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## Education of the Adolescent.[1]

TO form and to strengthen character; to train tastes which will dignify leisure; to awaken and guide intelligence, especially on its practical side: these are the three ends which the Consultative Committee of the Board of Education had in mind when framing the recommendations which have been embodied in its Report on the Education of the Adolescent, and, even though we may have some difficulty in discovering the exact dividing line between the qualities of the second and third, we must admit that they are ends which, if attained, would make formal education almost as vital to human life and activity as nutrition and reproduction.

There are, of course, many forces which operate against the attainment of such ends, and not the least is the attitude of mind of the very committees which make such valuable recommendations. Let there be no mistake: if, as we shall attempt to show later, the present Committee has not been infallible, there can nevertheless be no doubt that it has faced its problems with unusual breadth and clarity of vision. It has faced boldly—whether the revision and extension of school nomenclature it suggests receive approval or not—the inevitability of a regrading of education, and it has not lacked the courage to recommend the raising of the school leaving age. It has left no avenue unexplored, and it has neglected no statistical detail in order that, so far as it could see them, no factors of the present system should be avoided in its argument. Not forgetting that "a community must solve its . . . problems in accordance with its own traditions and customs," the Committee has carefully examined the history which has brought these factors into being, and has lucidly set forth the lines of advance which it believes will lead to a system capable of securing for its pupils the benefits we have described. Nor has it shirked the issue of demonstrating how its recommendations may be made administratively possible.

These points, in themselves, are perhaps sufficient to demonstrate with what sense of responsibility the Committee regarded terms of reference which not only requested attention to the organisation, objective, and curriculum of courses of study for children (other than those attending secondary schools) who will remain in full-time school attendance up to the age of fifteen, but also that regard should be had to their probable future occupations

[1] Board of Education. Report of the Consultative Committee on the Education of the Adolescent. Pp. xxiv+339. (London: H.M. Stationery Office, 1926.) Paper, 2s. net; cloth, 3s. net.

in commerce, industry, and agriculture—a feature which led the Committee at an early stage in its report to make a pronouncement so important that we need not apologise for its reproduction: "The educationalist, unless he would build his castles in the air, is bound at every turn to take into account the probable future of the children and the nature of the industrial society into which . . . the majority will enter." Or, again: "School and industry are different facets of a single society, and the habit of mind which isolates them is a habit to be overcome."

Reading that, the technical teacher might well begin to congratulate himself that, at last, the liberal quality, as well as the importance of his work, was being recognised; and he would be strengthened in his view when he read, further, a recommendation which begins: "A humane and liberal education is not one given through books alone, but one which brings children into contact with the larger interests of mankind." If he read still further, however, he would discover that the Committee is discussing the proposed 'Modern' (at present 'Central') Schools, and that when it realises whither the argument may lead, seems to become suddenly fearful and is careful to point out that it is *not* suggesting any wide extension of Junior Technical Schools, but that the 'modern' school should develop with a 'realistic' or 'practical' bias and should not aim "at giving a technical or vocational education." He would see that the Committee's attitude towards technical education is one which fits but ill with the philosophical statements which preceded his search. A little puzzled, he would turn to the Committee's definition of this word 'bias,' and find his dilemma still further increased. Finally, he would lose the last vestige of his optimism when he discovered the Committee's view that a foreign language is regarded as necessary in the modern school, but its necessity in the Junior Technical Schools—even though its lack may be a barrier against matriculation and entry into the learned institutions—is set out in very guarded terms. He will not, therefore, be very much to blame if he thinks the work of technical education is still but little understood, and that the ancient and arid arguments between the values of 'arts' and 'sciences,' and between 'pure' and 'applied' science are not yet at an end. A crumb of comfort will fall to him, however, when he reads that, on suggested examination boards, "Technological teachers might be co-opted."

If, in its view and knowledge of the work of technical schools, the Committee has not been infallible, it is beyond doubt that it has been very largely influenced by the inevitable trend towards the linking up of education and industry. It has not failed to observe that the modern development of industry has resulted in a loss of craftsmanship and an increase in leisure, due to the lessening hours of labour, and it has therefore rightly regarded the school as an instrument which can do much to counteract the loss of craftsmanship and to secure that leisure may be wisely used. In this connexion it has laid some stress upon handwork, and, in addition, to recommending that a sufficient number of teachers must have the craftsman's interest and outlook; it has given evidence of its recognition of another important question by its suggestion that girls as well as boys should learn something of the use of tools, and should be allowed to take a short course in wood and metal work.

There is not, perhaps, much that is new in the Committee's suggestions on the teaching of science. The interdependence of the various subjects is clearly indicated. Not only is the science teacher to keep closely in touch with the teachers of drawing and mathematics, but also "simple apparatus might be made by pupils in wood and metal lessons." In the case of girls, the science courses of the Modern Schools should, in their later stages, have a biological trend; and the work should not, as is frequently the case, be confined to botany. The reasons given for this recommendation show that the Committee has taken care that the liberal qualities of science teaching shall be thoroughly understood, and that it shall not aim at the assimilation of unrelated facts. "The study of simple forms of animal life can . . . be made an admirable means of widening and disciplining the pupils' sympathies" and will increase happiness and efficiency. In the same way, for boys and girls, instruction in biology and elementary physiology "might well provide the basis for a right attitude to many social problems." To the initiated these suggestions may form part of an accepted philosophical attitude towards education—especially on its scientific side—which is almost a *sine qua non* of a rapidly developing society. For our part we welcome them, since we do not lack evidence that words and actions are often poles apart, and we realise that there cannot be too much examination and repetition of fundamentals.

If post-primary education is to be a unity in the full sense of that word, we may be pardoned if we refer to a subject sometimes (wrongly) regarded as outside our province. In dealing with the teaching

of history, the Committee has dealt well with the view that it is a study of the organised life of a community, and has regarded part of its function as the enabling of the pupil to see the present as a development of the past. On our side we are tempted to regard the present as but a thin dividing line between the past and future. Doubtless the Committee holds the same view, but until the science section of the Report is reached we do not observe any suggestions which would mean the presentation of any historical view of what science has done for mankind. In these days of the cinema, aircraft, wireless telephony and broadcasting, it seems to us an essential part of a liberal education that the influence of science in breaking down the barriers of space, and in drawing together people who formerly were antagonistic because of their lack of mutual understanding, should have some definite part in the most formal teaching of history.

