy series of different metals. There is promise of reducing to order the vast array of hitherto uncorrelated data.

Medical Research in Great Britain

THE annual report of the Medical Research Council* again indicates the great variety of the scientific investigations carried out under its auspices with the ultimate aim of improving the health and well-being of the community. The scope of the research work initiated and aided by the Council has, as in previous years, been widened by grants from a number of public bodies interested in research work within the medical field, by the availability of university laboratories for use by investigators receiving grants from the Council, and by co-operation with Government departments and the committees of Privy Council for Industrial and Agricultural Research. The Council has exercised the strictest economy in the use of its available funds: the salaries of all its officers, and of all members of the scientific staff and whole-time grant holders have been 'cut' on the Civil Service scale. The reduction of various subsidies received from other public bodies imperilled the progress of different schemes of research, the abandonment of which, at the stage reached, would have been a very wasteful procedure. Fortunately, voluntary benefactions from private sources and notably those received from the Rockefeller Foundation and the Leverhulme Trustees prevented the setback in the work of the Council from being, it is hoped, more than temporary.

Three changes occurred in the composition of the Council during the year, Mr. W. S. Morrison, Prof. E. D. Adrian and Prof. A. E. Boycott taking the places of Major A. G. Church, Prof. R. Muir and Sir J. Herbert Parsons respectively.

The Council points out that the promotion of clinical research has always been given a primary place in its policy from the beginning of its work. The problem has been to find means of promoting the conditions in which clinical research work can be brought to its fullest development. With the co-operation of University College Hospital, London, the Council has maintained a Clinical Research Department there, with Sir Thomas Lewis as director, with charge of beds and free from all preoccupations except those of gaining new knowledge by clinical research. During the past year, the Rockefeller Foundation has generously provided a sum of money to endow in perpetuity the directorship of this Research Department, thereby releasing funds which the Council will apply to further clinical research elsewhere. The University of Aberdeen and the National Hospital for Nervous Diseases, Queen Square, London, have also shown their sympathy with clinical research: at the latter, a Research Department is in course of formation and Dr. E. A. Carmichael has been appointed by the Council as whole-time director.

The scope of the clinical work at University College has been widened. In earlier years the Department of Clinical Research dealt chiefly with cardiac problems and especially those of cardiac mechanism; more recently it has taken up problems of the peripheral blood circulation. At present, studies of hypertension and cardiac asthma are bringing problems of kidney function into view, and special attention is being paid to the symptom, pain. Interesting correlations between anginal pain and that derived from muscular ischæmia have been found.

The National Institute for Medical Research has continued the regular distribution of the standards held under the Therapeutic Substances Act, and of those held on behalf of the Health Organisation of the League of Nations. The international standards for vitamin A (carotene) and vitamin D (a solution of irradiated ergosterol in olive oil) were prepared in the Institute and together with the standard for vitamin B_1 (a dry adsorption product from an extract of rice bran prepared in Java) have now been issued for general use. Work has also been carried out on serum standards and a standard for Type I antipneumococcus serum has been prepared and issued. A review is at present in progress of different preparations coming under the general title of "Tubercle Vaccine", to ascertain the practical interpretation given by manufacturers to the regulations made under the Therapeutic Substances Act. The Institute also has obligations with regard to standards required by the new "British Pharmacopœia", other than those already held under the Therapeutic Substances Act, namely, those for digitalis, strophanthin and strophanthus tincture: the latter two were prepared during the year. A conference was held in London in July under the auspices of the Health Organisation of the League of Nations to discuss the possibility of establishing a uniform notation in units for the œstrus-producing hormone and eventually for other hormones for the reproductive functions. The conference

* Report of the Medical Research Council for the year 1931–1932. Committee of the Privy Council for Medical Research. (London: H.M. Stationery Office, 1933.) 2*s*. net.

recommended the adoption of a sample of the ketohydroxy form of the crystalline hormone as the international standard and entrusted the Institute with its preparation and distribution.

The work on canine distemper by Dr. Laidlaw and Mr. Dunkin, which was aided by the *Field* fund, has now been brought to a successful conclusion. Its progress has been described in previous reports. The whole cost of the work, spread over ten years, has been about £55,000. This has been supplied by the *Field* Fund, of which about £22,000 was contributed from British sources and £15,000 from the United States, while the rest, in services of staff, and in accommodation and other facilities, has been provided by the Council from its Parliamentary grant-in-aid. A review has been made of the results of simultaneous side-to-side inoculation with anti-serum and virus. This method appears to be rather less efficient in producing a solid and durable immunity than the original vaccine and virus method.

The usefulness of this work is not limited to the prevention and cure of canine distemper. The method of using vaccine and virus has been employed for the immunisation of man against yellow fever in West Africa and is also being used for the prevention of rinderpest among cattle in East Africa. At least one type of epidemic disease in silver fox farms appears to be due to the virus of canine distemper, and should therefore be preventable by similar means.

Work has also been continued on other virus diseases of both man and animals. In addition, a series of different bacteriophages has been subjected to critical filtration through Elford's filters. The diameter of the smallest is identical with that found for the virus of foot-and-mouth disease. The largest is stopped by a filter of such coarseness as to indicate that its particles are almost within the range of microscopical detection. The size of any one bacteriophage has been found constant and uniform independently of the nature of the bacterial organism which it attacks, and it is unchanged by purification. It appears that the bacteriophages are distinct infective agents of the nature of viruses. Confirmation is found in the fact that specific immune sera can be produced to different bacteriophages by injecting them into animals.

In concluding this brief review, it may be mentioned that the report describes, amongst numerous other investigations, work on malignant disease and nutritional problems.

News and Views

National Academy of Sciences Medal Awards

IT is announced by Science Service, Washington, D.C., that at the closing session of the meeting of the National Academy of Sciences held in Washington on April 24–26, the following medal awards were made: Alexander Agassiz medal for oceanography to Dr. Albert Defant, of the Institute for Oceanography, Berlin, for his studies on atmospheric and oceanic circulation and his notable contributions to theoretical oceanography; Public Welfare medal to Dr. William H. Park, of New York, for his work as head of the research laboratories of the New York City Department of Health as a pioneer and leader both in research and in the application of scientific discovery to the prevention of disease; John J. Carty medal and award for the advancement of science, a newly-established honour of the Academy, posthumously to the man in whose honour it was named, the late Dr. John Joseph Carty, who was noted for his accomplishments in the field of electrical engineering, particularly as they influenced the development of electrical communication; Henry Draper medal to Dr. V. M. Slipher, of the Lowell Observatory, Flagstaff, in recognition of his spectroscopic researches, which have opened up several important fields in astronomic research; Mary Clark Thompson medal to Dr. Francis Arthur Bather, formerly keeper of the Department of Geology, British Museum (Natural History), for his services in the fields of palæontology and geology.

AT the same meeting of the National Academy of Sciences, the following men of science were elected to membership of the Academy: Dr. Oswald Theodore Avery, Rockefeller Institute for Medical Research, known for his work in bacteriology; Harold Delos Babcock, physicist at the Mount Wilson Observatory, Pasadena; Dr. Thomas Barbour, curator of reptiles and amphibians at the Museum of Comparative Zoology, Harvard University; Dr. Alphonse Raymond Dochez, professor of medicine in Columbia University; Dr. Bernard Ogilvie Dodge, plant pathologist in the New York Botanical Garden; Dr. Eugene Floyd DuBois, professor of medicine in Cornell University Medical College; Prof. Griffith Conrad Evans, professor of pure mathematics in the Rice Institute, Houston, Texas; Bancroft Gherardi, vice-president of the American Telephone and Telegraph Company, New York City; Dr. Herbert Eugene Ives, physicist at the Bell Telephone Laboratories, New York City; Prof. Walter Richard Miles, professor of psychology in Yale University; Prof. Samuel Alfred Mitchell, professor of astronomy in the University of Virginia and director of the Leander McCormick Observatory of the University; Prof. Linus Pauling, professor of chemistry in the California Institute of Technology, Pasadena; Prof. Joseph Fels Ritt, professor of mathematics in Columbia University; Prof. Henry Clapp Sherman, Mitchill professor of chemistry in Columbia University.

Technical Training of the Police

LORD TRENCHARD'S recently issued annual report as Commissioner of Police of the Metropolis (Cmd. 4294. London: H.M. Stationery Office) has been received with mixed feelings. In all essentials, however,

the case which has been made out for reorganisation is unassailable. The suggested formation of a police college is one of the recommendations to which exception has been taken, the grounds of objection being apparently that experience is the only training of use to the police officer. It is interesting to compare this point of view with that on the Continent. In Belgium, France and Germany, schools for the technical training of the police have been in existence for many years. In Belgium, for example, all policemen are required to take a short course at the school of scientific police. The course is designed to give the candidate an elementary grounding in the application of scientific methods to the detection of crime. More advanced courses up to the standard of a university degree are available for the higher ranks. In this respect the reorganisation advocated by Lord Trenchard will bring the system of police training closer to the Continental model. Having regard to the great advances which have been made in the application of scientific methods to the detection of crime in recent years, this is all to the good. It has been proved beyond doubt that the laboratories of the technical police can and do greatly assist the progress of criminal investigation. Apart from the practical work itself, a great deal of research work is done in these laboratories, which are specially equipped for the purpose. Absence of facilities has made this impossible in England, where very little investigation of this kind has been done. We may certainly hope that the implications of Lord Trenchard's report will become explicit in this direction and that we shall have a department for the scientific detection of crime.

Musk-Rats at the London Zoo

THE Zoological Society is indeed rendering a valuable service by putting specimens of the musk-rat on exhibition. By this means it is hoped to spread information of the grave menace which threatens large areas of Great Britain from the hosts of musk-rats which have insidiously appeared among us. It will be remembered that an article by Prof. J. Ritchie on this subject appeared in NATURE of March 18, p. 385. As was pointed out there, the musk-rat was originally introduced into Great Britain a few years ago to encourage 'fur-farming'; but the enthusiasts who entered into this scheme had no knowledge of the habits of the animals or of their amazing fecundity. As a consequence of bad housing, many made their escape to the nearest rivers, or sheets of open water, where they remained unmolested amid ideal conditions for a considerable time, because their presence was unsuspected. It was not until railway embankments, dams, water-mills and the foundations of bridges were found to have been seriously damaged over large areas of the country, that the peril in our midst was realised. It has now been made illegal to import or keep musk-rats in Great Britain. The ill-advised introduction of the grey-squirrel has given abundant cause for repentance; but the mischief done by this pest is as nothing compared with the potential mischief which threatens from the musk-rat.

ANOTHER rodent of no little interest just added to the collection at the Gardens of the Zoological Society is the rock-cavy, or moco-cavy, of Brazil, a near relation of the guinea-pig. It is a cave-dweller, but boulder-strewn areas serve it quite as well, though even in these fastnesses it is eagerly pursued by the natives, who find its flesh delectable. In appearance it is more slender than the guinea-pig, with a long snout, and soft grey fur. A collection of humming-birds from tropical America, two of those remarkable reptiles, the egg-eating snakes, giant land-crabs from Gambia, and migratory locusts in the wingless, hopper-stage, are other additions adding still further to the attraction of the Gardens just now.

Zoological Society of London

THE report of the Zoological Society for 1932 impresses with the magnitude of the undertaking: a membership of 8,307, a visitors' list of more than a million and a half, an annual income of £130,403 and expenditure of £128,803, and a surplus of assets over liabilities amounting to £143,413. In spite of their magnitude the figures, compared with those of the past four years, show some effect of the present financial stress, but this has scarcely affected the steady progress made in the Gardens in London and at Whipsnade. The health of the animals has improved, a noteworthy record being the absence of any death from tuberculosis amongst the primates, whereas in 1926, 43 died from this disease alone. The architectural experiment of a new gorilla house of unique construction (see NATURE of May 6, p. 646) should contribute further to the health of animals admittedly difficult to keep in captivity. The position of the "Zoological Record" Fund has improved, but the loss on each volume is still much greater than the £500 per annum contributed by the Society, and societies, institutions and individuals who wish the "Record" to be maintained are requested to support the "Record Fund" by annual donations. Appeal is also made for contributions towards the maintenance of the famous herd of Chillingham Park white cattle, since a sum of £500 per annum is required to meet the rental of the Park at Chillingham Castle in Northumberland, which has been leased for seven years with the object of preserving the herd.

University of London and the British Museum

IN a correspondence between the Trustees of the British Museum and the Court of the University of London, published in the *Times* of May 18, the former body extends a cordial welcome and warm congratulations to the University on the acquisition of a home which will express its functions as a centre of humanistic and scientific research for Great Britain and the Empire. The Trustees touch on what everyone will recognise as an all-important element in the future development of teaching and research in the University, when they point to the opportunities for co-operation between the Museum and the University which will arise. In this connexion they refer more particularly to relations with the Institute of Archæology, for which a scheme is under the consideration of the University authorities. This

will be a great step forward in the study of archæology in London. On one hand, the increased activity in archæological research of recent years and the need of trained men to take full advantage of the opportunities for archæological investigation which are now open in many directions, have for some time past made the need for an archæological institute, such as is contemplated, a matter of urgency. On the other hand, the efforts of the Museum to meet the varied requirements of the general public, the advanced research worker and the student in archæology, appreciated as they have been, have made an undue and unjustifiable demand on the energy and time of the staff. An earnest of future benefit to the University is already offered in the intimation that that very necessary adjunct of a practical training, a supply of cultural material, will be available for the Institute from the superabundance of the Museum.

Lower Thames Valley Deposits

A TEMPORARY exhibition is now on view in the prehistoric section of the British Museum, which includes a sequence of stone implements and flakes found by Mr. J. P. T. Burchell in the area between Swanscombe and Northfleet in North Kent. The exhibit illustrates Mr. Burchell's correlation of the industries with the glaciations of the Thames area, this involving a fresh interpretation of the events following the Boyn Hill Terrace deposits. Briefly, his contention is that following on the Boyn Hill or '100 ft.' terrace, with Clactonian I (abraded and striated), Clactonian II, Acheulean and early Mousterian, comes a period of elevation with pauses, causing terraces at progressively lower levels, in which are early Mousterian abraded implements, until Sunk Channel No. I was cut. These deposits were then sealed by glaciation and the deposit of Combe rock. Melt-water gravels then formed in the valleys and on the plateaux, which contain abraded implements of the above cultures. A period of elevation and aggradation and submergences followed, in which a thick layer of brick-earth with middle Mousterian implements was laid down over a wide area. There was then an elevation and an accumulation of sub-aerial deposits containing upper Mousterian and Aurignacian implements with coarse pottery. This was followed by a glaciation and the deposition of Trail and/or strong loam with 'rafts' of Combe rock, the equivalent of the Upper Hessle boulder clay of Yorks and East Anglia.

IT will be seen that Mr. Burchell's interpretation differs from that of the geologists, who have hitherto regarded the Taplow or '50 ft.' terrace as earlier than the Combe glaciation. Archæologists and geologists alike have recognised the division of the Taplow or '50 ft.' terrace into a lower gravel with heavily rolled Acheulean and early Mousterian artefacts, as at Ealing and Hanwell, and an upper brick-earth, sealing floors containing unrolled middle Mousterian implements, as at Acton, Crayford, and Northfleet. Mr. Burchell finds that this sequence constitutes two distinct terraces separated by the glaciation responsible for the Combe rock. Capping the brick-earth is the glacial deposit known as the Trail. Among the exhibits are photographs of critical sections, as well as implements, in support of Mr. Burchell's view, as against that current in geological circles, that the Combe rock is to be equated with the Trail. This correlation is rejected by leading archæologists in the 'Handbook' of the Prehistoric Congress, 1932, p. 10. Mr. Burchell's discovery of coarse pottery in association with an upper Mousterian or Aurignacian industry is rendered less unorthodox by the evidence of Leakey from Kenya and Peyrony in France. The identification of extensive areas of brick-earth in the Swanscombe district containing shells belonging exclusively to land types seems to form a link with the upper loess of the Continent.

