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Creative Thought and Social Service

MANY who listened to the national lecture broadcast by Dr. T. R. Glover on December 19 of last year on the challenge of the Greek must have recalled the plea for courage and magnanimity with which Sir Arthur Salter closed his "Recovery", and that rectorial address of General Smuts at St. Andrews on "Freedom", which should be among the enduring monuments of the literature of 1934. The adventure of the new age, the call to creative thought, to the untiring endeavour to give to every man the physical comfort, leisure and free access to all the world's rich heritage which he possesses the capacity to enjoy, demands courage and vision, but demands above all the individuality and freedom which were among the outstanding characteristics of the Greek.

The note of adventure sounded in these addresses repays consideration. To sustain any civilisation at a high level requires more than learning ; it requires a search for new perfections, which is the element of adventure and avoids the tedium of indefinite repetition and repressing mechanisation. Only the adventure of ideas and of practice conforming to these ideas can save a civilisation from decadence, and the first service that ideas can render is that of mental fertilisation—preparing the mind to receive the ideal of other types of perfection which in turn becomes a programme for achievement.

This is the essential characteristic of creative thought—the provision of new ideas, new ideals, new forms of service. It flourishes in an atmosphere of freedom and of adventure. The real problem indeed is not that of producing great men but of producing great societies who will put up the men for the occasion, as Whitehead truly reminds us. It is just because over whole departments of life to-day the tradition of freedom is steadily weakening and individual initiative is being repressed that the world situation is so dangerous. In the new experiments at government which are being tried out, the individual, as General Smuts pointed out, is more and more at a discount. Individual freedom and independence of mind are essential to all real progress. Without them neither science, art nor politics can flourish.

This issue of freedom, the most fundamental of our civilisation, raised once again by the events of the last few years, cannot be evaded. The new forms of government which have sprung up on the Continent, and are urged elsewhere by political

groups, are based on a denial of liberty, not as a temporary expedient but on principle. It is the false assumptions on which these experiments are based, not the fact of experimenting, despite the risks in experimenting by those who have not been trained in the technique of experience, that is our danger; and the warning given by General Smuts last autumn is as impressive as it is eloquent. Without freedom, "peace, contentment and happiness, even manhood itself, are not possible. 'Happiness is Freedom, and Freedom is Courage.' That is the fundamental equation of all politics and all human government and any system which ignores it is based on sand. . . . The vision of freedom, of the liberation of the human spirit from its primeval bondage, is perhaps the greatest light which has yet dawned on our human horizon. It forms the real spur of progress, the lure of our race in its ceaseless striving towards the future. . . . Freedom should be a creative force inspiring our young men and women to noble action."

The experiments to which General Smuts refers are in some respects reactions from abuses or failures on the part of democratic or supposedly democratic institutions. They are also attempts to save the State from the untoward consequences of such abuse or failure, but in doing so they offer merely a temporary security while jeopardising our fundamental human ideals and our finest heritage from the past. Here, as so often, the deliberate search for security leads to an anæsthesia which conceals the paralysis and decay proceeding beneath the surface, all the more readily when uniformity of speech and conduct steadily limit and standardise thought.

Many dangers attend this standardisation and mechanisation of life, but few are more serious than the opportunity they afford for shallow and specious doctrines to be imposed upon masses of mankind by a few groups the interests of which are served by their propagation. The scientific worker at least should be alive to the danger which threatens him. The limitation of scientific inquiry has been experienced in the past under the domination of theology. The bondage of political theories and expediencies will prove no less deadly to scientific advance than the earlier fetters which science has long since shed, and for his own sake the scientific worker must not tamely watch their imposition. As General Smuts said in his address on February 9, read before the newly founded South African Institute of International Affairs (*The Times*,

Feb. 11), "in these grave developments we see not new life for the world but rather decay, not an enrichment of the European tradition but an impoverishment, a negation of the finest and noblest insights of human spirit, and a falling back rather than an advance in the great cause of civilisation".

The man of science, however, does not stand alone. In these last few years, he has been rapidly learning to view his work in relation to society, to see it not as an isolate but as an integrated part of the functioning of society. He has seen before him whole fields of society in which his method and habit of impartial investigation might be fruitfully applied, and indeed must be applied if society is to be secure under the conditions created by the growing application of scientific discoveries in the mechanical world. These fields of work and these possibilities will disappear if the freedom of the individual continues to be restrained. The direction or rather exploitation of scientific work in the interests of a single class or of existing political theories contains the seeds of its own disaster and downfall.

Nor is this all. If humanity is to reap the full results of scientific investigations, if the knowledge thus acquired is to be turned to account in the service of mankind, above all in the wide fields of sociology and politics, science has to join hands with art. Civilisation requires beauty as well as truth, as well as adventure. Even more than science, if possible, art demands the free expression of individuality. Science, it is true, rests largely on creative thought and individual enterprise, and under modern conditions is evolving a technique of team work which ensures their full play in the concentrated attack on a definite objective.

Progress even here is thus founded upon the experience, the integration of discords, and the social value of liberty lies largely in its production of discords and stimulation of thought. Without such freedom and discord, art becomes impossible. Art is essentially, as Whitehead has said, a finite fragment of human effort achieving its own perfection within its own limits. It heightens the sense of humanity and evolves into consciousness the finite perfections which lie ready for human achievement. In its broadest sense, art is civilisation—the unremitting aim at the major perfections of harmony, the purposeful adaptation of appearance to reality. Its secret lies in its freedom.

To surrender freedom is to dry up the fountain springs of creative thought in science and art alike, and to render impossible that alliance of science and art which is probably our supreme need if the results of scientific knowledge over the widest fields not merely of the physical but also of the biological and sociological sciences are to be applied

wisely and impartially, and integrated into the structure of society. Well may General Smuts's words ring in our ears an insistent call to join issue at once with all those forces which menace so fair a prospect of advance, and jeopardise the noblest traditions and heritage which have come to mankind from the great civilisations of the past.

Reviews

The Anthropology of the Near East

An Introduction to the Anthropology of the Near East in Ancient and Recent Times. By C. U. Ariëns Kappers. With a Chapter on Near Eastern Bloodgroups, by Leland W. Parr. Pp. vii+200+3 plates. (Amsterdam: N. V. Noord-Hollandsche Uitgeversmaatschappij, 1934.)

IN 1929 Dr. Ariëns Kappers, director of the Central Institute for Brain Research in Amsterdam, landed in Syria as a visiting professor in the American University of Beirut. There he remained for a year lecturing on "Histology and Neural Anatomy"—for it is as a neurologist that he has made his world-wide reputation. At Beirut he was tempted into a new field of inquiry—that of anthropology. Amongst his students he found representatives of that welter of races which has made the Near East the despair of the modern anthropologist. Near at hand were the peoples of Syria—the Lebanese, the Druses, the Alouites along the coast to the north, the inhabitants of Damascus and of other Syrian cities on the border of the desert and the bedouin Syrians. He had communities of Armenians, Jews and Arabs open to him for observation. Near at hand was Palestine with its puzzling mixture of human types—old and new. He took the field, callipers in hand, and succeeded in measuring 2,500 individuals, representing the more outstanding racial types. To his own measurements he added those made by others. To obtain explanations of the data he collected in Syria, he found it necessary to extend his inquiries until they carried him far beyond the Caspian on one hand and the Persian Gulf on the other. The results of his inquiries appeared as a series of papers in the *Proceedings of the Royal Academy of Science of Amsterdam*. These researches have now been systematised and form the basis of the present work—"An Introduction to the Anthropology of the Near East". A very valuable chapter has been added by Dr. L. W. Parr, of George Washington University, Washington, D.C., in which is summarised the results of an investigation of the blood-reactions of Near Eastern race groups.

Before attempting to indicate the conclusions

reached by Dr. Kappers as to the number of races he has identified in the south-western part of Asia, and the relationships in which these races stand to each other, in an evolutionary sense, it is necessary to touch on the methods he has employed for the discrimination of one race from another. His method has the recommendation of simplicity. He takes two measurements of the head—its length and its width—and relies on the proportion which the width bears to the length to give him an indication of race. He insists, however, and all anthropologists will agree with him on this, that when a group of measurements has been made the result must not be expressed in a single figure as a mean or average but must be tabulated so that the individual measurements are expressed in the form of a 'frequency curve'.

Dr. Kappers regards the form of this curve as being indicative of race. Just because the Turk, the Armenian, the Lebanese, the Druses, the Assyrians, the Uzbeks, the Kirghiz of Turkestan, and the round-barrow people of England have frequency curves which fall on the same range of the cephalic scale, they must be regarded as members of the same race—to which Dr. Kappers proposes to give the name of "Central Asiatic". It would be difficult to find two peoples more sharply differentiated from each other than are the Armenians of Anatolia and the Kirghiz of Turkestan. If we are guided by external appearances we shall assign the Kirghiz to the Mongolian stock and the Armenians to the Caucasian stock.

Dr. Kappers holds that the cephalic index—the relative width of the head—is a more reliable guide to race than are outward appearances. After a lifetime spent in the study of cranial characters and racial traits, I have come to an opposite conclusion—namely, that external traits are better guides to race and to degrees of racial affinity than are the relative diameters of the skull. For example, if we are to judge the race of Charles Darwin according to his head form, then we must assign him to Dr. Kappers' "Central Asiatic Race", but if we judge him according to standards accepted by his fellow countrymen we must regard him as a Caucasian of the English breed.

I am certain the majority of anthropologists

will agree with me that relative head diameters have not the racial values which Dr. Kappers has assigned to them. I know, too, they will agree with me when I say that Dr. Kappers has done anthropology an important service by the compilation and publication of his head charts—92 in number. Indeed, his book will serve better, perhaps, as an 'introduction' to the study of the cephalic index than to a knowledge of the peoples of the Near East. He has also done a service by again directing attention to 'apices' or 'peaks' which appear with a certain degree of regularity in distributional curves of cephalic indices. When Dr. Kappers had plotted out the cephalic index (relative head width) of 136 Armenians measured by him in Syria, he found his frequency or distributional curve rose into two strongly marked peaks, showing a preponderance of individuals at 83 and at 86. He was surprised to discover that these two peaks appeared in series of measurements made on Armenians living in lands outside Syria. These peaks or apices were so constant that he felt confident they must have a significance. But what significance? Dr. Kappers seeks to explain them by supposing that the Armenians represent a fusion of two races—one in which the mean index was at 83, the other at 86.

There is no reason to suppose that such a fusion has occurred, and apparently Dr. Kappers is not entirely satisfied with this explanation, for he throws out the suggestion that evolution may work on the diameters of the head, not by running up or down a graded scale of diameters but by making jumps or mutations—just as we change gear in motor-cars by a series of big changes. For example, Dr. Kappers observed when the 86 peak rose to a higher level on his curve than did the 83 peak, then a third peak usually appeared towards the end of the frequency curve. This third peak was situated at 89 or 90 on the scale of cephalic indices. Likewise in the frequency curves representing the cephalic indices of narrow-headed peoples. If the 72 apex rose above that at 76, then an additional peak or apex usually appeared at 67, towards the lower end of the scale.

Dr. Kappers also accepts gross irregularity of a frequency curve as evidence that the people, represented by such a curve, is of mixed origin. For this reason he looks on the Samaritans of Nablus, who regard themselves as pure descendants of the pre-exilic Israelites, as a people of mixed race. Dr. Parr's investigation of the blood groups of the Samaritans was also unexpected in its results. The Samaritans showed no affinity to Hebrews or to any neighbouring Eastern people. Dr. Parr explains the peculiar blood-reactions of the Samaritans as a result of prolonged inbreeding.

But if inbreeding gives irregularity in blood groups, it ought to give uniformity in cephalic indices. Or is it the case that biometricians are wrong in supposing that a high degree of variation in form and structure is indicative of racial mixture? May it not be that degree of variability may be a characteristic of a race that although genetically pure is tending to evolve into new forms? The study of human races, as is evident from such instances, has not reached the status of a science.

Particularly interesting are Dr. Kappers' observations on the Jews. Among the northern Jews—the Aschkenasim—he found a considerable degree of round-headedness, whereas among the southern Jews—the Sephardim—long-headedness is the rule. The prevalence of round-headedness amongst the Aschkenasim is attributed by Dr. Kappers to an early prevalence of this form of head in Mesopotamia, from which country he derives the ancestry of the Hebrews. Also he believes that the Aschkenasim, as they had to cross Anatolia on their way to Europe, may have become further contaminated by some of the round-headed peoples of Asia Minor. The Sephardim, on the other hand, he supposes to be chiefly derived from the Phœnicians or Canaanitic inhabitants of Palestine, who were long-headed and presumably were darker skinned than the people of the Exodus. Because of the high degree of variability in head breadth and also in their blood affinities, Dr. Kappers has inferred that the Jews are to be regarded as a religious sect rather than as a race. Here again we meet a problem which is still a matter of debate amongst anthropologists—What is a race in the modern world of humanity?

I would conclude this brief review by quoting the modest paragraph with which Dr. Kappers ends his text:

"My only object is to give an introduction to the anthropology of one of the most interesting fields of ancient and modern history in a simple way, so that the reader who, like the author, is not mathematically trained, may get a general impression that, I hope, is not too far away from the truth."

ARTHUR KEITH.

South African Mammals

The Mammals of South West Africa: a Biological Account of the Forms occurring in that Region. By Capt. G. C. Shortridge. Vol. 1. Pp. xxv + 437 + 23 plates. Vol. 2. Pp. ix + 439 - 779 + 27 plates. (London: William Heinemann, Ltd., 1934.) 42s. net.

SOUTH WEST AFRICA—previous to the War German South-West Africa—is the dry and rather desolate land lying between the Cunene and the Orange Rivers on the north and south,

the Atlantic on the west and the Kalahari Desert and Bechuanaland on the east.

The coastal region, known as the Namib Desert, is practically rainless and is without vegetation except along some of the dry river beds, where there is sometimes a growth of a species of wild melon, the nama, *Acanthosicyos horrida*, and occasional examples of the very remarkable *Welwitschia mirabilis*. Inland from this, the land rises a few thousand feet, and the country is better watered and supports a small white population and a considerable coloured one. In this vast and desolate territory a great number of the larger game animals, formerly so abundant in the old Cape Colony and the Free State, still survive, some of them in large numbers, and it is this that gives so much interest to the present work.

Capt. Shortridge, who has been for many years the director of the Kaffrarian Museum at King William's Town, has made six collecting expeditions, extending over a period of ten years, to this happy hunting ground on behalf of his own Museum and the British Museum (Natural History). He has therefore had ample opportunity for acquainting himself with the ranges and habits of the mammalian fauna of South West Africa.

After a short introduction on the physiography of the country, he proceeds to enumerate the mammals, commencing with the monkeys and concluding with the pangolins. The nomenclature is very carefully worked out and all the numerous subspecific races are detailed, but there are no descriptions or keys, so that the work affords little help to the traveller or resident in identifying his captures. The author gives us, however, a great deal of other information as regards the native names, the distribution in South West Africa and outside, and full accounts of the habits both as observed by himself and as gathered from all previous sources available. In this matter he has perhaps been too meticulous. It would have saved a good deal of space if he had condensed the remarks of other authors into a general statement, for much of the quoted matter is mere iteration of the same facts, and a carefully condensed narrative embodying the information available would have been more satisfactory to the reader.

Among the larger mammals still surviving in considerable numbers are the Cape hartebeest, the blue wildebeest, the gemsbok, kudu and eland, but the rhinoceros is now nearly exterminated and the elephants, which were so numerous in the early days of the Swedish hunter, C. J. Andersson, and his successor, Eriksson, are reduced to a few hundred head in the Kaokoveld and Caprivi region in the north of the territory.

The volumes are illustrated with a number of

photographs. The most remarkable of these were taken by Mr. J. Koester from the air. They show herds of zebra and antelope galloping across the plains and give a most vivid idea of their numbers. There is also a series of maps showing the distribution of the more important species, and a larger general reference map. The two volumes, which are published by the assistance of a grant made by the Research Grant Board of the Union of South Africa from funds provided by the Carnegie Corporation of New York, are a worthy example of book-making art and are prefaced by a short foreword by Field-Marshal Viscount Allenby.

An appendix of more than a hundred pages contains a detailed series of measurements of the various mammals collected by Capt. Shortridge during his several journeys in South West Africa. These would have found a more suitable place in the technical papers in which the results of the expeditions were worked out, such as the *Proceedings of the Zoological Society*, where several memoirs have appeared. If this space had been devoted to descriptions and keys by which the various genera and species could have been identified, the volumes would have been undoubtedly of greater use both to the systematic zoologist and also to residents and visitors to South West Africa.

The two volumes, however, do contain a great deal of information about the mammals of South Africa, and will doubtless be welcomed by many sportsmen and naturalists who visit that country.

The Algæ

The Structure and Reproduction of the Algæ.
Vol. 1: *Introduction, Chlorophyceae, Xanthophyceae, Chrysophyceae, Bacillariophyceae, Cryptophyceae, Dinophyceae, Chloromonadineae, Euglenineae, Colourless Flagellata.* By Prof. F. E. Fritsch. Pp. xvii+792. (Cambridge: At the University Press, 1935.) 30s. net.

ALTHOUGH work on the algæ has been very extensive during the last twenty years, there has been, during that period, a noticeable lack of accessible summaries of recent information. This work should remedy the omission. It is a comprehensive treatment of the morphology of the algæ and it gives impressive testimony both to the extent and variety of the recent work and also to the thoroughness and judgment of its author.

The present volume deals with all groups except the red, brown and blue green algæ, which are to be treated in a succeeding volume. The general method of treatment adopted brings out very well the parallel development of similar and increasingly complex vegetative and reproductive structures in the different groups. The details now available

for the Xanthophyceæ (Heterokontæ) and, to a less extent, for the Chrysophyceæ and Dinophyceæ permit a further development of this view. At the same time, more flagellate types have proved to show obvious relationships with these diverse lines of development and, as a result, the Flagellata (in the old sense of the term) have almost disappeared as an independent group. Most of the forms now fall naturally into the different algal groups.

Further, the great extension of cytological work now permits a general view of cytological problems in the algæ; while, in the light of this work, the problems relating to alternation of generations can be adequately reviewed in the forms of more lowly organisation. Although Prof. Fritsch disclaims any attempt to deal fully with the physiology and ecology of the algæ, it will be found that the sections dealing with these topics, though brief, are both full and suggestive. Moreover, because the different main groups of algæ produce parallel growth forms and very similar structures, the distinctions between these main groups are primarily and largely physiological. The nature

of the pigments present, the chemical structure of the wall and of the food reserves thus become of fundamental importance and are necessarily treated in detail. At the same time, this peculiar feature of the algæ makes it very difficult to relate fossil forms with any certainty to any of the groups now living, and Prof. Fritsch rightly stresses the need for caution in dealing with interpretations which have been advanced.

This critical and well-balanced attitude is, indeed, one of the outstanding features of the book. A second feature which will strike the reader is its thoroughness. Perhaps this will be only fully apparent to those who have some claim to specialised knowledge of the algæ. To these, the exhaustive lists of references will be a joy, and, it may be said, probably a revelation. Although the book will certainly prove extremely valuable and will be generally welcomed as a textbook of the best type, it is much more than this. One may venture to predict that as a statement of principles and as a source of information, it must long remain the standard work on the subject.

W. H. P.

Short Notices

(1) *Handbuch der Experimentalphysik*. Herausgegeben von W. Wien und F. Harms. Unter Mitarbeit von H. Lenz. Band 17, Teil 2: *Technische Akustik*, Teil 1. Pp. xv+538. 44 gold marks. Band 17, Teil 3: *Technische Akustik*, Teil 2. Herausgegeben von E. Waetzmann. Pp. xi+434. 36 gold marks. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1933, 1934.)

(2) *The Voice: its Production and Reproduction; a Treatise on Voice Training, Production and Reproduction*. By Douglas Stanley and J. P. Maxfield. Pp. xii+287. (New York: Pitman Publishing Corporation; London: Sir Isaac Pitman and Sons, Ltd., 1933.) 10s. 6d. net.

(3) *Acoustique*. Par Prof. Adrien Foch. (Collection Armand Colin: Section de physique, No. 166.) Pp. 210. (Paris: Armand Colin, 1934.) 10.50 francs.

(1) THE first two volumes under notice, written by nearly twenty experts and forming a comprehensive survey of present-day knowledge of all applications of acoustics, show how acoustics has become largely a branch of electricity. In most experimental acoustical researches now, the pressure fluctuations of the sounds are first converted into electrical fluctuations by such devices as the microphone and the indispensable thermionic valve, and are then studied as purely electrical fluctuations. The general methods used are described in a 150-page section on methods of measurement which follows a theoretical section on the basic ideas used in technical acoustics. Greater detail is to be found in the sections on the micro-

phone, telephone and loud speaker. The propagation of sound in free space covers such applications as echo-sounding. Propagation over longer distances is treated in the sections on broadcasting and long-distance telephony. Speech and hearing are treated in a section on medical acoustics. Musical instruments, broadcasting, sound recording and reproduction magnetically, by gramophone records and sound films, noise prevention and shock absorption all receive detailed treatment.

(2) The second work, dealing with voice, is a more advanced treatment than the earlier volume published as "The Science of Voice" (1929). For the new work the co-operation of J. P. Maxfield, known in Great Britain as joint author of the first serious treatment of gramophone acoustics, secures the accuracy of the physical treatment. Maxfield's brief, but very clear, outline of methods used in sound measurement is well illustrated, and is followed by Stanley's treatment of voice-production, covering all aspects of vocal technique. The whole book is a serious contribution to a subject still full of unsolved problems. An excellent index is provided.

(3) Prof. Foch's little volume, which forms one of the Collection Armand Colin, the aim of which is "Vulgariser sans abaisser", is an excellent well-balanced treatment of general acoustics. There is no English book of similar size and price which covers so wide a range and is so up-to-date, and the volume would be suitable for all university students of physics. Some of the mathematics is of an honours degree standard. To have covered so wide a range without being superficial is a remarkable achievement.