We willingly run the risk of being told that we are not aware of the correct place of such teaching. For the moment we regard it as sufficient that the point be made, and, while waiting for the later pronouncements upon such an important theme, we may leave it quite safely in the hands of the teachers of science.

## Modern Occultism.

*Der physikalische Mediumismus.* Von Dr. W. v. Gulat-Wellenburg, Graf Carl v. Klinckowstroem und Dr. Hans Rosenbusch. ("Der Okkultismus in Urkunden," herausgegeben von Max Dessoir.) Pp. xiv + 494 + 15 Tafeln. (Berlin: Verlag Ullstein, 1925.)

THIS imposing volume is known in Germany and Austria as the "Dreimännerbuch." It is the first of a trio of books intended to deal exhaustively with modern representatives of those 'occult sciences' which have never ceased to occupy a certain type of mind since the days of Paracelsus. The increasing habit of civilised humanity to submit all such 'hidden' sources of knowledge to examination by modern scientific methods has driven their advocates and devotees to adopt at least an apparently up-to-date terminology.

Thus we do not hear much about the Secret Rose, the Elixir of Life, or the Fifth Essence. But we are told all the more about Psychophysical Energy, Metapsychics, Rigid Rays, Telekinesis, and Ectoplasia—imposing words which to many minds convey an irresistible suggestion of reality.

It would of course be impossible to deal in one book with the vast volume of occult literature, nor do the 'three men' make any attempt to do so. But they do pass in review what may be called the serious treatments of the subject, and the sporadic attempts to apply some scientific method to the study of alleged phenomena which seem to contradict well-known physical and biological laws.

Of the three authors of this book, Count von Klinckowstroem deals with the "Confessions of a Medium" as well as classical mediums like D. D. Home, Florence Cook, Slade, Guzik, and Mrs. Gilbert. Dr. Rosenbusch studies Eusapia Paladino, Stanislava Tomczyk, and Kathleen Goligher, while Dr. von Gulat-Wellenburg examines the claims of Marthe Béraud ('Eva C.'), Franck Kluski, Willy Schneider, Nielsen, and Laszlo.

It may seem a deplorable waste of time and energy to devote five hundred pages of close print to the criticism of alleged phenomena which have been almost unanimously rejected by the scientific world. But it is necessary to remember that we are here dealing with alleged happenings which, if authenticated, would necessarily change our whole outlook on the possibilities of life and even of non-living matter. Even in their unproven state these alleged observations are exerting a very wide influence on great masses of contemporary thought and feeling. To millions they form the basis of a new religion purporting to have a sound scientific basis. One cannot envy the fate of the few leaders of science whose names are perennially quoted as supporting and sanctioning spiritualist practices. The name most widely exploited in this connexion is that of the late Sir William Crookes, whose few experiments, undertaken without appropriate training and then abandoned, have formed a peerless model for all later investigators and imitators.

The truth appears to be that these 'supernormal' phenomena bring us face to face, not so much with a higher world of spirit as with an underworld of human credulity, based upon an irresistible appetite for the marvellous. This appetite or need has always existed; and it has always rebelled against the established order of things. It has always postulated the existence of beings superior to it, whether angels or jinns or the spirits of the dead. Who can wonder that men trained in scientific methods have sometimes shown a similar weakness! Physicists show this tendency perhaps more than others. But that may be due to the fact that their researches are the most fundamental as regards the structure of the universe. They work on the very frontier of the unknown,

and their recent discoveries are so marvellous that a miracle more or less does not seem to signify.

The modern attempt to erect occultism into a science was supported, if not initiated, by Alexander Aksakof, whose "Animism and Spiritism" advocated the view that spiritistic phenomena were not due to disembodied intelligences but to unexplained powers of the human organism itself. It was he who coined the word 'telekinesis' for movement without contact, and one cannot help wondering how many conjuring tricks, clever or otherwise, have since been dignified by that beautifully fashioned Greek word. It was Dr. Ochorowick who invented 'ectoplasy,' though it did not become popular until F. W. H. Myers defined it in his work on "Human Personality and its Survival of Bodily Death." He called it "the power of forming outside some special organism a collection or reservoir of vital force or of vitalised matter which may or may not be visible or tangible but which operates in like fashion as the visible and tangible body from whence it is drawn."

Many attempts have been made to investigate this mysterious 'vitalised matter' and to define its properties. If we were to take the current spiritualist view, ectoplasy, or rather 'ectoplasm,' would be the substratum of all 'materialisations,' even of full figures like Crookes's Katie King, *plus* her calico dress. It would also constitute the 'rigid rays' emanating from the fingers of Mlle. Tomczyk, the 'psychic rods' of the Goligher circle, and the plastic structures described by Dr. v. Schrenck-Notzing. The latter were supposed to consist of amorphous material capable of assuming any form or appearance suggested by the medium's subconscious mentality. Thus they sometimes showed the structure of half-formed faces in plaster-of-Paris, which were ascribed to the frequent visits of the medium to a sculpture studio.

According to Schrenck-Notzing the ectoplastic structures are very sensitive to illumination and to touch. 'Katie King,' in Crookes's charmed circle, could cut off strips of her dress, and materialise them permanently enough to be examined in daylight. But ordinarily the material is fugitive in light, and contact is not allowed for fear of injuring the medium.

Here again it is difficult to arrive at any sort of consistency. Dr. Crawford was allowed to touch a 'psychic rod.' It felt like a stockinged foot, with toes complete, but the medium was neither hurt nor injured by the touch. Also, did not v. Schrenck-Notzing himself take a kinematograph picture of a materialisation without inflicting any injury?

A biologist inclined to credit the existence of ectoplasm endeavoured some time ago to form some intelligible conception of it by supposing it to partake of the nature of pseudopods put out by unicellular organisms. But this would scarcely account for Katie King's obviously woven calico. The late Dr. Crawford's speculations concerning 'X' and 'Y' matter building up 'psychic rods' capable of lifting tables and adhering to carmine and other pigments cannot be taken seriously, in view of the total absence of scientific control of the Goligher circle. Nobody has as yet put forward a description of 'ectoplasm' which will cover the various forms of its alleged occurrence or permit of any consistent theory as to its properties. Even the assertion that it emanates from the epithelium of any natural orifice of the organism fails to cover cases where it is alleged to emanate from the fingers. The analysis of a fragment of the substance said to have been isolated by Dr. v. Schrenck-Notzing showed nothing but epidermis such as might have been peeled off a human heel.