Physics in the Boot and Shoe Industry

THE nineteenth lecture in the "Physics in Industry" series of the Institute of Physics was delivered by Mr. H. Bradley, director of the British Boot, Shoe and Allied Trades Research Association, on May 23, on "Physics in the Boot and Shoe Industry". A problem of first-rate importance in the boot and shoe industry is mensuration or anthropometry. How shall a foot be measured in order to specify concisely and accurately its shape ? The industry has hitherto relied on the eye and skill of handicraftsmen of the old school ; few of these now remain and there is need for a scientific method of foot specification. A useful start has been made on this investigation, and experiments with the most recently designed foot-measuring instrument have proved most successful. Measurements of the foot when stationary should be supplemented by a knowledge, either qualitative or quantitative, of the requirements of the foot in motion. As yet very little is known in this direction and experimental investigations were planned several years ago. The proposed experiments are closely allied with physiological studies. More about the change in conformation of the foot during walking is required. Furthermore, in the case of normally healthy feet the arches of which have not broken down, there are three main points of pressure, namely, under the heel, the inside joint or ball, and the outside joint ; it is necessary to know how the body weight is distributed among these several points of support and how this distribution changes during walking. For a material in common everyday use, leather has received little attention from physicists, particularly in Great Britain. The science of leather has developed during the past thirty years mainly on the chemical side from the point of view of its manufacture. A line of investigation into the physical properties of leather, which has been selected because there is a likelihood of its being profitable in two or three directions, is the reaction of leather to the influence of water both in the liquid and vapour state.

Alcoholic Fermentation

THE twenty-second Bedson lecture was delivered on May 19, at Armstrong College, Newcastle-on-Tyne, by Prof. A. Harden, emeritus professor of biochemistry in the University of London, who took as

his subject "Alcoholic Fermentation". Besides the president (Dr. R. E. Slade) and the chairman (Prof. G. R. Clemo), the past presidents, Prof. P. P. Bedson and Dr. J. T. Dunn, and Profs. H. J. Hutchens, Irvine Masson and H. L. Riley were present. Dr. Harden traced the history of the scientific investigation of fermentation from Lavoisier to Büchner and then outlined briefly but with great clarity the work of Neuberg, Meyerhof, and others as well as his own. He developed and reviewed the equations advanced for the process, discussed the rôle of the hexose mono- and diphosphates formed, and the co-enzymes required in yeast, muscle extracts, and bacteria. The fermentation processes leading to glycerol, the glycols, compounds of the butane series, lactic acid, and fumaric acid were all dealt with, as well as the energy relationships in muscle contraction with which these processes are linked. Finally, the differences between the actions of extracts and living cells were discussed.

Jubilee of the University of Oxford Junior Scientific Club

ON May 20, at the University Museum, Oxford, the Junior Scientific Club held a successful and largely-attended conversazione to celebrate the jubilee of its foundation. The Club was inaugurated in 1882 with the object of bringing together undergraduate and bachelor of arts members of the University for the discussion of scientific matters. The holding of conversaziones has always been an important part of the Club's activities, and special interest was attached to last Saturday's gathering in view of the fact that the Club has just passed the fiftieth year of its useful existence. Numerous demonstrations and exhibitions of scientific objects had been arranged by the Club, supplemented by some assistance from others. Among the features that excited most interest were a demonstration by Prof. J. G. Gray of the properties of gyroscopes, experiments with liquid air, phenomena of polarised light, series of insects, chiefly butterflies, illustrating the theory of mimicry and the phenomenon of seasonal change, and an exhibit of the results of a zoological survey of Bagley Wood. The Main Court, including the Pitt Rivers Museum of Archæology and Ethnology, was open throughout the evening; and a water-colour drawing by Bernard Gotch of the entrance to the Old Ashmolean, together with objects from the historic scientific collections there preserved were also on view. The guests of the Club were received by the president, Mr. D. H. P. Peel, of Merton College.

James Watt Memorial Institute, Birmingham

ON May 15, Mr. A. E. L. Chorlton, M.P., president of the Institution of Mechanical Engineers, opened the James Watt Memorial Institute in Great Charles Street, Birmingham, which has been provided out of the funds subscribed at the James Watt Centenary in 1919. The original scheme for which the funds were raised included both the endowment of a chair at the University of Birmingham and the erection of a building for the joint use of engineering societies. The sum subscribed, however, did not allow of the scheme being carried out in its entirety, and after establishing a research scholarship and defraying other expenses, the balance was placed in the hands of trustees, by whom the present premises have been leased and fitted up with a hall, committee room and library. In declaring the premises open, Mr. Chorlton reminded those present that the Institution of Mechanical Engineers had its birth in Birmingham and remarked that the Memorial Institute could not fail to contribute to progress by bringing engineers together for intercourse and discussion.

Alaskan Earthquake of April 26

ON the night of April 26, much damage was caused in several towns in Alaska by an earthquake. The epicentre, as determined by the U.S. Coast and Geodetic Survey, lay in Lat. 61° N., Long. 153° W., a point north-west of the Kenai Peninsula, the time at the origin being 9.36 p.m., eastern standard time. An interesting and unusual observation was made by Mr. Earl L. Williams at Gaithersburg, Md., 4,000 miles from the epicentre. While working in his observatory at about 10 p.m., he noticed that the bubble in the spirit level attached to his telescope was sliding to and fro with a slow, even motion (Science Service, Washington, D.C, April 27 and 28). Similar observations have been made in a few other earthquakes. For example, on May 9, 1877, about 74 minutes after the great Iquique earthquake, the Russian astronomer Nyren noticed unusual oscillations in the bubble of a spirit-level fixed to the transit instrument in Pulkova Observatory, more than 8,000 miles from the epicentre. Again, on April 4, 1905, after the Kangra earthquake, movements were observed in levels at Tando Masti Khan (Sind) and Thedaw (Upper Burma), which are respectively about 660 and 1,300 miles from the epicentre.

Fifth Pacific Science Congress

REFERENCE has already been made in these columns to the Fifth Pacific Science Congress to be held in Victoria and Vancouver on June 1–14 (NATURE, April 22, p. 581). From a report dated May 2 issued by the National Research Council of Canada, it appears that of 393 scientific papers received for presentation at the Congress, 131 have come from Japan, 101 have been received from the United States, fifty-six from Canada, seventeen each from China and New Zealand, eleven each from Australia and Great Britain, eight from the Netherlands Indies, four each from Hawaii, Mexico, Siam, and the Netherlands, three each from India and Peru, two each from Norway, Straits Settlement and Federated Malay States and Sweden and one each from Colombia, Denmark, Ecuador, Fiji, France, Guatemala, Philippine Islands and Spain. Arrangements are being completed whereby through the courtesy of the British Post Office, the Canadian Marconi Company, the Bell and British Columbia Telephone companies, a demonstration of a long distance wire and radio circuit will be made at the Congress and a speaker heard from Great Britain. Commdr. C. P. Edwards, Director of the Radio Branch, Department of Marine, Canada, is in charge of the demonstration.

World's Grain Conference

SIR DANIEL HALL, director of the John Innes Horticultural Institute, Merton, Surrey; Sir John Russell, director of the Rothamsted Experimental Station, Harpenden, Herts; and Prof. William Robb, director of research of the Scottish Society for Research in Plant Breeding, Corstorphine, Edinburgh, have been appointed by the Ministry of Agriculture to represent the British Government at the World's Grain Conference to be held at Regina, Canada, on July 21–August 4. At the Conference experts from all the chief grain-producing countries of the world will examine every aspect of the grain problem. The agenda provides for a thorough examination of the present trends of the world wheat position and the question of controlling production of wheat and other cereals. Another difficult problem to be faced is changes that may be necessary in the financing of the world wheat surpluses. Wheat import standards, improvements in merchandising and marketing and economy in transportation and storage will also be considered. In addition, various technical groups will discuss soils, seeds, fertilisers, pests, economics, harvesting, machinery and milling. A prominent position amongst the educational exhibits will be occupied by the display which is being arranged by the Rothamsted Experimental Station under the personal supervision of Sir John Russell. The exhibit will include sheaves of wheat from the 89th successive crop grown on the same field under varying conditions, and will demonstrate recent research into potato and other root crops in which Canada is now particularly interested.

World Petroleum Congress

THE international nature of the petroleum industry, coupled with numerous strides it has made during the last decade, make the holding of a Congress at this juncture desirable. The need for such a Congress on technical matters is unquestioned, particularly in view of the international discussions which have taken place in recent years concerning, specifically, nomenclature and methods of testing, and it was high time that an earnest endeavour was made to co-ordinate these discussions and bring about some measure of universal agreement. The Institution of Petroleum Technologists is in every way qualified to sponsor such a Congress and, since the proposal was first put forward and adopted, the organising efforts of the Committee have met with great success and encouragement. At a recent general meeting of the Institution, the arrangements for the Congress, which is to be held at the Imperial College of Science and Technology, South Kensington, S.W.7, on July 19–25, were discussed fully and a very comprehensive programme, dealing with all phases of the petroleum industry, was presented. Among the subjects to be reviewed are petroleum geology and production, oil collection, treatment, transport and measurement, hydrogenation, bituminous materials, refining problems, alternative fuels and international co-operation in standardisation. The Congress has been recognised by His Majesty's Government and delegates from various societies, institutions and committees concerned with petroleum technology all over the world have been appointed and will take an active part in the vital work scheduled for this Congress. Apart from the technical business of the Congress, there will be a government reception to the delegates, a lecture by Sir John Cadman at the Royal Institution, visits to works and laboratories of interest, exhibitions of films illustrating the petroleum industry at the Imperial Institute, a banquet at the Mayfair Hotel on July 24 and a number of social functions, which are now universally recognised as essential factors to the achievement of a full measure of success in undertakings of this character.

Atmospheric Pollution

THE eighteenth report of the Department of Scientific and Industrial Research on the "Investigation of Atmospheric Pollution" (H.M. Stationery Office, 5*s*. net) records observations for the year ending March 31, 1932. It shows that the co-operation of local authorities has been well maintained in spite of the financial difficulties of the times. Comparisons between towns on the basis of the tests, should, it is stated, be made with caution. A deposit gauge may be placed in a position where conditions are not truly representative, and it is the trend of the results over a period rather than the absolute weights of deposit which should be stressed. From this point of view there is evidence of improvement in the atmosphere of some provincial towns of Great Britain. This cannot be said of the deposit of tarry matter, which is "pre-eminently a product of domestic fires and there is little reason to think that the amount of smoke from domestic fires has decreased much in recent years". Deposits of sulphate have increased in some places, notably Ravenscourt Park, London. Such increase, it may be inferred, may be due to the increase in the sulphur content of the fuels burnt—some fuel oils are rich in sulphur—or to the concentration of fuel burning on one site, such as in large power stations. London does not show up well in the matter of smoke fog while Coventry again has an excellent record, ascribed last year to the use of gas for domestic and industrial heating.

International Illumination Congress, 1931

THE final report and statement of accounts of the International Illumination Congress, 1931, held in London and the provinces under the presidency of Mr. C. C. Paterson, has now been published. Upwards of a hundred papers, contributed from all over the world, were presented at the technical sessions in the provinces. Some of these papers contained important original matter that has led to much discussion. Donations amounting to more than £6,000 were received from industries, etc., connected with electrical engineering and £2,000 from the gas industry. Grants of £724 have been made for the development of illuminating engineering. The Committee states that the success of the Congress exceeded the most sanguine expectations.

New Journal of Experimental Agriculture

THE publication of the new *Empire Journal of Experimental Agriculture* is, as the Minister of Agriculture states in his prefatory message in the first issue, "a natural and valuable development from the Imperial Agricultural Conference of 1927", for "in an Empire which fundamentally is founded on agriculture it is impossible to over-estimate the value of co-operative research work in agriculture". Furthermore, to quote the introductory message from the Secretary of State for the Dominions, it is of the utmost importance "to provide that those who are responsible for guiding agricultural policy shall keep in close touch with each other and shall quickly pool for the common advantage every new fruit of discovery and invention in the agricultural field". It is to meet these needs that the new journal has been published. The contents of the first number (April 1933) indicate that all types of problems dealing with crop or animal husbandry will lie within the scope of the journal. Subjects such as soil investigations in Canada and Cyprus, nutrition of sheep and dairy cows, animal disease, grassland management, haymaking machinery, Canadian wheat breeding and residual values of crops are dealt with, and, as an interesting contrast to the problems of to-day, an account of grain growing in Kent in the thirteenth century is included.

Announcements

AT the annual general meeting of the Linnean Society of New South Wales, held on March 29, Prof. A. N. St. G. H. Burkitt, Challis professor of anatomy in the University of Sydney, was elected president for the ensuing year.

AT a meeting of the Linnean Society of London, held on May 24, the following were elected foreign members: Dr. Elmer D. Merrill, director of the New York Botanical Garden; Dr. Erwin Baur, director of the Kaiser-Wilhelm Institute of Genetics, Müncheberg; Prof. Adolf Pascher, professor of botany in the German University, Prague; and Prof. Filippo Silvestri, professor of genetics and agrarian zoology, Portici. Mr. F. J. Killington and Mr. Thomas Sheppard were elected associates of the Society.

PROF. H. S. TAYLOR, David B. Jones professor of chemistry in Princeton University, was presented with the Mendel medal of Villanova College, Pa., U.S.A., on May 4. The Mendel medal was founded by the Augustinian fathers of Villanova College in 1928 to commemorate the well-known work of Gregor Mendel. It is awarded annually to "a Catholic who has signally advanced the cause of science". Prof. Taylor has been associated with chemistry at Princeton since 1914, and was appointed David B. Jones professor in 1927. He was made a fellow of the Royal Society in 1932, and is the author of numerous papers dealing especially with catalysis and the mechanism of chemical reaction. In collaboration with Prof. E. K. Rideal he wrote "Catalysis in Theory and Practice" and he is also the editor of a "Treatise on Physical Chemistry".

THE twelfth annual conference of the Institut International de Documentation (formerly de Bibliography) will be held at Brussels on July 18–21. A series of lectures is being arranged and visits to institutions in the neighbourhood will be a feature of the programme. Further information can be obtained from the Secretary, British Society for International Bibliography, Science Library, South Kensington, London, S.W.7.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A headmaster of the Sheffield Junior Technical School for Boys—The Secretary for Education, Education Office, Leopold Street, Sheffield (May 31). A domestic science mistress at the Polytechnic, Regent Street, London, W.1—The Director of Education (June 2). A lecturer in electrical engineering at the Kingston-upon-Hull Municipal Technical College—The Director of Education, Education Offices, Guildhall, Hull (June 3). An inspector of technical schools and colleges either in electrical engineering or chemistry (fuel technology)—The Director of Establishments, Board of Education, Whitehall, London, S.W.1 (June 3). An assistant lecturer in education at University College, Hull—The Registrar (June 9). A teacher of domestic economy (cookery and dietetics) at the Belfast Municipal College of Technology—The Principal (June 10). An assistant lecturer in physics in the University of Manchester—The Registrar (June 16). A professor of physiology at the University of Birmingham—The Secretary (June 12). An assistant lecturer in botany at the University of Bristol—The Registrar (June 17). A professor of metallurgy at the University College of South Wales and Monmouthshire, Cardiff—The Registrar (June 17). Instructor lieutenants in mathematics, science and engineering in the Royal Navy—The Adviser on Education, Admiralty, S.W.1 (July 1). Three research bacteriologists in the Medical Research Department of the Government of India; a professor of biochemistry and nutrition, a professor of malariology and rural hygiene (including venereology and tuberculosis) and a professor of vital statistics and epidemiology, and an assistant professor of public health administration, an assistant professor of biochemistry and nutrition, an assistant professor of malariology and rural hygiene (including venereology and tuberculosis), and assistant professor of vital statistics and epidemiology, at the All-India Institute of Hygiene and Public Health, Calcutta—The High Commissioner for India, General Department, India House, Aldwych, W.C.2 (July 1). A city engineer and surveyor for Capetown—Messrs. Davis and Soper, Ltd., Agents of the Corporation, 54, St. Mary Axe, E.C.3 (July 5). A research worker and a civil engineer for the Malaria Survey of India—The Secretary, Indian Research Fund Association, Simla, India (July 31). A lecturer in biology at the Stockwell Training College for Women, London, S.W.9—The Principal. An assistant in the Department of Domestic Science of Battersea Polytechnic, London, S.W.11—The Principal.