- (1) *Introduction à la théorie des groupes et à ses applications à la physique quantique.* Par Prof. Edmond Bauer. Pp. ii+170. (Paris: Les Presses universitaires de France, 1933.) 40 francs.
- (2) *Microénergétique.* Par Dr. Pierre Bricout. Tome 1: *Introduction.* Pp. vii+303. Tome 2: *Les théories et les faits.* Pp. iv+429. (Paris: Gauthier-Villars et Cie, 1933.) 100 francs each.
- (3) *Statistische Mechanik auf quantentheoretischer Grundlage.* Von Prof. Dr. Pascual Jordan. (Die Wissenschaft, herausgegeben von Prof. Dr. Wilhelm Westphal, Band 87.) Pp. xi+112. (Braunschweig: Friedr. Vieweg und Sohn A.-G., 1933.) 6.80 gold marks.

THE three books under review are complementary to one another in so far as they cover the whole range of quantum mechanics between them.

(1) M. Bauer's volume deals with group theory and its applications to quantum mechanics according to the methods of J. v. Neumann, H. Weyl and E. Wigner. The arrangement of the material is on much the same lines as in Weyl's well-known book, but the treatment is easier to follow and probably more suitable for students, the arguments being set out with the clarity so frequent in French books.

(2) Dr. Bricout proposes to give a complete summary, adapted to the needs of students, of the researches, both experimental and theoretical, which are the basis of the quantum theory, but group theory and its applications are excluded. When we consider the difficulty of collecting together in a volume of 300 pages all the mathematics and physics required by a student as a preparation for the study of modern quantum theory, we cannot help admiring the skill with which the author has carried out his difficult task. The second volume of Dr. Bricout's book is devoted partly to a detailed study of the principles and methods of the various forms of the modern quantum theory and a critical comparison of them, partly to a full account of the various hypotheses put forward and the experimental facts to be explained by them.

(3) The small book by Dr. P. Jordan is on a different plane, its object being to provide a purely quantum basis for statistical mechanics. The book constitutes an original and valuable contribution to the literature of quantum statistics; no one interested in this branch of quantum theory can afford to ignore it.

Moderne Physik: Sieben Vorträge über Materie und Strahlung. Von Prof. Dr. Max Born. Ausgearbeitet von Dr. Fritz Sauter. Pp. vii+272. (Berlin: Julius Springer, 1933.) 19.50 gold marks.

PROF. BORN has made a very successful attempt to give a clear statement of the outstanding advances in modern physics in a form which should be intelligible even to those of modest mathematical attainments. The book contains the substance of seven lectures given to various associations of electrical engineers in Berlin. The essential foundations for the later chapters are set out in chapters i and ii, which give brief but sufficient accounts of the kinetic theory

of gases, discharge of electricity through gases and radioactivity (including isotopes). The historical order is disregarded in the next two chapters in that the idea of wave-particles is introduced before the Bohr atom is discussed. The last three lectures deal with electron spin and Pauli's principle, quantum statistics and electron theory of metals, molecular structure and chemical bonds. These subjects are treated with admirable clearness. The illustrations and tables are particularly useful, and the book is well produced. It closes with some remarks on the problems that at present confront the physicist, problems the solutions of which depend largely on successful investigations of nuclear phenomena.

H. L. B.

A Key to the Stars. By R. van der Riet Woolley. Pp. viii+143+8 plates. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1934.) 5s. net.

THIS elementary sketch of the more fundamental aspects of astronomy is specially designed by the author to describe "certain knowledge" or "demonstrable results . . . which partake of the character of laws of Nature". The latest developments of astronomy in which "speculation is still rife" are deliberately excluded, though there are occasional lapses when controversial points are discussed. On the whole, the author has succeeded in his object of giving the lay reader a clear outline of the methods used in astronomical research and of the more definitely ascertained facts which have been disclosed. He has been more particularly successful in describing some of the fundamental conceptions on which modern astrophysics is based, in two chapters on the temperatures and composition of the stars. There might, however, have been more extensive treatment of several points without violating the expressed rule against introducing speculative matter—especially as he devotes a certain amount of attention to such subjects as stellar evolution and the rotation and expansion of the universe.

Dreams in Old Norse Literature and their Affinities in Folklore. With an Appendix containing the Icelandic Texts and Translations by Dr. Georgia Dunham Kelchner. Pp. viii+154. (Cambridge: At the University Press, 1935.) 10s. 6d. net.

THE material with which the author here deals is in its special field unique. Not only do the dreams which she has extracted from Old Norse literature constitute the only record of its kind from among the old Teutonic peoples; but also they belong to both pagan and Christian times. It is thus possible to mark the change in thought implicated by the transition from one system to another. In this respect this material is probably a safer guide than the folk-lore with which the author has instituted a comparison. The sources from which the material is drawn are the Elder and Younger Eddas, the prose Saga and Skaldic poetry. The original Icelandic text, with translation, of a selection of the dreams is given in an appendix, and introductory chapters add a background in a brief account of early Icelandic history and culture.

Electron Diffraction as a Method of Research*

By PROF. G. P. THOMSON, F.R.S.

IN 1924, Prince Louis de Broglie put forward the thesis that all material particles, and in particular electrons, have properties analogous to those of a train of waves. This view, which is now universally accepted, is the foundation of 'wave mechanics', the modern theory of interatomic effects. It predicts that electrons should show diffraction effects with crystals similar to those given by X-rays. For the present purpose, it is a sufficient statement of the theory to say that a beam of electrons uniform in energy is regarded as replaced by a train of waves the wave-length λ of which is given by $\lambda = (h / mv)$ (Planck's constant h / (the momentum of an electron)). As this wave train passes through matter, each atom of the matter is the source of a scattered wavelet the amplitude of which is (very roughly) proportional to the atomic number of the atom. These wavelets will interfere with one another and with the original wave exactly as the corresponding wavelets in optics, and form an interference pattern, varying in intensity from point to point, in the space behind the scattering matter. De Broglie asserted that if any detector of electrons, for example, a fluorescent screen or photographic plate, be placed in this space, the distribution of electrons recorded by it reproduces exactly the interference pattern, the electrons recording themselves in large numbers where the intensity of the waves in the pattern is large, and only sparsely where it is weak.

Calculation shows that $\lambda = 10^{-8}$ cm. for electrons of 150 volts energy; it diminishes as the energy increases, being about 0.7×10^{-9} cm. for 30,000 volts, which is the order of energy used in most of the work to be described. The wave-length is thus of the order of that of X-rays, but the scattering per atom is about 10^7 times as strong, corresponding to the far greater stopping and scattering power of matter for electrons than for X-rays.

The first test of de Broglie's hypothesis was made by Davisson and Germer¹ using slow electrons (~ 100 volts); although they found an agreement with theory which was rightly taken as establishing the truth of the hypothesis, there were outstanding differences from the simple theory which later experiments have rather increased than diminished. Some of these are probably due to difficulties of technique and the extreme sensitivity of slow electrons to surface impurities, others to neglect of second order effects in the theory, but until there is better agreement with theory the experi-

ments cannot be used with safety to investigate unknown structures.

Work with cathode rays ($\sim 30,000$ volts energy) is free from this objection. Experiments² with thin films of metals ($\sim 10^{-6}$ cm.) showed an excellent agreement in all particulars with the theory, making use of the known crystalline structure of the metals as previously found by X-rays. Once this is established, the electron waves become a new tool to investigate the structure of matter. All that is necessary is that they should pass through the specimen to be studied without losing energy by inelastic collision, for this would alter the wave-length and destroy all phase connexion with the original wave.* The new tool closely resembles X-ray diffraction but the two are in some respects complementary in their usefulness, for while the X-rays are deep penetrating and average over a considerable volume of matter, the electrons only penetrate a shallow layer and can detect surface peculiarities which would be swamped by the excess of internal matter if X-rays were used.

A further advantage of the greater scattering is that exposure times are less. Electron diffraction patterns require seconds or less, while the corresponding times for X-rays run into hours. This is important for the investigation of gases, and promises to have considerable importance in chemistry. The diffraction pattern obtained from a gas, either with electrons or X-rays, consists of diffuse rings. It is due to interference between wavelets scattered from atoms *in the same molecule*, and the position and intensity of the rings depend mainly on the various distances between the atoms. Consequently it is possible to test stereochemical theories by comparing patterns calculated from them with those actually found. Important work has been done on these lines by Wierl³, Brockway and Pauling⁴, de Laszlo⁵ and others.

Debye has used X-rays in a similar way, the theory being practically identical. As compared with the crystal method of investigating the shapes of organic molecules, there is the advantage that the molecule is studied free from its neighbours' influence, and also that the effects of molecular shape are not mixed up with those of the crystal lattice. As an example of the method, Wierl³ was able to show that the benzene ring forms a plane hexagon, while cyclohexane is wrinkled. Again, Hendricks and others⁶ showed that in 1,2-diodobenzene the I-C valency

* Substance of a course of four lectures given at the Royal Institution on January 15, 22, 29 and February 5.

* Even so, it may be possible for interference effects to occur, but only between wavelets elastically scattered *after* the inelastic collision and originating from the same electron.

directions are bent out 10° from the symmetrical positions, thus leaving room for the normal I—I distance of 4.00 Å., an example of 'steric hindrance'. Considerable progress has been made with determining inter-atomic distances. The table shows some of the latest results.

TABLE A.

Link	Aliphatic $\begin{array}{c} \\ -C-X \\ \end{array}$	Ethylenic $=C \begin{array}{l} \nearrow X \\ \searrow X \end{array}$	Aromatic $\begin{array}{c} \diagup \\ C-X \\ \diagdown \end{array}$	Acetylenic $\equiv C-X$
C to C	1.50×10^{-8} cm.	1.30×10^{-8} cm.	1.41×10^{-8} cm.	1.18×10^{-8} cm.
C to Cl	1.76	1.74	1.69	—
C to Br	1.93	1.91	1.88	1.84
C to I	2.12	2.10	2.05	2.03

For solids which can be obtained as thin films, a very simple apparatus is sufficient. All that is needed is a beam of cathode rays limited by fine holes, a holder for the film and a photographic plate which can be lowered into place without disturbing the vacuum. Fig. 1 shows a typical diffraction pattern formed in this way. But the range of usefulness of the method is greatly increased if we can investigate surface layers on massive solids. To do so requires a more elaborate apparatus, as it is necessary to adjust the surface to the beam by moving it in the vacuum. The adjustment has to be fairly precise, for the angles of diffraction are only of the order of 1° – 5° . Suitable specimens are about 1 cm. square and are carefully flatted before use. A metal specimen, if then etched, will give sharp semi-circular rings (the other half or rather more lies in the shadow of the specimen) similar to those given by a thin metallic film and characteristic of the crystal structure of the metal.

The rings are due to electrons passing through minute crystalline projections on the surface. If the surface is then oxidised, the pattern changes to rings characteristic of the oxide. In this way, for example, Cates⁷ has shown that the surface layer of rust is γFeOOH even when the rust is black, though the bulk of the material in this case is probably Fe_2O_3 . Copper⁸ shows sometimes ordinary Cu_2O and sometimes another, unidentified oxide, not CuO in its usual crystalline form but perhaps an unstable modification. Silver mirrors are known to be improved by holding for a short time in the fumes of aqua regia; Dixit⁹ has shown that they then become covered with a layer of Ag_2O . Many other compounds have been observed as a result of chemical reactions. In some cases they cannot be identified, for the evidence given by a ring pattern is like that given by an optical spectrum in that one cannot deduce the nature of the substance from the pattern or the spectrum, except by comparison with that of a known substance. If the presence of some

compound is suspected, it can be tested for by comparing the pattern given by the specimen with that given by the compound, which can often be found by powdering some of the compound on to a very thin film of celluloid or similar substance transparent to electrons, which is then examined by transmission.

It is a rarity to find a clean surface which does not give some sort of pattern, but to get good results the surface must be carefully prepared. The chief difficulty is to reduce the 'background' due to electrons inelastically scattered. Electrons will not penetrate more than a small multiple of 10^{-8} cm. without an inelastic collision, but they will go hundreds of times as far before they get so slow that they fail to affect a photographic plate. A good specimen is one which has relatively few lumps of thickness within this range.

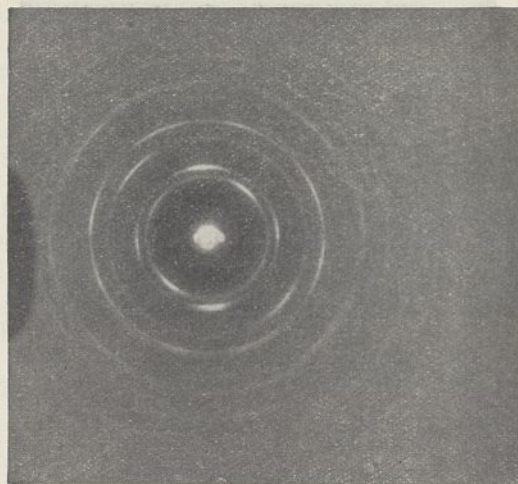


FIG. 1. Diffraction pattern of gold foil (85 kilovolts).

Just as in the case of X-rays, the sharpness of the rings is a valuable indication of the size of the minute crystals causing them. Small crystals give diffuse rings, being equivalent to diffraction gratings of poor resolving power. In practice the diffuseness becomes marked if the crystal size is less than about 10^{-6} cm. Owing to the small angles involved in electron diffraction, there is a marked difference in the effectiveness of the rows of atoms along and perpendicular to the beam, which is important in dealing with patterns such as those given by the cleavage faces of ionic crystals and indeed by single crystals generally. Unless the thickness in the direction of the beam is greater than about 10^{-5} cm. the atoms along the beam will not interfere completely, and the pattern will resemble that given by a 'crossed grating' corresponding to the array of atoms in the plane normal to the beam, rather than that given by a

three-dimensional crystal (Fig. 2). Since 10^{-5} is greater than the effective penetration of the electrons, the patterns given by rough (etched) crystals are all found to be of the 'crossed grating' type. On the other hand, smooth cleavage surfaces can give the X-ray type of pattern since the whole surface is bathed in each electronic wave, and interference can occur between atoms on the surface any



FIG. 2. Diffraction pattern due to etched single crystal of copper.

distance apart provided only that the crystal structure is perfect. This last restriction is interesting because it enables one to deduce the degree of regularity of the surface from the sharpness of the diffraction pattern. In some cases, for example, diamond, the structure can be shown to be regular over a distance greater than 2×10^{-5} cm.; in others, for example, rocksalt, the region of regularity is less and depends greatly on the care with which the surface is prepared. There is no evidence of any inherent 'coarse structure' in crystal surfaces.

Another valuable test of crystal accuracy is afforded by the Kikuchi lines; these are pairs of parallel black and white lines which often appear on the photographs when single crystals are used as specimens. Kikuchi¹⁰ showed that they are caused by repeated scattering of the electrons, and that each pair lies symmetrically on either side of the line in which some plane of the crystal intersects the plane of the photographic plate. It follows that if different parts of the crystal are inclined to one another, they will give different lines, and if there is any continuous range over which the crystal directions vary, the lines will be smudged. Actually they are often surprisingly sharp, and in such cases one can say that the orientation of the crystal is perfect to 10' or better. The lines are often poor or absent from metallic crystals, as one might expect,

since the softness of these single crystals favours distortion.

An interesting modification of the theory becomes necessary when dealing with diffraction by very flat surfaces. The wave-length of the electrons depends on their momentum, and changes when they enter a region at a different potential. It follows from Huygen's construction that there is a refraction of the waves at entering and leaving the surface, and a consequent shift in the position of diffracted spots. For cathode rays the refractive index of most substances only differs from unity by about 1 in 5,000 but, owing to the small glancing angles used, the effect is quite appreciable provided the surface is flat. It is negligible if the electrons pass through roughnesses or if the glancing angle is more than about 5° . The values found for the inner potentials of ionic crystals are of the order of 12 volts (see table B); this is in general agreement with the mean potential which would result from the distribution of electrons in the crystals, but no accurate calculations have so far been made. It is difficult to get flat enough surfaces on metals, but Darbyshire¹¹ has been able to show that the inner potential of zinc is 15.5 volts and of antimony about 12 volts, values which agree roughly with what is to be expected on Sommerfeld's theory of electrons in metals.

Electron diffraction seems likely to yield important information as to the process of crystallisation and the mechanism of crystal growth. For example, it is found that films of metals deposited either by cathodic spluttering or by evaporation are in the form of small crystals

TABLE B. INNER POTENTIALS OF IONIC CRYSTALS.

Substance	Density	Yamaguti	Shinohara	Dixit	Tillman	Mean
Rocksalt	2.1	7.7	6.3		7.9 ¹ 6.0 ²	7.0
Zincblende	4.1	12.7			12.6 12.1	12.5
Galena	7.5			12.5	14.1 13.1	13.2
Pyrites	5.0			5.1	3.8	4.4
Stibnite	4.6	11.9			14.7	13.3
Fluorspar	3.1		(Raether 15)		11.9 13.3	12.6
Calcite	2.6	12.4	13.8		12.9 12.5	12.9
Gypsum	2.3	9.1			7.9 8.5	8.5
Mica	2.9	10.6	10.4			10.5
Molybdenite	4.7	16.5;				16.8
		17.1				
Graphite	2.3	11.5	(Jenkins 10.7)			11.1
Talc	2.6	12.0				12.0

Long-chain hydrocarbons (Murrison) 1.3; various organic mixtures, 3.1-7.2. PbO, 12.3; ZnO, 12.3; SnO, 14.2 (Jenkins). Fe₂O₃, 12.6 (Dixit).

¹ Measurements with electrons of average energy 30,000 volts. ² Measurements with electrons of 3,000-5,000 volts.

disposed at random on the substrate. Heating to quite a moderate temperature, far below the melting point, results in the films recrystallising in such a way that some simple crystal face is more or less parallel to the surface of the substrate¹². In some cases the orientation is almost perfect, in others not so marked. The face chosen seems to depend mostly on the temperature² and not on

the nature of the substrate unless this is closely related in crystalline structure to the film. Thin films of oxide lifted off the surface of molten metal often show strong orientation; usually a tetragonal or hexagonal axis, as the case may be, is normal to the plane of the film¹³. Trillat¹⁴ has observed the growth of thin films of metals into single crystals under heat treatment. Kirchner¹⁵ finds that films of salts such as cadmium iodide, when deposited on celluloid by evaporation, give diffraction patterns by transmission which show that the crystals when first formed are small, but grow on standing even at room temperature, and orientate themselves.

An interesting effect has been reported by Finch¹⁶ when a surface of polycrystalline zinc is oxidised *in vacuo*. The zinc oxide, which, like the zinc itself, is hexagonal in structure, appears in a modified form in which the basal plane is constricted so as to conform in size with that of zinc, there being a corresponding extension of the hexagonal axis so that the volume of the unit cell remains approximately unchanged. Presumably the oxide is formed on the basal plane of zinc crystals and tries to accommodate itself to the spacing it finds. I have observed¹⁷ a different effect with a copper single crystal; a cubic structure (probably Cu_2O) appears which conforms in *direction* with the cubic structure of the copper, but has a different spacing. Interesting effects occur with oxide films on the surface of molten metals. Thus Jenkins¹⁸ has shown that these take the form of small patches of oxide orientated with a crystal axis normal to the surface but otherwise at random. When the lead solidifies—under the conditions of the experiment it forms a few large crystals—the oxide patches on it turn round into parallelism forming a single thin crystal, presumably under the influence of directive forces from the crystallising metal.

Researches by electron diffraction in England¹⁸ and Germany¹⁹ have furnished proof of the existence of the layer of amorphous material on the surface of polished metals which Sir George Beilby first discovered by microscopy. If a polycrystalline metal surface is worked with abrasives in the usual way, the rings get gradually more diffuse, indicating a reduction in crystal size, until when the surface is fully polished all that remains is two very diffuse rings. These broad rings can sometimes be regarded as due to the fusing together of groups of rings which have grown diffuse, but more often they occur in the wrong position. In these cases, and, by analogy, in the others too, one must regard them as due to a truly amorphous state of the metal. The relative size of the two rings is constant (1.85 : 1) and agrees well with that found by X-rays in liquid mercury, and with

the theory of diffraction by a random aggregation of spherical atoms. From the size of the rings we can deduce the diameter of the atoms. In some cases this agrees well with those found from crystal structure, in others the sizes are too small, perhaps indicating an abnormal configuration of the outer electrons. Finch²⁰ has observed that thin layers of other metals deposited on these polished surfaces disappear after a few seconds, being apparently dissolved by the amorphous layer. Only after repeated deposition of the foreign metal can a permanent layer of it be formed.

A research of a very different type is that made by Murison²¹ on layers of grease and other lubricants. He found that long-chain carbon compounds and greases when smeared on a metal or oxide surface form a structure of molecules orientated with their lengths normal to the surface. The structure is pseudo-crystalline in that these long molecules have a common direction and roughly constant distance apart between their chains, but there is no lattice. The orientation indicates a strong attraction for the metal surface which prevents the grease being squeezed out of a lubricated bearing, while the absence of rigid crystal form makes it possible for the molecules to bend readily past one another and so accommodate the irregularities in the surfaces to be lubricated. The lubricating effect of graphite has also been studied²²; it depends on the orientation of the flakes of graphite parallel to the surfaces.

The above short and incomplete account may perhaps give an idea of the kind of problem which can usefully be attacked by the method of electron diffraction. Readers may be surprised at the absence of any mention of gas layers adsorbed on solids. So far no effects which can be attributed to them have been observed with fast electrons. It is possible that the electronic bombardment is intense enough to remove them from the surface.

¹ Davisson and Germer, *Phys. Rev.*, **30**, 707; 1927.

² Thomson, *Proc. Roy. Soc., A*, **117**, 600; 1928.

³ Wierl, *Ann. Phys.*, **8**, 521; 1931; **13**, 453; 1932.