The authors of the "Dreimännerbuch" must be congratulated on the minute and serious analysis of all 'supernormal' phenomena which have been vouched for by persons of any scientific standing. Their criticism is objective and temperate, and in all cases where a normal explanation is difficult or impossible they frankly admit its being so. One is therefore inclined to give all the more weight to their main conclusion, which is that the scientific proof of the reality of physical mediumistic phenomena has never yet been furnished, all the alleged phenomena being capable of a normal explanation based upon deception or inadequate observation. The only cases which they are inclined to leave in doubt are certain reports concerning D. D. Home and a few experiments with Eusapia Paladino. But even these are now of little value owing to the impossibility of repetition.

That the phenomena in question are rare and elusive does not in itself deprive them of scientific interest. But it is becoming increasingly clear that any hope of their substantiation depends upon the provision of competent observers. The qualifications of such observers must be very high, much higher than in the case of ordinary physical and biological investigations. Not only must the psychic researcher be acquainted with all the abnormalities of vision in a feeble light and under prolonged strain, but he must also be versed in the numberless possibilities of deliberate deception

and trickery. The ordinary physicist or biologist is quite incapable, as a rule, of explaining a clever conjuring trick performed in a bright light. Yet he will sometimes assert that all possibility of fraud was excluded in circumstances which would make a conjurer smile.

No new observations can in future be taken seriously unless the observer shows a close acquaintance with the sources of error involved in these investigations. In this respect the "Dreimännerbuch" furnishes a valuable test of knowledge. Considering that the English-speaking world is more obsessed by spiritualism than the rest of civilised mankind, an English translation of this book would fill an important place by the side of Myers and Podmore.

## German Handbooks of Physics.

(1) *Handbuch der Experimentalphysik.* Herausgegeben von W. Wien und F. Harms. Band 2: *Mechanik der Massenpunkte und der Starren Körper.* Von Prof. Dr. Arthur Haas. Pp. xiv + 355. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1926.) 30 gold marks.

(2) *Handbuch der Physik.* Herausgegeben von H. Geiger und Karl Scheel. Band 1: *Geschichte der Physik; Vorlesungstechnik.* Redigiert von Karl Scheel. Pp. vi + 404. (Berlin: Julius Springer, 1926.) 31·50 gold marks.

THE progress of physics during the last few decades has been truly remarkable, and it is with a feeling akin to hopelessness that the present-day physicist vainly attempts to keep abreast of the times. As the science has developed, specialisation has become more and more necessary, and it is to this intensive specialisation that physics owes its present vastness. In such circumstances, the need for an up-to-date "Handbook of Physics" for purposes of reference has become increasingly urgent, and it was to be expected that sooner or later such a work would be forthcoming. In English, the "Dictionary of Applied Physics" serves a useful purpose in enabling physicists to have easy access to recent developments in the divers branches of their subject, and in German, apart from several excellent handbooks on special branches, Winkelmann's "Handbuch" has done valuable service, though it is now somewhat out-of-date.

The deficiency is now being rectified, and there are at present in course of publication two distinct 'handbooks' of physics. One of these, the "Handbook of Experimental Physics," is being edited by Wien and Harms. Its aim is to give a detailed presentation of modern physics and geophysics from the experimental viewpoint, and to introduce only that minimum amount of theory necessary for the intelligibility of the actual facts, in view of the tendency of modern theory to age as fresh experimental material accumulates. For obvious reasons of uniformity, the number of contributors to the work has been kept as low as is consistent with an authoritative treatment of the various branches of the subject. Geiger and Scheel are primarily responsible for the editing of the other "Handbook of Physics." The number of contributors is larger than in the work of Wien and Harms, and the scope of the 'handbook' is more comprehensive, for it aims at giving a complete survey of the current position of theoretical as well as of experimental physics.

The list of distinguished scientific workers contributing to these two 'handbooks' is a guarantee of the excellence of the finished products. Nevertheless, one cannot suppress a feeling of regret at the publication simultaneously of *two* monumental works, the expressed aims of which are so similar. Surely one such work would have sufficed to fill the gap in current literature. Each 'handbook' is to comprise some twenty or more volumes, at a total cost of anything from forty to sixty pounds. Few private individuals can afford such an outlay for a comprehensive work on physics, and whereas most scientific libraries will endeavour to procure one or other of the handbooks, it is equally certain that they will be unable to procure both. The volumes can, however, be obtained separately.

(1) Vol. 2 of the Wien-Harms 'handbook' is entitled "The Mechanics of Particles and of Rigid Bodies." This is probably the most difficult of the various branches to bring within the scope of a handbook of experimental physics, for in it experiment plays a much less predominant part than in other branches of physics, and it has reached such a state of development that it has fewer fundamental advances to record than have other departments of the subject. For this reason, and we believe wisely, Prof. Haas has departed from the acknowledged form of 'handbooks,' usually so full of detailed references to the literature, and the result is very pleasing.

The book is divided into three parts, the first dealing with the motion of a particle, the second with the mechanics of a rigid body, and the third being devoted to the mathematical treatment of the mechanics of rigid bodies. The first two parts are comprehensive, but essentially elementary in

their mode of treatment, and only the most important results of theory are presented, in so far as they are of importance in experimental physics. The experimental foundations of the theory and the comparison of the results of theory and experiment are discussed, and particular attention is given to mechanical problems which are important in the physics of measurement. The mathematical development of the subject has been intentionally relegated to the third part of the volume, so as to simplify the task of the less mathematical reader.

In accuracy of thought, logical development, and clearness of expression, the author is a master, and it would be difficult to imagine a more admirable treatment of the fundamental conceptions of kinematics than we find in the opening chapter of the book. Equally good are the chapters on pendular motion, processes of motion on the rotating earth, celestial mechanics, and gyroscopic motion, to mention but a few.

Free use of vector notation is made in the third and essentially mathematical part of the book. As the various results are derived, the appropriate references to the earlier non-mathematical sections of the text are given. This last section of the volume is perhaps the most valuable of all, for the treatment, though brief, is masterful, and contains all the essential steps in the development of the numerous results.

The book is attractively produced, and contains more than two hundred illustrations, carefully done, which add greatly to its clearness. The volume concludes with a list of references to recent literature on the experimental aspects of such topics as general and terrestrial gravitation, gyroscopic phenomena, and friction between solid bodies.

We have learned from experience to expect something good from Prof. Haas, and once again we are not disappointed.