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.*]

Scales of Loudness

IN the course of an extensive investigation into the measurement of noise, it became clear that the accepted standards of sensitivity of the human ear both on a basis of absolute pressure and subjective loudness needed revision. Previous work on this subject has been largely directed towards telephone conditions of listening, whereas in the more usual case of listening under 'free space' conditions, other factors such as the collecting power of the outer ear, and diffraction of the sound waves by the listener's head are involved. In order to obtain representative data, measurements have been made on 48 people of the just inaudible sound pressures at typical frequencies. All the subjects were of normal hearing and the pressures were those measured by a microphone of accurately determined field calibration in the absence of the subject. The figures given in Table I are the modes of the results and, therefore, refer to the most probable values. The subjects were chosen to represent both sexes and ages from fifteen to sixty-five years.

TABLE I

Frequency	100	200	400	800	1,600	3,200	6,400
Pressure R.M.S. Dynes/ Sq. cm.	0·0036	0·0018	0·00040	0·00023	0·00020	0·00020	0·00097

The unsatisfactory nature of the loudness scale based on the law of the logarithmic sensitivity of the ear, and conveniently embodied in the decibel scale, became obvious during experience with the method of assessing noise in terms of the intensity of an 800 cycle note which appears equally loud. By expressing the results in decibels above the threshold of audibility at 800 cycles, the figures should, by the above law, be proportional to loudness. Experience gained on the measurement of a great variety of noises shows this is not so; for example, the relation between two noises assessed in this way at 90 and 45 db. is judged by the average person to be that one is much more than "twice as loud" as the other. Since this aural comparison of loudness is so common and is, indeed, the final criterion of any scale of loudness, measurements were made on 30 people to determine what meaning, if any, could be attached to the estimate "twice as loud". The results were surprising in that, in spite of misgivings on the part of the subjects, the results were quite concordant. This result was in agreement with that obtained over a more restricted range by Ham and Parkinson[2] who also gave a reference to a paper by Richardson and Ross[3]. After preliminary measurements, the normal range of intensities at 800 cycles was covered in steps of 2 : 1, starting from 100 db., which was called 100 on the loudness scale. What is perhaps more surprising is that the curve obtained with 4 : 1 steps agreed very well with that derived from the 2 : 1 steps. Table II gives the final average figures for the relation between decibels above the threshold at 800 cycles and loudness deduced from these 2 : 1 and 4 : 1 estimates.

TABLE II

Db. above Threshold at 800 cycles	0	49	58·5	68·5	80	87·5	94·5	100	104·5	108	110
Loudness	0	5	10	20	40	60	80	100	120	140	160

An alternative loudness scale constructed as suggested by Kingsbury[3] by integrating the minimum detectable intensity changes, redetermined at 800 cycles for free space conditions, while being better than the simple decibel scale, was much less in accordance with mental estimates than the above.

To make the loudness scale apply to other frequencies the equal loudness contours determined by Kingsbury were redetermined for free space conditions, and his figures, obtained with a telephone, found to be applicable. His results were extended to 6,400 cycles and up to 100 db.

Several years' experience with the 800 cycle comparison tone method of assessing noise intensities has shown that it is most reliable, particularly for fairly steady noises, assessments by different individuals being usually to within ± 2 db. A suitable 800 cycle valve oscillator, direct reading attenuator, and single headphone have been developed in easily portable form, and this apparatus has been used to measure a great variety of noises both in the laboratory and in particular places such as streets, buildings, etc. The attenuator reads directly in decibels but the above table enables the corresponding loudness figures to be determined.

An account of the development of this apparatus and the determination of the above tables from the physical, psychological and practical points of view will be published in the near future.

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[1] *J. Ac. Soc. Am.*, April, 1932.
[2] *J. Gen. Psychol.*, April, 1930.
[3] *Phys. Rev.*, **29**, 588; 1927.

Diffraction of Electrons in Amorphous and in Crystalline Antimony

A THIN layer of antimony was deposited on a film of cellulose nitrate by evaporating in high vacuum. The specimen was then examined by electron diffraction in transmission. It was mounted in such a way that it could be rotated about an axis lying in the plane of the film and perpendicular to the electron beam. The following results were obtained and could be repeated at will:

When the metallic deposit is not too thick (showing weak or medium absorption of light) the diffraction pattern (Fig. 1, *a*) shows that the structure is amorphous. Numerous tests with other metals and blank films exclude the possibility that the pattern observed may be due to a cause other than the deposit of antimony.

If the deposit is very thin, the amorphous state remains absolutely unchanged for an indefinite time (at least for six months); electronic bombardment seems to have no influence. In the case of medium thickness, crystalline spots appear after some time

and within a couple of hours the whole film shows a crystalline structure (Figs. 1 *b* and *c*) agreeing perfectly with the results of X-ray analysis[1]. As shown by the figures, the crystallites are not oriented at random but tend to arrange themselves so as to form a single crystal having its rhombohedral axis normal to the surface of the film[2]. Sometimes after crystallisation the amorphous state persists at the edge of the film where the thickness of the deposit is least. The crystallisation seems to set up strains in the film as it often breaks afterwards and scarcely ever before. It may be added that the deposit shows a metallic lustre in the amorphous state as well as after crystallisation.

With thick deposits (strong absorption of light) only the crystalline structure was observed. It may be pointed out, however, that in this case the films often crack some seconds or minutes after the evaporation has finished. From this it is inferred that the deposit is probably still amorphous for a short time after condensation.

I may be allowed to emphasise that in the case of Fig. 1, *a* the state should be considered as truly amorphous and not colloidal. This is based on the fact that the diffraction pattern is sensibly the same with different specimens and at different times. Crystallisation is either perfect or absent. Moreover, the diffraction pattern of the amorphous state shows little analogy with a 'broadened' powder diagram of crystalline antimony. On the other hand it agrees well with that to be expected from a packing of spherical monatomic molecules as in a liquid[3]. It is well known that in this case the 'grating constant' d (calculated by putting into Bragg's law the value of the diffraction angle for the first maximum) is related to the mean intermolecular distance a by the formula :

$$d = \alpha\, a$$

where α is a constant which Keesom[4] puts equal to 0·81, but which by a more rigorous treatment[3] and by considering the strong decrease of the scattering of electrons with the diffraction angle, would come out slightly higher (perhaps 0·85). As shown in the papers quoted, the value of a in A. is approximately :

$$a = 1{\cdot}33 \left(\frac{M}{D}\right)^{1/3}$$

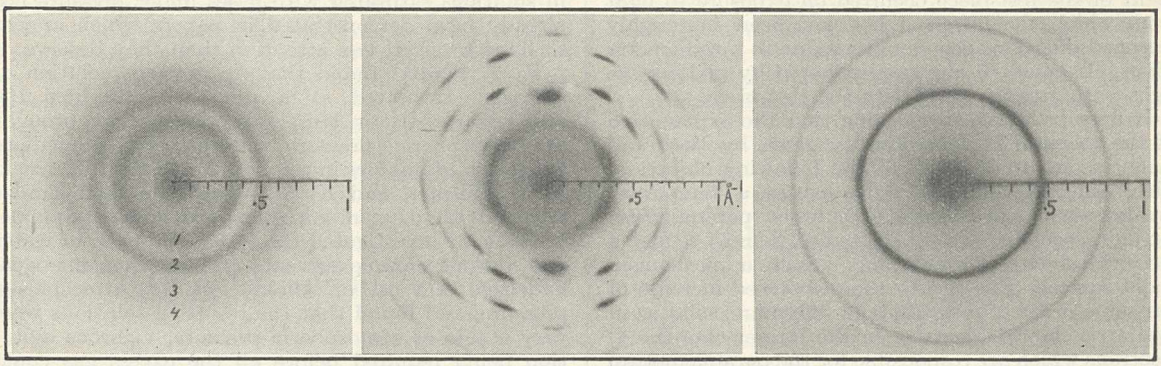
where M is the molecular weight, D the density of the substance. Now crystalline antimony has a density 6·7 and as melting does not influence the value appreciably, it seems reasonable to use the same value for our amorphous antimony. The formulæ then yield :

$$d = 0{\cdot}85 \times 3{\cdot}47 = 2{\cdot}95 \text{ A.}$$

in excellent agreement with the experimental value given below.

In the present investigation, four subsequent 'maxima' of decreasing intensity were observed. The corresponding values of d^{-1} and d are given below :

Maximum	1 (strong)	2 (medium)	3 (weak)	4 (weak)
d^{-1} (in A.$^{-1}$)	0·335	0·514	0·679	0·791
d (in A.)	2·99	1·94	1·47	1·26



(*a*) (*b*) (*c*)

FIG. 1. Electron diffraction patterns in antimony.

(*a*) Amorphous ; $\theta = 45°$. (*b*) Crystalline ; $\theta = 45°$. (*c*) Crystalline ; $\theta = 0°$. Diffraction of electrons (40–50 kv.) in antimony. The normal of the film makes an angle θ with the direction of the electron beam (axis of rotation vertical). The scale indicates the reciprocal grating constants d^{-1} calculated from Bragg's law : $\lambda = 2\, d \sin \varphi$.

A measurement of the intensities sufficient for a calculation of the frequency curve[5] for the intermolecular distance could not be made.

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Groningen.

[1] A. J. Bradley, *Phil. Mag.*, **47**, 657 ; 1924. "Strukturbericht", 59.
[2] F. Kirchner, *Naturwiss.*, **20**, 123 ; 1932.
[3] J. A. Prins, *Z. Phys.*, **56**, 617 ; 1929. *Naturwiss.*, **19**, 435 ; 1931.
[4] W. H. Keesom and J. de Smedt, *Proc. Roy. Soc. Amsterdam*, **25**, 118 ; 1922 ; **26**, 112 ; 1923.
[5] F. Zernike and J. A. Prins, *Z. Phys.*, **41**, 184 ; 1927. P. Debye and H. Menke, *Phys. Z.*, **31**, 797 ; 1930.

Influence of Light on Paramagnetic Susceptibility

THE so-called 'photomagnetic effect' was first described by Bose and Raha[1] as a decrease in the paramagnetic susceptibility of chromic chloride and of several other salts on exposure to light. Later the same authors corrected themselves[2] and claimed an increase in susceptibility followed by a slow decrease. Specchia[3,4] and Gorter[5] have also investigated the effect, the former finding a slight increase followed by a slow decrease, while the latter found only the decrease. None of these workers states the sensitivity of the apparatus used, although Specchia, who used the capillary rise method, says that water gave a deflection of 3,000 scale divisions.

I have investigated the effect in solutions of ferric chloride, chromic chloride, and neodymium nitrate by a method similar to that described by Decker[6]. In this method a small rod (test-piece) is suspended between the pole pieces of the magnet and the couple

acting on it is a function of the difference in volume susceptibilities of the test-piece (K_0) and of the surrounding solution (K_1). In order to eliminate errors from variations in field intensity the test-piece was made of glass filled with gadolinium oxide so that $K_0=K_1$. The apparatus was sensitive to 0·005 per cent, apparently about four times less sensitive than Specchia's apparatus. The light sources were a 100 watt microscope lamp, and a carbon arc. Cupric chloride solution was used to filter out the infra-red. The results obtained in every case confirmed those of Gorter; no increase was observed, but a slow decrease took place. The temperature increase due to radiation absorption was about 0·0002° per second, which was roughly that expected to cause the observed decrease in susceptibility. A marked movement of the test-piece occurred on exposure to light from which the infra-red had not been thoroughly screened off. This was doubtless due to a radiometer effect. It could be almost eliminated by making the light path strictly parallel to the test-piece.

It may be worth mentioning that the explanation of the increase in susceptibility given by Bose and Raha[7] seems to be open to the following objection. They suggest that the light causes a temporary breakdown of the *l*-coupling between paramagnetic ion and associated solvent molecules, thereby reducing the orbital moment damping. Such a mechanism could scarcely give rise to their observed increase of the same order of magnitude in didymium salts, as in say ferric chloride, because in the former case the 4*f* electrons which are responsible for the paramagnetism are almost completely screened from external influences, while for elements of the first transition series the orbital moments are usually strongly if not completely damped by the electrons of neighbouring ions or molecules.

P. W. SELWOOD.

Frick Chemical Laboratory,
Princeton, N.J.

[1] Bose and Raha, NATURE, **127**, 520, April 4, 1931.
[2] Bose and Raha, NATURE, **130**, 544, Oct. 8, 1932.
[3] Specchia, NATURE, **130**, 697, Nov. 5, 1932.
[4] Specchia, *Nuovo Cimento*, N.S., **8**, 291; 1931.
[5] Gorter, NATURE, **130**, 60, July 9, 1932.
[6] Decker, *Ann. Physik.*, **79**, 324; 1926.
[7] Bose and Raha, *Z. Physik*, **80**, 361; 1933.

Supersaturation of Liquids with Gases

ALTHOUGH it is well known that liquids may be supersaturated with gases, the *extent* to which a gas may be retained in supersaturated solution does not seem to be generally realised, and no quantitative information about the phenomenon is given in most textbooks on physical chemistry.

We recently had occasion to repeat some experiments by E. C. Gilbert[1] on the oxidation of hydrazine by potassium ferricyanide, in which the course of the reaction was followed by measuring the rate at which nitrogen gas was evolved. The velocity constants obtained were much higher than those recorded by Gilbert at the same temperature and with the same initial concentrations of reagents. It was found that the rate of evolution of gas was controlled mainly by the rate of stirring, increasing with the latter up to about 1,000 r.p.m. (The rate of stirring in Gilbert's experiments was 250 r.p.m.)

That this result was due to supersaturation of the aqueous solution by the nitrogen produced in the reaction, and not to genuine variation of the reaction rate with stirring, was shown by allowing the reaction to proceed for some time in unstirred solution, and then stirring vigorously. Rapid evolution of gas occurred, and the total volume evolved soon equalled that which would have been obtained if the solution had been stirred from the beginning. In some cases the amount of nitrogen which accumulated in the unstirred solution was seven or eight times the normal solubility of the gas.

Since the course of many reactions is followed, in quantitative work on chemical kinetics, by noting the rate of evolution of a gaseous product, it is important to emphasise the fact that supersaturation, unless broken down by adequate means, is likely to invalidate completely results obtained in this way.

The extent to which supersaturation may occur in solutions saturated with gases under pressure has already been demonstrated in papers which appear to have received less attention than they deserve.

K. S. Wyatt[2] found that an aqueous solution of nitrogen, saturated at a pressure exceeding 100 atmospheres at air temperature, could be brought to atmospheric pressure without the immediate formation of bubbles in the liquid, and F. B. Kenrick, K. L. Wismer, and K. S. Wyatt[3] obtained similar results with oxygen, nitrogen and carbon dioxide. J. Metschl[4] investigated the supersaturation of water and various organic solvents with oxygen, nitrogen, hydrogen and carbon dioxide at five atmospheres pressure, and found that the resulting solutions were very stable at atmospheric pressure, vigorous agitation being required before all the excess gas could be removed. Metschl's paper contains references to earlier work on the subject, mostly of a qualitative nature.

When a solution is supersaturated with a solid, introduction of a crystal of the solid immediately induces crystallisation, but in the case of a solution supersaturated with a gas, the presence of bubbles of the gas is not similarly effective. For example, in the oxidation of hydrazine by ferricyanide, gas is slowly but continuously evolved, even when the solution is unstirred, without breaking down the supersaturation.