⁴ Brockway and Pauling, *Proc. Nat. Acad. Sci.*, **19**, 68; 1933.

⁵ de Laszlo, *Proc. Roy. Soc., A*, **146**, 672; 1934.

⁶ Hendricks, Maxwell, Mosley and Jefferson, *J. Chem. Phys.*, **1**, 549; 1933.

⁷ Cates, *Trans. Farad. Soc.*, **39**, 817; 1933.

⁸ Thomson, *Proc. Roy. Soc., A*, **128**, 649; 1930.

⁹ Dixit, *Phil. Mag.*, **16**, 1049; 1933.

¹⁰ Kikuchi, *Jap. J. Phys.*, **5**, 87; 1928.

¹¹ Darbyshire, *Phil. Mag.*, **16**, 761; 1933.

¹² Thomson, Stuart and Murison, *Proc. Phys. Soc.*, **45**, 381; 1933.

¹³ Jenkins, *Proc. Phys. Soc.*, **47**, 1; 1934.

¹⁴ Trillat and Hirsch, *J. Phys.*, **3**, 185; 1932.

¹⁵ Kirchner, *Z. Phys.*, **76**, 576; 1932.

¹⁶ Finch and Quarrell, *Proc. Roy. Soc., A*, **141**, 398; 1933.

¹⁷ Thomson, *Proc. Roy. Soc., A*, **133**, 1; 1931.

¹⁸ French, *Proc. Roy. Soc., A*, **140**, 637; 1933. Darbyshire and Dixit, *Phil. Mag.*, **16**, 961; 1932.

¹⁹ Raether, *Z. Phys.*, **88**, 82; 1933.

²⁰ Finch, Quarrell and Roebuck, *Proc. Roy. Soc., A*, **145**, 676; 1934.

²¹ Murison, *Phil. Mag.*, **17**, 201; 1934.

²² Jenkins, *Phil. Mag.*, **17**, 457; 1934.

Light-Waves as Units of Length*

By DR. W. EWART WILLIAMS, King's College, London

COMPARISON OF THE RESULTS

WITH the exception of Sears and Barrell, none of the investigators seems to have realised the full implication of the fact that, while the yard or metre are purely distances, the paths observed by means of all forms of interferometers are 'optical paths', or the product of the metrical distance and the refractive index of the space concerned. The two quantities only coincide when the space is a vacuum, so that if a given standard is said to contain so many waves in air, the nature and consistency of the air must be specified to such limits that its index cannot vary by an amount greater than the percentage accuracy within which the value is specified. Not only are the temperature and pressure of importance, but almost equally so the constitution and composition of the air.

The primary importance of the work of Sears and Barrell lies not so much in the accuracy and thoroughness with which the investigation has been carried out, as in the fact that they have provided us with the vacuum wave-length of the red cadmium line, carrying out a direct comparison with evacuated units as well as with air. It is very disquieting to find that the refractive index of air thus accurately observed is considerably different from that given by the Meggers and Peters tables¹⁹, which is the standard conversion table in general use by spectroscopists for obtaining the vacuum frequencies of spectral lines.

The humidity of the air was not observed in the earlier work of Michelson; at 15° C. the index increases by 7 parts in 10⁷ when saturated air is replaced by dry air. If we assume the air to have had an average humidity of 50 per cent, Michelson's value for the wave-length must be reduced by 0.0023 A. to obtain the result for dry air.

Neither Michelson, nor Benoit, Fabry and Perot, took account of the percentage of carbon dioxide present during their experiment. Normal 'fresh air' is supposed to contain 0.03 per cent carbon dioxide, but the amount present in a closed room may be far in excess of this due to the presence of observers. Pérard²⁰ has shown that an observer will contribute approximately this amount to the air of a room of 100 cubic metres capacity in the time required for a single set of observations, namely, 1½ hours. An increase of 0.03 per cent in the carbon dioxide content decreases the wave-length by 0.0003 A., so that only the more recent determinations can with strict fairness be inter-compared.

The values of the wave-length of the red cadmium line in dry air containing 0.03 per cent carbon dioxide at 760 mm. pressure and 15° on the normal temperature scale are given below:

Standard No.	Year	Investigators	Value in 10 ⁻¹⁰ metres
*26 and T ₃	1906	Benoit, Fabry, Perot	6438.4703
10 and 20	1928	Watanabe and Imaizumi	6438.4682
16	1933	Sears and Barrell	6438.4708
18	1934	Kösters	6438.4672
Mean			6438.4687

* The results have been corrected in terms of the more recent determinations of the lengths of these International Sub-standards.

For the present, this is probably the best value that can be taken for the wave-length of this line in 'normal' air. It differs but little from the accepted value of 6438.4696 A., which was primarily based on the determination of Benoit and his co-workers. The difference of 0.0036 A. between the values of the Reichanstalt and the National Physical Laboratory seems far too great, since it amounts to almost a whole wave-length in the number of waves in the metre. The discrepancy has most probably arisen in the initial comparison of the national standards with the Sèvres sub-standards. The preliminary Japanese results showed a difference of 0.002 A. between the values obtained from the two standards No. 10 and No. 20. These were later sent to Paris for re-measurement against the international sub-standard No. 26 and others. The corrections of +0.2 μ for No. 10 and -0.11 μ for No. 20 brought the wave-length values into close agreement. The result of Benoit and his co-workers has been included in the above table in spite of the uncertainty regarding the carbon dioxide content. The probability is that the lengths of No. 26 and T₃ are more accurately known than those of the National Standards, and the greatest source of error undoubtedly lies in this portion.

It seems imperative that the rule prohibiting the actual use of the prototype metre itself will have to be waived, and the German and British standards be compared with it as soon as possible. The difficulty of this work can best be appreciated from Fig. 1. This photograph (reproduced by courtesy of M. Pérard) shows, with a magnification of 300, one of the fiduciary lines of the International Sub-standard No. 26 which has been used in the earlier determinations. The centre of the whole is supposed to be the actual position of setting, and metrologists claim that they can inter-compare two standards to within ±0.2 μ. This is equivalent to finding the centre of Fig. 1 to within ±0.03 mm., which is clearly impossible. By

* Continued from p. 461.

reducing the magnification a sharp image is obtained, which is more of the diffraction pattern of the comparator objective than an image of the actual line itself. The result in a great measure will then depend on the conditions of illumination of the line comparator.

It seems certain that minor systematic errors, in the optical portion, chiefly connected with the conditions of illumination of the étalons, still remain uncorrected. Their effects are, however, negligible compared with the real uncertainties of line standard measurements. Even at the present time, there would be a considerable gain in accuracy if a wave-length were accepted as the fundamental standard, but before a change is decided upon, it seems very desirable that the whole position should be reconsidered in the light of recent knowledge. The discovery of the hollow cathode discharge by Paschen and its further development by Schüler have given us a light source that is much more monochromatic than the Geissler tube of Michelson or the argon-filled cadmium lamp as used by Sears and Barrell. The further possibility now exists of finding a more suitable line from a heavier, non-isotopic element of zero nuclear spin, since we are no longer limited to the more volatile elements.

Tilton²¹ has recently carried out a statistical analysis of the data on the refractive index of carbon dioxide-free air, from which he deduces a correlation between the refractivity ($\mu - 1$) and the twenty-three year magnetic cycle of sunspots. Some of the data are admittedly uncertain, but there seems to be evidence of a real variation that

makes it essential to adopt a vacuum wave-length as the ultimate standard, if and when a change is made.

For the moment, we cannot do better than accept the mean value given in the above table as the wave-length of the red cadmium line in

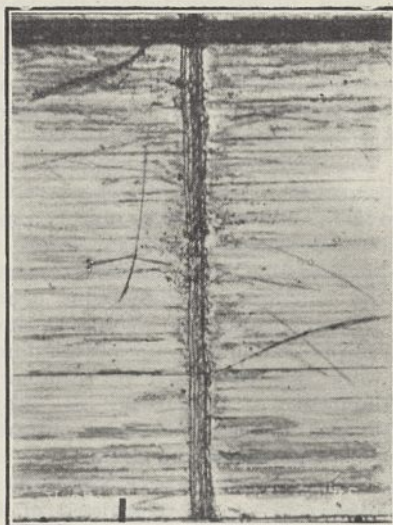


FIG. 1. One of the fiduciary lines of the International sub-standard. No. 26. ($\times 300$.)

'normal' air, and to adopt Sears and Barrell's value, 1,000,276.49, as its refractive index. The vacuum wave-length then becomes 6440.2493 Å. and the Imperial yard, defined as a length at 62° F., contains 1,419,818.31 vacuum wave-lengths.

¹⁹ Meggers and Peters, *Bull. Bur. Stand.*, **14**, 697; 1918.

²⁰ Péard, *Proc. verb. Com. int. Poids Mes.*, p. 27; 1927.

²¹ Tilton, *Bur. Stand. J. Res.*, **13**, 111; 1934.

Obituary

PROF. BOHUSLAV BRAUNER

PROF. BOHUSLAV BRAUNER, one of the best-known representatives of Czech chemistry of the last half century, died in Prague on February 15, after a short illness. He was born on May 8, 1855, in Prague, the son of Dr. Francis Brauner, who was a noted Prague lawyer and Czech political leader. His mother Augusta, a very talented and spirited lady, was the daughter of Prof. K. A. Neumann, the first professor of chemistry at the Polytechnic Institute of Prague, and the grand-niece of the well-known German pharmacist, Prof. Caspar Neumann (1683-1737), one of the founders of pharmaceutical chemistry.

Thus Brauner seems to have inherited his liking and ability for chemistry from his mother's side. Great attention was paid in the Brauner family to languages, amongst which besides the Czech mother-tongue, Russian, English, German and French were equally cultivated. There the foundation was laid of Brauner's astonishing practical linguistic knowledge. He showed a refined taste for fine arts like the

other members of his family; his sister Zdenka Braunerová being a well-known Czech painter.

In 1873, Brauner went to the University and to the Technical School in Prague, where one of his teachers was the physicist Ernst Mach, at that time professor in the University of Prague. Before attaining the doctor's degree, young Brauner went abroad for training in research; contrary to the fashion at that time, when "every chemist had to embark on organic chemistry", he preferred inorganic training under Bunsen in Heidelberg in 1878. Two years later, Brauner went to Manchester, attracted by the work of Sir Henry Roscoe on rare elements.

The school of chemistry in Owens College, Manchester, had a profound influence upon Brauner, who learned there to love the original Anglo-Saxon spirit of experimental investigation in natural philosophy. During his years in Manchester, Brauner was eagerly investigating the rare earths, and he succeeded in preparing a double fluoride of tetravalent cerium and potassium which on gentle heating gave off free fluorine, thus for the first time obtained

by purely chemical means. Fourteen years later, he found a similar reaction with lead tetrafluoride.

Fascinated with Mendeléeff's system, Brauner entered into scientific correspondence with the genial Russian chemist in 1881 and was greatly impressed by meeting him in St. Petersburg. There a cordial friendship between the two enthusiastic Slavonic chemists began, to last for twenty-five years, until the death of Mendeléeff.

A problem which occupied Brauner's mind for a long time was the position of the rare earth elements in the Periodic System. As a strong adherent of the tabular form of the system, he expected that these elements would somehow fit in so as to show their chemical analogies. By determining carefully their atomic weights, he was already able to predict the gap between neodymium and samarium. In his investigations at Manchester, Brauner succeeded in showing the complexity of didymium, denoting by Dix and Diß what Auer von Welsbach three years later called praseodymium and neodymium. This brilliant work was submitted by Brauner to the Charles University of Prague for his 'habilitation' thesis. He was appointed assistant professor there in 1890 and full professor in 1897.

During his whole academic career, Prof. Brauner worked intensively at the chemistry of the rare earths and on the determination of atomic weights. As a specialist in the first branch, he was asked by Mendeléeff to write the account on rare earths in his famous textbook "Principles of Chemistry", whilst in the other branch he immortalised himself in Abegg's well-known "Handbuch der anorganischen Chemie", to which he contributed his masterly critical discussion on atomic weights. As an authority on these determinations, he fought, together with Venable, for the new base $O = 16.000$, right down to its general adoption at the Paris Congress in 1900.

Prof. Brauner retired in 1925, after forty-three years of teaching, during which time he lectured to generations of chemists and pharmacists. The highest scientific distinctions came to him not only from his own people, but still more so from abroad. Those he treasured most were the honorary memberships of the Chemical Society of London, the American Chemical Society and the Société Chimique de France, and the honorary D.Sc. of the University of Manchester. His seventieth birthday was celebrated by a jubilee number of the *Recueil des Travaux Chimiques des Pays-Bas* in 1925, and his seventy-fifth birthday by the jubilee number of the *Collection of Czechoslovak Chemical Communications* in 1930.

The personality of Prof. Brauner was one of imposing and original individuality. His Herculean figure, quick penetrating eyes, high and broad forehead, and strong features harmonised well with his commanding voice, dry remarks and sarcastic wit. Yet his sanguine enthusiasm often also brought tears into his eyes, revealing his gentleness of heart and love for mankind and the whole of Nature. One of his great hobbies was astronomy, the progress of which he followed as eagerly as that of chemistry. No wonder that with such naturalistic bent he soon became a passionate and ardent reader of NATURE,

of which he had read carefully every number, starting from his Manchester days in 1882. Often he contributed to it thoughtful and conscientious reports. His recreation was sport, which he introduced and promoted enthusiastically in Bohemia, having become attached to it during his studies in England. His Spartan mode of life most probably preserved his health in spite of the noxious atmosphere of the chemical laboratory and his somewhat delicate lungs. Yet pneumonia, which attacked him several times in his stronger days, succeeded at last in overcoming him in his eightieth year, to the sincere regret of his two sons and daughter and his many devoted friends and pupils.

J. H.

SIR LESLIE MACKENZIE

WE regret to record the death of Sir William Leslie Mackenzie, which occurred in Edinburgh on February 28.

Sir Leslie Mackenzie was a native of Ross-shire and graduated M.A., with double honours, at the University of Aberdeen in 1882. He studied medicine in Aberdeen and Edinburgh and, at the latter University, took the degree of M.B., C.M., with honours, in 1888, and M.D., with highest honours, in 1895. He held the D.P.H. and was a fellow of the Royal College of Physicians of Edinburgh. In addition to achieving a brilliant career in medicine, Sir Leslie was a recognised authority on psychology and mental philosophy. He had gained the Fullerton and Ferguson scholarships in mental philosophy, and was at one time examiner in mental philosophy as well as in medical jurisprudence and public health at the University of Aberdeen. His later work was recognised in the award of the Medal of Honour of the University of Brussels in 1920. In Aberdeen also he was a resident medical officer in the Royal Infirmary and afterwards was assistant professor of physiology and Arnott lecturer in physiology at Gordons Colleges. In his earlier work he had thus a wide knowledge and interest, as well as considerable and diverse experience.

For Sir Leslie's later work, which was more of a public nature and had its outcome in the development of the various modern branches of public health service during his term of office on the Local Government Board and Scottish Board of Health, he had his first insight while, for a time, assistant to that eminent and widely-known hygienist, Prof. Matthew Hay, medical officer of health for the City of Aberdeen. From this assistantship he became the first medical officer of health for the combined counties of Wigtown and Kirkcudbright, under the Local Government (Scotland) Act, 1889, where he had to organise the public health work of a very large area. He and Prof. Hay were selected to give evidence before the Royal Commission (for Scotland) on physical training. He had carried out for the Commission and reported on the examination of six hundred school children, and the Commission's report resulted in the establishment of the School Medical Service.

In 1894, Sir Leslie was appointed medical officer

of health for Leith, where his ability and achievements, added to those already accomplished in his previous appointments, led to his selection, in 1901, for the post of medical inspector under the Local Government Board for Scotland. In 1904, he became medical member of the Local Government Board and later of the Scottish Board of Health which took its place. In the latter capacities he took a prominent part in the development of the tuberculosis service and the scheme for medical services in the Highlands and Islands of Scotland. His name is also closely associated with the development of the maternity and child welfare service, he having, in 1915, prepared a report for the Carnegie Trust on "Scottish Mothers and Children", published in 1917. At this time also he was a member of the Royal Commission on Housing, the Ballantyne Commission, a branch of public health work which he himself regarded as among the most important, if not the most important,

of his activities for the betterment of the people of Scotland. He was also crown nominee for Scotland on the General Medical Council.

Among Sir Leslie's published writings, other than those already referred to, were "The Nervous System" in Prof. Bain's "Senses and Intellect"; "The Development and Outlook of Public Health" in Nelson's Loose Leaf Medicine; "Health and Disease"; "The Health of the School Child"; "The Medical Inspection of School Children".

The sympathy of all who knew him, personally or by repute, will go out to Lady Mackenzie, who also is a well-known and active social worker. Lady Mackenzie has taken a keen interest and no small part in the effort for the improvement of conditions in Scotland, and is a member of several boards of public bodies and of the Departmental Committee now receiving evidence on the health services of Scotland.

News and Views

'Backward Tribes' in the India Bill

COL. WEDGWOOD, by moving two amendments on Clause 91 of the India Bill in the House of Commons on March 22, secured from Sir Samuel Hoare a statement of the intentions of the Government in dealing with the primitive tribes of India. He pointed out the extreme undesirability of the probable course of action of the Provincial Governments in an effort to assimilate tribal areas to conditions in the rest of the territory under their jurisdiction, and urged the retention of such areas under British control with a system of administration similar to that of 'indirect rule' which has been introduced in West Africa. That the problem is by no means negligible in its dimensions is indicated by the numbers affected. Col. Wedgwood's estimate puts the numbers of the backward tribes at 43,000,000, of whom 13,000,000 only will be affected by the protective measures proposed by the Government. These figures are in excess of those given in the Census Report of 1931, where the primitive tribes are stated to number 25,000,000 (in round numbers), of whom 8,280,000 are said to retain their tribal religion. The difference is probably due to the more rigid exclusion in the Census figures of tribes which have passed over recently, or are in process of passing, into the depressed classes, the usual fate of tribes which have come into contact with outside conditions.

ALL observers are agreed as to the delicate equilibrium of the social organisation of the primitive tribes of India, which is unable to withstand even the most impartial application of the principles of British justice. In Rajputana, for example, it has been found to have led, in the desire to distribute even-handed treatment, by almost imperceptible degrees to an increase in the power of the land-owner and the restriction of the rights of the tribal holding. Any increase in facilities of communication has had a rapidly disintegrating effect. Sir Samuel Hoare

was able to give the House an assurance that the Government has this aspect of the matter in view; and he informed the members that, as the result of consultation with expert opinion in India, it had been decided that certain areas, wherever such treatment was possible, would be scheduled for control by the Governor only. He closed with the confident statement that "the Government had made the position safe". In so doing, he appeared to rely to a great extent upon the fact that there has developed a school of Indian administrators "who had specially concentrated on the study of the kind of problem that was in the mind of Col. Wedgwood". Some assurance, however, that measures are being taken to ensure that the supply of such administrators will not fail in the changed conditions would have been even more welcome.

Antiquities in Iraq

FURTHER details of the allocation of antiquities from Ur as between the Bagdad Museum and the institutions which were responsible for the Joint Expedition are given by Dr. Leonard Woolley in *Antiquity* of March. These, unfortunately, had to be omitted from his communication in *The Times* (see NATURE, 134, 999; 1934); but they should convince any impartial judge of the fairness of Dr. Woolley's contention that the principle of division has operated in favour of the Bagdad Museum, and that there is no ground for the accusation that Iraq has received a negligible proportion of the finds or has been deprived of priceless treasures which should not have left the country. Dr. Woolley admits that in the earlier years of the excavations objects of exceptional importance or value were allotted to the share of the Expedition; but this was due to the fact that the Bagdad Museum had not then the technical equipment necessary for their special treatment and preservation. As Dr. Woolley's statement is precise, its detail is open to verification; but a reply which

has since appeared in the Bagdad paper *el Bilad* evades this issue. Dr. Woolley goes on to show specifically in detail that the Antiquities Department of Iraq, having first choice, was in a position to, and did, select the most valuable and finest specimens for its proportion of the finds, without any compensation being given to the Expedition. The law is interpreted in such a way that there is a danger that the share of any Expedition may become insufficient to justify the expenditure entailed by the work of excavation. The reduction of the number of expeditions in this field to three indicates that this view is only too well founded.

Artificial Lighting at the National Gallery

ON and after April 1 the public will be able to visit the National Gallery, Trafalgar Square, until 8 p.m. on three evenings in the week. This has been made possible by a new lighting scheme, which has been the subject of extensive research during the past six years. The installation has been designed to secure a reasonably high intensity—about 4 foot-candles—upon the pictures themselves, and at the same time to prevent too great a feeling of darkness over the remainder of the room. Suspended fittings, each containing a high-powered frosted bulb, are used, and a system of louvers and reflectors directs as much light towards the picture-carrying portion of the walls as the architecture of the several rooms will permit. The height of the fittings has been calculated upon the assumption of a viewing distance of eleven feet from the walls. Masks are employed to stop the glare in the direction of doorways: in the majority of cases this has proved satisfactory, though instances will always arise when the geometry cannot be satisfied without producing a shadow on the wall or in a corner. An emergency system of lighting, which comes into operation automatically in case of failure, is held in reserve.

International Vitamin Standards

THE International Standards for vitamins A, B₁, C and D are now available for issue to laboratories, institutions and research workers in Great Britain and Northern Ireland. These standards were accepted for international use at the Second International Conference on Vitamin Standardisation held in London in June 1934 under the auspices of the Permanent Commission on Biological Standardisation of the Health Organisation of the League of Nations. The Conference recommended that they should be kept at the National Institute for Medical Research, Hampstead, N.W.3, which would act for this purpose as the central laboratory on behalf of the Health Organisation of the League of Nations. The standards for the vitamins B₁ and D remain unchanged, and their supply at regular half-yearly intervals will be continued as before. The standard for vitamin A has been changed; a pure specimen of β -carotene having been adopted in place of the impure preparation of carotene hitherto employed. The unit of vitamin A remains unchanged, though it is now defined as the vitamin A activity contained in 0.6

microgram of pure β -carotene. In accordance with the recommendations of the Conference, the β -carotene is issued in the form of a solution in oil, of which 1 gm. contains 500 international units. The quantity of this standard solution supplied to each applicant is approximately 5 gm., and, on account of the small quantity available, it can be supplied only at yearly intervals, and not half-yearly as formerly. *l*-Ascorbic acid has been adopted as the international standard for vitamin C, the unit of activity being defined as the vitamin C activity contained in 0.05 mgm. of pure *l*-ascorbic acid. A fuller account of the recommendations of the Conference on Vitamin Standardisation appears elsewhere in this issue (p. 516).