(2) Vol. 1 of the Geiger-Scheel 'handbook' is devoted to the history of physics and to the technique of lecture experiments. It comprises four chapters—rather an odd term, in view of the fact that the second and third chapters together occupy only twenty-eight of the four hundred pages in the book.

The history of physics (Chap. i.) has been admirably written by an acknowledged authority on the subject, Prof. Hoppe of Göttingen. In one hundred and eighty pages we are provided with a fascinating account of the progress of physical science from Babylonian times up to the year 1895. The first section deals with the contributions of the Babylonians, the Egyptians, the Greeks, and the Arabians, and concludes with a review of scientific advance in Christian Europe as far as the year 1600. At this point was initiated a period of sound progress, when men like Kepler and Newton placed the subject on an exact basis, and freed it from methods of idle speculation which all too frequently characterised the work of those who preceded them. The second section of the chapter is concerned with this period of intensive growth, and brings us to the year 1842. In the third and final section, which ends with the year 1895, we pass in review the work of Kelvin, Helmholtz, Maxwell, and their contemporaries, and are led from classical physics to the fringe of modern atomic physics, for the chapter concludes with the discovery of radium and polonium. Detailed references are to be found on almost every page. This interesting account of the development of physics through the ages arouses feelings of regret that more time is not devoted, in academic courses, to the history of physics. Text-book physics often tends to give us a wrong sense of perspective in the development of the subject, for it has frequently happened that great advances have been stimulated by the use of hypotheses accepted at the time, but later shown to be untenable. Prof. Hoppe has endeavoured to give a balanced treatment of the growth of physical knowledge, and to place the historical evidence in its right perspective; the result makes informative and instructive reading.

Prof. Scheel contributes a brief but interesting account (Chap. ii.) of the development of the research literature of physics, commencing with the *Philosophical Transactions of the Royal Society*, which first appeared in 1665, and ending with the "International Critical Tables" of the National Academy of Science and the National Research Council, the first volume of which appeared in 1926. In Chap. iii., Prof. Timerding gives a critical account of the teaching of physics in elementary and in high schools. Although his remarks have particular reference to German conditions, many interesting and generally applicable aspects of the question are discussed. Teaching and research in the universities are also dealt with, and an account is given of the establishment and development of scientific societies and research institutes, and of research publications.

The importance of experimental lecture demonstrations in university courses of physics has long been recognised, and although the main lines of experimentation are more or less fixed, each department of physics has its own little specialities. University teachers are constantly on the look out

for new or modified experiments for lecture courses, and the editors of this 'handbook' have wisely included a section (Chap. iv.) on the technique of lectures, by Drs. Mecke and Lambertz, both of the University of Bonn. Many hundreds of representative lecture experiments on all branches of physics are described, numerous tables of data are given, and the text is copiously illustrated by excellent diagrams, many of which can be obtained from Dr. Mecke in the form of lantern slides. This collection of lecture experiments well repays careful study, and should prove invaluable to university lecturers in physics.

The volume under review is nicely printed on good paper, and is remarkably free from misprints. On p. 235, Fig. 21 has been erroneously inverted, and on p. 268 the melting point of mercury is given as 39° C.! R. W. L.

## Primitive Ferns.

*The Ferns (Filicales): Treated Comparatively with a View to their Natural Classification.* By Prof. F. O. Bower. (Cambridge Botanical Handbooks.) Vol. 2: The Eusporangiatæ and other relatively Primitive Ferns. Pp. vi + 344 + 1 plate. (Cambridge: At the University Press, 1926.) 30*s.* net.

"On a far-looking tower I stood to watch,
And three tribes I beheld, of war-bands three."

THE prologue of this second volume on the ferns, opening as it does with this apt quotation from Way's translation of Euripides' "Suppliants," serves well to define the author's position in dealing with his theme. For having in his first volume built for himself a basis of morphological criteria, drawn from the entire range of fern life, he now proceeds to use it as a point of vantage from which to view the group as a whole. As the armies in the Greek play were seen to be formed in three distinct columns, each moving independently, so also the author sees three main phyla of ferns progressing from geological time in an evolutionary march, at first distinct and mainly divergent, but later converging in character in the more recent stages of phyletic advance. As in the battle graphically described in the play, the several columns finally merged in an inextricable mêlée, so in the later phases of fern evolution does the writer find the advanced members of his group, and his task of complete segregation of the several phyla of descent, according to their detailed features, grows in difficulty.

The broad basis of comparison which Prof. Bower has raised in his first volume, with the view of phyletic seriation of the ferns, is skilfully built on the values which he assigns to morphological features, each of which he has sought to weigh truly. The external morphology of the shoot, the internal constitution of the plant body as indicated by segmentation, the architecture and venation of the leaf, the vascular system, the dermal appendages, the position and structure of the sorus, the indusial protections, the characters of the sporangium and of the spores, the spore-output, the morphology of the prothallus, and the embryology of the sporophyte, have all fallen under his critical judgment during his lifelong and intensive study. Each he has examined critically in the ferns at large, and his views have not passed unchecked by the fossil records.

As the analysis has proceeded the conclusions have become more acceptable that the simple shoot, radial in construction, and commonly unbranched, is primitive, while the prone, dorsiventral, and unequally branched shoot is almost undoubtedly derivative. In relatively primitive ferns there are several initial cells in the apices of stem, leaf, root, and sporangium, while in later derivative types there is usually a single initial cell in the apices of these organs. The primitive forms of leaf are characterised by a dichotamised distal region, sometimes with basal stipular growths, and by leaf-segments which may be all separate, and each provided with a single vein. The primitive venation is open with free endings. In advanced ferns the leaf may be webbed, the venation reticulate, and the lower pinnæ arranged monopodially. The primitive axis is protostelic, the more advanced solenostelic, dictyostelic, polycyclic, or marked by further complications. Dermal appendages in the form of simple hairs constitute a primitive feature, while branched hairs, and in particular flattened scales, are held to be indicative of advance from simple hairs themselves. The marginal position of the sorus, more frequent in early than in late fern types, has passed in several distinct phyletic series into the superficial, as the area of the leaf-blade increased. The individuality of the sorus has also been lost in many sequences by fissions or by fusions, or the sori have been obliterated in time by spreading of the sporangia generally over the leaf-surface. The most important variations are, however, those of constitution of the sorus, three types of which have been distinguished, namely, the simple, gradate, and mixed. The first is characteristic of Palæozoic ferns, though it survives to the present day. The last is to-day prevalent but is absent in Palæozoic ferns. The

gradate sorus is an intermediate type in many, but not all, phyletic lines.