Further work is being carried out on this reaction.

T. N. RICHARDSON.
KENNETH C. BAILEY.

Trinity College,
Dublin.
March 28.

[1] *J. Phys. Chem.*, **35**, 3631; 1931.
[2] *Trans. Roy. Soc. Canada*, [iii], **18**, 127; 1924.
[3] *J. Phys. Chem.*, **28**, 1308; 1924.
[4] *J. Phys. Chem.*, **28**, 417; 1924.

Alkylanilines with Tertiary Alkyl Groups

THE preparation of alkylanilines containing *tertiary* alkyl groups by the reaction of *tertiary* alkyl halides with aniline is known to present serious difficulties. Thus Nef[1] obtained only a poor yield of *tertiary* butylaniline in this way and his attempts to prepare *tertiary* amylaniline furnished only an impure product. By using suitable modifications of Nef's method, it has been possible to obtain *tertiary* butylaniline, *tertiary* amylaniline and *tertiary* hexyl aniline in a state of purity.

An examination of the reactions of these amines has revealed some surprising abnormalities. The tertiary alkyl group is split off by heating the amines

with aqueous mineral acids. This type of fission takes place more readily with the aryl sulphonyl derivatives of the amines. Thus while *tertiary* butylaniline is converted into aniline to the extent of 50 per cent by heating it with 15 *N* sulphuric acid at 120°–140° for 14 hours, the *p*-toluene sulphonyl derivative of *tertiary* butylaniline yields more than 90 per cent of the *p*-toluene sulphonyl derivative of aniline when it is heated with 15 *N* sulphuric acid for 1 hour at 135°–145°. The experimental evidence so far obtained indicates that the readiness with which the alkyl group is split off by the action of hot diluted sulphuric acid is in the order *tertiary* butyl < *tertiary* amyl < *tertiary* hexyl.

It has also been observed that the free amines do not react readily with acetic anhydride or with aryl sulphonyl chlorides. On the other hand, methyl iodide reacts with tertiary butylaniline fairly readily. Some of these reactions appear to find an explanation on the electrochemical theory recently elaborated by Robinson[2].

A detailed account will be submitted for publication elsewhere shortly.

W. J. HICKINBOTTOM.

Department of Chemistry,
University of Birmingham.

[1] Nef, *Liebigs Annalen*, **309**, 164; 1899.
[2] Robinson, "Outline of an Electrochemical (Electronic) Theory of the Course of Organic Reactions".

Higher Homologues of Sulphur Hexafluoride

IN fractionally subliming solid sulphur hexafluoride at low temperatures, we have noticed that the last fraction liquefied before vapourising. The vapour was obtained in a fairly pure state after repeated fractionation and its density was determined with a microbalance. As fractionation proceeded, the density rose rapidly from approximately 73 (that of sulphur hexafluoride) to the neighbourhood of 125, at which it remained steady. A new sample of sulphur hexafluoride was then prepared and a further quantity of the heavy constituent obtained. Two density determinations carried out independently by each of us on different microbalances and with different samples, gave values of 126 and 129.

From these figures it is evident that the gas has a molecular weight of about 256 and is probably S_2F_{10} (molecular weight 254). During the preparation of the sulphur hexafluoride the air present in the apparatus was previously displaced by nitrogen. Hence the possibility of contamination by oxygen compounds was excluded. Moreover, the gas was allowed to stand over concentrated potash for a long period before fractionation, so that the new gas resembles sulphur hexafluoride in not being easily hydrolysed. Its boiling point is in the vicinity of 0° C. We have also obtained, in very small quantity, a volatile oil, immiscible with and unattacked by water, which may be a still higher homologue of sulphur hexafluoride.

We are proceeding to analyse these compounds and to investigate their properties.

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R. WHYTLAW-GRAY.

Chemistry Department,
The University,
Leeds.
May 16.

Inheritance of Intelligence in Man

IN a recent paper[1] Dr. C. C. Hurst has discussed the inheritance of intelligence in man. After adverting to the fact that the data of Galton and Woods show that general intelligence in adults grades continuously from high to low both in general and in selected populations, Dr. Hurst finds it convenient to adopt ten grades of intelligence, because some of the data he uses is already so graded. He regards as a special *non-segregating* type those families which consist only of Grade 5 (mediocre) offspring whatever the grades of the parents, while he is content to classify as *segregating* a family of four Grade 4 (dull) offspring of parents themselves both of Grade 4.

Grade 5 is certainly peculiar, as will be seen at once from the frequency distribution of some of the data which is plotted upon permille paper in Fig. 1. The grading is stated to be equivalent to that of Galton except that the number of grades is reduced by compressing into Grade 5 six of Galton's grades,

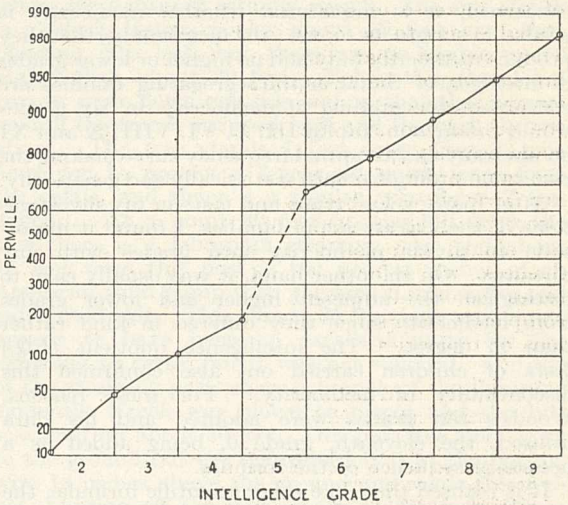

FIG. 1. Frequency distribution for R.F. data.

(*C*, *B*, *A*, *a*, *b*, *c*). It is just because these grades are merged into one that so many families consist only of Grade 5 offspring. These *non-segregating* families are a product of the system of grading and it is difficult to follow Dr. Hurst when he states that "the gradings are naturally imperfect . . . but, taken as a whole, the results show a general agreement which . . . signifies a close approximation to reality."

Dr. Hurst proceeds to develop a basic genetical formula for the inheritance of natural intelligence. This development, also, appears to be highly arbitrary, for by using three grades only a much simpler formula would surely emerge, while forty grades would yield a formula no less portentous than, and possibly quite as useful as Dr. Hurst's hexagenic one, with its 729 genotypical forms. It may perhaps be remarked that it seems somewhat lavish to postulate 729 genotypical forms in a hypothesis framed to justify ten discrete grades of intelligence.

A. F. DUFTON.

Greenbank, Garston,
Hertfordshire.
April 1.

[1] *Proc. Roy. Soc.*, B, **112**, 80; 1932.

In placing major and minor genes on an equal footing, Mr. Dufton has failed to realise the modest rôle played by modifiers in a genetical formula. Had he worked out the formula, he would have discovered that the 729 genotypes produce only seven different kinds of effective gametes, so that the formula is not so complex as he imagines and is thus more effective in predicting the inheritance of intelligence than he realises.

The statement that the special non-segregating families have parents of any grades is obviously incorrect. Reference to Tables II, IV, VII and IX of my paper shows that each non-segregating family has a Grade 5 parent, since it is these that are being tested.

It is suggested that the non-segregating families are merely a product of the system of grading and that if mediocrity had been divided into six grades instead of one, there would have been no non-segregating families. An examination of the tables of data shows that this inference has no foundation in fact. So far as the non-segregating families are concerned, it is immaterial whether mediocrity is graded in six grades or one; the fact remains that they produce mediocrity only and no higher or lower grades of intelligence. So far as the segregating families are concerned, the grading of mediocrity in six grades would produce in Tables III, V, VI, VIII, X and XI an aberrant and abnormal frequency curve making the results unintelligible both statistically and genetically.

After many years' trials and tests in my investigations of the Leicestershire families, I found it impossible to divide mediocrity into grades with any certainty. On the other hand, it was usually easy to distinguish the adjacent higher and lower grades from mediocrity since they differed in kind rather than in degree. The intelligence quotient (*I.Q.*) tests of children carried out also confirmed this discontinuity of mediocrity. For these reasons, Woods's ten grades were adopted and his data utilised, the eleventh, grade 0, being added as a necessary sequence of the formula.

It is realised that, like other scientific formulæ, the present formula is only tentative, representing as it does the present state of knowledge. But it is basic and it is clear that no simpler formula would cover the present data. Human intelligence is not so simple a matter as Mr. Dufton would have us believe, and it is now too late to attempt to account for its inheritance on the basis of a single Mendelian difference.

The alternative suggestion that forty grades would be quite as useful, may be nearer the truth than Mr. Dufton imagines, although the facts available do not warrant such a conclusion. Further research with more refined and precise methods of grading will no doubt increase the number of grades and the number of minor genes concerned. It is doubtful, however, whether any subdivisions of the present grades would affect the basic discontinuity between stable *NN* mediocrity and *nn* higher unstable and lower grades.

Recent research indicates that more important developments may be expected from a comparative study of the modifying genes for general intelligence (Spearman's *g*) and those for the special faculties (Spearman's *s*). There is evidence, for example, that the modifiers of general intelligence (*nn*) also act as modifiers of musical ability (*mm*), and the question arises whether these same modifiers also act as modifiers of other special faculties.

Cambridge. C. C. Hurst.
April 6.

A Possible Property of the Positive Electron

The detection of the positive electron (called positron) by Blackett and Occhialini[1] and by Anderson[2] makes it very probable that the positron has a great importance in the building up of nuclei. Anderson[2] suggests that the proton may consist of a neutron and a positron. In favour of this hypothesis we may mention the experiments of Stern (still unpublished), who found that the magnetic momentum of the proton is three times greater than it should be if the proton were to behave like an elementary particle in Dirac's theory. Following Heisenberg[3], both the proton and the neutron obey Fermi statistics and have a half integral spin momentum. This leads at once to the conclusion that, if the hypothesis of Anderson is true, the positron should obey Bose statistics and have an integral spin momentum (0 or 1). If this view should be confirmed by other experimental evidence we should understand better why the positrons can only be found in nuclei; for, since positrons have symmetrical wave functions, they can always be placed in the deepest energy levels. It seems to be an advantage of the proposed hypothesis, that contrary to Dirac's theory of 'holes'[4] an essential asymmetry between positive and negative electricity is introduced into the laws describing the behaviour of elementary particles. Since the light-quanta also have whole number momenta, it seems that it may be a general rule, that symmetrical wave functions are combined with integral momenta and anti-symmetrical wave functions with half integral momenta.

W. Elsasser.

Physikalisches Institut,
Technischen Hochschule,
Zürich. April 25.

[1] *Proc. Roy. Soc.*, **139**, 699; 1933.
[2] *Phys. Rev.*, March, 1933.
[3] *Z. Phys.*, **77**, 1; 1932.
[4] *Proc. Roy. Soc.*, **126**, 360; 1932.

Recent Magnetic Disturbances

A very notable magnetic disturbance—the greatest recorded at Stonyhurst for more than four years—occurred on April 30–May 2, the greatest movements being between noon and midnight on May 1. The 'storm', as it may fairly be called, began with a typical 'sudden commencement' at 16h. 27m. G.M.T. on April 30, when declination suddenly fell 2′ and then rose 6′, whilst horizontal force fell 36γ followed by a rapid rise of 75γ. No important movements followed until about 21h., when a 'bay' formed in both *D* and *H*, lasting about four hours, after which conditions were quiet until about 13h. on May 1, when the greatest movements began to manifest themselves, and the disturbance ended almost as abruptly as it began at about 1h. on May 2. The range in *D* was 60′ and in *HF* 436γ, ranges which have not been exceeded since 1929 Feb. 27–28.

It is noteworthy that there had been no spots on the visible hemisphere of the sun since April 21, when a small but active group, which passed the central meridian on April 20, died out. If this spot group is in any way associated with the magnetic disturbance, on the theory of emission from the sun of particles which reach the earth's atmosphere, the time of transmission of these particles, presumably emitted when the disturbed area was on or near the

central meridian of the sun, would be ten or eleven days, and their velocity 175–150 km. per second.

Another recent disturbance which seems to suggest the possibility of a long-deferred activity associated with a spot group occurred in February. On that occasion the largest spot group which had appeared for more than two years, and showed considerable activity, passed the central meridian on February 7, and disappeared at the west limb on February 13, without any accompanying magnetic disturbance. Thereafter the disc was completely free from spots until February 27. On February 19, however, a very notable magnetic disturbance commenced, which for six consecutive days ranked as 'great', and for a further three days as 'moderate' in the Stonyhurst system of characterisation. In this instance the time interval between the central meridian passage of the spot group and the commencement of the magnetic disturbance was twelve days, and that to the maximum range, which occurred on February 21, was 14 days; if a physical association between the two is assumed, this would imply particle velocities of 150 km. and 125 km. per sec. respectively, which are of the same order of magnitude as those postulated in the more recent disturbance, and are moreover of the order of radial velocities which have been observed spectroscopically in prominences and dark hydrogen flocculi.

Hitherto, it has been considered that the most probable interval between the occurrence of a spot group on the central meridian and an associated magnetic storm is about one and a half days, with a range of from two days before to four days after the central meridian passage[1].

An interval of 1½ days implies a velocity of transmission of the particles of about 1,200 km. per sec., and this interval seems well established for cases in which the association of spots and storms is fairly obvious. But the possibility of an association in particular cases at much longer intervals does not appear to be ruled out, and if such an association can be proved, it might go far to clearing up much of the obscurity which still remains as to the relation between terrestrial magnetic conditions and solar phenomena. The present time, when with the approach of sunspot minimum the solar conditions are much simplified, is an eminently suitable one for carrying out such an investigation.

The problem, however, is not simple, for if it be admitted that particles with so low a velocity as, say, 120 km. per sec. may be responsible for the production of magnetic disturbances, then there seems no reason why particles with any velocity between this and the maximum attainable may not be productive of disturbance, with any interval up to 14 days between the central meridian passage of the disturbed solar area and the associated magnetic disturbance. If it is found that the length of observed interval does not vary continuously throughout its range, but tends to be grouped round certain values, there would be an indication that the particles concerned tended to have certain specific velocities, perhaps related to their size, or to the wave-lengths of light responsible for the radiation pressure to which their velocities may be attributed.

J. P. ROWLAND, S.J.

Stonyhurst College Observatory,
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May 9.

[1] cf. Greaves and Newton, *Mon. Not. Roy. Ast. Soc.*, **88**, 556, and **89**, 84.

A Destructive Lightning Flash

ON Tuesday, May 9, at 3.40 p.m., a single destructive flash of lightning came to earth on my property at St. Marybourne, Andover, doing freakish damage there besides blowing very many of the electric light fuses in the village and 'blowing up' fourteen telephone boxes. The lightning struck a tree and a wire fence about 100 yards from the house but the charge of current in the local 230 volt village circuit was such that the fuses were not merely blown but those in my house made of copper 26 s.w.g. blew out the asbestos packing and deposited bright metallic copper all over the inside of the porcelain covers. A wireless set that was connected to the lighting circuit and to a well exposed aerial was not damaged at all even though there was no earth connexion to the aerial. A proper lightning guard is now in place. In my absence, the wireless set was not actually turned on; had it been, more things might have happened.

The more freakish incidents, however, occurred where the lightning actually struck. The tree struck is a black Italian poplar about 50 feet high then bursting into leaf, but there are no visible marks higher than about 20 feet. Below this there is a narrow score down one side and on the other a great area of the tree is stripped bare and the bark thrown about. The tree stands 7 feet away from a wire fence put to protect a 3-year-old quick fence from the cattle, and there is a similar wire fence 7 feet beyond. At a point 30 feet up the hill from the tree there is a laburnam straining post and about 15 feet from this post is the nearest corner of an American wind pump with galvanised iron tower and galvanised sails. This stands 35 feet high and would appear to have been an excellent route for the lightning to earth, but it was not touched. The top of the straining post where a branch of the lightning evidently struck was blown to pieces and the bits scattered for about 30 feet. This post was split down to the ground but the lightning left it at the bottom wire 18 inches above the ground and made this red-hot, burning off the zinc as far as the tree. There the strained wire broke and the lightning smashed the oak post at this point breaking it clean in half and splitting both ends. The three intermediate oak posts are undamaged except for being scorched by the red-hot wire.