Chemical Engineering in Industry

GREAT BRITAIN is awakening to the importance of the chemical engineer, a man who knows the nature and properties of the new constructional materials or is able to design large plants for the continuous production of those materials which are classed as chemicals. It is at least likely that the big developments in the future will be among the chemical industries making, at a low price, substances for which there is a considerable need, almost automatically as a continuous process. Such will require the ablest chemical engineers to design and operate them. There are two societies active in promoting the subject and in bringing together those who practise it, and post-graduate courses are provided in several of the London colleges. Greater progress in chemical engineering has been made abroad, particularly in the United States and in Germany, and for some time past the desirability of holding an international congress has been realised by those interested, in particular by the late Sir Frederic Nathan. Thanks to the assistance of the World Power Conference with its widespread organisation, a Congress has now been arranged, to take place in London on June 22-27, 1936. The programme, which has just been issued, lists the influential members of the organising committees, whose names are a guarantee of the support the Congress is receiving. It further indicates the scope of the projected programme: this covers plant, fuel and heat and general problems, administration, development and general aspects of the subject. It is desired that the papers, while adhering strictly to chemical engineering, should deal as fully as possible with the economic aspect of the subject. The Committee aims at inviting technicians of repute to present papers dealing with particular aspects of these subjects rather than having a miscellaneous collection of papers, and if they are successful the Congress should be a memorable one.

Dr. William Derham, F.R.S. (1657-1735)

ON April 5, the bicentenary occurs of the death of Dr. William Derham, rector of Upminster, Essex, and for thirty-three years a fellow of the Royal Society. Born at Stoughton, near Worcester, on November 26, 1657, he entered Trinity College,

Cambridge, in 1675 and took holy orders. In 1682 he was made vicar of Wargrave, Berkshire, but seven years later was appointed to Upminster, where he spent the remainder of his life and where he is buried. Derham united a sincere devotion to his calling with a passion for mathematical and philosophical studies. Elected a fellow of the Royal Society in 1702, he contributed papers to the *Philosophical Transactions* on the motion of the pendulum in a vacuum, on sound, sunspots, Jupiter's satellites, the aurora borealis and other subjects. His separate writings included his "Physico-theology", 1713; and his "Astro-theology", 1715; while in 1726 he edited "The Philosophical Experiments . . . of Robert Hooke and other Virtuoso's". He was made a canon of Windsor, and in 1730 the University of Oxford conferred upon him the degree of D.D. for his services in the cause of religion by his culture of natural philosophy.

Lead Mining in the Northern Pennines

THE history of lead mining in the Tyne, Wear and Tees areas during the eighteenth and nineteenth centuries was described by Dr. A. Raistrick before the Durham Philosophical Society on March 15. Two companies have worked practically all the mines in these areas, the London Lead Co. and the Beaumonts. The former began with a charter granted in 1692 to a company formed in Bristol to attempt the smelting of ore with coal. This venture closed after two years, but two Quakers, Edward Wright and John Haddon, of London, obtained the reversion of a much older charter (of 1654) of the Society of Mines Royal (Copper), a German concern formed to work Cumbrian ores. Wright seems to have invented the reverberatory furnace, long called the cupola from its shape, and found that it was very suitable for lead refining. They extracted silver, and with some Newcastle Quakers founded a smelt mill at Ryton-on-Tyne in 1704; before that (from 1696), difficulties with the oath it contained prevented their taking up the 1692 charter, but these were overcome in 1704, when the accumulated silver was sold to the mint. This company, long known as the "Quaker Lead Company", until 1730 had an output of about 150 oz. of silver a week, and in 1705, Sir Isaac Newton then being Master of the Mint, they were granted a mark which appears on most of Queen Anne's coinage until 1737. The maundy money was coined from their silver for another hundred years. They bought ore from Alston Moor, and worked lead also in Flintshire, and finally in Yorkshire, Scotland, Ireland and the Isle of Man. The tale is too long to repeat here, but the Pattinson process of desilverisation was discovered at Blaydon in the Beaumont works. The two concerns worked harmoniously together, and many improvements were made by the London Lead Co. In 1860, the decline set in, the company surrendered all its leases in 1907; and now only three mines are working under the new Weardale Lead Co., and those recently closed will never re-open. An interested visitor at the lecture was the last manager of the old company.

Speed in Aviation

IN his Friday evening discourse delivered at the Royal Institution on Friday, March 22, Prof. B. Melvill Jones discussed the problems of speed. The speed of aerial transport is limited solely by the power which can be provided to drag the aeroplane through the air, without reference to its support; the power required increases very rapidly with speed, but can be much reduced by good stream-lining. The recent increases in speed of civil air transport are due mainly to improved stream-lining. With well stream-lined aeroplanes the power is expended mainly in overcoming skin friction, so that the detailed study of the skin friction on the curved surfaces of the wings and body merits, and is receiving, great attention by research workers. The magnitude of the skin friction force is delicately dependent on surface smoothness and on the smoothness or otherwise of the flow very close to the surface of the wings and body. After perfect stream-lining, in the ordinary sense, has been achieved, still further important increases in speed would follow from any considerable extension of the area over which the flow remains smooth very near to the surfaces of the wings and body; but to obtain this smooth flow over large surfaces moving at high speeds may be very difficult, and it is still a matter for conjecture how much of the great increase of speed which might conceivably be obtained in this way will ever be realised in practice.

Recent Acquisitions of the Natural History Museum

THE Department of Entomology has received from Mr. R. W. Lloyd a gift of drawings of quite exceptional interest and value. These consist of the original coloured plates prepared by Jacob Hübner for his "Collection of European Butterflies", published during the years 1796-1830, at Augsburg in Germany. There are 852 plates in all, a number which exceeds that of the published work by many cancelled and amended copies. Concerning the identity of some of the smaller insects illustrated there has long been doubt; it is hoped the comparisons which it will now be possible to make between the originals of these figures and the material available in this Department will enable most of these doubts to be removed. It is interesting to note that until a few weeks ago it was unknown in Great Britain that these drawings even existed. The Department of Geology has recently acquired from Dr. Wyatt Wingrave a large collection of fossil invertebrates (chiefly Ammonites) from the Lias and Inferior Oolite of the Dorset district. A crystal of gem olivine (peridot) from Burma has been purchased for the Department of Minerals. Presents to the Department include a fine group of large crystals of wolframite from Pelagatos Mountains, Peru, collected by the late Prof. J. W. Gregory and presented by Mrs. Gregory.

THE Department of Botany has received a collection of dried plants made in Twaong (Tibet) and Bhutan by Messrs. G. Sherriff and F. Ludlow. There are 523 flowering plants and 53 cryptogams, which are

specially dried and preserved, and form a most valuable addition to the herbarium, for few plants have previously been collected from this area. They have not yet been wholly worked over, but it is probable that they contain a percentage of new species which will be of horticultural interest. Seeds of a number of plants likely to prove of horticultural value have been sent and distributed to the more important gardens in the country. The Maharajah of Bhutan kindly granted permission for this expedition to remain longer in the country than originally arranged, and thus enabled collections to be made after the rains were over, which had not been possible in the previous season. Miss Gulielma Lister has presented the 221 original drawings of the "Lister monograph" on Mycetozoa published by the British Museum. The drawings are of considerable artistic beauty and scientific accuracy.

Marine Biology in Ceylon

MR. A. H. MALPAS, acting marine biologist to the Department of Fisheries, in his Administrative Report (Marine Biology) for the year 1933 (Ceylon, Part 4. Education, Science and Art (G), April 1934, Ceylon Government Press, Colombo) expresses his regret at the severe loss the fisheries research in Ceylon has sustained by the departure on leave, preparatory to retirement, of Dr. Joseph Pearson, who has done so much for the fisheries, especially the fish resources of Ceylon. The survey of the pearl banks in 1933 revealed a promising sign of repopulation of the banks, small branches of oysters being found over most of the pair areas, especially over the West Cheval, usually the first pair to receive spatfall after a long period of barrenness. These oysters are not themselves of any fishable value, but are important as they may produce subsequent spatfalls to repopulate the banks. It is anticipated that a considerable area will be covered with spat at the next inspection. Favourable prospects are also shown for a series of fisheries of the window-pane oyster. Experiments were conducted with the view of ascertaining the effects on pearl oysters of abrupt changes of salinity. It was found that oysters kept in a mixture of 1 part of fresh water to 2 parts of sea water were unaffected after several days, while others kept in a mixture of equal parts of fresh-water and sea-water quickly succumbed. Although the experiments are not conclusive they indicate that, as the pearl banks are some miles distant from land, it is not possible for flood-water to bring about such a reduction in salinity as would be harmful to the pearl oysters.

Survey of Salmon and Freshwater Fisheries

PROBLEMS of biological interest are raised in the Ministry of Agriculture and Fisheries Report on the Salmon and Freshwater Fisheries for the year 1933. In at least three rivers, the Wye, the Severn and the Exe, there have been reports that the size and number of smolt shoals migrating seawards in 1933 were well above the average. It is considered that the great majority of these will have arisen from the 1930 spawning, and that year was noteworthy as one

in which the number of fish observed on the spawning beds was unusually low. Under such conditions the eggs will have been relatively undisturbed and well distributed. The possibility arises therefore that the presence of too many fish on the spawning beds may be detrimental by causing disturbance of the already spawned eggs and overcrowding of the newly hatched fry. The production of good broods in years when the breeding stock does not appear to be large has also been observed among some sea fish. A further problem of considerable interest is afforded by the occurrence in 1933 of spring-run salmon in the River Plym, where spring fish are not normally found. Their occurrence follows on the introduction of salmon fry from eggs of early running Scottish fish in 1928. If this is an indication that such fish breed true, always producing spring fish, the results of experiments to eradicate the autumn fish running up after the close season will be watched with interest. Although in the year under review there had been a slight decline in the total catch of salmon and migrating trout, the reported mortality of fish as a result of pollution or from furunculosis has fortunately been low in spite of the dry weather conditions. Much work of interest and value is being conducted at the Alresford Experimental Station from the chemical, botanical and zoological points of view, and the usual surveys of a large number of rivers have been made.

Balance of Life in National Parks

THE institution of animal reserves, on a large or small scale, eventually raises a question as to whether artificial control of conditions should be encouraged or abolished. Everyone will agree with the dictum that the object is "to preserve National Park areas in as nearly as possible their natural condition and at the same time to make them accessible to the people for study, for recreation, and for play". Dr. Joseph Grinnell quotes with approval, and suggests (in a short article in the *Journal of the Society for the Preservation of the Empire*, Jan. 1935, p. 61) that animal life in national parks should simply be left alone. "It can be encouraged in amount and variety most practically by desisting from any avoidable interference with the full range of natural conditions of food and shelter. A *do-nothing* policy is the soundest policy. . . . Also introduction of non-native kinds of animals should be guarded against like the plague." In general, Dr. Grinnell is correct, but the guardian of reserves, especially of those on a small scale, must be on the alert to correct any tendency to extremes in the population. The reason is that no reserve is a thoroughly 'natural area'; it has somewhere a boundary, and at the boundary natural migrations are checked, and unnatural slaughter takes place which rebounds upon the reserve population.

Quality of Wheat

THE quality of wheat as influenced by environment is the subject of a recent paper by F. T. Shutt and S. N. Hamilton (*Emp. J. Exp. Agric.*, 2, p. 119). The question is not one of scientific interest only, but also of the first commercial importance in the flour-

milling and baking industries. Value in wheat depends chiefly on the character and amount of the protein (gluten) it contains, but whereas the former is essentially an inherited factor, the latter may be considerably influenced by environmental conditions. The time which elapses between the formation and ripening of the kernel practically controls its gluten content—the shorter the period the higher the percentage—so that seasonal conditions such as high temperatures and absence of excessive moisture during the later stages of development, which tend to hasten ripening, result in a valuable high-protein wheat. Conversely, a starchy grain is produced if climatic conditions tend to prolong growth during this period. The richness of the soil, even as regards its nitrogen content, does not appear to have much influence on the quantity of protein in the grain, but its moisture absorbing capacity may be of considerable importance as it is necessarily closely associated with the rate of ripening of the crop. From data which have been collected over a period of twenty-eight years at a number of stations in Canada, it has been deduced that the excellent quality of the wheats from the prairie provinces is largely to be attributed to the favourable seasonal conditions that obtain, and not solely to the selection of the most suitable varieties for that district.

Forest Products Research

THE annual report of the Forest Products Research Board with the report of the Director of the Forest Products Research Laboratory, Princes Risborough, for the year 1933 has recently been published (London: H.M. Stationery Office, 1934). In a general statement, the Director notes that the progress of timber research has been satisfactory, whether regarded from the point of view of the actual results achieved or from the value of the results when applied in the timber-using industries and professions. Sir Ralph Pearson retired from the post of director during the year, and Mr. W. A. Robertson, late of the Indian Forest Service, was appointed. The report states that there is evidence of the increasing interest taken by industry in the activities of the Laboratory. The work carried out during the year on seasoning of timber, both kiln and air-seasoning, on steam bending, the structure and mechanical strength of wood and on preservation, is summarised. As a result of investigation work, it is stated that "there is no material difference between old and new timbers from the point of view of shrinkage and expansion", thereby disproving a common belief. Investigations were carried on in connexion with dry rot and insect damage. Tests were also carried out on the cricket bat willow.

Birefringence of 'Viscabelle'

DR. N. H. HARTSHORNE, of University College, Swansea, writes: "With reference to my letter on the birefringence of 'Viscabelle' in the issue of *NATURE* of February 16 (p. 269), my attention has been directed to a note on the birefringence of 'Cellophane' contributed by Mr. Arthur M. Grundy to *Watson's*

Microscope Record in 1931 (Sept., p. 22). The name 'Cellophane' is commonly, though mistakenly, used as a general term for artificial cellulose sheet, and as Mr. Grundy did not state the source of his material, I am uncertain as to its exact nature. It was, however, doubtless very similar to, if not identical with 'Viscabelle'. He noted the uniformity of its optical character, and the fact that specimens of different thicknesses gave appropriately different polarisation colours, but he gave no data for the relative retardations associated with different thicknesses. He expressed the view that the optical uniformity of the material ruled out stress as a cause of its double refraction. As regards 'Viscabelle', I do not think that the double refraction is due in any degree to stress in the finished material, but, as I indicated in my letter, the stress involved in the spinning process (that is while the material is being drawn from the spinning slot into the coagulating bath) almost certainly causes an orientation of the cellulose molecules, and this accounts for the observed direction of 'slow' vibration. I regret that I did not see Mr. Grundy's note earlier, and I gladly acknowledge his prior discovery of the double refraction of artificial cellulose sheet."

Native Chinese Drugs of Animal Origin

REMEDIES derived from the animal kingdom bulk large in the old Chinese literature, and three instalments dealing with this Chinese materia medica, compiled by Mr. Bernard E. Read, assisted by Chinese scholars, have been published by the *Peking Natural History Bulletin*. The first instalment, containing the 'animal drugs', and the second the 'avian drugs', were issued some time ago, and now the third dealing with 'dragon and snake drugs' has been published ("Chinese Materia Medica". 7: "Dragon and Snake Drugs". By Bernard E. Read. Pp. 66+6 plates. Peiping: The French Bookstore, 1934. 1.50 dollars). Besides products derived from snakes, crocodiles, lizards and others, preparations from the fossilised bones of gigantic extinct saurians are included. Attempts are made to identify the creatures mentioned in the old works, and a Chinese index is appended. The whole forms a scholarly work of considerable interest and importance.

British Mosquitoes

A REVISED second edition of the pamphlet entitled "British Mosquitoes and their Control", Economic Series 4A, published by the British Museum (Natural History), has recently appeared. The authors, Messrs. F. W. Edwards and S. P. James, describe the characters and the habits of the twenty-eight species of these insects found in Britain. Measures for the control of mosquitoes and their larvae are also described, together with means of protection against bites of the insects. The object of the pamphlet is to assist medical officers and others engaged in mosquito control with up-to-date information. It is obtainable, price 4d., from the British Museum (Natural History), Cromwell Road, London, S.W.7, or through booksellers.

The Sky in April

THE major planets are moving round towards positions favourable for evening observation. In the middle of the summer we shall see Venus, Mars, Jupiter and Saturn in the evening sky. At present, Venus is very conspicuous in the western sky just after sunset, while Mars becomes conspicuous in the eastern sky a little later. In April, Mars will precede Spica, near which star it has been during March. This planet is in opposition on April 6. Jupiter follows Mars, about two hours behind in right ascension, but its declination is about 17° S. in April. Saturn is still an early morning object. The moon will occult the Pleiades on April 6. The elements of the occultations visible at Greenwich being as follows :

Star	Magnitude	Phenomenon	G.M.T.
η Tauri	3.0	Disappearance at dark limb	18 ^h 50 ^m
η Tauri	3.0	Reappearance at bright limb	19 19
27 Tauri	3.8	Disappearance at dark limb	19 24
28 Tauri	5.2	Disappearance at dark limb	19 37

On the early morning of April 22, the moon will occult Antares, magnitude 1.2. The reappearance of this star at the dark limb will be visible at Greenwich and will take place at 1^h05^m G.M.T.

Announcements

A DISCUSSION on "Gravity Measurements" will be held in the rooms of the Royal Astronomical Society, Burlington House, London, W.1, on April 26 at 4.30. The discussion will be opened by Dr. E. C. Bullard.

THE Triennial Gold Medal of the Royal Asiatic Society has been awarded to Sir Denison Ross, director of the School of Oriental Studies, and professor of Persian in the University of London. The Triennial Gold Medal was founded in 1897 in commemoration of the sixtieth year of Queen Victoria's reign, and is awarded to an Oriental scholar in recognition of outstanding and distinguished services in the field of Oriental research, calculated to further the objects of the Society. The last award was made to Sir Aurel Stein.

THE senate of the Free City of Danzig has decided to found a State Academy of Practical Medicine consisting of eight professors and fifteen honorary lecturers, with Dr. Kluck as director and Prof. Bürgele as general secretary.

THE third International Congress of Comparative Pathology will be held at Athens on April 15-18, 1936, and will consist of three sections devoted respectively to human and veterinary medicine and the pathology of plant life. Further information can be obtained from Dr. A. Codounis, 40 rue Didotou, Athens.

A CONFERENCE on "Population Studies in Relation to Social Planning" will be held under the auspices of the Population Association of America at the Hotel Willard, Washington, D.C., on May 2-4. The purpose of this conference is to focus attention on the importance of population studies in public affairs, especially in relation to planning Government activities, and to clarify problems on which further research is needed. It will be primarily a conference between research workers in the field of population and persons engaged in administration or teaching in related fields. Further information can be obtained from the Secretary, 308 Victor Building, Washington, D.C.

WE are informed by M. Ch. Marie, general secretary of the International Committee of Annual Tables of Constants, 9 rue de Bagneux, Paris, 6, that the Academy of Sciences of the U.S.S.R. has guaranteed for the next five years a contribution to the international fund for the publication of the Annual Tables. In exchange, the U.S.S.R. Academy of Sciences is to receive a certain number of volumes issued by the Committee of the Annual Tables. These volumes will be distributed among the universities and scientific institutions of the Soviet Union. Similar agreements have been already signed with the French Government, the Swiss Government and the Polish Academy of Sciences.

WE regret to learn that the name of Prof. Ig. Tamm was given incorrectly as "G. Tamm" at the foot of the letter by Mr. J. D. Bernal and Prof. Tamm entitled "Zero Point Energy and Physical Properties of H₂O and D₂O" in NATURE of February 9 (p. 229).

THE January number of *Watson's Microscope Record*, published by W. Watson and Sons Ltd., 313 High Holborn, W.C.1, contains some interesting articles, among them an account of the manufacture of optical glass by Dr. W. N. Wheat, a note on projection with the microscope by W. C. Clothier, and the first part of a description of the theory of the resolution of microscopic objects by E. M. Nelson. These articles will be found of interest by many readers of NATURE, to whom the publication will be sent free on request by Messrs. Watson.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A lecturer in mathematics at the City of Leeds Training College—The Director of Education, Education Department, Calverley Street, Leeds (April 10). A physical assistant in the Scientific Department of the Courtauld Institute of Art, 20 Portman Square, W.1—The Registrar (April 12). A City engineer and surveyor for the City of Nottingham—The Town Clerk, Guildhall, Nottingham (April 15). An assistant in psychology at Bedford College, Regent's Park, N.W.1—The Secretary (April 27). A director of the Imperial Forestry Institute, Oxford—The Registrar, University of Oxford.

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 511.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Production of Radioactivity by Neutrons

In a previous letter¹ we described the measurement of the half-lives of a few elements made weakly radioactive by neutron bombardment. The same neutron source and method have been used to investigate the radioactivity produced by slow neutrons in metallic zinc, caesium nitrate, thallium acetate and bismuth carbonate, with the following results:

	Half-life
Zinc	100 minutes
Caesium nitrate	75 minutes
Thallium acetate	97 minutes
Bismuth carbonate	No detectable activity

In addition we obtained the 6-minute half-life for zinc, reported by Fermi and co-workers.