There is no indusial protection in Palæozoic ferns, nor is such found in certain modern advanced types. But between such extremes protection by various means is provided notably by different types of indusium. The indusiate sorus is thus considered a later and derivative type, while on the other hand there is good evidence that the modern non-indusiate state has often resulted from the abortion of an indusium previously present. In the progression from Palæozoic to modern times the sporangium shows consistent reduction in size, with increasing specialisation of the mechanism of spore dispersal, while the sporangial form, length of stalk, and the position of the annulus and the stomium vary likewise in close relation to the constitution of the sorus. A gradual diminution of the spore-number accompanies the reduction and specialisation of the sporangium from geological time onwards. There is little to be gleaned for phyletic purposes from the vegetative features of the prothallus, though a surer basis for comparison seems to be provided by the sexual organs, and in particular by the antheridia, which are not only deeply sunk in the prothallus of the primitive ferns, but are also there massive, while in the more advanced types they project and are relatively delicate. As to the embryology of the ferns, it is held that the primitive embryo was probably a spindle-like structure with suspensor and shoot, while the root is an accessory organ of later development. The presence or absence of a suspensor is regarded from the phyletic viewpoint as the most important comparative feature relating to the fern embryo.

With the field of comparison thus widened the author proceeds to the detailed consideration of certain families which are held to be the most ancient among known ferns. These are the Cœnopteridaceæ and Osmundaceæ, which have had undoubted Palæozoic existence. With them are closely grouped for comparative reasons the Marattiaceæ and Ophioglossaceæ, as they also are Eusporangiate ferns.

The remainder of the ferns, though prefigured in some measure by fossils of the Palæozoic period, first began to assume their ordinary characters in the Mesozoic period or later. Their relationship is clearly with two relatively primitive families, namely, the Schiziaceæ and the Gleicheniaceæ, both of which became firmly established in early Jurassic times. The former bears its sori on the margins of the leaves, the latter produces them superficially. With their allies they constitute two consistently defined series, the Marginales and the Superficiales, and are regarded as having not improbably originated from some common earlier source.

To the discussion of these fascinating and primitive families this beautiful book is mainly devoted. With consummate skill in presentation of fact and argument, and with a wealth of illustration to illumine the written page, the author carries the reader through the intricacies of form and structure which the ferns display. It is only when the closing chapters are reached and the general review of the primitive ferns as a whole has been read, that a full appreciation is gained of the power of the argument which has guided the author throughout the arduous task of phyletic grouping. The consideration of the more advanced series of ferns is delayed to a later volume, but to all who read this book must come a growing desire for the production at an early date of the remainder of this fascinating narrative of the march of evolution.

J. McL. T.

## Our Bookshelf.

*Measurements of the Cubical Contents of Forest Crops: being a Critical Investigation into the Methods of Measuring Sample Plots, with special reference to the Liability to Error.* By M. D. Chaturvedi. (Oxford Forestry Memoirs, No. 4.) Pp. xv + 142. (London: Oxford University Press, 1926.) Paper, 10*s.* net; cloth, 12*s.* 6*d.* net.

SYLVICULTURAL research is becoming more and more dependent on observations made in permanent sample plots. These plots are marked out in the forest, treated according to the desired experimental methods, and the volume of timber standing in them is periodically measured. The value of such observations is entirely dependent on the accuracy with which the volume of standing crops can be measured, and even small errors in the measurement of any plot may lead to very false results. Thus if the volume of a plot increases in five years by 20 per cent., an error of +3 per cent. in the first measurement and −3 per cent. in the second may reduce the increment, as measured, to about 13 per cent. Fair accuracy in measurement can be assured if a large number of sample trees can be felled for detailed scaling, but the felling of numerous sample trees is generally sufficient to upset the sylvicultural experiment in hand.

In order to obviate these difficulties, nearly every forest research station in Europe has designed its own method of measuring standing timber, and it is claimed that many of these methods give very considerable accuracy. In the memoir under review, Mr. Chaturvedi has collected together all

available records of these methods, and by personal visits to many of the continental research stations he has equipped himself with the latest relevant information. He has subjected the various methods to mathematical analysis, and has applied most of them to the measurement of certain plots in which all the trees were felled to allow of accurate volume determination, by which means he has obtained useful empirical evidence as to their relative reliability.

Mr. Chaturvedi also propounds a new method which aims at combining the good points of several other systems. This method avoids felling any excessive number of trees, and is well worth testing carefully in the field. W. E. H.

*Tables of Physical and Chemical Constants; and some Mathematical Functions.* By Dr. G. W. C. Kaye and Prof. T. H. Laby. Fifth edition. Pp. vii + 161. (London: Longmans, Green and Co., Ltd., 1926.) 14*s.* net.

SIX years have elapsed since the publication of the fourth edition of these invaluable tables, and it is significant of the change in scientific outlook that the first page of the book is now devoted to atomic numbers and the last to a new table of isotopes. In the list of elements in the order of atomic numbers, three numbers only, 61, 85, and 87, are still unrepresented; the first of these gaps will now be filled by the new element illinium, the isolation of which was reported in NATURE of June 5, 1926, p. 792. New matter has been added on the mechanical equivalent of heat, a subject which Prof. Laby has personally investigated, and the weighted mean of the determinations of Joule's equivalent made since 1880 is given as $4{\cdot}182 \times 10^7$ ergs per 20° calorie on the scale of the hydrogen thermometer.

The reviewer turned eagerly to the value assigned to Planck's constant, $h$, only to find that the authors have made no attempt to discriminate between the various experimental values quoted. Even the critical discussions by Ladenburg and by Birge are not referred to. The true value is probably very near to Planck's original estimate, $h = 6{\cdot}55 \times 10^{-27}$ erg sec. The same cautious attitude is adopted in the value quoted for the fundamental electron charge, which is given as $e = 4{\cdot}77 \times 10^{-10}$ e.s.u., with a reference to Millikan, July 1917. It may be suggested that in future editions more attention should be paid to spectroscopic constants—even Rydberg's constant does not appear to be mentioned—and other important constants associated with the quantum theory. Scientific workers owe a debt to the authors of this volume, which only those who have attempted to collect such numerical results can fully appreciate. H. S. A.

*The Evolution and Development of the Quantum Theory.* By N. M. Bligh. Pp. 112. (London: Edward Arnold and Co., 1926.) 9*s.* net.