At the foot of the smashed post a big flint put there to help steady it showed a mark which attracted the attention of Mr. F. H. Mackintosh, a well-known geologist, who thought it due to the lightning, and when I tried to lift the flint up the upper half came clean away from the lower half. A number of small flints also showed clean new fractures. This post, No. 4 from the start, was 7 feet from the tree and the flash dug a trench between in the turf about two feet wide and one deep, throwing the earth and sods as much as twenty feet away, and two sods were left in the tree about 12 and 15 feet up.

It so happened that my gardener, Mr. Waters, was standing at the door of the house and was looking that way at the time as he did not like the look of the cloud; he saw the earth and stones thrown up like a shell-burst and as they fell a cloud of dark smoke and steam blew away. Almost immediately after the flash there was a deluge of rain of very short duration—0·03 inch all told. This no doubt started before but was overtaken by the flash. Some of the bark was combed into a fine matted fabric

and nearly black. Some of these fell 50 to 60 feet away but the short sharp wind may have helped them to travel. A second trench was dug through the quick fence to the further wire fence.

About 100 yards of the fence was badly damaged. Continuing down the hill the 9th post was broken clean through below the bottom wire but posts 5, 6, 7 and 8 were not touched, nor were posts 10, 11, 12, 14, 16, 18, 21, 22, 23. Posts 13 and 15 showed slight damage near the ground but post 17, which had been an oak gate post, was split from the top wire to the ground. Posts 19, 20, 24 and 25 showed slight damage near the ground. This fence went on another 100 yards to the river but no more posts showed any damage.

Going up the hill from the straining post much the same sequence of damaged and undamaged posts was found. Perhaps it may be worth mentioning that post No. 16, 100 feet from the straining post, had the top broken clean off and below the bottom wire the post was split open so badly that the one part was nearly free.

Only ten minutes before cows had been lying round the mill but fortunately they had been taken away to be milked.

The whole village was properly scared by the flash which seems to have been of exceptional violence, and they were expecting me to come and dig up the thunderbolt.

St. Marybourne, Andover.
May 15.

C. V. BOYS.

Photographic Graticules

IN the annual report of the Department of Scientific and Industrial Research, 1932–1933, par. 4 on p. 111, dealing with the work of the British Scientific Instrument Research Association, gives the impression that photographic graticules were not produced in Great Britain previous to the investigation carried out by the British Scientific Instrument Research Association to which the paragraph refers. This arises as the result of certain excisions which I made for the purpose of reducing the draft drawn up by the British Scientific Instrument Research Association to a length suitable for its inclusion in the Report of the Department of Scientific and Industrial Research. I had no intention, in abbreviating the draft, of rendering it open to being read so as to convey this wrong impression.

In fairness to Mr. Julius Rheinberg, I should like to direct attention to the fact that he did great service to the optical industry during the War by developing the manufacture, by his firm, of large numbers of graticules required in instruments for Service purposes, and that his firm has been regularly supplying "grainless" and "filmless" photographic graticules since that time, though I learn that production of the latter variety has now been discontinued. I am the more sorry that the excisions should have made the paragraph capable of giving rise to the impression mentioned above since, on one occasion at my personal request, Mr. Julius Rheinberg undertook the production of graticules of a particular kind needed for a new type of instrument which had just been developed by a British manufacturer who had failed to obtain satisfactory graticules of that type from any other source.

HERBERT JACKSON.

26, Russell Square, W.C.1.

An Oestrogenic Substance from Plant Material

IN a recent communication[1] A. Butenandt mentions the identity of animal folliclar hormone with the substance found by him also in plant material. In this connexion I should like to take the opportunity of presenting the results of my researches, which will appear shortly in full in the *Bulletin* of the Polish Academy of Sciences.

From 65 kgm. of the female flowers of the willow I obtained a semi-crystalline substance having a strength of 35,000 m.u. of the follicular hormone. After the further extraction of this original preparation with 60 per cent ethanol and benzene, more than 11,000 m.u. were found in the benzene fraction. From the alcoholic solution I obtained by G. Marrian's method 7·5 mgm. of crystals, the properties of which were identical with the properties of trihydroxyoestrin prepared by me from female urine. The microscopical aspect and the solubility in various solvents of the two substances were in both cases very similar; the absorption spectrum in the ultraviolet and the melting point of the acetyl derivatives (126°) being identical. By mixing crystals of the willow preparations with crystals of trihydroxyoestrin from urine (m.p. 277°) the melting point of the urine preparations was lowered only 1°.

The substances differ, however, in their biological activity, which in plant material was about 1,000 m.u. in 1 mgm., whereas in the purest preparations of trihydroxyoestrin from urine I have found the activity to be 4,000 m.u. in 1 mgm. (aqueous injections in five doses, each 0·2 c.c. in 36 hours). From the mother liquid after the crystallisation of trihydroxyoestrin, a yellow substance in the form of small particles separated, the activity of which was about 1,800 m.u. in 1 mgm. The small quantity of this substance prevented, however, its further examination.

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April 1.

[1] *Naturwiss.*, **21**, 49; 1933.

Detection of Traces of Carbon Monoxide in Air

IN NATURE for March 25 and May 6, pp. 441 and 654 respectively, it has been pointed out that carbon monoxide can be detected in air (1) in proportions of 0·015 per cent by the palladium chloride solution method, and (2) in proportions of 0·004 per cent by the Hartridge reversion spectroscope.

While palladium chloride papers have been used here to this order of accuracy, the iodine pentoxide method is used when the detection (and measurement) of still smaller proportions is required; it has been claimed[2] that 10^{-6} grams of carbon monoxide can be detected as iodine in this way. Such sensitivity has not been required here; we have, however, used this method to detect one part in 200,000 (0·0005 per cent), and find it suitable for routine use.

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T. C. SUTTON.

Research Department,
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May 8.

[1] Ackermann, *Chem. Ztg.*, **67**, 154; 1933.
[2] Tausz and Jungmann, *Gas- u. Wasserfach.*, **70**, 1049; 1927.

Research Items

Burmese Spirit-World. In *Man* for April, Maung Htin Aung describes certain beliefs relating to spirits held in Burma. Spirits are of many kinds, but fall into two main divisions—the higher, which are worshipped, and the lower, which are not. The former are Buddhist, or pre-Buddhist which became semi-Buddhist on the introduction of that religion into the country, among them being 'the thirty-seven Nats'. The lower spirits have not yet been described in detail. Of them there are three kinds. The commonest, the *ah-sain-tha-yè*, are 'ghosts' which wish to hurt and frighten human beings. There are four grades, of which the lowest, the *hmin-zar*, appear in the form of small animals, darting out of the darkness. If one of these runs around a man three times completely, he will die in seven days. The *tha-hsè* appear in various forms and make noises. The *tha-yè* and the *tha-bet* do not differ greatly and are more powerful than the *tha-hsè*. They can inflict physical injury and prefer human flesh to the meat which satisfies the first two grades. Witch masters give these spirits meat regularly to have them as servants; but if they then fail to supply the meat, they are liable to be attacked. The *ôt-ta-sount* guards hidden treasure, its power varying with the value of the treasure. It does not harm human beings unless they attempt to take the treasure. The *kyat* is totally harmless, and lives in holes in the ground, coming out at night to feast and laugh the whole night through. They are kindly and often entertain travellers at their feasts. All these spirits, being forms of evil, are frightened by religion and piety. When a spirit is troublesome, it may be driven away by summoning a monk to recite prayers, or a master of magic to exercise his art against it or by an offering made to the Nats, who order the spirit to leave, or by appealing to an administrative officer, who orders it not to interfere with the King's subjects on pain of exile. A spirit is powerless to disobey an order of exile from the Crown.

Mesolithic Culture in Palestine. Three communications in the *Journal of the Royal Anthropological Institute*, vol. 62, pt. 2, deal with the mesolithic period in Palestine, which was unknown before the investigations therein described. Miss Dorothy Garrod describes the excavation of the caves of Shukba and Mugharet el-Wad, Mr. Turvile Petre that of the cave of Mugharet el-Kerbarah, and Miss Dorothea Bate reports on the animal remains from the caves, in so far they throw light on the mesolithic fauna of Palestine. The stratification of the two caves excavated by Miss Garrod was much involved. In the Shukba cave the strata extended from Byzantine to Mousterian. At Mugharet el-Wad, the outer chamber showed remains of all ages to Arab times in inextricable confusion, while the inner chamber had an undisturbed sequence of four strata of upper palæolithic. The terrace of this cave, however, showed from recent to bronze overlying a mesolithic stratum with two subdivisions, which corresponded with a clearly marked typological differentiation. The evidence from the two caves points to a distinctively characterised microlithic culture, precisely like nothing previously known, and therefore distinguished by the name 'Natufian', divisible into a Lower (Mugharet el-Wad *B*.2) and an Upper (Mugharet el-Wad *B*.1 and Shukba). A tentative dating 5000–4000 B.C. is suggested. At Mugharet el-Kerbarah, Mr. Petre found a comparable culture which was particularly rich in worked bone. It resembles the Lower Natufian of Mugharet el-Wad and represents the earliest phase of Natufian yet known. Miss Bate reports that many forms well represented in the cave deposits have become much rarer or have disappeared in the modern fauna. Such are a horse, a large ox or buffalo, and the spotted hyæna. There is nothing to suggest domestication, though the Natufians were acquainted with agriculture. In Mousterian times the deer was the predominant form; by Mesolithic times the gazelle was predominant. This points to a change of climate from moist to dry and inferentially from a wooded to open country.

Reptiles and Amphibians of the Pacific Islands. In connexion with their description of the reptiles and amphibians collected in the Pacific Islands by the Whitney South Sea Expedition during the years 1920–30, Charles E. Burt and May Danheim Burt discuss the geographical relationships of the fauna (*Bull. Amer. Mus. Nat. Hist.*, **63**, art. 5, Dec. 1932). The reptiles and amphibians on the islands of the Pacific Ocean are obviously derived from East Indian elements, which in turn show strong Asiatic and Australian affinities. The fauna of the South Sea Islands has been derived from New Guinean (or Papuan) elements and its eastward migration seems to have taken place through the Solomon, Banks, Santa Cruz and New Hebrides groups to New Caledonia and the Loyalty Islands in the west and to the Fiji group and points still closer to America in the east. That this distributional pathway has been made use of by the oriental fauna as a whole, is indicated by the progressive and continuous reduction in the number of species inhabiting the more distant areas. It has even resulted in a few instances in the transplantation of oriental forms into the New World. Chance dispersal has been very common in this distributional pathway, which has been determined by the linear order in which the greater land masses are arranged.

Night Migrations of *Schistomysis* and *Pseudocuma*. In a short paper ("Quantitative Studies Between the Tide Marks", *Glasgow Naturalist*, 1932) Mr. Richard Elmhirst, superintendent of the Scottish Marine Biological Station, Millport, gives some interesting information as to the abundance of some common animals of the beach. He shows that there is a set of tidal migrants which invade sandy shores after darkness. These include several amphipods, the mysid *Schistomysis spiritus* and the cumacean *Pseudocuma cercaria*. In hauls taken in February 1932 at the water's edge in a sandy bay, *Schistomysis* was found in quantities near low water at 7.30 p.m. with the moon obscured. At 5 a.m. at low water with the moon shaded there were only a few left but a large number of *Pseudocuma* had taken their place. Neither species was abundant at 10 p.m. when the moon was clear and the tide rising. Thus *Schistomysis* apparently left the shore when the moon was clear and was later replaced by *Pseudocuma*. Further hauls on different occasions show that these two species do not usually occur together but are found at different times of night or in the early morning in the same place. On the other hand, several amphipods

were taken with *Pseudocuma*, especially at midnight. The proportions of the sexes were different at different times, adult females of *Schistomysis* occurring more frequently at 9 p.m. or midnight than in the early morning.

Aristogenesis. In a communication to the National Academy of Sciences, Washington, on April 25, Prof. Henry Fairfield Osborn defined the term "aristogenesis", which he had proposed at the meeting of the British Association in 1931. It is to be used as a descriptive term, without theoretical significance, and implies the orderly creation of something better or more adaptive, as observed when tracing series of fossils through successive ages. The new characters which tend towards betterment, arise independently in widely separated geographical areas, at the same or different aristogenic rates. They are definite secular changes, rather than the changes due immediately to new habit or environment which were noted by Lamarck. They were studied by Waagen in evolving series of shells of fossil mollusca, and by Osborn himself in the grinding teeth of successive fossil mammalia. The new characters which Osborn formerly named "rectigradations" may now better be termed "aristogenes". They develop more slowly than the "allometrons", or changes in the proportion of parts.

Spray Spreaders. The days belong to the past when a fungus attack was combatted by spraying infected plants with a fungicide only. Modern spray fluids contain a 'spreader' or wetting agent in addition to the fungus-destroying or insect-killing substance. A very useful survey of the various substances which can be used as spreaders and their chemical actions with some fungicides and insecticides appears in the 1932 Year Book of the Horticultural Education Association (vol. 1) entitled "The Present Uses and Future Development of Spray Spreaders" by Hubert Martin (pp. 76–84). The author deals first with the action of spreaders, and then discusses the various classes of substances used to this end. Soap was the first, and is, perhaps, still the most widely used spreader, but it is shown to have many limitations. A new method for its preparation from fatty acid and dilute alkali is described and shown to require less labour of preparation than the standard method of making a stock solution. The newer spreaders—sapamines, agrals and sulphite lye—are described and by-products from oil refinement and oils themselves can also be used. The special question of spreaders for sulphur and the new idea of using a spreader for Bordeaux mixture are also discussed. The article is of great interest to all scientific horticulturists.

Volatile Transport of Silica. In a contribution on this subject from the Geophysical Laboratory at Washington by J. W. Greig, H. E. Merwin and E. S. Shepherd (*Amer. J. Sci.*, Jan. 1933, pp. 61–73), experiments are described showing that if the volatiles that are driven off from rocks when they are heated are under a small pressure, transfer of silica through the vapour phase is brought about at an important rate. In the absence of water or other volatiles, under conditions otherwise identical, the transfer was found to be too slow to be appreciable by the methods adopted. In the experiments, which were conducted at constant temperature, silica was vapourised from the inner surface of sealed bulbs of silica glass and deposited on platinum as crystals of crystobalite. When the temperature was high, crystobalite formed a continuous crust on the inner surface of the tubes. It was found that even a small pressure of the volatiles produces a striking effect in inducing crystallisation in certain silicate liquids. This phenomenon may be applied to prepare crystals in glass for the study of equilibrium relationships in cases where it would otherwise be extremely difficult to grow crystals. The various deposits of crystobalite are described and illustrated by eight photomicrographs.