The method we have used to calculate these half-lives, and also those published earlier, affords considerable accuracy in the case of relatively long-lived elements, even when the activity, measured by counts per minute, is very weak. Instead of plotting the rate of counting, dN/dT , as a function of time as is usually done ('differential method'), we have constructed an 'integral' curve (Fig. 1) in the following manner:

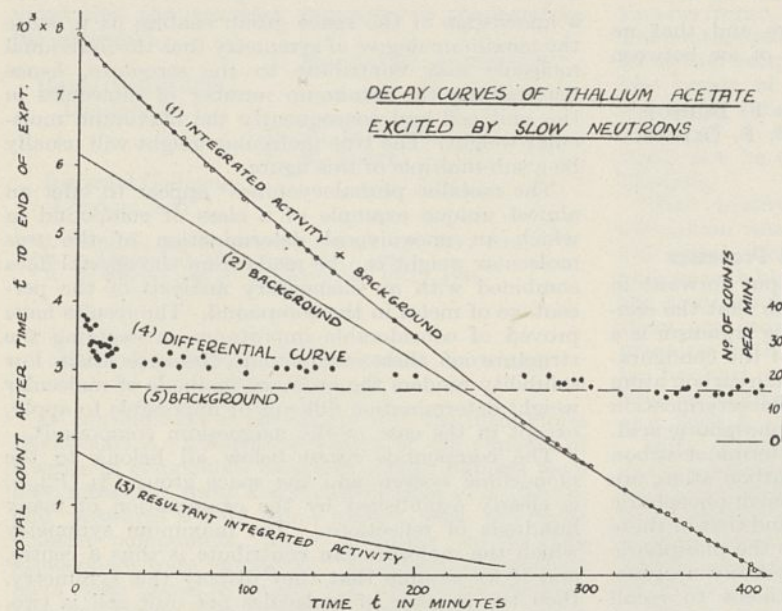


FIG. 1.

The activity was measured continuously until it had decayed to the normal background of the counter. A curve was then plotted to show the total number of impulses recorded, going backwards in time from the end of the experiment (curve 1). Part of this curve was due to the background, which contributed a total count increasing uniformly in

time (curve 2). The difference between these two curves gave the true decay of the active substance (curve 3); it actually represented the number of excited atoms present at any time. The points of a logarithmic plot lay very close to a straight line.

The superiority of the integral curve method over the differential curve method is apparent from curves 3 and 4. The fluctuations in the counting rate make it exceedingly difficult to draw a smooth differential curve when the activity is weak.

J. C. McLENNAN.
L. G. GRIMMETT.
J. READ.

Radium Beam Therapy Research,
Radium Institute,
16 Riding House Street,
London, W.1.

¹ NATURE, 135, 147, Jan. 26, 1935.

X-Ray Diffraction Patterns of Ice

DURING the last visit of the late Dr. E. W. Washburn to Toronto in the latter part of 1933, in an address on the properties of heavy water, he announced that water vapour, when condensed at very low temperatures, formed an amorphous rather than a crystalline solid. He reported that he did not know of any X-ray evidence to this effect. Mr. Fraser Oliver undertook to test this theory by taking X-ray photographs of the ice formed by condensation of water vapour on the outside of a copper rod. The copper rod could be maintained at any given temperature. The X-ray photographs were taken by the Hull-Debye-Scherrer method.

In the accompanying figure [see over] are reproductions of two photographs showing the X-ray diffraction patterns of ice formed at -85°C . (a) and -155°C . (c) respectively, together with microphotometer tracings (b and d) of the films. In the former case the diffraction pattern consists of lines characteristic of the close-packed hexagonal structure of ice, while in the latter there is one diffuse line corresponding to a spacing of 3.7 \AA ., indicating the amorphous character of the condensate. The lines due to diffraction by copper are indicated in both photographs, the other lines being those due to ice.

The results of our experiments, to be published later more fully, indicate that there is a critical temperature about -110°C . below which the

condensate is vitreous and above which crystals are formed. Barnes has already established¹ that ice formed by the freezing of water at 0° C. exhibits

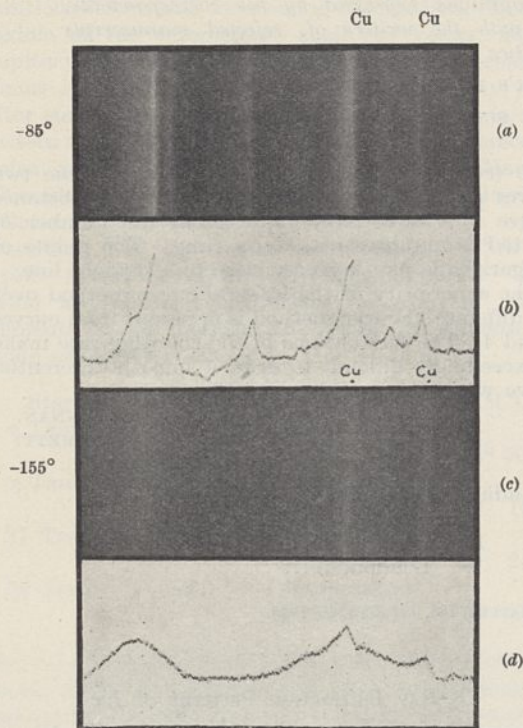


FIG. 1. X-ray diffraction patterns of ice from water vapour condensed at (a) -85° C., (c) -155° C., with corresponding microphotometer curves, (b) and (d).

the close-packed hexagonal structure and that no change takes place in the structure of ice between 0° C. and -183° C.

McLennan Laboratory,
University of Toronto.
Feb. 26.

E. F. BURTON.
W. F. OLIVER.

¹ *Proc. Roy. Soc., A*, 125, 670; 1929.

Formation of Galactose in Vital Processes

SOME years ago, Prof. Robinson¹ put forward in these columns the ingenious suggestion that the conversion of glucose into galactose in the organism is a direct one and due to an inversion of the configuration of the groups attached to the fourth carbon atom of the glucose molecule, consequent upon esterification of the hydroxyl group concerned by phosphoric acid. It is, however, now recognised that the terminal carbon atoms, as distinct from the fourth carbon atom, are those which are esterified in the fructose di-phosphoric acid involved in biological processes, and that in these latter the acid suffers disruption into the phosphoric esters of *d*-glyceric aldehyde and dihydroxy acetone.

In these circumstances it is pertinent to recall first, the demonstration by Schmitz² that the α - and β -acroses resulting from Emil Fischer's classical synthesis of hexoses from *dl*-glyceric aldehyde (and dihydroxy acetone) are respectively *dl*-fructose and *dl*-sorbitose, and secondly, the interconvertibility, shown by De Bruyn and van Ekenstein³, of *l*-sorbitose (which, together with fructose, would result from combination of *d*-glyceric aldehyde with dihydroxy acetone) and *d*-galactose under the influence of alkali.

It may, therefore, be said that in principle a transition from *d*-glucose to *d*-galactose has been experimentally realised, and it may reasonably be asked whether Nature does not avail herself of these reactions for the conversion in question as well as for its direct synthesis in plants of one or both of these carbohydrates. Failure to detect trioses in plant products is no more conclusive against this hypothesis than was the difficulty in detecting formaldehyde. Again, whilst it is true that *l*-sorbitose has not been found in Nature, *d*-tagatose (which stands in the same relationship to *d*-galactose as fructose does to glucose) also has not been observed, and, on the other hand, *d*-sorbitose, but not *l*-galactose, does occur naturally. A more serious objection to a biological inter-relationship between *l*-sorbitose and *d*-galactose perhaps lies in the fact that the former does not seem hitherto to have been fermented.

J. KENNER.

College of Technology,
Manchester.

¹ *NATURE*, 120, 44; 1927.

² *Ber.*, 46, 2327; 1913.

³ *Rec. trav. chim.*, 16, 263; 1897; 19, 1; 1900.

Molecular Weights of the Phthalocyanines

THE accuracy attainable in determining the molecular weights of organic compounds from the density and cell dimensions of the crystal has recently been the subject of a note in these columns¹. It is well known, of course, that the crystal data can in general give only a maximum figure for the molecular weight. Thus in the relation:

$$\text{Molecular weight} = \frac{\text{volume of cell} \times \text{density}}{\text{number of molecules per cell}}$$

a knowledge of the space group enables us to state the maximum degree of symmetry that the individual molecule may contribute to the structure, hence determining the minimum number of molecules in the unit cell and consequently the maximum molecular weight. The true molecular weight will usually be a sub-multiple of this figure.

The metallic phthalocyanines² appear to offer an almost unique example of a class of compound in which an unequivocal determination of the true molecular weight can be made from the crystal data combined with an elementary analysis of the percentage of metal in the compound. The results have proved of considerable importance in deciding the structure of these compounds, because their low solubility renders the ordinary methods of molecular weight determination difficult or impossible to apply, except in the case of the magnesium compound³.

The compounds listed below all belong to the monoclinic system, and the space group $C_{2h}^2 (P2_1/a)$ is clearly established by the examination of many hundreds of reflections. The maximum symmetry which the molecule can contribute is thus a centre, and if we assume that they display this symmetry, then the number of molecules per unit cell is two, and we obtain the following figures for the maximum molecular weight.

	Nickel phthalocyanine	Copper phthalocyanine	Platinum phthalocyanine
<i>a</i>	19.9 Å.	19.6 Å.	23.9 Å.
<i>b</i>	4.71	4.79	3.81
<i>c</i>	14.9	14.6	16.9
β	121.9°	120.6°	129.6°
Mol. per cell	2	2	2
Volume of cell	1186 Å. ³	1180 Å. ³	1186 Å. ³
Density	1.63	1.63	1.98
Max. mol. weight	586	583	712

Now the percentage of metal in the compound by elementary analysis gives the minimum possible molecular weight, namely, that of the molecule containing only one atom of the metal. The results are as follows:

	Nickel phthalocyanine	Copper phthalocyanine	Platinum phthalocyanine
Percentage metal	10.5	11.1	27.1
Minimum mol. weight	559	573	720

As the values of the maximum and minimum molecular weights coincide (within the experimental limits), it follows that these figures represent the true molecular weight, and that the formula in each case is $C_{32}H_{16}N_8M$, where M represents the metal atom, which must reside at the centre of symmetry. The calculated molecular weights from these formulæ are 571, 576 and 707, for the nickel, copper and platinum compounds respectively. An interesting point is the practical constancy of the molecular volumes. The cell dimensions show that the large flat molecules must be well spread out in the *ac* plane. A full discussion of the many remarkable features of these structures, however, cannot be given here.

Nickel and platinum phthalocyanines were prepared by the general methods already described². Details will be reported elsewhere. All three metallic compounds were obtained in a macro-crystalline form suitable for X-ray examination by vacuum sublimation at temperatures above 500° C. The crystal densities were determined by ordinary flotation methods. The improved technique described by Bernal and Crowfoot¹ would doubtless increase the accuracy very considerably.

It is possible that these methods might prove of value in the study of other complex compounds which contain a single atom of some element, provided that the necessary symmetry is displayed by the molecule.

J. MONTEATH ROBERTSON.

Royal Institution,
London, W.1.

R. P. LINSTEAD.

C. E. DENT.

Imperial College,
London, S.W.7.

¹ J. D. Bernal and D. Crowfoot, *NATURE*, **134**, 809; 1934.

² R. P. Linstead, *J. Chem. Soc.*, 1016; 1934.

³ R. P. Linstead and A. R. Lowe, *ibid.*, 1031; 1934.

Absorption Spectra of Substances containing Alkyl Radicals

In continuation of previous work¹, the ultra-violet (2000–5000 Å.) absorption spectra of the vapours of a series of compounds containing alkyl radicals have been measured, using absorbing columns of 5–100 cm. and pressures 0.1–15 mm., except with the more volatile compounds, when pressures up to one atmosphere were employed. Extensive precautions have been taken to purify the substances studied, previous work having shown that minute traces of impurity may considerably affect the results obtained.

The absorption spectrum of mercury ethyl, $Hg(C_2H_5)_2$, with pressures greater than a few mm. is completely continuous at wave-lengths greater than 2380 Å. With higher pressures than hitherto used, the long wave limit may lie at greater wave-lengths. With lower pressures a system of diffuse

bands is observed, prominent in which are the relatively intense pairs at 2362, 2345; 2305, 2290; 2250, 2235 Å. Between these pairs are similar but less intense bands at 2327 and 2272 Å. A much feebler band occurs at 2390 Å. and another extremely faint and more doubtful one at 2560 Å. The bands appear to degrade to the red and in general are broad. The system as a whole has an appearance in general similar to that observed with zinc diethyl, but there are differences. With longer columns there is a much feebler continuous absorption extending from 2420 to 2760 Å. with a maximum at 2560 Å., the position of the very faint band. This continuum appears to be independent of the former. The intervals and intensity relationships suggest that a ground state frequency involved is 498 cm^{-1} , modified in the excited state to 305, 294, 279. These frequencies are probably to be associated with valency vibrations of the metal-carbon link, which is excited electronically. The other prominent excited state frequency has values 1046, 1060, 1020, and 1075 cm^{-1} , and is probably related to a deformation oscillation in the C–H linkage (1090 cm^{-1}) as found in the case of diethyl zinc and many other examples². If the feeble band at 2560 Å. is genuine, there would also be a ground state frequency of 3276, which might be connected with a valency vibration in the alkyl group.

The above results agree with the previous conclusion with zinc dialkyls that the region of discrete bands is displaced towards longer waves in passing from methyl to ethyl compounds, for Terenin³ has recently reported a system of bands with mercury dimethyl in the region of 2000 Å., with a similar overlapping continuum extending to much higher wave-lengths at the higher pressures.

With germanium tetramethyl, absorption is continuous from c. 2330 Å., as found for lead tetramethyl⁴. The continuous absorption previously reported for lead tetraethyl occurs at wave-lengths less than c. 2350 Å. The bands at longer wave-lengths then given for the latter substance have been traced to the presence of a minute amount of benzene, which could not be entirely removed by the vacuum distillation.

With triethylamine at pressures up to 20 mm. absorption was continuous from c. 2650 Å., but the absorption limit may be at somewhat longer wave-lengths with higher pressures; with triethylphosphine the continuous absorption begins at c. 2500 Å. and there are indications that in both cases at lower pressures with longer columns the continuum may be resolved into extremely narrow diffuse bands. With trimethylamine continuous absorption begins at c. 2600 Å.

With dimethyl and diethyl ether there is a very feeble continuum at wave-lengths less than c. 2350 Å., agreeing with the results of Scheibe and Grieneisen⁵. With diethyl sulphide, on the other hand, a well-marked continuum extends from c. 2300 Å., or with higher pressures from slightly longer wave-lengths. At lower pressures a broad diffuse band appears at c. 2290 Å. Using long columns and very low pressures, when the band at 2290 Å. is scarcely visible, there is a faint continuous absorption from a noticeably sharp limit at c. 2240 Å., and there are indications that the interval 2290–2240 (974 cm^{-1}) is important. It is of significance that a strong Raman frequency of diethyl sulphide is given as 977 cm^{-1} . Taken in conjunction with the results obtained for hydrogen sulphide, and ethyl mercaptan C_2H_5SH , it appears

that with the diethyl-sulphide the electronic excitation is in the S-C link.

Details of the above work and a discussion of it will shortly be published elsewhere, when the data for other compounds will also be given.

H. W. THOMPSON.
J. J. FREWING.

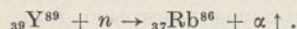
Old Chemistry Dept.,
University Museum, Oxford.
Jan. 21.

- ¹ H. W. Thompson, *J. Chem. Soc.*, 790; 1934.
² G. Herzberg and G. Scheibe, *Z. Phys. Chem.*, B, 7, 390; 1930.
G. Herzberg and E. Teller, *Z. Phys. Chem.*, B, 21, 410; 1933.
³ *J. Chem. Phys.*, 2, 441; 1934.
⁴ A. B. F. Duncan and J. W. Murray, *J. Chem. Phys.*, 2, 636; 1934.
⁵ *Z. Phys. Chem.*, B, 25, 52; 1934.

Radioactivity of Rubidium

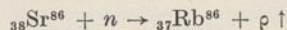
KLEMPERER¹ has recently shown that $^{19}\text{K}^{40}$ is very probably the source of the natural β -radioactivity of potassium. This supports the suggestion put forward by the authors² based on Fermi's failure to observe induced β -radioactivity when calcium is bombarded with neutrons. Klemperer also suggested that $^{37}\text{Rb}^{86}$ is similarly the source of the natural β -radioactivity of rubidium. The effects observed when rubidium, yttrium and strontium are bombarded with neutrons support this suggestion as follows.

Hevesy and Høffer Jensen³ have shown that $^{19}\text{K}^{42}$ formed from scandium has the same period as the radioactive isotope produced when potassium is bombarded with neutrons and it is, therefore, apparent that $^{19}\text{K}^{42}$ is formed by $^{19}\text{K}^{41}$ capturing a neutron. In a similar manner, the short-lived and weak β -radioactivity induced in rubidium when it is bombarded with neutrons is probably due to $^{37}\text{Rb}^{88}$ formed by $^{37}\text{Rb}^{87}$ capturing a neutron. If $^{37}\text{Rb}^{86}$ is also formed by $^{37}\text{Rb}^{85}$ capturing a neutron, then if this nucleus is the source of the natural β -radioactivity of rubidium, so few new nuclei are produced, that the long period will effectively prevent the observation of the corresponding disintegration electrons. It is noteworthy, as Hevesy³ points out, that the disintegration electrons from the $^{19}\text{K}^{40}$ nuclei newly formed when $^{19}\text{K}^{39}$ captures a neutron cannot be observed experimentally for the same reason. It is also significant that Fermi and his co-workers⁴ have observed no induced β -radioactivity when yttrium and strontium were bombarded with neutrons. Moreover, Szilard and Chalmers⁵ have shown that heavy particles are probably ejected from indium ($Z = 49$) and v. Grosse and Agruss⁶ have suggested that protons are probably ejected from uranium bombarded by neutrons. It seems, therefore, that under the conditions existing in Fermi's experiments, the emission of heavy particles may have followed neutron capture, and that this phenomenon prevails more generally than is to be expected. As, moreover, Chadwick and Feather⁷ have shown that the five examples of neutron capture followed by α -particle emission are elements of odd atomic number, it appears that yttrium $^{89}\text{Y}^{89}$ is disintegrated under neutron bombardment thus:



Hence the failure to observe induced β -radioactivity with yttrium may be evidence in favour of Klemperer's suggestion, since the β -rays due to the newly formed $^{37}\text{Rb}^{86}$ would be too few to be observed experimentally.

In addition, of eight elements of even atomic number, six emit protons following neutron capture. Accordingly when strontium is bombarded with neutrons the action:—



may occur and, therefore, the failure to observe disintegration electrons from strontium bombarded with neutrons may be additional evidence in favour of Klemperer's hypothesis.

F. H. NEWMAN.
H. J. WATKINS.

Department of Physics,
Washington Singer Laboratories,
University College, Exeter.
March 1.

- ¹ Klemperer, *Proc. Roy. Soc.*, A, 148, 638; 1935.
² Newman and Watkins, *NATURE*, 135, 98, Jan. 19, 1935.
³ Hevesy, *NATURE*, 135, 96, Jan. 19, 1935.
⁴ Fermi, Amaldi, D'Agostino, Rasetti and Segrè, *Proc. Roy. Soc.*, A, 146, 483; 1934.
⁵ Szilard and Chalmers, *NATURE*, 135, 98, Jan. 19, 1935.
⁶ v. Grosse and Agruss, *Phys. Rev.*, 46, 241; 1934.
⁷ Chadwick and Feather, International Conference on Physics, 1934.

A New Band System of NH

A NEW band has been observed in the spectrum of a hollow cathode discharge through streaming ammonia. The band is degraded to the red and is of simple structure, consisting of single P , Q and R branches. Heads are formed at $\lambda 4502$ and $\lambda 4523$ by the R and Q branches respectively.

Preliminary analysis has shown that the upper level of the band is identical with that of the $\lambda 3240$ band¹ of the $^1\Pi \rightarrow ^1\Delta$ system of NH. The simple structure of the band shows that the transition involved is of the type $^1\Pi \rightarrow ^1\Sigma$, so that the final level may be identified with the lower $^1\Sigma^+$ level predicted by Mulliken² for NH, but previously unobserved. Full details will be published shortly.

R. WINSTANLEY LUNT.
R. W. B. PEARSE.
E. C. W. SMITH.

Imperial College of Science
and Technology,
London, S.W.7.

University College,
London, W.C.1.

- ¹ R. W. B. Pearse, *Proc. Roy. Soc.*, A, 143; 1933.
² *Rev. Mod. Phys.*, 4, 6 (Fig. 37); 1932.

Action of Alternating Magnetic Fields upon Ferromagnetic Particles

WILL you allow me to demur to the statement on p. 349 of the issue of NATURE of March 2 that "No satisfactory interpretation of the phenomena was given" of certain experiments of mine on magnetism. The Physical Society invited me in 1928 to give an address on the subject of a 'discourse' which, at the request of the late Sir James Dewar, I had given in 1923 at the Royal Institution. My address at the Physical Society, published in abstract in the *Proceedings* of that Society (vol. 40, part 5, August 15, 1928) ended as follows:

"In his Royal Institution paper the Lecturer gave his reasons for attributing the repulsion to hysteresis. He sees no reason for changing that view. In that Paper fuller explanations of some of the effects for which there is not space here are attempted."

Readers of NATURE will, I think, find that the attribution of the effects to hysteretic repulsion was not made by me without very careful consideration.

In his book "The Interaction of Pure Scientific Research and Electrical Engineering Practice" (1927), Sir Ambrose Fleming describes the phenomena and on p. 72 remarks:

"In the Lecture above mentioned Mr. Mordey discussed the various causes to which the above effects may be due, and he came to the conclusion, with which the author of this book agrees, that the effective source of the repulsion is magnetic hysteresis."

The Athenaeum,
London.
March 4.