PROF. MAX PLANCK, whose photograph adorns its frontispiece, contributes a short foreword to this little book. The author sets out with the praiseworthy object of producing a "concise handbook" for the "general scientific reader." In Part 1 he sketches the classical arguments leading to Wien's radiation law and the Raleigh-Jeans law, and describes how their disagreement with each other and with experiment led Planck to his formula and law. Part 2 is a description, which does not profess to be complete, of some applications of the theory; band spectra, for example, are barely mentioned in two sentences. Planck's second hypothesis and a somewhat irrelevant discussion of Nernst's heat theorem, however, fill a whole chapter. The chapters on the light quantum hypothesis, specific heats, and optical spectra, though of necessity brief, are good.

Unfortunately, the author is much at sea in radiation theory and statistical mechanics. Chap. i., his introduction to radiation theory, is so involved that it would be almost unintelligible to any one unfamiliar with the arguments used, and the proof of Wien's displacement law in Chap. ii. is still worse. In Chap. iii., on statistical mechanics, the preliminary explanation is worthless, while the proof of Maxwell's distribution law contains ". . ., let $\delta n$ be the number of molecules having velocities whose $x$-components lie between $u$ and $u + \delta u$"; and later, "$\Sigma \delta n = 0$," no distinction being made between that number and its variation. There is a considerable number of mis-statements, such as "A complexion is thus the number of ways in which a particular arrangement can be carried out," and "Now since the mass of the helium nucleus is slightly greater than that of the hydrogen nucleus," and misprints are frequent.

*Animal Ecology.* By Prof. A. S. Pearse. (McGraw-Hill Publications in the Zoological Sciences.) Pp. ix + 417. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1926.) 20*s.* net.

THE science of animal ecology is relatively new, but a considerable amount of attention has been directed to this aspect of zoology since the beginning of the century. In this development American biologists have played a leading part. We recall Shelford's valuable work on the animal communities in temperate America and Adam's useful guide to the study of ecology in this connexion, both of which gave a tremendous impetus to the study of animals in relation to their environment. Most of our knowledge of the subject is, however, contained in short scattered papers through a vast range of periodical literature or in more specialised works dealing with particular groups.

Some guide to this maze of literature was clearly needed, and Prof. Pearse has rendered conspicuous service in undertaking this task. His book seeks to indicate the scope of the subject and to outline its various sub-divisions. The treatment is of necessity brief, but with the aid of a comprehensive bibliography the reader is directed to fuller details regarding any particular aspect of the subject. The book should serve a useful purpose as a work of reference to university teachers and students in presenting to them a broad and orderly survey of a very large field.

## Letters to the Editor.

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

### Atmospheric Circulation.

THE omission of references seldom leads to intelligibility, and I fear I should have been unable to trace the review mentioned by Prof. W. H. Hobbs (NATURE, Dec. 25, p. 915) had Mr. Bonacina not alluded to it in a letter to me. Prof. Hobbs asserts that my result (*Q.J.R. Met. Soc.*, 1926, 85-104) that the prevailing pressures around the poles should be low was explicitly stated by me to refer to an atmosphere circulating symmetrically over a uniform earth and unrestricted by friction. This is not the case. It is true that I worked out the solution of such a problem, but the result I obtained was that, with the highest temperatures over the equator, the pressure would increase all the way to the poles; this is diametrically opposite to Prof. Hobbs's attempted quotation. Prof. Hobbs omits to mention that I went on to examine which of the neglected factors was responsible for the chief difference between theory and observation; that I traced it to friction; and that my final inference of the existence of low pressures about the poles was the result of an argument depending essentially on friction. Incidentally, the despised frictionless theory, if adapted to cooled continents, would be in qualitative agreement with the facts as stated by Prof. Hobbs.

While this matter is under discussion reference must be made to a criticism by Mr. F. J. W. Whipple (*Q.J.R. Met. Soc.*, 1926, p. 333). I showed in my paper that if the prevailing circulation north of a given parallel of latitude is either easterly or westerly, it can be maintained against friction only by interchange of air with lower latitudes. Thinking that I had dynamical grounds for believing that this interchange would, in the conditions of the northern hemisphere, involve mainly south-west and north-east winds, I inferred that the polar circulations must be westerly. Mr. Whipple points out a weakness in the argument, and has led me to modify this conclusion. It seems clear that if there were no horizontal interchange of air, the effect of surface friction would be simply to make the air drift across the isobars until all differences of pressure at sea-level were annulled, and there would be no surface winds anywhere. Somehow this condition is forestalled by the development of irregular winds of cyclonic type, which maintain a continual interchange of air across the mean annual isobars, and the primary effect of such interchange, with an actual distribution of temperature, would probably be a transmission of angular momentum polewards, giving an equatorial belt of easterly winds with broad belts of westerly winds north and south of it. The winds at the southern boundary of the belt of prevailing westerlies in the northern hemisphere must be mainly north-east and south-west; but there seems to be no reason why they should persist all the way to the pole, and if the currents are deflected within this belt so as to become mainly north-west and south-east at its northern margin, they will be capable of maintaining an easterly circulation north of it.

Accordingly I see no great objection to anticyclonic circulations in Arctic and Antarctic regions. The main results that emerge from the discussion are that friction plays a dominating part in atmospheric circulation, and that cyclones are essential to the maintenance of any general circulation and are not disturbances superposed on it. Presumably the distribution of the belts of easterly and westerly winds would be affected by a change in the distribution of temperature in latitude.

Mr. Bonacina's quotation in his review (*Geog. Jour.*, Sept. 1926) expressed correctly the views I held at the time he wrote, but as a result of Mr. Whipple's note I have somewhat modified them in the sense indicated above. The question of the existence of glacial anticyclones strikes me as one to be settled by observation. I would only point out that the great majority of the observations quoted on the point are irrelevant. They refer to stations near the coast, where permanent outflowing antitriptic winds are to be expected whatever the winds in the interior of the continent may be. To infer an anticyclonic circulation over a glaciated continent on the basis of winds from the land at coastal stations is like finding out whether it is raining by turning the tap on. The observations in the interior of Greenland and Antarctica by Koch, de Quervain, and Scott, quoted by Prof. Hobbs in his book, are to the point, but none of the others are.

HAROLD JEFFREYS.

### The Significance of Phosphorus in Muscular Contraction.

AN examination of the very extensive literature dealing with the function of phosphorus compounds in the chemical mechanism of muscular contraction reveals so many contradictory statements that it is evident that the technique in use must be subject to some serious fault. Since we have found what is probably the main cause of the discrepant results obtained in this field, it seems desirable to communicate our results without delay.