Magnetic Data and Mine Surveying. In a paper read before the Institute of Mine Surveyors (Staffordshire and Warwickshire Branch), on April 8, Mr. T. G. Bocking directed the attention of mine surveyors to certain phenomena of terrestrial magnetism which have a practical bearing on the accuracy with which precise magnetic surveying may be carried out. For accurate surveys, it is essential in the first place that the degree of magnetic disturbance occurring during the process of surveying should be known, and for the use of mining engineers, the *Colliery Guardian* and the *Iron and Coal Trades Review* publish every week tables provided by the Royal Observatory, Greenwich, and the Meteorological Office, which give, by means of appropriate symbols, a measure of the disturbance in magnetic declination as recorded at Abinger and Eskdalemuir respectively. The ideal conditions for magnetic surveying are obviously at times of little or no disturbance, and Mr. Bocking points out the possibility of forecasting favourable periods by making use of the well-known tendency of magnetic disturbance and magnetic calm to recur at intervals of about twenty-seven days, equivalent to the synodic rotation period of the sun. In 1918, Dr. C. Chree, in a paper read before the Institution of Mining Engineers, pointed out that there is decidedly more than the average chance that a day which follows about twenty-seven days after a disturbed day will show more than normal disturbance and, conversely, that a day which follows about twenty-seven days after an international 'quiet' day will show less than normal disturbance. Using the daily Abinger magnetic data, Mr. Bocking constructed a chart covering the period April, 1928–March, 1933, by arranging the daily symbols successively in horizontal rows of 27. The recurrence tendency becomes at once apparent by well-marked groupings or sequences of similar symbols. Mr. Bocking advocates that in Great Britain magnetic surveying should be carried out between 10^h and 14^h G.M.T.; during these hours his analysis shows that a small percentage only of magnetic disturbances occur and, in addition, the rate of change of the diurnal variation of declination is then usually least.

Low Temperature Research. The "Reports and Communications" made by the Kamerlingh Onnes Cryogenic Laboratory at Leyden to the First International Committee of the International Refrigeration Institute at the Sixth Congress held at Buenos Aires in the summer of 1932 have been issued as a separate volume of 460 pages by Ijdo of Leyden. Under the head of thermometry, Prof. Keesom reports that the coefficient of increase of pressure with temperature for helium has been found to be 0·0036609 by the Leyden and 0·0036606 by the Berlin observers, the normal boiling point of oxygen −182·977° and −182·965°, of hydrogen −252·754° and −252·780° C. by the two laboratories, that Leyden is not prepared to accept the international scale of the resistance

thermometer as defined by the Paris agreement of 1927, that for resistance thermometry at helium temperatures a phosphor-bronze is best and that thermo-electric couples of gold with 1 per cent cobalt and silver with 1 per cent gold are most suitable. Other communications deal with vapour pressures of hydrogen and helium, specific heats, speed of sound, a bibliography of thermodynamic diagrams for refrigerants, magnetic susceptibilities, and the effects of low temperatures on organisms.

Latitude Variation of Cosmic Rays. A. H. Compton has published (*Phys. Rev.*, March 15) the results of an elaborate co-operative investigation into the geographical distribution of cosmic rays. Seven sets of ionisation chamber apparatus were constructed and measurements were made at 69 stations. The ionisation due to the cosmic rays was compared with that due to a γ-ray source, and measurements with different thicknesses of lead shielding allowed corrections to be applied for local γ-rays. The ionisation plotted against barometric pressure (including therefore both altitude and 'barometer effect') lies on a smooth curve for any one latitude, but the ionisation curves for high latitudes lie definitely above those for more equatorial regions. At sea-level the change in intensity from the highest to the lowest latitude was 14 per cent, at 4,400 metres it was 33 per cent. The change with latitude was more consistent when plotted with reference to the earth's pole of uniform magnetisation. The shape of the curves is in excellent agreement with the theory of Lemaître and Vallarta, which considers the effect of the earth's magnetic field on electrons coming from remote space, and a well fitting curve is obtained by assuming that a considerable portion of the ionisation at high latitudes is due to electrons with energy about 7×10^9 volts. It appears that the variation cannot be due to the magnetic deflection of particles within a few hundred kilometres of the earth, and it seems likely that the primary cosmic rays consist at least in part of charged particles. These experiments are apparently the first to give any systematic information about the primary cosmic rays as distinguished from the secondaries which they produce. (See also NATURE, May 20, p. 713.)

Energy Absorbed in the Cold Working of Metals. Rosenhain and Stott, working at the National Physical Laboratory, have measured the evolution of heat produced by drawing down a wire in a diamond die (*Proc. Roy. Soc.*, April). The wires were of copper and of aluminium and the drawing was carried out continuously with the die immersed in a calorimeter full of oil. The tension in the wire was measured by passing the wire to and from the die over pulleys connected to electrically-indicating spring balances. The results indicate that the heat liberated is less than that equivalent to the work performed, so that some energy becomes latent in the deformed metal. Since this energy is measured as a small difference on a rather small quantity of heat, the accuracy of measurement is not high, and the differences in the manner of working the metals make it impossible accurately to compare the values with those of other workers. The order of magnitude of the values is, however, the same as that obtained by Farren and Taylor, who used a bar stretched in a testing machine.

Astronomical Topics

Astronomical Notes for June. There is a close conjunction of Mars and Jupiter at 9 p.m. on June 4, Mars being 15′ south of Jupiter; the planets will be above the horizon in England until after midnight. On the evening of June 8 there is a conjunction of Mercury and Venus, Mercury being about a degree north of Venus. The planets will be low down, but it may be possible to observe them. Saturn may be observed in the morning hours, but its south declination of nearly 17° is a hindrance to accurate work.

The sun reaches the solstice, and summer commences, at 9 p.m. on June 21.

No occultations are visible in London under favourable conditions.

Absorption of Light in the Galaxy. Several astronomers have in recent years expressed the opinion that the amount of absorption of light by scattered matter in interstellar space is greater than that previously assumed, and in consequence that the ordinarily accepted distances of remote objects need reduction. A Science Service bulletin of April 19 gives an outline of work being carried on by Prof. Joel Stebbins and Dr. C. M. Huffer at Washburn Observatory, Madison, Wis. They conclude that there is more matter in interstellar space than that embodied in the stars themselves, and that we probably do not see even to the centre of our galaxy, much less to the farther side of it. The suggestion has already been made that the dark obscuring cloud in the Sagittarius region may hide from us the bright central region of the galaxy, which may be conjectured to exist from the analogy of the great nebula in Andromeda.

Variation of Latitude. The Cookson floating telescope, lent by Cambridge Observatory to the Royal Observatory, Greenwich, has now been in use there for three periods of seven years. The period of seven years is that in which the curve of latitude variation is expected to repeat itself, as its principal components have periods of 14 and 12 months. A large diagram, showing the variations for 21 years, is reproduced in *Monthly Notices of the Royal Astronomical Society* for March. The first seven years show the largest amplitude, attaining nearly 0·30″ in each direction. In the second period it is smaller, barely exceeding 0·20″. At the end of the second period and the beginning of the third there are four years, 1925–28, in which the variation barely reaches 0·10″. After that it revives somewhat, though not reaching the amplitude of the first period. As Sir Frank Dyson describes it: "The natural period had been damped out and a fresh start was made in the second half of 1929".

The same issue of the *Monthly Notices* contains a paper by Dr. J. C. Dobbie, investigating the effects of tidal displacements of the vertical on latitude variation. Some recent work by Dr. H. Stetson suggested that this might amount in magnitude to 0·09″, which would be an important fraction of the whole variation. Dr. Dobbie's investigation, which makes use of the Michelson-Gale experiment on tides in pipes, gives a much smaller value, barely reaching 0·01″, which is practically negligible. It is inferred that the effects noted by Stetson arise from some other cause.

Vitamin Content of Butters

BUTTER is an important source of vitamins A and D in the diet, but the amounts present vary with the feeding of the cow and also, in the case of vitamin D, with the amount of sunlight to which the animal is exposed. Summer butter is more potent than winter butter. Since much of the butter consumed in Great Britain is imported, it is essential to know whether it can compare in vitamin value with the home-produced article and whether storage has any influence upon its potency. Experiments carried out during the past few years by Crawford, Perry and Zilva on Australian, New Zealand and English butters add to our information on this subject.*

The tests were carried out on young rats: for vitamin A assays they were given a diet deficient in this vitamin, but containing irradiated hardened vegetable oil, dried yeast and lemon juice to supply vitamins D, B and C respectively. When growth had ceased, small doses of butter were given daily for four weeks and the growth rate compared with that of other animals supplied with 3–5 drops of cod liver oil daily. For vitamin D tests the animals were kept on McCollum's rachitogenic diet No. 3143: the prophylactic method was used and the positive controls were given 3–5 drops of cod liver oil daily. All the animals were killed after 28 days and the ash content of the dried fat-free bones of the hind-legs estimated. The ratio of ash to organic residue was worked out and the degree of protection from rickets expressed as a percentage of the protection given by the cod liver oil. Three doses of butter were usually employed, 0·1, 0·2 and 0·6 gm. daily, and six rats were put on each dose.

The English butters tested were obtained in winter from cows stalled but also given up to 8 oz. cod liver oil a day. 0·1 gm. daily produced about as good growth in the depleted rats as the dose of cod liver oil given to the positive controls, whilst 0·6 gm. daily gave almost complete protection from rickets. The butters were retested after 5–20 months storage at −10° to −12° C. There appeared to have been some loss of vitamin A after 20 months', but no, or only slight, loss of vitamin D after 5 months', storage.

Summer and winter butters from New Zealand and two summer butters from Australia were examined. The latter were as potent as the English butters, and the New Zealand summer butter was not significantly less active. The New Zealand winter butter, however, contained less vitamin D than the others. Storage at a low temperature for periods up to two years had little effect on the vitamin content of these butters: the New Zealand summer butter showed some loss of vitamin D in this time.

Further conclusions from this research are that the breed of the dairy herd, the district in which it is pastured, and the process of neutralising acid creams before churning, have no effect on the vitamin content of the butter from Australia and New Zealand. Butters from these Dominions therefore may be recommended to fill deficiencies in the home supply. The preface to the report states that imports from Australia and New Zealand have already increased from 20 per cent of our total imports in 1913 to 44 per cent in 1932.

* Medical Research Council. Special Report Series, No. 175: Vitamin Content of Australian, New Zealand and English Butters. By M. E. F. Crawford, E. O. V. Perry and S. S. Zilva. (London: H.M. Stationery Office, 1932.) 1*s.* net.

University Statistics of Great Britain

THE tabular statements compiled annually by the University Grants Committee from returns submitted by universities and university colleges in Great Britain and published by H.M. Stationery Office* are models of what such publications should be—lucid, comprehensive, concise. Here is set out on twenty pages a conspectus of fifty-five institutions, comprising all important aspects susceptible of statistical presentation. The tables are preceded by a brief introductory note directing attention to some salient features of the returns with comments on their significance.

Students are classified according to sex, domicile, dwelling place (hostel, lodgings, home) during term, age on admission, grade, subjects of study, degrees and diplomas obtained. Of the total number of full-time students (35,751 men and 12,759 women) in attendance in 1931–32, approximately 23 per cent were in London, 21 per cent in Oxford and Cambridge, 21 per cent in the provincial universities of the midlands and northern England, 23 per cent in Scottish universities, 6½ per cent in Wales and 5 per cent in Bristol, Reading, Southampton and Exeter. Some 4,400, nearly 10 per cent, came from abroad, that is, from homes outside the British Isles, as did likewise 1,500 (more than 10 per cent) of the part-time students. Of these 5,900 visitors from abroad, more than half (2,609 full-time and 726 part-time) were from countries within the British Empire, whilst 1,741 full-time and 775 part-time students were foreigners. The following table gives the numbers of full-time students from abroad at those seats of learning to which they resorted in the greatest numbers and the ratios of such visitors to the total numbers of full-time students in attendance:

	(1) B.E. overseas	(2) Foreign countries	(1) and (2)	Per cent of total
London	1116	607	1723	15
Univ. Coll. ..	230	131	361	18
Sch. of Economics	133	168	301	37
Imp. Coll. ..	177	47	224	22
King's Coll. ..	121	59	180	12
Medical Schools ..	300	132	432	13
Edinburgh ..	369	182	551	15
Oxford ..	306	235	541	11
Cambridge ..	342	187	529	9
Glasgow	133	79	212	4
Manchester ..	65	68	133	5
St. Andrews ..	14	102	116	14
Birmingham ..	24	82	106	7
Leeds	65	32	97	6

* University Grants Committee. Returns from Universities and University Colleges in Receipt of Treasury Grant. Academic Year 1931–32. Pp. 26. (London: H.M. Stationery Office, 1933.) 1*s.* 3*d.* net.

At a time when world economic problems and the quest of internationally acceptable solutions have assumed the tragic urgency of riddles of the Sphinx, it is interesting that more than a third of the London School of Economics students were from abroad and more than a fifth from foreign countries. The Imperial College (of Science and Technology) justified its name by drawing 17 per cent of its students from the outlying parts of the Empire. The number of such students at Oxford was smaller than at Cambridge, notwithstanding the imperial mission assigned to Oxford by Rhodes as the *alma mater* of the Rhodes scholars from the dominions. The large proportion of foreigners at St. Andrews and Birmingham is noticeable.

Closely associated with the question of the resort to our universities of students from abroad is the pursuit of advanced studies in them. Of the total number of full-time students 2,399 (7 per cent more than in the previous year) were engaged in research or other advanced studies and they were congregated chiefly at London (Imperial Coll. 241, Univ. 234, King's 131, School of Economics 118), Cambridge (372), Oxford (241), Edinburgh (145), Manchester (139), Birmingham (83). Part-time advanced students were numerous at London (Univ. Coll. 192, Birkbeck 178, School of Economics 99, King's 84, Univ. Coll. Hosp. Medical School 80), Liverpool (217), Glasgow (105).

University libraries are confronted everywhere at the present time with the difficulty of coping with the increasing number and cost of periodicals. The returns disclosed the fact that last year the ratio between expenditures on the purchase of periodicals and of books respectively rose from 2 : 5 to more than 3 : 5. The University Grants Committee points to the danger lest "What we may call the 'Periodicals interest' may by force of circumstances become so firmly established that it will in effect succeed in securing for itself the first call on limited library funds, and that only what is left over after its demands have been met will be available for the purchase of books proper."

University finances seem to have stood the strain of hard times well, thanks to timely limitation of commitments and concentration upon essentials, and the deficits of all the institutions, ten in number, of which the expenditure exceeded income amounted only to just over £11,000. The largest of these lapses (it was at Aberdeen) was but £3,684.

Fundamental Laws of Optical Rotatory Power

THE February issue of the *Berichte der deutschen chemischen Gesellschaft* contains an interesting account, by Dr. Werner Kuhn of Heidelberg, of a theory of optical rotatory power which he has developed with conspicuous success in recent years. A mathematical treatment of the problem has also been worked out by Dr. Kuhn and was published three years ago in the *Transactions of the Faraday Society*.

It is pointed out that in spite of the general application of the principle that optical activity is associated with structural dissymmetry, attempts to predict the magnitude or even the sign of the rotation of a new compound are singularly unsuccessful, and a more complete knowledge of the physical aspects of rotatory power seems to be necessary for a better understanding of this elusive problem. Kuhn appears to have recognised that absorption bands in the visible and ultra-violet regions constitute the physical equivalents of the asymmetric molecule of the chemist. Each of these bands furnishes a definite contribution to the rotatory power, which is the algebraic sum of all such contributions, though some of these may be negligible in value. Thus the observed rotation is in reality an additive function and each individual part of the molecule may contribute its quota.

In 1896, Cotton showed that the rotatory power of optically active compounds becomes abnormal in the region of absorption and that it is associated with circular dichroism. Now circular dichroism is caused by the unequal absorption of *d*- and *l*-circularly polarised light. Kuhn has developed this idea and has shown that a quantitative relation exists between circular dichroism and rotatory power; that is, either of these values can be calculated from the other, as illustrated by the case of chromium potassium tartrate dissolved in a solution of potassium hydroxide. Cotton investigated this solution in the visible region. In 1931 Kuhn and Szabo re-determined the values for both properties and extended their observations also into the ultra-violet region of the spectrum.

Still more striking evidence is furnished by the much more complex case of β-octyl nitrite, which Kuhn and Lehmann described in 1932. Here the curve of circular dichroism consists of several undulations and is partly positive, partly negative. From this highly complex curve a correspondingly complex curve of rotatory dispersion has been calculated and the values which are thus obtained are shown graphically to approximate very closely to experimental results.