W. M. MORDEY.

THE necessary brevity of the Research Items paragraphs makes it impossible to introduce the reservations and qualifications which would be appropriate in fuller accounts. In the item referred to, the purpose was to direct attention to the main points in a paper by H. S. Hatfield. Reference was made to the earlier work of W. M. Mordey, but full justice could not be done to it. To Mr. Mordey is due full credit for the discovery of the effects in question, and for his admirable investigations of them. His work demonstrated very clearly a dependence on hysteresis. This, however, does not enable an immediate explanation of the effects to be given. In the last part of his Royal Institution lecture, Mr. Mordey appears to admit that he cannot find a satisfactory explanation of the phenomena; and there seems to be no suggestion of an interpretation on the lines proposed by Hatfield. Until Hatfield put forward his convincing and essentially simple explanation of the observed movements of the particles, it seems fair to say that a full explanation of the phenomena had not been given.

THE WRITER OF THE NOTE.

Definition and Measurement of General Intelligence

THE fundamental reason why general intelligence cannot be measured exactly by a hierarchical set of tests even if we agree that they define it (unless one of them tests nothing but general intelligence) is that in such a set there is always one more Spearman 'factor' than the number of tests: for each test has its own specific factor, and in addition there is the general factor.

Let z represent a set of k hierarchical test-scores, each test standardised to unity, that is, let $z = Ls$, or

$$\begin{bmatrix} z_1 \\ z_2 \\ z_3 \\ \dots \end{bmatrix} = \begin{bmatrix} l_1 & m_1 & \cdot & \cdot & \cdot \\ l_2 & \cdot & m_2 & \cdot & \cdot \\ l_3 & \cdot & \cdot & m_3 & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \end{bmatrix} \begin{bmatrix} s_0 \\ s_1 \\ s_2 \\ s_3 \\ \cdot \end{bmatrix} \quad (l_i^2 + m_i^2 = 1)$$

where s_0 occurs in every test, the other s 's in one each. Further, let q be the column vector $\{q_0, q_1, q_2, q_3, \dots\}$ where $q_0 = -1$ and $q_i = l_i/m_i$ ($i = 1, 2, 3, \dots, k$). After q_k the q 's are entirely at our disposal. q' is the transposed of q , and I the unit matrix. Then the orthogonal matrix

$$B = I - 2qq'/q'q$$

has the property that $L\bar{B} = L$, where \bar{B} is the first $k+1$ rows of B . We can therefore write $s = \bar{B}t$ where it is clear that the 'factors' t are different from the 'factors' s although every test is still 'two-factor'

and the correlations are unchanged. Thus even if we agree that these tests define general intelligence, we do not know whether it is s_0 , or t_0 , or u_0 , or v_0 , or any of the infinite possibilities, all giving different measures for the general intelligence of the whole population. We can rid it of this indeterminateness by adding one or more 'singly-conforming' tests (a better term I think than 'non-conforming' which I used in NATURE of January 12, p. 71).

Whether what the tests thus define is general intelligence is a question for the psychologist, not the mathematician.

University,
Edinburgh.
Jan. 28.

GODFREY H. THOMSON.

Biology of Growth and Breeding

THE observations by Cottam¹ on reproduction and growth of the sea-grass, *Zostera marina*, are of considerable biological interest. He suggests that perhaps the length of the growing season may be an important factor in determining the breadth of the leaves in any habitat, and points out that Setchell has shown that reproduction in the species occurs between 15° and 20° C. and growth in the range 10°-20° C. In recent work on increase in shell-area in the oyster², I found that there is large spring as well as autumn growth in the Fal Estuary, but only a trace of growth in spring, with a large summer or autumn growth in the River Blackwater. Now in the Fal Estuary the temperature rises slowly from about 10° in winter, whereas in the more insular Blackwater oyster beds the rise is very rapid. Breeding begins in the oyster³ at about 15°-16° C., and increase in shell-area ceases at the onset of the breeding season. There is thus a longer spring growing period in such hydrographical situations as the Fal Estuary than in localities like the Blackwater.

The parallel of growth and breeding in the oyster with *Zostera marina* is striking, as also is the convergence in their biology. It is well known that many animals breed at a relatively small size under relatively high temperatures³, and the explanation offered² is that there are, in many non-stenothermic animals, growth and breeding metabolisms governed by different temperature ranges, which give rise to a physiological antagonism between breeding and growth. It may therefore be deduced that when such an organism has attained a certain level of maturity, it will begin to breed providing temperature and other conditions are suitable. This level of maturity may occur at a small size, and if breeding conditions do not then obtain, growth may continue and produce a larger or different facies of organism before breeding occurs. There are winter as well as summer breeders, and the habitat and rhythms of the whole life cycle need to be studied in each species for a full understanding of the biology. The observations made in the study of the habitat of the oyster and the cockle⁴, it is interesting to note, may be of value in leading to an understanding of the broad-leaved *Zostera* found in deeper water off the coast of Great Britain.

Department of Zoology,
University, Liverpool.
Feb. 22.

J. H. ORTON.

¹ Cottam, C., NATURE, 135, 306, Feb. 23, 1935.
² Orton, J. H., J. Mar. Biol. Assoc., 15, 384, 419; 1928.
³ Orton, J. H., ibid., 12, 339; 1920.
⁴ Orton, J. H., Johnstone Memorial Volume, p. 97, 1934.

Experimental Induction of Coupling in *Xenopus laevis*, with the Production of Fertilised Eggs

In the course of an investigation into the sexual cycle of *Xenopus laevis*, the South African clawed toad (Shapiro and Zwarenstein¹, Shapiro and Shapiro²), certain outstanding differences in the sexual behaviour of this amphibian were observed under laboratory conditions as compared with natural conditions prevailing in the pond. It was noticed, among other things, that mating activity was never in any circumstances exhibited in captivity in the laboratory even at the height of the breeding season (July to September in South Africa).

In order to investigate the factors concerned with the mating reflex, toads fresh from the pond were brought into the laboratory at monthly intervals from August 1934. These toads were divided into three groups with appropriate controls. (Details of these experiments will be given in a forthcoming publication.)

In the first group, both the male and the female toads were injected with an acid extract of sheep's anterior pituitary, with an extract of pregnancy urine (prepared according to the method of Katzman and Doisy³) and a similarly prepared extract of male urine. In the second group, females only and not males were injected with these extracts. In the third group, males only and not females were injected similarly.

The results were as follows:—

A maximum percentage of coupling took place when both males and females were injected with either pregnancy urine or anterior pituitary extract.

A smaller percentage of coupling occurred when females only and not males were injected. This percentage rapidly dwindled to zero, the further from the breeding season in point of time the injections were made.

No coupling was observed when males only and not females were injected, even at the height of the breeding season.

In no case did the male urine extract induce the act of coupling or ovulation.

Colour change in *Xenopus* (which involves a pituitary mechanism, Hogben and Slome⁴) did not affect the mating reflex.

Several pairs of coupling toads were killed at the beginning of the act of mating and their oviducts were found to be entirely free of ova. Ovulation has also been observed without concomitant coupling.

In all, the mating reflex has been induced experimentally in 71 different pairs of toads with pregnancy urine extract and in 20 different pairs with anterior pituitary extract. The act of coupling lasts 24–48 hours, and fertilised ova were recovered from the containers of such coupling pairs. The ova were successfully reared for 4–5 months to the tadpole stage.

By injection of the above extracts coupling can be induced in the laboratory not only near the breeding season, but also in midsummer, that is, the mid-point between two breeding seasons. In all cases tadpoles have so far been reared successfully from such fertilised eggs.

The experiments also suggest:

(1) That a female stimulus initiates the response by activating the male.

(2) That the anterior pituitary is involved in this complex pattern of motor behaviour.

(3) That the pituitary mechanism associated with colour change in *Xenopus laevis* is not concerned with the mating reflex.

(4) That if the same chemical substance initiates ovulation as well as coupling, it initiates these two activities at different thresholds.

A further investigation into the details of the mating reflex is being carried out.

H. A. SHAPIRO.

Department of Physiology,
University of Cape Town.
Jan. 31.

- ¹ Shapiro and Zwarenstein, *J. Exp. Biol.*, **10**, 4, 372; 1933.
² Shapiro and Shapiro, *J. Exp. Biol.*, **11**, 1, 73; 1934.
³ Katzman and Doisy, *J. Biol. Chem.*, **744**; 1932.
⁴ Hogben and Slome, *Proc. Roy. Soc.*, **B**, **108**, 10; 1931.

Use of Cellulose Films in Palæontology

REFERENCE has been made by S. Leclercq¹ and J. E. Appel² to the use of cellulose films or 'peels' in palæontology, but there does not seem to be any published account of the procedure involved. In the method outlined below, which was suggested to me by Prof. L. J. Wills, and used in the first place to record the internal structure of rugose corals, a cellulose cast is made from an etched surface, and structural detail stands out solely by reason of the optical effect of textural variation.

The cellulose solution is most easily prepared by diluting the commercial preparation 'Durofix' with about twice its volume of butyl acetate; I have also found very satisfactory the solution advocated by R. Graham³.

The cut surface of the coral is ground with fine carborundum, etched for five to ten seconds with dilute (10 per cent) hydrochloric acid, washed and allowed to dry; the finer the organic structure, the shorter is the time of etching required. The specimen is mounted on plasticine so that the etched surface is horizontal, and after moistening the latter with butyl acetate as a precaution against air bubbles, the cellulose solution is poured on to form a layer about 2 mm. thick. The solution dries in 3–5 hours, and the edge of the film is then lifted from the specimen with a sharp blade, and the whole film peeled off. The film can conveniently be preserved between glass plates bound together at the edges.

The method is applicable to any fossil in which a difference in relief and texture between the organic parts and the surrounding matrix can be obtained by etching with hydrochloric or hydrofluoric acid. In the preparation of serial records it is advisable to embed the specimen in plaster of Paris before grinding; the distance between successive peels can be measured with a spherometer. Peels from corals and brachiopods show not only the outlines of the skeletal elements, but also the detailed fibrous or lamellar structure of these; some which were prepared in 1931 are still free from contraction or discoloration.

An important possibility is the distribution of duplicate records of type specimens, since a great many peels can be made from a prepared surface without re-grinding or re-etching.

A. J. BUTLER.

Department of Geology,
Victoria University of Manchester.
Feb. 28.

- ¹ *Annales de la Soc. Géol. Belg.*, **52**, B24–27; 1928.
² *Econ. Geol.*, 383–388; 1933.
³ "Stain Technology", 1928, vol. 8, pp. 65–68.

A Remarkable Whirlwind

'DUST-DEVILS', or rotating columns of sand travelling rapidly across open spaces, are not uncommon objects to desert travellers. Their height and breadth is often very considerable and the violence of the eddies causing them very great.

The smallest of this type I have seen was only about 5 ft. high, that is, the visible column of sand, and less than a foot in diameter. It passed so close to me that it was easy to see its narrow cycloidal path marked on the sand, which was deposited and lifted as the eddy travelled on at not less than 15 miles an hour, although the wind was actually very light.

I recently encountered a much more remarkable example while walking over a smooth surface of desert on a flat calm day. Hearing a swishing sound behind me, I turned and observed a large revolving ring of sand less than a foot high approaching me slowly. It stopped a few feet away and the ring, containing sand and small pieces of vegetable debris in a sheet less than one inch thick, revolved rapidly round a circle of about 12 ft. diameter while the axis remained stationary. It then moved slowly round me after remaining in one spot for at least thirty seconds, and slowly died down. It would be interesting to know if others acquainted with the desert have come across similar examples of a broad, flat eddy.

The ancient superstition among desert tribes that these whirlwinds are spirits, called 'afrit' or 'ginni' (the 'genii' of the "Arabian Nights"), would seem to have a reasonable foundation in face of such an 'inquisitive' apparition.

Cairo.

J. L. CAPES.

Thermal Decomposition of Acetaldehyde

In a letter in NATURE of January 12, Mr. Hinshelwood stated that further work in his laboratory by Dr. Winckler on the thermal decomposition of acetaldehyde had refuted the criticism of his work contained in a communication to the Royal Society of May 10, and in letters in NATURE of October 13 and 27, 1934. The results of this work appear in a paper which he communicated to the Royal Society at a meeting held on March 7, at which it was read in title only. The results are held to yield no evidence that the reaction represented by the equation, $\text{CH}_3\text{CHO} = \text{CO} + \text{CH}_4$, is appreciably heterogeneous, or that it depends upon a chain mechanism.

Mr. R. V. Seddon and I have also been engaged in a research on the same subject, with results which appear to us to point in exactly the opposite direction. The work is not completed, and the results may not be published for some time, so we ask permission to point out that the last word has not been said upon this subject.

M. W. TRAVERS.

Points from Foregoing Letters

THE half-life period of radioelements formed when metallic zinc, caesium nitrate, thallium acetate and bismuth carbonate are submitted to bombardment by slow neutrons is given by Prof. J. C. McLennan, Mr. L. G. Grimmett and Mr. J. Read. The authors also describe a way of plotting the observed activity, which allows of a more exact determination of the life period of relatively long-lived radioelements.

Prof. E. F. Burton and Mr. W. F. Oliver submit photographs of X-ray diffraction patterns indicating that at very low temperatures (below -110°C .) water vapour solidifies in amorphous form, while above that temperature it forms crystalline ice.

Galactose, a constituent of the milk sugar molecule, is apparently formed in the animal body from glucose, which has the same chemical composition, but different structure. Prof. Robinson has suggested that the change from glucose to galactose occurs through a relatively simple rearrangement of the atoms (brought about by phosphoric acid). Prof. J. Kenner now suggests that the glucose molecule is first broken up and then recombined to form galactose.

Molecular weights were first determined from combining ratios, osmotic and gas pressure, etc. Recent physical methods (for example, ultracentrifuging) sometimes give results differing from those obtained by the original methods. A way of obtaining the maximum molecular weight from density and X-ray crystallographic data is described by Dr. J. Monteath Robertson, Dr. R. P. Linstead and Mr. C. E. Dent. They show that, in the case of metallic compounds of phthalocyanines, it gives values agreeing with those obtained by the combining ratio method.

Prof. F. H. Newman and H. J. Walke adduce reasons supporting Klemperer's view that the natural

radioactivity (emission of electrons) of rubidium is due to the presence of an isotope of mass 86.

From the fact that independent intelligence test-scores fit 'tetrad' formulae which equate to zero, Spearman has deduced that a general intelligence factor g must exist in addition to special abilities. Prof. G. H. Thomson explains that though such hierarchical tetrad sets may prove the existence of g , they cannot in general measure it unless one of the tests measures general intelligence alone, or unless a 'singly-conforming' test is added.

In the case of animals which can live under various temperature conditions (non-stenothermic) there may be temperatures which are favourable for growth and not for breeding. Prof. J. H. Orton finds that the oysters in the Fal Estuary show a larger spring growth than those in the River Blackwater; he ascribes this to the fact that the temperature in the Fal Estuary remains longer in the spring between 10° and 15°C . (which promotes growth), while that of the River Blackwater rises more quickly to 15° to 20°C . (which facilitates reproduction).

Dr. H. A. Shapiro has investigated the effect of extracts of the anterior pituitary, of pregnancy urine, and of male urine, upon the mating instinct of the South African clawed toad. He finds that coupling is induced by the first two extracts. He deduces, among other things, that the anterior pituitary is involved in the mating reflex and that a female stimulus initiates the response in the male.

Mr. A. J. Butler describes the technique of preparing cellulose film casts from the etched surface of corals and other fossils. Such casts show structural details and have the advantage that a number of identical reproductions can be readily obtained to serve as type specimens.

Research Items

An Orissa Cult. Research in India during the last half century has brought to light the unexpected existence of a number of obscure cults, such as the masked Buddhism of Bengal, fire-worship in a remote corner of Rajputana, and curious agricultural cults in Bihar. Such survivals are compared by Sarat Chandra Mitra in a recent communication (*J. and Proc. Asiat. Soc. Bengal*, New Series, 30, No. 1) to a cult of a horse-headed goddess, of which evidence has been discovered in Orissa. Prof. Priya Ranjan Sen has found the "mare-headed Bāsuli" worshipped in various localities in Orissa by Keots and allied castes. The cult has a sacred book, said to have been written in Uriya by Achyutā Dās, one of the five companions of the great Vaishnava reformer Chaitanya Deva. He thinks that Bāsuli was originally a Dravidian deity, who was gradually transferred to the Hindu Pantheon. Her deityship is represented by an image with a horse's head and sometimes by a horse wholly made of wood. From a recently discovered folk-ballad, the development of the cult can be traced to a horse which was born from the water to help, and then serve as the mount of, a Dāsa king. It is hence inferred that the horse is the totem of the Keots and allied castes of Orissa, for the horse in the ballad is evidently a spiritual being connected in some way with the origin of the Keots—possibly their ancestor to whom they paid homage in the form of a wooden image, afterwards transformed into a goddess with a horse's head. The Khangars of Bundelkhand have a horse for their totem, but do not worship it. Reference is also made to the peacock totem cult of the Mori sept of the Bhils, and the tiger and hyæna totems of the Orāons, the Kurmi sept of the Mahilis of the Santal Parganas and the Jagganāthi Kumbhars of Orissa. If this contention can be maintained, it provokes dissent from the opinion of Risley that "the religious side [of the system of totemism] has fallen into disuse" in India.

Early Pottery in Beth Shan. In 1933 the expedition to Beth Shan of the University Museum, Pennsylvania, then in the tenth year of its work, carried its excavations down to virgin soil within a restricted area with the view of discovering the depth and nature of the levels which underlay the Middle Bronze Age stratum of about 1700 B.C. at a depth of thirteen metres (43 ft.) then being explored. A stratified succession of eight occupation levels was discovered, through a depth of 8.50 m. below the level previously reached, which goes back to an occupation of pit-dwellings in virgin soil earlier than anything previously found in Palestine. The pottery from these eight levels, which cover twelve separate periods of rebuilding, has been described and figured by Mr. G. M. Fitzgerald (*Museum J.* (Philadelphia), 24, No. 1). For convenience of description the pottery is classified into a threefold division: Levels xviii-xvi, xv-xiii, and xii-xi, which represent conspicuous changes in the character of the pottery, but cannot be assumed to indicate any change or interruption in occupation until the end of the Early Bronze Age. There are no sterile layers or burnt strata between any of the levels. The ware of the pit-dwellings is poorly burnt and gritty, hand-made, and often showing signs of a red slip or wash. In levels xii-xi the dominating characteristic is an abundance of lustrous

burnished pottery which is unlike anything in the levels below. This is the Kherbet Karan ware, so called from the site on the lower side of the Sea of Galilee where it was first found. It may be regarded on one view as here marking the first period of the Middle Bronze Age.

Dynamics of Animal Populations. Several mathematicians have recently been trying to codify into a harmonious system of formulæ the facts about increase and periodic fluctuations in animal populations. A. J. Lotka, a pioneer worker in this field before the War, has published the first part of a monograph on the subject ("Theorie analytiques des associations biologiques", *Actualités scientifiques et industrielles*, 187. Exposés de biométrie et de statistique biologique No. 4. Part 1: Principes. Pp. 45. Paris: Hermann et Cie, 1934). Changes in numbers in an animal community are really the redistribution of available matter and energy, through the selecting and concentrating powers of various living organisms, and as such can be studied by some of the mathematical equations employed for defining physico-chemical reactions. Equations expressing the interaction of two species are discussed, with special reference to the rates of increase, as a preliminary to the consideration of more complicated cases.

Historical Review of the Woodcock. The January number of the *Canadian Field-Naturalist* is given over to a historical review by Henry Mousley of the knowledge of the habits and anatomy of the woodcock, compiled from the earliest drawings and accounts to those of the present day. Both the European and American species (*Scelopax rusticola* and *Philohela minor*) are included in the review, and the author has been fortunate in having at hand the 5,000 original drawings and paintings of birds and other animate things in the Blacher and Emma Shearer Wood Libraries of McGill University. For example, a drawing of about 1805 showed that the flexibility of the upper mandible of the woodcock's bill was known to the artist, although the discovery has been attributed to Turnbull so late as 1890; the only reference to the character, earlier than the drawing mentioned, is by Naumann in 1799. The story of the discovery of the unusual position of the ear and vertebral column relative to the skull as a whole is traced, as well as other points of interest.

Life-History of *Philine*. Mr. Herbert H. Brown has made a detailed study of the tectibranch *Philine aperta* (*Trans. Roy. Soc. Edinburgh*, 58, Part 1, No. 9, 1934). This mollusc is common in the estuaries and creeks of the British coasts, burrowing in the sandy mud, especially above low-water mark, and is often associated with *Zostera*. In Loch Sween, where the author collected his material for the present research, it is one of the victims of the recent *Zostera* disease, its numbers being much reduced in places. Part 1 deals with the anatomy of *Philine*, Part 2 with its development. The eggs are laid in gelatinous strings by which the mass is firmly moored in the mud or sand. The newly hatched veliger has a simple shell and small bilobed velum. A conspicuous feature of the animal is a round black mass on the right side

in the body wall. This is the so-called 'secondary kidney', which does not itself give rise to the true kidney, the latter replacing it in due course. The larva grows quickly and gradually metamorphoses into the adult. After the velum is lost, the young animal may still be found in the plankton but soon finds its way to the bottom. The paper is well illustrated with text figures of the anatomy of both adult and larva.

Sandflies and Kala Azar. In their further investigations on Mediterranean kala azar, S. Adler and O. Theodor (*Proc. Roy. Soc. Lond.*, B, 801, Feb. 1935) have found that infections of the proboscis are rare in sandflies infected with the Maltese and the Catania strains of *Leishmania infantum*, and that the majority of such infections of the proboscis occur towards the end of the sandfly season. They also found that only those sandflies (*Phlebotomus*) which have the flagellate stage of *Leishmania* in the distal part of the proboscis are capable of depositing the flagellates in the skin during the act of piercing. The flagellates are passively deposited during the movements of the epipharynx in the tissue. It is inferred that the majority of infections in human beings are acquired towards the end of the sandfly season, and this view is supported by the fact that half of all the cases in Catania are diagnosed from the end of April to the middle of May, that is, from six to eight months after the end of the sandfly season. They consider it is highly probable that there are distinct strains within all the recognised species of human *Leishmania*. In the area in which the investigations have been carried out, dogs form reservoirs from which sandflies obtain *Leishmania*; the number of sandflies which infect themselves on human cases is comparatively small.