There appears to be in muscle tissue an organic phosphorus compound which, by reason of its great instability in acid solution, has been confused hitherto with inorganic phosphate, to which it gives rise in the course of the estimation of inorganic phosphates by the methods of Embden or of Briggs, or by any method involving the use of mineral acid. The confusion is increased by the fact that this substance, the organic phosphorus compound which we have designated 'phosphagen,' is intimately connected with the chemical mechanism of contraction; the estimation, therefore, of 'inorganic' phosphate by the above methods is hopelessly misleading, since by them one measures the sum total of two substances which vary independently in amount. It is possible, by avoiding the use of acid solutions, to estimate true inorganic phosphate, since 'phosphagen' appears to be stable in neutral or slightly alkaline solution. The following table, which concerns the gastrocnemius muscle of the frog, illustrates the changes in the amount of phosphate and 'phosphagen' in a muscle subjected to different treatments:

| | Resting. | Rapidly Fatigued. | Heat Rigor. | Incubation in $NaHCO_3$. | |
|---|---|---|---|---|---|
| | | | | Without NaF. | With NaF. |
| Inorganic phosphate . . | 20 | 50 | 90 | 110 | 20 |
| 'Phosphagen' | 65 | 25 | 0 | 0 | 0 |
| Sum total . | 85 | 75 | 90 | 110 | 20 |

The figures are given as milligrams of phosphorus per 100 gm. of muscle, and are representative of a number of experiments. The third row of figures

corresponds to the ' inorganic ' phosphate as estimated by the ordinary methods.

These facts suffice to explain many of the anomalies to be found in the literature. We will deal here with only one of these. Embden and his co-workers have noted a disappearance of inorganic phosphate in a suspension of minced muscle in sodium fluoride solution. They have attributed this to a synthetic action of the fluoride ion. Comparing the first and last columns in the above table there is an apparent synthesis of 65 mgm. of ' inorganic ' phosphate into something not estimated by the Embden technique. The real state of affairs, however, seems to be that the true inorganic phosphate is not affected at all. Either the fluoride ion catalyses the conversion of ' phosphagen ' into some acid-stable compound, or else it poisons a catalyst which normally causes its transformation into inorganic phosphate. Rapidly induced fatigue produces a similar but smaller effect.

One further point of interest worthy of note here is that while unstriated muscle contains about the same amount of genuine inorganic phosphate as does striated (skeletal) muscle, it appears to contain no ' phosphagen.' The heart muscle of the frog also gives about 20 mgm. of inorganic phosphorus per 100 gm. of muscle, together with a slight but definite amount of ' phosphagen.' One is tempted to correlate the ' phosphagen ' content of a muscle in its resting condition with its ability to respond to sudden demands for violent activity.

Whilst we have at present no definite knowledge of the nature of this substance, it seems quite possible that it may be the unstable (' active ') hexose monophosphate, the existence of which was inferred by Meyerhof in interpreting the phenomena of glycolysis in cell-free muscle extracts, and the fermentation of sugar by yeast.

P. EGGLETON.
M. G. EGGLETON.

Dept. of Physiology and Biochemistry,
University College, London,
Jan. 5.

### Effect of a Large Number of Receiving Aerials on the Propagation of Wireless Waves.

IN connexion with some experiments, I was led recently to estimate the extent to which a large number of receiving aerials would contribute to the absorbing effect of the earth's surface on wireless waves in resonance with them. A short calculation showed that, with a density of aerial distribution such as now exists in an urban district surrounding a local broadcasting station, the energy absorbed by the aerials should be the decisive factor in determining the surface attenuation. Since the aerials would naturally only effect those waves which were very close to wave-lengths to which they were tuned, it was not difficult to test this conclusion. A number of experiments have been made on the general principle of measuring the intensity of waves which have travelled across a considerable area containing large numbers of broadcasting aerials, the wave-length being gradually varied from just below to just above the normal wave-length of the local broadcasting station (2 LO) to which the majority of the aerials may be assumed to be tuned (that is, a wave-length of 364 metres).

These experiments, which were carried out with the assistance of Dr. Smith-Rose and Mr. Munro, with the kind co-operation of the B.B.C., have yielded results that constitute very definite evidence of a critical effect of large magnitude occurring at or near the resonant wave-length, and the phenomenon appears only ascribable to the selective action of the multiplicity of tuned aerials in the path of the waves. Thus, at Slough (see Fig. 1), when receiving from the 2 LO transmitter at Marconi House, an increase in intensity of the order of 90 per cent. was observed for a variation in wave-length of only 5 per cent.; while it will be seen that for a wave-length change of 120 metres a total increase of field strength of nearly five to one was obtained; that is, for a given power transmitted, the received power increased more than twenty-fold.

Now the hypothesis that this effect is mainly due to the transmitted waves passing in and out of resonance with the aerials in their path is confirmed

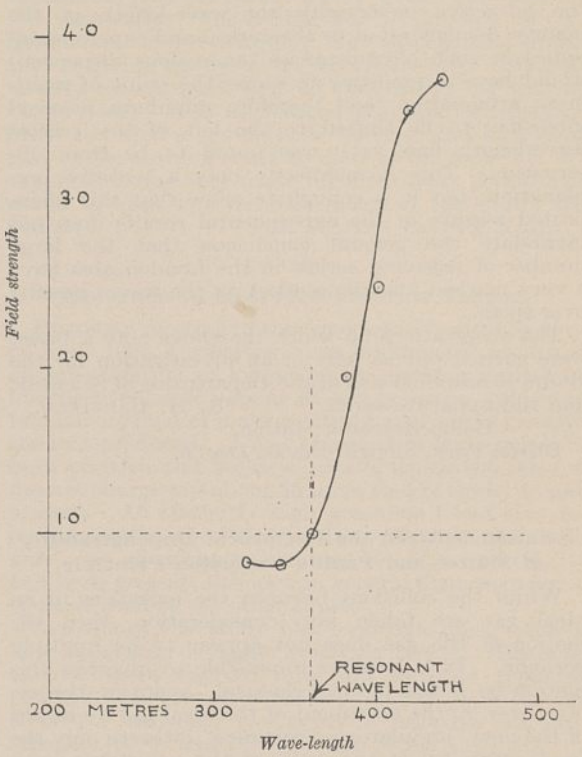


FIG. 1.—Effect of wave-length change on received field strength. Transmitter—2 LO. Receiver—Slough.

by the fact that the effect was found to increase in proportion to the distance which the waves travelled over crowded residential districts, and was negligible when the wave path lay almost entirely over open country with only a small residential area round the transmitter. The hypothesis was further confirmed by the fact that the effect was shown not to be peculiar to a given transmitter or receiving site. On the other hand, it seems at first to be contradicted by the fact that the minimum intensity, and therefore apparently the maximum absorption, does not occur at the resonant wave-length but at a wave-length considerably below. In some cases the minimum had not been reached at 300 metres, below which wave-length experiments have not yet been carried. A brief study of the theoretical side of the problem, however, shows that this is not necessarily the case. If an electromagnetic wave is propagated in a medium containing resonators of all one periodicity, it is well known that, on varying the wave-length of the waves in the neighbourhood of the resonant value, there is a critical change in the medium, not only of its absorption factor but also of its refractive index, the latter being responsible for the optical phenomenon of anomalous or selective dispersion.