Thus the rotatory power is the sum of the positive and negative contributions of several bands, which in the visible region are nearly but not completely balanced. Now general absorption is due to the presence in the molecule of chromophore groups, but optical rotation is not produced unless the electronic vibrations in a chromophore group are coupled with those of another group (which is probably non-absorbent or colourless), in such a way that when one vibration proceeds, say, from left to right, the other proceeds from back to front. Coupling of two vibrations in this fashion produces a difference in the absorption of *d*- and *l*-circularly polarised light and therefore dichroism, which in its turn gives rise to optical rotatory power. Thus in order that an absorption band may contribute rotatory power, it is essential that the electronic vibrations originating from a chromophore group should be capable of transmission to another part of the molecule; and the effect is greatest when this chromophore group lies near the 'centre of asymmetry'. Should these bands lie in the visible or early ultra-violet region of the spectrum, the effect on rotatory power will be very marked.

The author also deals with the vicinal effect on rotatory power of chemical changes near the absorption band. This aspect of the problem forms the subject of a separate contribution by Dr. K. Freudenberg.

University and Educational Intelligence

CAMBRIDGE.—An election to the Isaac Newton studentships will take place early in the Michaelmas Term 1933. These studentships are for the furtherance of advanced study and research in astronomy (especially gravitational astronomy, but also including the other branches of astronomy and astronomical physics) and physical optics. Those members of the University are eligible for the studentship who have obtained a degree in the University and were less than twenty-five years of age on January 1, 1933. The studentship will be of the value of £250 and will be tenable for three years. Candidates are invited to send in their applications to the Vice-Chancellor between October 10 and 16.

The Raymond Horton-Smith prize for 1931-32 has been awarded to Dr. J. E. Semple, of Corpus Christi College.

The Council of the Senate recommends that the rooms in the Forestry School when vacated by the Department of Forestry be assigned to the Department of Geography.

It is recommended by the General Board that an additional University lectureship be established in the Department of Geography, and additional University demonstratorships in the Departments of Chemistry, Physiology, and Zoology.

DUBLIN.—Sir Charles Arthur Kinahan Ball has been appointed Regius professor of surgery in succession to the late Sir William Taylor. Sir Arthur is a fellow of the Royal College of Surgeons in Ireland, and has been senior surgeon to Sir Patrick Dun's Hospital since 1922, as well as being honorary consulting surgeon to several other institutions in Ireland.

Mr. John Purser has been appointed professor of civil engineering in succession to Prof. David Clark. Mr. Purser is assistant professor of civil engineering in the City and Guilds (Engineering) College, and reader in civil engineering in the University of London.

LEEDS.—Dr. W. MacAdam has been elected to the chair of clinical medicine as from the beginning of next session and Dr. R. H. Evans has been appointed lecturer in civil engineering.

It has been decided to institute a part-time course in biology leading to a diploma. The course will occupy six hours a week (three hours in the evening and three on Saturday morning) and will extend over two sessions. It is designed particularly to meet the needs of teachers who want a qualification in this subject.

The University Council has accepted most gratefully from Mrs. Graham of Headingley a gift of £1,200 for the endowment of a scholarship in memory of her husband, Dr. James Graham, who was for twenty-five years director of education in the city of Leeds. The scholarship will be open to candidates whose parents live or have lived in Leeds, and who have attended an elementary or secondary school in Leeds for at least three years, provided that they have passed either the matriculation or the Higher School Certificate examination prior to enrolment at the University. Preference will be given to a candidate desiring to proceed to a degree in commerce.

LONDON.—Mr. C. A. Mace, since 1930 head of the Department of Experimental Psychology in the University of St. Andrews, has been appointed University reader in psychology (Bedford College).

The title of University reader has been conferred on the following in respect of posts held at the Colleges indicated: biochemistry, Dr. Katharine H. Coward (College of the Pharmaceutical Society); chemistry, Dr. David C. Jones (East London College), and Mr. Bryan Topley (University College).

The Dunn exhibitions in anatomy and physiology for 1933 have been awarded respectively to Mr. J. C. B. Bone (Middlesex Hospital Medical School) and Mr. J. S. Horn (University College).

MANCHESTER.—Prof. I. M. Heilbron has accepted an invitation to a chair of organic chemistry in the University. Prof. Heilbron was born in Glasgow, and received his early education in that city at the High School and the Royal Technical College, of which institution he was a lecturer from 1909 until 1914, and, after the War, professor of organic chemistry. He was appointed to the Heath Harrison chair of organic chemistry in the University of Liverpool in 1920, and has held that post to the present date. He is known for his researches on natural products, especially fish liver oils, fat soluble vitamins, cholesterol and other sterols, and was elected to a fellowship of the Royal Society in 1931.

Dr. John Prescott, lecturer since 1905, and, since 1922, head of the Department of Mathematics in the College of Technology, retires at the end of the present session. Mr. James Winterbottom, director of spinning in the College of Technology, also retires; he has been on the staff of the College since 1894.

Dr. R. W. Gurney, at present assistant lecturer in physics in the University, has been appointed research fellow in the University of Bristol.

READING.—The Council of the University has appointed Mr. R. Rae to be professor of agriculture in succession to Prof. S. Pennington, who retires in September. Mr. Rae is at present professor of crop and animal husbandry in the Queen's University, Belfast.

THE twenty-fourth Conference of the Association of Teachers in Technical Institutions is to be held at Lincoln on June 3–6. All meetings will be in the Technical College. The arrangements have been in the hands of a committee of the Association's Leicester Branch (Joint Hon. Conference Secretaries—Messrs. T. E. Hartley, and M. Brewitt, Technical College, Lincoln). The first public meeting will be held on June 5, when the Conference will be officially welcomed by the Mayor of Lincoln (Alderman J. W. Rayment), and the retiring president, Mr. S. H. Moorfield (Mining and Technical College, Wigan), will induct the president for 1933–34, Mr. F. H. Reid (Technical College, Paddington). Resolutions on the following topics, among others, will be discussed by the Conference: regional co-ordination of technical education; increase in number of technical institutions and extensions; education and industry; junior instruction and junior unemployment centres; closure of junior technical schools; recruitment for industry. An exhibition of books and apparatus will be held in the Technical College during the Conference.

Calendar of Nature Topics

Persia, "Wind of 120 Days"

In the Persian province of Seistan a violent wind from between north-west and north-north-west sets in every year about the end of May or early in June and blows almost without cessation until about the end of September. From its duration it is known as the "Bad-i-sad-o-bist roz" or "wind of 120 days". It sometimes reaches a velocity of more than 70 miles an hour, and carries a great quantity of sand and dust, which have remarkable effects. In some places the whole land surface is eroded, and old buildings are eaten away and undercut near the ground. Elsewhere the sand is deposited in wandering dunes, which overwhelm villages and choke water-supplies. All buildings, both ancient and modern, are built with blank walls on the windward side; this wind appears to have been a regular feature of the climate of Seistan since early historic times.

The Cuckoo's Call

"On the first of June
The Cuckoo changes her tune."

It has been suggested that the change referred to in the old rhyme is the singing of a triple instead of the usual double note, but this is probably an individual peculiarity, since there are birds also which can sing only *cuck*. It is more likely that the reference is to a change which takes place in the tune itself. In the spring, the cuckoo begins singing with an interval of a minor third; about June, it is said to proceed to a major third; and later to a major fourth, then a fifth, after which its voice breaks before reaching a minor sixth.

"Der Kuckuck drauf anfing geschwind
Kuckuck! sein'n G'sang durch Terz, Quart,
Quint."

The cuckoo's note itself has given trouble to the recorders. Gilbert White's neighbour, "who is said to have a nice ear", found that it varied in different individuals; "for about Selbourne wood, he found they were mostly in D; he heard two sing together, the one in D, and the other in D sharp, which made a disagreeable concert." Some he heard in C. Hoffmann says that the German folksongs mostly pitch the song in G major, which makes the song too deep. The English rhyme quoted above attributes the song to the female bird, but although the female sings and is even said to have a call of her own, the male is the most persistent caller.

Display of Sage Grouse

Amongst the many remarkable displays of birds, associated with the courting season, one of the most striking is that of the sage grouse (*Centrocercus urophasianus*), a native of the sage-brush region of western North America from southern British Columbia to New Mexico. In Oregon, R. Bruce Horsfall found the cocks assembling on May mornings by the shore of Klamath Lake, strutting with puffed-out chests and spread tails, and making noises which reminded him of the popping of corks on the pier at Atlantic City (this was in 1918). The strut was made up of four movements. First, the filling of air sacs enormously expanded the throat pouch to the accompaniment of a grunting sound; second, a short stiff-legged run was made with neither pouch nor wings touching the ground; third, the bird stopped suddenly, spread his tail and pushed forward his wings so as to raise the air pouch well up on the chest; fourth, a sudden upward throw caused the air pouch to rise and descend upon the chest with a rubbery 'plop', which was repeated three times before the whole performance recommenced (*Zoologica*, 2, 243; 1920). As many as sixty sage cocks were seen displaying at intervals of twenty-five to fifty feet, for each bird appeared to have a select territory on which no other dared to trespass with impunity. The display was not altogether a courting action, because when hens wandered through the throng during the performance, no notice was ever taken of them.

Barracuda Fisheries

During the month of May, the Barracuda fishery of California, which for six months supplies the markets of Los Angeles, reaches its height. Occasional fish may appear in winter, but the appearance of shoals occurs about mid-March, and after the May maximum the catch tails away, having furnished some $3\frac{1}{4}$ million pounds of fish flesh in about six months. For the remaining six months a catch of about two million pounds from Mexico stocks the markets. The barracuda (*Sphyræna argentea*) belongs to a group of fishes represented in tropical waters throughout the world, but little has been known until now about their habits and life-histories. The importance of the American and Mexican fisheries, however, has led to a thorough investigation of the Californian species, and the results have recently appeared from the Division of Fish and Game of California as *Fish Bulletin No. 37* (1932), by Lionel A. Walford. The spawning period begins in April, reaches its climax in June and ends in September, and the number of eggs laid depends upon the size of the fish, a two-year old of 50 cm. length containing about 50,000 eggs, a seven-year old of 91 cm. about 340,000 eggs. The fish may attain an age of at least eleven years. An analysis of the catch-records in relation to fertility suggests that the present legal limit of three pounds should be replaced by a limit of not less than 30 in. length.

Summer Thermocline in Seas and Lakes

Solar radiation is absorbed by the surface waters in lakes and seas causing them to become warmer and lighter than the water beneath. In temperate climates, during a quiet summer, heating of the surface warm layer may continue and by August a difference of as much as 7° C. may be found between the surface and the twenty-five metre layers. There is often an abrupt transition between these warm and cold layers, often called the thermocline or discontinuity layer. This may occur at about twenty metres in the English Channel, first becoming evident usually in May, and at between forty and fifty metres in the Barents Sea. The thermocline may be broken down by a period of stormy weather resulting in a uniform distribution of temperature down to a considerable depth. Due to this mixing, in a shallow sea, sunless stormy weather may lead to high bottom temperatures, whereas in a sunny, quiet year with high surface temperature, the bottom temperatures will be low. Although often left out of consideration, this is probably a factor of importance in the distribution of animals and plants in different seasons.

Societies and Academies

LONDON

Royal Society, May 18. W. T. CALMAN and ISABELLA GORDON: A dodecapodous pycnogonid. *Dodecolopoda mawsoni*, a new species representing a new genus of Pycnogonida, is described. It was obtained by Sir Douglas Mawson in the antarctic, and has the remarkable peculiarity of possessing six leg-bearing somites. It is suggested that the ten-legged and twelve-legged Pycnogonida originated by the development of instability in the metameric pattern of octopodous forms; also that the Pycnogonida as a whole may owe their origin to an analogous disturbance of the cephalic metamerism of normal Arachnida (see also NATURE, **131**, 242, Feb. 18, 1933). J. GRAY: Directional control of fish movements. In all the fish examined, a change in the direction of motion is effected by propagating an abnormally large wave of muscular contraction down the side of the body towards which the animal turns. During the first phase of the movement the anterior end of the fish turns on the posterior end, which remains relatively stationary in position. During the final phase of the movement the posterior end of the body moves towards the new axis of movement and during this process the anterior end of the animal remains relatively stationary. Except for fish with long and flexible bodies, the caudal fin plays an essential rôle during turning movements for it enables the posterior end of the body to act as a fulcrum on which the head is able to move through the water. A typical pelagic fish such as a whiting can turn through 180° within a circle the diameter of which is not greater than the length of the whole fish.

PARIS

Academy of Sciences, April 10 (*C.R.*, **196**, 1057–1152). JULES DRACH: The congruences of right lines and their focal surfaces. CHARLES RICHET: An aerofilter for the purification of air. Remarks on a recent note on this subject by Gaston Meniér and recalling an apparatus described in 1909 achieving the same object. SERGE BERNSTEIN: The Fokker-Planck differential equation. M. GIGNOUX and L. MORET: The internal structural units of the Alpine chain between the Pelvoux and Durance. J. MIRGUET: Certain ensembles of right lines. PAUL MENTRÉ: A projective deformation of tetrahedral complexes. ANTOINE APPERT: Orders of separability in abstract spaces. D. VAN DANTZIG: Monobolic groups and nearly periodic functions. JUAN CARLOS VIGNAUX: The method of summation of Edouard Le Roy. E. KOGBETLIANTZ: The approximate expression of the Laguerre polynomial $L_n^{(a)}(x)$. MICHEL LUNTZ and PAUL SCHWARZ: Coaxial annular alternate vortices and some phenomena of asymmetry relating to the rotation of a cylinder in a viscous fluid. MAX SERRUYS: An optical manograph with small inertia. G. LEMAÎTRE: The formation of nebulæ in the universe in expansion. E. M. ANTONIADI: Some changes recently observed on the planet Mars with the 83 cm. telescope of the Meudon Observatory. LÉON BRILLOUIN: How can supraconductivity be interpreted? A. PÉRARD: The elimination of the error of parallax in precision thermometers. LEW KOWARSKI: The movement of liquid drops in growing crystals. Contribution to the study of the intermediate state between a crystal and its sublimed vapour. HENRI ABRAHAM: The laws of action at a distance in electricity. G. ALLARD: The calculation of electric moments. R. FORRER: Interatomic electrons in crystalline networks. A. SESMAT: A new form of Michelson's experiment. G. A. BOUTRY: A precision densitometer with a photoelectric cell. PIERRE AUGER and GABRIEL MONOD-HERZEN: Collisions between neutrons and protons. MME. IRÈNE CURIE and F. JOLIOT: Contribution to the study of the positive electron. MLLE. C. CHAMIÉ: The expansion of the atoms of radioactive recoil in air. HENRI MULLER: The lowering of the eutectic point in the case of a ternary eutectic. F. BOURION and E. ROUYER: The cryoscopic determination of the total hydration of the ions of potassium chloride. RENÉ WOLFF: Electrochemical phenomena of the catalytic decomposition of hydrogen peroxide by platinum. J. BARLOT: A new method of analysis of bituminous schists. The mineral matter is removed by treatment with hydrofluoric acid. A study of the bituminous schist from the Creveney basin leads the author to the conclusion that this is not an impregnated rock like petroliferous sands, but a mother rock, possibly the fundamental mother rock of petroleum. MME. G. ALLARD: The refractometric determination of organic acids. MLLE. B. GREDY: The acetylene linkage. The study of some bisubstituted acetylene hydrocarbons. Details of the Raman spectra of eleven bisubstituted acetylenes: all show two lines of unequal intensity in the region 2200–2300 cm.$^{-1}$. JEAN AMIEL: The slow combustion of benzene. A mixture of the composition C_6H_6+15O under an initial pressure of one atmosphere was heated at temperatures between 400° C. and 540° C. The experimental results are given graphically. J. A. GAUTIER: *N*–Hydroxyethyl–α–pyridone and some of its derivatives. F. KAYSER: The two diastereoisomeric 1.2.3–triphenyl–1–propanols. The exclusive preparation of each of them starting with the oxides of stilbene and isostilbene. CHARLES PRÉVOST: An iodo-silver-benzoic complex and its application to the oxidation of ethylene compounds into α-glycols. A solution of iodine in benzene reacts with silver benzoate giving a compound $(C_6H_5.CO_2)_2AgI$ which can be crystallised from hot benzene. This reacts with ethylene derivatives giving good yields of the corresponding glycol benzoates. J. BARTHOUX: Lapis lazuli and balas rubies of the Afghan cipolins. MLLE. E. DAVID: The Oligocene and Burdigalian of northern Syria. P. CORBIN and N. OULIANOFF: The inclination of the granite sheets in the Mont Blanc massif. JAMES BASSET, MME. E. WOLLMAN, M. A. MACHEBOEUF and M. BARDACH: Studies on the biological effects of ultra-pressures. The action of very high pressures on bacteriophages and on an invisible virus (vaccine virus). The resistance to pressure of the bacteriophages is of the same order as that of vaccine virus and much less than that of the diastases and toxins previously studied. E. ROUBAUD: Desert anhydrobiosis and its influence on the animal cycle of *Schistocerca peregrina*. Preserved in air of low humidity, the winged locusts remain in an immature state and their normal manifestations of reproductive activity are retarded. Placed in moist air, sexual activity is recovered in a few days. H. BORDIER: Merget's phenomenon may be produced by the vaporisation of solid bodies. MME. Y. KHOUVINE: The synthesis of cellulose by *Acetobacter xylinum* starting from mannite and sorbite. MICHEL POLONOVSKI, PAUL BOULANGER and GASTON BIZARD:

Pancreatic ammoniophaneresis. A. JELLINEK: Measurements of temperatures in the interior of an egg placed in the electric field of ultra-short waves.