Finger-and-Toe Disease of the Cabbage Family. Dr. G. Potts has recently published a paper giving a large amount of information about the incidence and control of finger-and-toe disease of cruciferous plants (*Trans. Brit. Mycol. Soc.*, 19, No. 2, Jan. 1935). The experiments were performed before 1905, and it is rather a reflection on the slow progress of knowledge about this disease, that the paper is still of great interest and significance. Severity of attack by the fungus varies with the host, and symptoms for a considerable number of plants are given. Many experiments were directed to a study of the effect of soil reaction on the virulence of the pathogen. The application of sodium carbonate to the soil invariably controlled the disease more thoroughly than lime, though *Plasmidiophora* was found to occur and produce the characteristic swellings in highly calcareous soil, and in soil devoid of organic matter. Several questions as to infection by spores were also investigated, and the account has been brought up to date and correlated with more modern work on the same subject.

Mycorrhiza in Relation to Forestry. There is general agreement that healthy growth of pine and other conifer seedlings is always accompanied by free development of fungus-roots, and that poor growth and lack of vigour are associated with defective mycorrhiza formation. No satisfactory evidence has hitherto been offered that the two phenomena are causally related, but M. C. Rayner (*Forestry*, 8, No. 2, 1934) now describes field experiments and laboratory cultures with various species of *Pinus*

which prove that the presence of mycorrhizas normal for the species is causally related with proper nutrition and healthy growth of the seedlings. In cases where mycorrhiza development was defective, the condition was relieved and growth of the seedlings stimulated by inoculating seed-beds with small amounts of humus containing active mycorrhizas of the species. But the beneficial effects following inoculation are controlled by factors operating within narrow limits, since they are readily influenced by variation in experimental treatment, as, for example, the date of sowing. Hence it is important that a suitable technique for promoting mycorrhiza formation by means of humus treatments should be carefully worked out and standardised. Evidence was obtained of close correlation between particular soil conditions and the behaviour of specific mycorrhiza-formers; disturbances leading to replacement of mycorrhizas by parasitic pseudo-mycorrhizas with consequences adverse to the health and vigour of the hosts. On the heath soils used in the field experiments, it was found that mycorrhiza deficiency was due to inhibiting soil conditions rather than absence of appropriate mycorrhiza-formers, and the inhibiting action was reversed by the addition of organic composts to the seed-beds, resulting in mycorrhiza development, accompanied by increases in root and shoot growth which could not be attributed to direct manurial action.

Hydrology of Asia. Accompanying a paper on "Die Gewässer Eurasiens", Dr. F. Jaeger has produced in *Petermanns Mitteilungen* of January 1935 a novel map of the water features of Europe and Asia. In addition to the topographical features in which water plays a part, there are differentiated the wet and the dry climates, the limits of frozen soil, the occurrence of ice dams on the rivers, the limits of snowfall and the occurrence of glaciers. A further useful feature of the map is the distribution of the main types of surface apart from vegetation, such as sand, swamp, karst, etc. The map is on too small a scale (1:30,000,000) to show any country in detail, but is useful in illustrating broad contrasts.

Scottish River Gauging. We have received from River Flow Records, Parliament Mansions, S.W.1, a further memorandum (No. 2) on the subject of river flow measurement on the Aberdeenshire Dee, which was originally noticed in *NATURE* of September 8, 1934, p. 352. The development of the records is shown by three documents, the first exhibiting a standard form for water-level records intended to be completed at the Water Engineer's Office, Aberdeen; the second a stage-flow table compiled from river gaugings taken, mainly, between mid-September and mid-November 1934, with two types of apparatus—in all, about 7,000 velocity observations were made, including continuous night and day work during three high floods; the third document is a quarterly records diagram, exemplified by readings from the River Garry, at Invergarry, the diagram being designed to present the complete data of records relating to water levels, aggregate rainfall and run-off in a form suitable for publication. It is anticipated that the record diagrams for the River Dee for the whole year 1934 will be completed in a few weeks time and that, thereafter, other water recorders will be established at Balmoral and Dinnett, with a view to the completion of the flow gauging, the records being kept at an office in Aberdeen.

The Claude Power Scheme. The December 1934 issue of the *Annals of the Brazilian Academy of Sciences* contains an address by Georges Claude, of the Paris Academy of Sciences, on the present state of his work on the use of the sea as a source of power. His proposal is to evaporate surface water by reducing the pressure on it to about 1/100 atmosphere and condense it by means of water at a lower temperature brought up from a depth of 600–700 metres. His attempt to carry out this project on the coast of Cuba failed owing to the destruction of the cold water tube 2 kilometres long by a storm. His present attempt is being made at sea 70 miles south of the Bay of Rio de Janeiro on board the S.S. *Tunisie*. The cold water tube is here vertical, and of sheet iron insulated by wood; it is 650 metres long and 2.5 metres in diameter. The surface water has an average temperature of 24.5° and the lower water 6.5° C. The tube is supported by a float independent of the ship, a flexible tube connecting the two. The vapour produced by the evaporation of water taken from the surface passes through turbines to the condensers, and the power available is estimated at 1,300 kilowatts, but the figures on which this is based are not given, nor are the heats of evaporation and condensation mentioned.

Combustion and Explosion. The *Zeitschrift für Elektrochemie* of March 1935 contains a review by Dr. W. Jost of the "Mechanism of Explosions and Combustions". Chain mechanisms, which are now so much in the limelight, do not occupy much space in this review, although Semenoff's work is frequently referred to; but ample references are made to the experiments of Bone, Finch, Wheeler and Coward, in Great Britain, and of Bernard Lewis in America, as well as to Haber's experiments in Germany. Two tables of observed and calculated velocities of detonation are cited from Lewis's work, and the literature references number exactly one hundred. The wide scope and unbiased character of the discussion make this review of real value as a summary of the present position of this important subject.

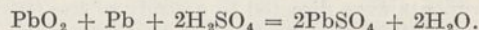
Early Stages of the Electric Spark. U. Nakaya and F. Yamasaki have studied the formation of ions in a spark gap by putting the gap in a Wilson cloud chamber (*Proc. Roy. Soc., A*, Feb. 1). Immediately after the expansion, the potential was applied to the gap for a short time by means of an impulse generator, and a photograph was taken a few hundredths of a second later. Distortion of the ion distribution by electric winds was avoided by the short time of application of the potential. The potential was usually insufficient to produce a fully developed spark, but violet brushes could be seen in some of the experiments. At low voltage a spindle-shaped ion cloud appears at a point on the negative electrode; at a higher voltage a bundle of streamers appears in addition on the positive electrode. These grow longer and take a branched form when the potential is further increased. These figures have a resemblance to the positive Lichtenberg figures obtained on a photographic plate.

A Spectroscopic Determination of e/m . Work carried out before 1929 did not give good agreement between the values of e/m obtained for free electrons and those obtained spectroscopically. This discrepancy has tended to disappear in more recent work. C. D.

Shane and F. H. Spedding (*Phys. Rev.*, Jan. 1) have made a precise spectroscopic determination by measuring accurately the frequency difference between corresponding parts of the line structure of $H^1\alpha$ and the heavy hydrogen line $H^2\alpha$. The method gives directly the ratio of the mass of the electron to that of the hydrogen nucleus, and e/m may then be calculated when we know the Faraday electrolytic constant. A liquid-air cooled discharge tube was used as light source, and a Fabry Perot étalon combined with a large grating was employed to resolve the lines. The separation was found by analysis of microphotometer curves. The final value is $e/m = 1.7579 \pm 0.0003 \times 10^7$, which agrees with other recent results by the two methods.

Empirical Heat Capacity Equation. The classical form of equation relating heat capacity to temperature: $C_p = a + bT + cT^2 + dT^3 + \dots$, is known to fail in certain cases, and it is proposed that it should be replaced by an equation of the type $C_p = a + bT + cT^n$. The success of this equation depends upon the value of n employed, and it is desirable that a single value of n should be selected which gives satisfactory values for a wide range of substances, and it is also essential that the equation shall be readily integrable for the purpose of arriving at values for the energy. J. Chipman and M. G. Fontana (*J. Amer. Chem. Soc.*, 57, 48; 1935) propose the equation in which $n = -\frac{1}{2}$, and show that for several typical substances, including gases, magnesia, graphite and calcium silicate, the equation gives results which are sufficiently accurate for thermodynamic calculations, the temperatures in all cases extending to above 1,000° C. The data for the solids used are experimental; those for the gases are theoretical values calculated from spectra. An equation of the first-power series-type, proposed by Eastman, and one proposed by Kelly, were found to be not at all trustworthy when extrapolated beyond the range for which each was intended.

The Lead Accumulator. In three recent papers (*J. Amer. Chem. Soc.*, 57, 9, 27, 33; 1935), H. S. Harned and W. J. Hamer have reported experimental work and calculations which have an important bearing on the thermodynamic theory of the lead accumulator. They conclude that the reversible cell reaction is that proposed by Gladstone and Tribe:



The experimental work involved the measurements of the electromotive forces of various types of cells at different acid concentrations and temperatures. In the calculations, the activities of water in sulphuric acid solutions, the activity coefficients of sulphuric acid in aqueous solutions of concentrations 0–17.5 *M* and at temperatures from 0 to 60°, and also thermal data are involved. The results are compared with measurements of vapour pressures, freezing points and heats of dilution, and very satisfactory agreement is found. A number of interpolation equations have been worked out and a very comprehensive study of the electrode potentials and reversible electromotive forces of cells related to the lead accumulator is presented in a condensed and convenient form. One of the matters investigated was the preparation of lead dioxide by different methods, the specimen prepared by electrolysis of a solution of lead nitrate and nitric acid giving the most consistent results.

Atmospheric Electricity in Australia

THE work initiated by the late Prof. W. G. Duffield on the foundation of the Solar Physics Observatory at Canberra included preparations for the study of atmospheric electricity. This work is now yielding results; a few months ago Mr. A. R. Hogg published an analysis of observations of conductivity and of the nucleus-content of the air, and now a memoir on potential gradient prepared by Mr. C. W. Allen has been printed in the series of official publications of the Commonwealth Observatory*.

Potential gradient has been recorded at various places with more or less precision for the best part of a century, but it is only within the last few years that clear ideas as to the significance of the measurements have been developed. Mr. Allen has been able to incorporate some of the new ideas in his discussion of the records obtained at the Commonwealth Observatory, and there are many points of interest in his memoir.

The Observatory is on Mount Stromlo, a flat-topped hill 780 m. above sea-level, 200 m. above the surrounding country, which is 12 km. west of Canberra and 120 km. from the sea-coast. The only sources of pollution in the atmosphere are the occasional bush fires. It is not likely that these have affected seriously the results which Mr. Allen sets out in his memoir, which deals in the main with the potential gradient in fine weather.

It is well known that the upper atmosphere is at a high positive potential compared with the ground. For this purpose we may regard the upper atmosphere as being either the Heavyside layer or the atmosphere at a height of 10 km. or so. Under the influence of this high potential, a current, the air-earth current, flows down to the ground. The strength of this current varies inversely with the resistance of the air column. The potential at a height of say one metre above the ground is proportional to the current and to the resistance of the air in this lowest metre. The potential gradient may also be regarded as a measure of the negative surface charge on the ground or of the complementary positive charge distributed through the atmosphere. For the interpretation of observations of potential gradient all these factors must be borne in mind.

Mr. Allen has looked for the influence, at Canberra, of the world-wide changes in the potential of the upper atmosphere, by studying the changes of potential gradient on days with continuous strong wind, realising that on such days the changes of conductivity of the lower atmosphere will be comparatively small.

* Memoirs of the Commonwealth Solar Observatory, Mount Stromlo, Canberra, Australia. Memoir No. 4: Atmospheric Potential Gradient Observations at the Commonwealth Observatory, Mount Stromlo, Canberra. By C. W. Allen. Pp. 47. (Canberra: Government Printer, 1934.)

He finds that under these conditions the diurnal variation of potential gradient approximates to the type found over the oceans, a type in which the maximum gradient occurs at about 19 h. G.M.T., the minimum at about 3 h. G.M.T. According to Wilson the potential of the upper atmosphere is maintained by thunderstorms and, as was first pointed out by Appleton, the diurnal variation is due to the fact that the activity of thunderstorms is at its maximum when it is afternoon in one of the tropical continental areas and at a minimum when it is afternoon over the Pacific. When the distribution of thunderstorms is studied in detail, it is found that the regions of activity are farther west in the northern summer than in the northern winter, so that the maximum activity occurs later in the Greenwich day in the former season. The corresponding delay in the occurrence of the maximum potential gradient is not manifest in the rather irregular graphs which represent Allen's Canberra results, but the corresponding shift in the phase angle of the 24-hour term comes out in harmonic analysis.

The effect of wind on the potential gradient at Mount Stromlo is curious. The gradient is comparatively small during calms and with very light winds but has its maximum value with winds of 5 m.p.h. A falling off with stronger winds occurs with south-east winds but not with north-west winds (these are the two prevailing currents). Allen endeavours to explain the minimum in calms by the 'electrode effect'; but this explanation should, as he would be the first to admit, be tested by observation. The test would be straightforward, for the gradient as published is deduced from the potential difference between the ground and a collector at a height of 2.4 metres. If the 'electrode effect' is there, a higher value of the gradient would be found by using a collector only one metre above the ground.

Enough has been said to indicate the high value of Mr. Allen's memoir. It is to be hoped that his methods of analysing potential gradient records will be copied and extended elsewhere.

One curious detail must not be forgotten. It appears that in summer the sea-breeze reaches Mount Stromlo in the early evening. The arrival of the sea-breeze is always marked by a drop in the potential gradient, and frequently there is a negative gradient for a few minutes. The more sudden and violent the wind change the more prominent is this effect. The gradient soon becomes positive again and is generally higher than previously. Is this evidence that at the head of the sea-breeze little whirlwinds are generated, raising dust which settles and leaves the air negatively electrified, so that a negative space charge is carried onwards for a considerable distance? It seems likely.

F. J. W. W.

Man's Place among the Primates

PROF. W. E. LE GROS CLARK, Dr. Lee's professor of anatomy in the University of Oxford, contributed a closely reasoned review of the present position of the questions of the evolution of man to the recent congress of Anthropological Sciences which is now published in full (*Man*, January). The main conclusions at which he arrives are summarised below.

The evidence suggests that one sub-order of the Primates, the Lemuroidæ, branched off at least at the very beginning of the Tertiary period from a basal primate stock which had been segregated from a generalised placental mammalian group in the Cretaceous period, and that any resemblance that it shows to the monkeys at later stages of its evolution is due to parallel development. Another sub-order,

the Tarsioida, also a branch from the basal primate stock, approximates much more closely in its evolutionary tendencies to those of the higher primates. It is not improbable that the latter arose from fossil tarsioids in Eocene times, originating from the earliest and most primitive members of the group. Some of the resemblances shown by the tarsioids to the monkeys are due to parallel evolution.

The evidence also suggests that the monkeys diverged from the main stem of evolution very soon after the tarsioid stage had been passed. Of all the primates, the anthropomorphous apes stand nearest to man structurally, but there is no reason for believing that they derive from a common ancestor so distant and so generalised that it would not come into the category of the anthropomorphs. It is necessary to postulate an anthropomorph ancestry for modern man, though this does not mean that in the line of human descent there ever was a form which showed the characteristic specialisation of modern anthropoid apes such as the great elongation of the arms and degeneration of the thumb.

It is certain that the earlier anthropomorphs were relatively generalised creatures, in which the primitive proportions of the limbs were still retained, and yet they would have shown a grade of development of brain, skull, dentition, etc., which would have entitled them to be called 'anthropoid apes'. There is every reason for supposing that man was initially derived from such a type. The evidence of foot structure, as shown by Dr. Morton in America, is decisive. Structural features afford evidence that the foot of modern man is derived from a foot once used for grasping purposes.

At what stage in the evolutionary differentiation of the anthropomorphs did the human stem become segregated from that which led to the modern anthropoid apes? The mandible and lower dentition of the fossil *Parapithecus* of lower Oligocene age are regarded by most as representing a small and very generalised member of the Anthropomorpha, which may have formed the basis for the development of the later types. This may involve regarding the platyrrhine and catarrhine monkeys as precocious and specialised offshoots of the anthropomorphous stock.

Of the same geological age as *Parapithecus* is *Propliopithecus*, which so closely resembles the modern gibbon that it is included in the Hylobatidæ. Thus even in these early times the anthropoid apes were already undergoing rapid differentiation.

It is generally conceived that man arose in Miocene times from a *Dryopithecus* stock which also gave rise to the modern African apes. Prof. W. K. Gregory has shown that the human dentition was almost certainly derived from this type. The human stock, however, has avoided modifications which are a necessary concomitant of brachiating habits, and it is improbable, therefore, that the direct ancestors of man practised brachiation to any considerable extent. The evidence suggests strongly that in the evolution of man the limbs attained to human proportions in advance of other parts of the human body. In early types of man such as *Pithecanthropus* or *Sinanthropus*, while the skull and brain were astonishingly ape-like, the limb structure was closely comparable or even identical with that of *Homo sapiens*. The larger an animal becomes, the more difficult it is for that animal to adopt the upright posture, and hence the common ancestor of man and the apes must have been a comparatively small animal, that is, at a hylobatid rather than a giant anthropoid level.

This harmonises with the fact that the gibbon is the only animal which shows an erect bipedalism comparable with that of man. The strikingly human characters of the large African apes must owe their origin to parallel evolution. The general form of ancient types of man—*Pithecanthropus* and *Sinanthropus*—recalls the gibbon rather than the great apes. If modern types of man did come into existence early in the Pleistocene, it is probable that the direct ancestors of man are to be found in the Miocene forms of *Dryopithecus*, already distinct from the line leading to the modern large anthropoid apes.

The known remains of *Dryopithecus* are almost entirely limited to jaws and teeth, and it has been surmised that the skull was probably not unlike that of the African ape. It may be, however, that future discoveries will show that it manifested characters shadowing in a much greater degree those of the Hominidæ. If Schlosser's interpretation of the Eppelsheim femur as really belonging to *Dryopithecus* be correct, it indicates that *Dryopithecus* was much more adept in erect bipedalism than any of the great apes of to-day, and lends further support, therefore, to the conception that the precursors of the chimpanzee and gorilla set off on their own evolutionary adventures some considerable time before the dryopithecine precursors of man had come on the scene.

Vitamin Standards

THE International Conference held in London in June 1931 under the auspices of the Permanent Commission on Biological Standardisation of the League of Nations Health Organisation recommended for international adoption standards and units for vitamins A, B₁, C and D, which were to be provisional for two years. As certain of the standard preparations were not available until 1932, the second Conference was postponed until 1934, when two years experience of the practical application of the standards would be available.

The report of the second Conference, which was held in London in June 1934 under the chairmanship of Prof. E. Mellanby, has now been issued (*Quart. Bull. of the Health Organisation of the League of Nations*: Vol. 3, Extract No. 15; 1934). No change has been

recommended in the standards for vitamins B₁ and D. The former, which has perhaps proved the most satisfactory of all the standards recommended in 1931, is an adsorption product of the vitamin, extracted from rice polishings, on fuller's earth. The unit is the activity of 10 mgm. of the standard. It was prepared in the Medical Laboratory, Batavia (Java) by the method of Seidell, as described by Jansen and Donath. The standard for vitamin D, which was prepared at the National Institute for Medical Research, London, is a solution in oil of irradiated ergosterol. The unit is the activity of 1 mgm. of this solution, which has been found equal to that of 0.025 γ of crystalline vitamin D. It is recommended that when a new standard solution becomes necessary it should be replaced by a solution

of the pure crystalline material in olive oil, of such strength that 1 mgm. contains 0.025 γ .

The Conference recommends that pure β -carotene be adopted as the standard for vitamin A, in place of the present standard, which is a mixture of the isomers of carotene. The value of the unit is unchanged and one such unit is contained in 0.6 γ of the new standard: the old standard contained the same activity in 1.0 γ . The standard preparation is to be issued in solution in a vegetable oil, in which it has been shown that it does not lose colour on incubation in the presence of air at 37° C. for 7 days, the strength of the solution being such that 1 gm. contains 500 units, or 300 γ of β -carotene. The Conference report states that it has been found that measurement of the coefficient of absorption at 3280 A. affords a reliable method for measuring the vitamin A content of liver oils and concentrates, and that the value obtained for $E_{1\text{cm}}^{1\text{ per cent}}$ 3280 A. can be converted into a figure representing units per gram by multiplying by the factor 1,600. This figure is the average of a series of comparative and independent tests on the unsaponifiable fractions of liver oils and on concentrates of high potency.

For vitamin C the Conference recommends the adoption of *l*-ascorbic acid as standard, the unit being the activity of 0.05 mgm. of the pure substance. (The previous standard was lemon juice, one unit being contained in 0.1 c.c.: it has since been found that the potency of lemon juice varies, but the adoption of the new standard does not involve any significant change in the value of the unit.) It was decided to ask the Institute of Medical Chemistry, Szeged, through Prof. A. Szent-Györgyi, to prepare a batch of 500 gm. of the standard and to ask Prof. W. N. Haworth to co-operate in controlling its purity.

Among the subjects suggested for future work are the provision of a sample of cod liver oil as a subsidiary standard of reference for vitamins A and D and the investigation of the anomalous action on certain species of different sources of vitamin D.

All the standards are kept at the National Institute for Medical Research, London, acting for this purpose as the central laboratory on behalf of the Health Organisation of the League of Nations.