ROME

Royal National Academy of the Lincei, Dec. 18. E. ALMANSI: Deformations of elastic strips (2). G. ASCOLI: The conditions for the validity of Taylor's development in the real field. D. BONVICINI: Non-infinitesimal deformations. M. KOURENSKY: The integration of the equations to the partial derivatives of the second order with two functions of two independent variables (4). Systems containing three derivatives of the second order. G. MAMMANA: The numerical solution of a system of equations. MARIA PASTORI: Tensorial assemblages generated by Pascal-Vitali absolute systems. F. ZAGAR: The increase in mass of a planet by the effect of cosmic dust (1). Premises and a particular case. In Levi-Cività's treatment of this question, the translatory motion of the planet as a material point is considered. For the case in which only the surface elements are struck by the dust, while the internal points retain their mass unchanged, the general expressions are now deduced and a particular case is discussed. G. R. LEVI and D. GHIRON: Magnesium chlorite and double chlorites of copper with magnesium, barium, and thallium. Magnesium chlorite, $Mg(ClO_2)_2$, $6H_2O$, obtained by double decomposition from concentrated solutions of barium chlorite and magnesium sulphate, followed by slow evaporation in the dark, forms pseudocubic, rhombohedric, colourless crystals having the density 1·62 and the axial ratio $c : a = 2·45$. The following double chlorites have also been prepared: 2 Cu $(ClO_2)_2$, Mg $(ClO_2)_2$, $8H_2O$, in brown crystals appearing yellow in transmitted light; Cu $(ClO_2)_2$, Ba $(ClO_2)_2$, $4H_2O$, in yellow crystals showing green fluorescence; Cu $(ClO_2)_2$, Tl ClO_2, $2H_2O$, as a reddish-brown, crystalline powder. These double chlorites are markedly more stable than copper chlorite itself. A. FABRIS: The absorptive power of soil for pyrophosphoric acid. It has been already found that pyrophosphates take part in the transformation cycle of phosphoric acid in the soil and in the phosphatic nutrition of plants. Experiments made with soils of different characters show that these are capable of fixing the pyrophosphoric ion from solutions of pyrophosphates. This absorptive power is shown in greatest degree by the organic constituents of the soil. Under the experimental conditions employed, the absorption from 0·1 *N* solutions reaches its maximum intensity in about twenty-four hours, whereas with more dilute solutions (0·01 *N*) the maximum occurs after a few minutes. The phenomenon exhibits the characters of a typical colloidal absorption effect. T. CARPANESE: The mineral deposits of Monte Rosso di Verra (Monte Rosa group). As a conclusion to a series of investigations on the minerals occurring in these deposits, the results of a study of the rocks and of the mineralogical paragenesis of the deposits are given. F. RODOLICO: The water in the tremolites of Monte Spinosa in the Campigliese. Debye-Scherrer photograms of Monte Spinosa tremolite, before and after dehydration, are not superposable and show marked differences in both the position and the intensity of the interference lines. The results obtained up to the present indicate that the water in this mineral must be regarded as water of constitution.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, 19, 1–207, Jan. 15, 1933)*. W. E. CASTLE and C. E. KEELER: (1) Blood group inheritance in the rabbit. Only two agglutinogens were found in the blood of rabbits and they are inherited as Mendelian dominants, probably different allelomorphs of the same autosomal gene. (2) Tests for linkage between the blood-group genes and other known genes of the rabbit. No linkage has been found with five of the eight known gene-bearing chromosomes. C. D. DARLINGTON: The behaviour of interchange heterozygotes in *Œnothera*. A. DOROTHY BERGNER, S. SATINA and A. F. BLAKESLEE: Prime types in *Datura*. 'Prime' types are races with modified chromosomes and they are useful for testing. A. F. BLAKESLEE, A. DOROTHY BERGNER and AMOS G. AVERY: Methods of synthesising pure-breeding types with predicted characters in the Jimson weed, *Datura stramonium*. 'Prime' types are used as a source of modified chromosomes. JOHN W. GOWEN and E. H. GAY: Eversporting as a function of the *Y*-chromosome in *Drosophila melanogaster*. PRESTON E. JAMES: The higher crystalline plateau of south-eastern Brazil. ERNST CLOOS: Structure of the "Ellicott City granite", Maryland. LINCOLN DRYDEN: Xenohelix in the Maryland Miocene. The term 'Xenhelix' has been given by Mansfield to large corkscrew-like structures found in the St. Mary's formation of Maryland. Similar structures are also found in the Culvert formation. They appear to be animal borings made by soft-bodied forms, always associated with a definite unconformable surface. ARTHUR E. KENNELLY: Conference of the Symbols, Units and Nomenclature (S.U.N.) Commission of the International Union of Pure and Applied Physics (I.P.U.) at Paris, in July, 1932, and its results. A historical outline of the C.G.S. units and an unofficial summary of the results of the above meeting. JOHN F. SHEPARD: Higher processes in the behaviour of rats. Rats differed considerably in ability to learn a maze. T. H. CHANG, R. W. GERARD and M. SHAFFER: The *in vitro* respiration of nerve. The increased respiration of nerves in serum and delayed rise in oxygen consumption is due to bacteria. ROBERT GESELL and CARL MOYER: Observations on the nervous control of respiratory movements. EUGENE U. STILL: On the metabolism of the pancreas. Oxygen consumption and carbon dioxide contents of venous blood from the gland were measured. RUDOLF RUEDEMANN: Palæozoic planktonic faunas of North America. A planktonic fauna corresponding with that of the present Sargasso Sea is found associated with graptolites in the typical graptolite shales. Its distribution suggests 'Sargasso seas' east and west of North America in the Palæozoic Atlantic and Pacific Oceans and, in consequence, the very early existence of these oceans. HENRY FAIRFIELD OSBORN: Biological inductions from the evolution of the Proboscidea. The fundamental principle of evolution is germinal stability, adaptive biomechanical variation of the germ plasm being merely secular. The term aristogenesis is given to this germinally predetermined evolution always tending toward improvement. Recent palæontological work on proboscidean teeth gives further support to the hypothesis. A. FRANKLIN SHULL: The time of embryonic segregation in aphids as determined from intermediate types. The change from gamic to parthenogenetic individuals is marked by a definite

* Continued from p. 739.

series of changes; the direction of this series should give two complementary series. Three quarters of the intermediate types produced support the 'time of determination' hypothesis. G. H. PARKER: The cellular transmission of neurohumoral substances in melanophore reactions. The denervated area on the tail of a chub shows very slow response to background changes. It is suggested that the cellular transmission this indicates is the primitive mode. WILLIAM BEEBE: Preliminary account of deep sea dives in the bathysphere with especial reference to one of 2,200 feet. The pressure and temperature outside the bathysphere were 993·7 lb. per sq. in. and 53° F.; the total pressure on the bathysphere was 5,120 tons. The eye could not detect any light below 1,700 ft. Fish and other organisms observed, many of them carrying their own illumination, were as active as surface animals and fish up to six feet in length were seen. It would seem that the usual trawling methods allow the larger and more active forms to escape. The dives have taken place off Nonsuch Island, Bermuda. JESSE DOUGLAS and PHILIP FRANKLIN: A step-polygon of a denumerable infinity of sides which bounds no finite area. JESSE DOUGLAS: Crescent-shaped minimal surfaces. G. A. MILLER: Groups generated by two operators of order 3 whose commutator is of order 2. J. L. WALSH: Interpolation and an analogue of the Laurent development.

Forthcoming Events

[*Meetings marked with an asterisk are open to the public.*]

Monday, May 29

UNIVERSITY OF LONDON, at 5.30—(at University College, Gower Street, W.C.1).—Prof. W. K. Gregory: "The Evolution of Man from the Lower Vertebrates" (succeeding lectures on May 30 and June 1).*

INSTITUTE OF EDUCATION, at 5.30.—S. Charléty: "L'Etudiant à Paris à travers les âges".*

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Major R. A. Bagnold (read by W. B. K. Shaw): "The South-West Libyan Desert".

Tuesday, May 30

ROYAL SOCIETY OF ARTS, at 4.30.—Dr. H. E. Hurst (Director-General, Physical Department, Ministry of Public Works, Egypt): "The Sudd Region".

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE, at 5.—Dr. F. C. Shrubsall: "Mental Deficiency" (succeeding lecture on June 1).*

ROYAL AERONAUTICAL SOCIETY, at 6.30—(in the Lecture Hall of the Royal Institution).—Col. F. P. Lahm: "Training of the Airplane Pilot" (Wilbur Wright Memorial Lecture).

Thursday, June 1

UNIVERSITY OF OXFORD.—Prof. H. N. Russell: "The Composition of the Stars" (Halley Lecture).

Friday, June 2

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE, at 2.—R. R. Hyde: "Industrial Welfare".*

INSTITUTION OF MECHANICAL ENGINEERS, May 30–June 2.—Summer Meeting at Edinburgh.

ROYAL INSTITUTE OF PUBLIC HEALTH, May 30–June 4.—Annual Congress at Eastbourne. The Right Hon. Viscount Leverhulme, president.

Official Publications Received

GREAT BRITAIN AND IRELAND

Imperial Bureau of Plant Genetics: Herbage Plants. Bulletin No. 8: Recent Research on Forage Crop Cultivation, Fodder Conservation and Utilisation, at the Animal Breeding Institute of the University, Königsberg. By W. Kirsch. Pp. 14. 1*s*. Bulletin No. 9: Vernalization, or Lyssenko's Method for the Pre-treatment of Seed. By Dr. R. O. Whyte and Dr. P. S. Hudson. Pp. 27+2 plates. 2*s*. 6*d*. (Aberystwyth.)

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1497 (T.3277): The Influence of Wing Density upon Wing Flutter. By A. G. Pugsley. Pp. 17+7 plates. 1*s*. net. No. 1499 (T.3288): Reversal of Aileron Control due to Wing Twist. By Dr. W. J. Duncan and G. A. McMillan. Pp. 22. 1*s*. net. No. 1500 (T.3314): Resistance Derivatives of Flutter Theory, Part 1. By Dr. W. J. Duncan and A. R. Collar. Pp. 14. 9*d*. net. (London: H.M. Stationery Office.)

Leeds University: Department of Pathology and Bacteriology. Annual Report by Prof. Matthew J. Stewart and Prof. J. W. McLeod; with Abstract Report on Experimental Pathology and Cancer Research by Prof. R. D. Passey. Pp. 15. (Leeds.)

Scientific Proceedings of the Royal Dublin Society. Vol. 20 (N.S.), Nos. 29–26: Effect of the Conditions of Storage on the Vitamin D Potency and on other Features of Codliver Oil, by E. J. Sheehy; A Suggested Mode of Radiotherapy when Long-continued Feeble Gamma Radiation may be Desirable, by Dr. J. Joly; On the Colloidal Calcium Phosphate of Milk, by G. T. Pyne and J. J. Ryan; An Investigation of the Behaviour of Neon Discharge Tubes in a Flashing Capacity Circuit by means of a Cathode Ray Oscillograph, by Dr. J. H. J. Poole; Bast-Sap, by Prof. Henry H. Dixon; A Study of *Phoma lingam* (Tode) Desm., and the "Dry Rot" it Causes, particularly in Swede Turnips, by William Hughes; A Classification of the Biological Elements, with a Note on the Biochemistry of Beryllium, by Dr. William Robert Fearon; Experiments on the Suitability of some Rectifier Photo Cells for the Measurement of Daylight, by Dr. H. H. Poole and Dr. W. R. G. Atkins. Pp. 463–546+plates 44–47. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 7*s*.

OTHER COUNTRIES

United States National Museum. Bulletin 100: Contributions to the Biology of the Philippine Archipelago and adjacent Regions—The Land Shells of the Genus Obba from Mindoro Province, Philippine Islands. By Paul Bartsch. Pp. 343–371+plates 87–93. (Washington, D.C.: Government Printing Office.) 10 cents.

University of Denver: Department of Anthropology. Archæological Survey of Eastern Colorado, Third Report, Season 1932. By E. B. Renaud. Pp. 46. (Denver, Colo.)

Field Museum of Natural History. Report Series, Vol. 9, No. 2: Annual Report of the Director to the Board of Trustees for the Year 1932. (Publication 318.) Pp. 289–429+plates 23–31. (Chicago.) 1 dollar.

U.S. Department of the Interior: Office of Education. Pamphlet No. 34: School Administrative Units, with Special Reference to the Country Unit. By Walter S. Deffenbaugh and Timon Covert. Pp. 25. (Washington, D.C.: Government Printing Office.) 5 cents.

Proceedings of the United States National Museum. Vol. 82, Art. 15: Description of Two Parasitic Nematodes from the Texas Peccary. By Benjamin Schwartz and Joseph E. Alicata. (No. 2956.) Pp. 6. (Washington, D.C.: Government Printing Office.)

Journal of Science of the Hiroshima University. Series B, Div. 2 (Botany), Vol. 1, Articles 10–14. Pp. 135–205+plates 17–25. (Tokyo: Maruzen Co., Ltd.) 1.42 yen.

Publikationer fra det Danske Meteorologiske Institut. Aarbøger. Mean Values of Observations from Danish Light-Vessels. Pp. 12. (København: G. E. C. Gad.)

U.S. Department of the Interior: Office of Education. Bulletin 1933, No. 3: A Symposium on the New Homemaking Education. Pp. ix+56. (Washington, D.C.: Government Printing Office.) 10 cents.

Bulletin of Yale University. Supplement: Report of the Director of Peabody Museum for the Academic Year 1931–1932. Pp. 32. (New Haven, Conn.)

Bulletin of the Geological Society of America, Vol. 43. Memorial of James Williams Gidley. By Richard Swann Lull. Pp. 57–68. (New York City.)

Proceedings of the American Academy of Arts and Sciences. Vol. 68, No. 5: Contributions from the Gray Herbarium of Harvard University, No. 102: 1. Studies in the *Bromeliaceæ*, IV, by Lyman B. Smith; 2: The *Bromeliaceæ* of Trinidad and Tobago, by W. E. Broadway and L. B. Smith. Pp. 145–188+2 plates. (Boston, Mass.) 90 cents.

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