University and Educational Intelligence

CAMBRIDGE.—The General Board recommends that the following additional University teaching offices be established: (a) an assistant directorship of research in the Faculty of Economics and Politics; (b) an assistant directorship of research in colloid science; (c) a University lectureship in the Department of Mineralogy and Petrology; (d) a University demonstratorship in agricultural engineering (subject to financial provision being made by the Ministry of Agriculture and Fisheries); (e) two University lectureships in the Department of Pathology; (f) a University lectureship in experimental psychology; (g) a readership in industrial psychology (subject to the provision by the Medical Research Council of the stipend and pension contribution); (h) an assistant directorship of research in industrial psychology (subject to the provision by the Medical Research Council of the stipend and pension contribution).

EDINBURGH: On the recommendation of the Senatus, the Court has approved of the establishment

of a Sharpey-Schafer lectureship in physiology, a fund for the endowment of this lectureship having been contributed by pupils and friends of Sir Edward Sharpey-Schafer. The first of the lectures, to be given biennially, will be delivered in the coming summer term.

LONDON.—The Buckinghamshire County Council has decided to make a grant of £5,000, payable over ten years, towards the erection of new buildings in Bloomsbury.

A grant of £2,000 has been made by the Pilgrim Trustees to the London School of Economics towards central expenditure on the Land Utilisation Survey. The grant, which is for staff salaries and the preparation of the report on the Survey, is estimated to cover the cost of completing the Survey as far as central expenditure is concerned. Local bodies and others are subscribing to local expenditure, and it is hoped that sufficient additional contributions from these sources will be obtained to complete the total cost of the work. The Pilgrim Trustees have further given valuable assistance to the Survey by setting aside a sum of £1,000 which can be drawn upon as required by the London School of Economics to secure the continuance of the publication of the maps. This sum is to be repaid by the School from the publication account of the Survey.

Science News a Century Ago

Walker's Eidouranion

"The Strand Theatre," said *The Times* of March 31, 1835, "from which Thalia and Melpomene have been banished by the Lord Chamberlain, has during Lent become the residence of Urania. Mr. Walker, the well-known popular lecturer, and perhaps the original lecturer, on the motion of the heavenly bodies and the phenomena of the planets, has commenced his very interesting lectures at this house. His lectures, and the reputation he has deservedly acquired by them, his apparatus and machinery, are so well known to almost all persons, that there is no need of giving a further description of them. They are in their contrivance elaborate and complex, but the illustration which they afford of the subject which he discusses is at once simple and intelligible. . . . The lecturer himself enters into his subject with a spirit of inquiry, and an earnestness of endeavour to familiarize science, which are very refreshing to those whose attempts at gaining information have been chilled by the technical formality of more stately teachers. . . . At a time when the theatres are closed against dramatic performances the public cannot do better than devote a few hours to the acquirement of the scientific knowledge which these lectures, and similar lectures, convey and there can be little doubt that to the younger branches of the community they will convey that information to which young persons are exceedingly averse, unless it is conveyed in such a manner as to excite attention without distracting the understanding and wearying the patience." The lecturer was presumably Deane Franklin Walker (1778-1865) who, like his father Adam Walker (1731?-1821), lectured on science at Eton and Harrow and other public schools.

The Tides of the United Kingdom

On April 2, 1835, Whewell read a paper to the Royal Society entitled "On the Results of Tide

Observations, made in June 1834, at the Coast-Guard Stations in Great Britain and Ireland". Through representations made by Whewell, orders had been given for simultaneous observations of the tides at all the stations of the Preventive Service on the coasts of England, Scotland and Ireland from June 7 until June 22, 1834. The observations were sent to the Admiralty, and a part of them had been reduced. From them Whewell had been able to deduce many important inferences. He found that the tides in question were not affected by any general irregularity having its origin in distant sources, but only by such causes as were merely local, and that therefore the tides admitted of exact determination with the aid of local meteorological corrections. The curves expressing the tides of high-water presented a very satisfactory agreement with theory. A diurnal difference in the height of the tides, he said, manifests itself with remarkable constancy along a large portion of the coast under consideration. The tide hour appeared to vary rapidly in rounding the main promontories on the coast, and very slowly in passing along the shores of the intervening bays, so that the co-tidal lines are brought close together in the former cases, and in the latter run along nearly parallel to the shore; circumstances which would account for comparative differences of level and of corresponding velocities in the tide stream.

Theories of Electricity

Prof. William Ritchie (1790-1837), after being a schoolmaster in Scotland, went to Paris, where he studied under Thenard, Gay Lussac and Biot. In 1829 he became professor of natural philosophy at the Royal Institution, and three years later was given a similar post in the University of London. On April 3, 1835, he gave a lecture at the Royal Institution on the "Comparison of the two Theories of Electricity". The first of these theories, he explained, supposed that electrical phenomena depended upon the existence of a fluid universally diffused through matter and space, the particles of which repel each other inversely as the square of the distances. If we abstract a portion of this fluid from a body, the latter becomes negatively electric; while if we add a portion, we produce the phenomena exhibited by positive electricity. Another theory considered electricity to be a compound substance, consisting of two elements, positive and negative electricity. None of the phenomena is observed until this fluid is decomposed, and then a portion of it goes to the attracted body. Perhaps, said Prof. Ritchie, the fluid may be the ether to which the phenomena of light seem attributable.

The Dublin and Kingstown Railway

"The following is a statement," said the *Mechanics' Magazine* on April 4, 1835, "of the number of passengers, of different classes, conveyed along this railway during the first quarter of a year since it was opened, namely, from the 17th December 1834 to the 17th March 1835:

1st Class fare, 1s. each	10,008
2nd ditto 8d. each	72,148
3rd ditto 6d. each	94,961

Total number of passengers 177,117

The whole of this immense number of passengers has been carried without the slightest accident of any sort. The receipts during the same period have amounted to £5,283 16s. 8d."

Societies and Academies

LONDON

Royal Society, March 21. D. R. HARTREE and W. HARTREE: Self-consistent field, with exchange, for beryllium. Fock's equations for the self-consistent field of an atom, including exchange effects, have been completely solved numerically for the normal state of neutral Be. In connexion with the numerical calculations of energy values, a new check, depending on the direct calculation of the difference of energy values calculated using the solution of Fock's equations and using any other wave functions, is developed and applied. The inclusion of the exchange terms has a small but appreciable effect on the (1s) wave function, which becomes more like that for the Be^{++} ion, and a considerable effect on the (2s) wave function, which contracts, and also becomes smaller near the origin compared to its maximum value. These changes are qualitatively of a kind to bring calculated values of certain atomic properties into better accord with experiment. H. R. HULME, J. McDOUGALL, R. A. BUCKINGHAM and R. H. FOWLER: The photo-electric absorption of X-rays in heavy elements. A method is developed for finding the photo-electric absorption coefficient for the K-shell, σ_K . The calculations are rigorous and are not subject to the restriction $Z \ll 137$, where Z is the atomic number. Theoretically it is possible to apply the method for all values of $h\nu$, the energy of the quantum absorbed, but, as a considerable amount of numerical values is necessary, it is not practical for large values of $h\nu/mc^2$. Values of σ_K are given for $h\nu/mc^2 = 0.693$ and 2.21 for elements with atomic numbers 26, 50 and 84. The values obtained do not differ much from those given by Hall, using a method which is discussed. His expression has therefore been used for σ_K in the region $h\nu > 5mc^2$ and graphs have been constructed giving the photoelectric absorption *per atom* for various elements in the range $h\nu > 0.7mc^2$ or 3.4×10^5 e.v. The values obtained for lead are in excellent agreement with the experimental results as given by L. H. Gray's empirical formula.

DUBLIN

Royal Irish Academy, February 25. R. Ó CINNEIDE: Some 2.4-derivatives of thiophene. 2-Thiophene-carboxylic acid condenses with *N*-methylolamides to form derivatives of the general formula 2.4. $HOOC.C_4H_2S.CH_2NHCOR$. These derivatives, on acid hydrolysis, give the amino-acid 2.4. $HOOC.C_4H_2S.CH_2NH_2$, which can readily be oxidised to the known acid 2.4. $C_4H_2S.(COOH)_2$. The hydroxy-acid 2.4. $HOOC.C_4H_2S.CH_2OH$ can also be obtained from the above amino-acid.

PARIS

Academy of Sciences, February 11 (*C.R.*, 200, 501-596). A. GOSSET: The partial longitudinal resection of the inferior vena cava in the course of the ablation of a right pararenal tumour. Description of a rare operation. HENRI LAGATU and LOUIS MAUME: Leaf diagnosis of tobacco. The comparative influence of the scoria of dephosphoration, of superphosphate and of the basic phosphate on the PNK equilibrium. EDOUARD CHATTON and MLE. BERTHE BIECHER: *Amæobophrya* and *Hyalosaccus*: their evolutive cycle.

The new order of the Cœlomastigina in the Flagellates. CHARLES POISSON was elected *Correspondant* for the Section of Botany, in succession to the late William Morris Davis. E. J. GUMBEL: The m th extreme values and the logarithm of the number of observations. OCTAV ONICESCU and G. MIHOC: Chains of statistic variables. DIMITRI PEREPELKINE: The conformal transformation and the intrinsic normal Riemannian curvature of a V_m in V_n . SERGE ROSSINSKI: The deformation of a rectilinear congruence with conservation of the principal ruled surfaces. MAURICE JANET: Two theorems on the relations between linear differential expressions. ANDRÉ WEIL: Topological demonstration of a fundamental theorem of Cartan. GEORGES VALIRON: Systems of integral functions. ARMAND RAUCH: The trend of integral algebroids in the paths of infinite determination. HENRI PONCIN: The stable hydro-dynamical configurations which admit of surfaces of discontinuity for densities. DANIEL BELORIZKY: A remarkable change in the radial velocity of the new star in Hercules. The results of spectrographic measurements show that the radial velocity of this new star increased 230 km./sec. in ten days. MLLE. M. A. BAUDOT: Generalisation of the equation of continuity and of the theorem of Liouville for a space of wave functions. PAUL RENAUD: A generalisation of Curie's principle of symmetry. JEAN CAYREL: Comparative energetics of a two-current system and a system of equivalent layers. WILLEM UYTERHOEVEN and CORNELIS VERBURG: The superficial effect [skin effect] in the positive column of a sodium-neon discharge. RENÉ PLANTOL. An arrangement for the production of ions in a high vacuum. G. JOURAVSKY, P. CHARCZENKO and G. CHOUBERT: The residual induced magnetism of the eruptive rocks. The residual magnetism of igneous rocks is largely due to magnetite. After mechanical treatment by which the greater part of the magnetite is removed, the residual magnetism of the non-attracted portion is higher than would correspond to the proportion of magnetite remaining. ALBERT MICHEL-LÉVY and HENRI MURAOUR: A light source of exceptional intensity and of very short duration. By the explosion of a small quantity (0.4 c.c.) of a liquid explosive in an atmosphere of argon, a flash of light of very high intensity is obtained which lasts less than five millionths of a second. The spectrum extends into the ultra-violet and promises to have useful applications. FRED VLÈS: A spectral property of electrolytes in solution. NÉDA MARINESCO and MARIO REGGIANI: The impression of photographic plates by ultra-sounds. The action of ultra-sounds on a bromide plate free from any latent image results in the formation of a fine system of stationary waves. MLLE. SUZANNE VEIL: Gelatine submitted to the action of an electric field. Study of the properties of gelatine after submitting to an electric field. There is a diminution in the electrical conductivity, and the anode region is positive with respect to the cathode region. MLLE. CÉCILE STORA: The unsaturated character of colouring matters and the photo-voltaic phenomenon. P. CARRÉ: The relative mobilities of the normal primary alkyl radicals from C_1 to C_{16} in their chlorosulphites. The temperature of decomposition of the chlorosulphite in the presence of pyridine is taken as the measure of the mobility. The mobilities vary in the same direction from C_1 to C_7 : from C_8 to C_{15} they become lower than those of C_7 , presenting odd-even alternation. PIERRE TRUNEL: The permanent electric

moments of some alkyl chlorosulphites. From measurements of the electric moments of alkyl chlorosulphites it is concluded that the structure remains the same for any value of R up to normal hexyl. MICHEL LESBRE: The action of the alkyl iodides on the alkaline plumbites. Sodium plumbite reacts with methyl or ethyl iodide giving sodium iodide and a plumbonic acid, $RPbO.OH$. ANTOINE WILLEMART: Contribution to the study of the preparation of coloured hydrocarbons of the rubene type. PAN TCHENG KAO: A phenomenon shown in polarised light by quartz in vibration. NY TSI-ZE and TSIEN LING-CHAO: The oscillations of a hollow quartz cylinder. A hollow quartz cylinder can vibrate in four different ways. In certain cases, the piezo-electric quartz plate can be advantageously replaced by a hollow cylinder. LOUIS ROYER: The orientation of lead chloride and bromide by muscovite mica. MLLE. YVONNE BOISSE DE BLACK: New data on the constitution of the Puy Violent, an autonomous volcano of Cantal. G. DUBAR and D. LE MAITRE: The presence of Solenopores and Spongiomorphides in the Moroccan Lias. JEAN LEGRAND: The utilisation of observations of the mean sea-level in the investigation of climatic cycles. PIERRE GAUDAUDAN, MME. NOÉLIE GAUDAUDAN and MARCEL PELETTIER: The evolution and significance of the nucleolar apparatus in the somatic karyokinesis of some Angiosperms. RAOUL COMBES: The biochemical study of the flower. The mineral nutrition of the corolla. The comparative study of the corolla and leaf shows that the former is less mineralised than the leaf. MARC SIMONET: The experimental synthesis of *Iris intermediæ*. JOSEPH MEETERHANS: The pneumatic canal and the swim-bladder of the Physostome fishes. MME. JULIE KOSTITZINE: The female reproductive system of *Purpura lapillus*. LUCIEN PLANTÉFOL and GEORGES CHAMPÉTER: The action of heavy water (deutrohydrogen oxide) on revisescent animals. ARMAND DEHORNE: Cytological observations on a new species of Haplosporidium, parasite of the cœlom of *Nereis diversicolor*. GASTON RAMON and EDOUARD LEMÉTAYER: The immunising action of the tetanic toxin, mixed with lanoline, on the experimental animal. The toxin of tetanus mixed with lanoline and olive oil, after injection into the rabbit in quantities representing ten times the toxic dose, gave none of the symptoms of tetanus. The rabbit was immunised against tetanus. CONSTANTIN LEVADITI, RENÉ MARTIN, ANTOINE BONNEFOI and MLLE. RACHEL SCHOEN: The etiology of mumps.

SYDNEY

Royal Society of New South Wales, December 5*. G. HARKER: Note on the determination of traces of prussic acid in tissues. Chelle's method involves the distillation of the prussic acid and its subsequent concentration in a small volume of potash solution, by removing it from the distillate with a current of air. Owing to destruction of nearly half the prussic acid in the preliminary distillation process—a destruction which takes place also in the absence of tissue—the results were distinctly low. The percentage loss, however, is fairly constant and an allowance can be made for it, leaving but a small margin of error. The direct removal of the prussic acid from the tissue by a current of air gives higher yields except when less than 0.01 mgm. prussic acid

is present. ADOLPH BOLLIGER: The volumetric microdetermination of picrolonic acid in organic picrolonates with methylene blue. Picrolonic acid forms with methylene blue a compound which is sparingly soluble in water (less than 0.001 per cent), but fairly soluble in chloroform (0.16 per cent). Thus picrolonic acid is so far the most soluble *o*-nitrohydroxyl compound for titration with methylene blue. The technique of the titration is the same as that described for picric acid or other *o*-nitrophenols. The end point is very sharp. Varying amounts of 0.01N picrolonic acid could be recovered with an error not exceeding 0.2 per cent. Further, the picrolonates of α -naphthylamin, piperidin and *p*-toluidin were examined for their picrolonic acid content by the method described. P. M. GAME: Geology of the Cudgegong district. This paper describes a belt of country, 12-15 miles wide, extending south-eastwards from Mudgee for about 35 miles. Upper Silurian and Middle and Upper Devonian strata are represented. All three series are fossiliferous. A great strike fault, following the Cudgegong valley, separates the Upper Silurian and Upper Devonian systems here, but elsewhere the three series are conformable with each other. They have been intruded by acid igneous types of the Kanimbla epoch, and are overlain unconformably by horizontal Kamilaroi and Triassic strata. Remnants of thick Tertiary sills and flows cap the highest hills, such as Mount Bocoble (sill), and Cumbermelon Mountain (flow). S. C. BAKER: Testing a Lummer-Gehrcke interferometer; its use in a search for abnormality in the relative abundance of the isotopes of a special sample of mercury. A cadmium-amalgam lamp of new design is described. The relative intensities and half-value widths of the interference fringes of the cadmium red line were measured and compared with the theoretical values calculated from data of the apparatus. Discrepancies are attributed to the experimental limitations. The relative intensities of the hyperfine components of the green line emitted by two samples of mercury—one Australian, the other foreign—when excited by the high-frequency discharge differ by less than 2 per cent, which is within the limits of experimental error, so that there is no evidence of difference in the relative abundance of the isotopes of the two samples. F. A. COOMBS, W. MCGLYNN and M. B. WELCH: The tannin content of a variety of *Acacia mollissima*, Willd. (4). A description is given of a variety of *Acacia mollissima*, black wattle, which occurs over a wide area of New South Wales. Whilst the maximum tannin content found in seventeen analyses was found to be 51.5 per cent, the lowest was only 22.9 per cent. It is evident that under favourable conditions this variety may yield a tan bark of high quality. M. B. WELCH: The longitudinal variation of timber during seasoning (2). An examination was made of the longitudinal variation of some three hundred samples of a large number of different woods, in relationship to their densities. While 66 per cent of the total samples swelled or remained stationary during drying from a green condition to the fibre saturation point, only 33 per cent behaved similarly from the fibre saturation point to an air-dry condition. In general, woods of low density showed the greatest tendency to swell and heavy woods were more prone to remain stationary, during the initial drying period. Below the fibre saturation point, light timbers showed the greatest liability to shrinkage and heavy woods were inclined to remain stationary or to swell.

Forthcoming Events

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

Monday, April 1

- BRITISH MUSEUM (NATURAL HISTORY), at 11.30.—J. Ramsbottom: "Symbiosis in Plants".*
- ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Capt. Gabel-Jørgensen: "Dr. Knud Rasmussen's Contribution to the Exploration of the S.E. Coast of Greenland".

Tuesday, April 2

- LONDON NATURAL HISTORY SOCIETY, at 6.30.—(at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, W.C.1).—Sir F. Gowland Hopkins: "The Naturalist in the Laboratory" (Bacot Memorial Lecture).

Wednesday, April 3

- SOCIETY OF ENGINEERS, at 6.—(at the Royal Institution, Albemarle Street, W.1).—Sir William Bragg: "The Theoretical Strength of Materials and their Practical Weakness".

Thursday, April 4

- INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Prof. E. W. Marchant: "Electricity in the Life of To-day" (Faraday Lecture).

Official Publications Received

GREAT BRITAIN AND IRELAND

- Harper Adams Agricultural College, Newport, Shropshire. Soil Survey of North Shropshire. By W. Morley Davies and G. Owen. Pp. 33+2 plates. (Newport: Harper Adams Agricultural College.)
- The Board of Greenkeeping Research. Report for 1934. Pp. 44. (Bingley: St. Ives Research Station.)
- Proceedings of the Royal Society of Edinburgh, Session 1934-1935. Vol. 55, Part 1, No. 1: The Duration of Life in an Albino Rat Population. By Dr. B. P. Wiesner and N. M. Sheard. Pp. 22. 2s. Vol. 55, Part 1, No. 2: Dating of Late-Glacial Clay Varves in Scotland. By Gerard De Geer. Pp. 23-26. 6d. Vol. 55, Part 1, No. 3: The Invariant Theory of the Correlation. By Prof. H. W. Turnbull. Pp. 27-41. 1s. 3d. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

OTHER COUNTRIES

- Annual Report of the Indian Central Cotton Committee, Bombay, for the Year ending 31st August 1934. Pp. ii+152. (Bombay: Indian Central Cotton Committee.) 2 rupees.
- Carnegie Museum, Pittsburgh, Pennsylvania. Botany Pamphlet No. 1: Poisonous Plants of Pennsylvania. By Dr. Edward H. Graham. Pp. 16. (Pittsburg, Pa.: Carnegie Museum.) 10 cents.
- I.R.I. Broadcasts in conjunction with International Industrial Relations Institute Conference on Social Economic Planning, November 1934. Pp. iv+40. (New York and The Hague: International Industrial Relations Institute.) 30 cents.
- Lac and the Indian Lac Research Institute. By Dorothy Norris, P. M. Glover and Dr. R. W. Aldis. Pp. iii+53+12 plates. (Nankum: Indian Lac Research Institute.) 2.8 rupees.
- Report of the Aeronautical Research Institute, Tokyo Imperial University. No. 117: On the Motion of High-pressure Powder Gases and Compression Waves in the Neighbourhood of a Muzzle of a Rifle. By Kwan-ichi Terazawa, Mitsuo Tamano and Sin-iti Hattori. Pp. 439-492+9 plates. (Tokyo: Koseikai Publishing Office.) 75 sen.
- U.S. Department of Agriculture. Circular No. 342: The Waterfowl Flyways of North America. By Frederick C. Lincoln. Pp. 12. (Washington, D.C.: Government Printing Office.) 5 cents.
- The Hokkaido Imperial University. Calendar 1934-1935. Pp. iv+240. (Sapporo: Hokkaido Imperial University.)
- Education, India. Education in India, 1932-33. Pp. vii+117. (Delhi: Manager of Publications.) 2.8 rupees; 4s. 6d.
- Kungl. Svenska Vetenskapsakademiens Handlingar. Series 3, Band 14, No. 2: Studies in the Genus *Astelia* Banks et Solander. By C. Skottsberg. Pp. 106+24 plates. (Stockholm: Almqvist and Wiksells Boktryckeri A.-B.) 10.00 kr.
- Astrophysica Norvegica. Vol. 1, No. 3: Measurements of Luminous Night Clouds in Norway 1933 and 1934. By Carl Stermer. Pp. 87-114+17 plates. (Oslo: Jacob Dybwad.)

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