Now there is an undoubted analogy between this and the experiments under discussion. The medium containing resonators is in this case the layer immediately above the earth's surface containing the tuned aerials. We must, therefore, take into account the possible effect of a change in the refractive index of this medium as well as in its absorption factor. But the theory of wireless wave propagation as developed by Sommerfeld and others shows that the former factor may be as important as the latter in determining the attenuation which the waves will experience in passing over the earth's surface. Finally, the theory also shows that a variation of the refractive index with the wave-length in the manner demonstrated in theoretical and experimental optics in such circumstances (anomalous dispersion) would have a tendency to cause the point of maximum attenuation (and therefore minimum received intensity) to be shifted to the left of the critical wave-length line, as it was found to be from observation. This is manifestly only a tentative explanation, but it is enough to show that this unexpected feature in the experimental results does not invalidate the general conclusion that the large number of receiving aerials in the London area have a very marked absorbing effect on the waves passing over them.

The observations on which the above note is based were carried out as part of an investigation for the Radio Research Board of the Department of Scientific and Industrial Research.

R. H. BARFIELD.
Radio Research Station,
Ditton Park, Slough, Bucks, Dec. 6.

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**Relation between the Reciprocal Impenetrability of Matter and Pauli's Exclusion Principle.**

WHEN the collisions between the molecules of an ideal gas are taken into consideration, then the motion of the gas does not appear to be multiply periodic. It is therefore impossible to quantise this motion by means of the 'classical' quantum theory. Moreover, in the treatment of the ideal gas by means of the new 'undulatory mechanics,' hitherto only the impenetrability of the walls of the vessel has been taken into account, and not the reciprocal impenetrability of the molecules (E. Schrödinger, *Phys. Zs.*, **27**, 95, 1926). I propose to show here that, in the case of impenetrable moving mass-*points*, wave-mechanics gives an exact and very elementary solution. Simultaneously we arrive at the relation mentioned in the title.

For purposes of brevity we will limit ourselves to a 'one-dimensional' gas: $N$ monatomic mass-points of equal mass $M$ are enclosed in a tube, which extends from $x = -\frac{\pi}{2}$ to $x = +\frac{\pi}{2}$. If we first take into account only the impenetrability of the ends of the tube, then we have to look for all the solutions of the $N$-dimensional Schrödinger-equation:

$$\left[\frac{\partial^2}{\partial x_1^2}+\frac{\partial^2}{\partial x_2^2}+\ldots+\frac{\partial^2}{\partial x_N^2}+\frac{8\pi^2 M}{h^2}E\right]\psi=0, \quad (1)$$

which are equal to zero at the faces of the $N$-dimensional $\pm\frac{\pi}{2}$-cube. These solutions are:

$$\psi = \cos \alpha_1 x_1 \cos \alpha_2 x_2 \ldots \cos \alpha_N x_N, \quad (2)$$

where $\alpha_1 \ldots \alpha_N$ are arbitrary positive integers and where $E=\frac{h^2}{8\pi^2 M}(\alpha_1^2+\ldots\alpha_N^2)$. To the same $E$, and with the same numbers $\alpha_1 \ldots \alpha_N$, there belong also all the solutions obtained from solution (2) by exchanging all the co-ordinates $x_1 \ldots x_N$ with each other, at the same time keeping the numbers $\alpha_1 \ldots \alpha_N$ fixed. By multiplication of all these solutions by arbitrary constants and addition, we obtain the most general solution of this kind:

$$\Psi = \Sigma C(p_1 \ldots p_N) \cos \alpha_1 x_{p_1} \cos \alpha_2 x_{p_2} \ldots \cos \alpha_N x_{p_N}, \quad (3)$$

where $p_1 \ldots p_N$ signifies *one* permutation of the numbers $1 \ldots N$, and the summation must be taken over *all* the permutations.

Now let us also consider the reciprocal impenetrability of the molecules. That can be done by means of the additional 'diagonal-restriction'; which in wave-mechanics corresponds to the impossibility of two molecules occupying the same point in space at the same time. Of all the solutions of the form (3), only those are allowed which are *also* equal to zero at all points of the $\frac{N(N-1)}{2}$ flat 'diagonal-spaces' of $N-1$ dimensions which are represented by the equations $x_h = x_k (h, k = 1, \ldots N)$. It can be shown now best by considering first the cases $N=2$ and $N=3$ that all the constants $C(p_1 \ldots p_N)$ must have values equal to each other or opposite in sign, according as the arguments $p_1 \ldots p_N$ are derived from the numbers $1 \ldots N$ by an even or an odd number of simple permutations. Or, in other words, *because of the reciprocal impenetrability of the molecules* only the *antisymmetric* solutions are allowed:

$$\psi^{\text{antisym}}(x_1 \ldots x_N) = C \cdot \begin{vmatrix} \cos \alpha_1 x_1 & \ldots & \cos \alpha_1 x_N \\ \vdots & & \vdots \\ \cos \alpha_N x_1 & \ldots & \cos \alpha_N x_N \end{vmatrix}. \quad (4)$$

Thus, just those solutions which, according to the researches of Heisenberg and Dirac, are connected with Pauli's exclusion principle (the exclusion of equal quantum numbers for two electrons in the same atom—in our case for two gas molecules in the same vessel), the determinant becomes identically equal to zero when two of the numbers $\alpha_s$ are equal to each other.

Finally, we may remark as follows:

I. For a three-dimensional gas contained in a vessel of *general* form, naturally $\psi_{\alpha\beta\gamma}(xyz)$ must be substituted for $\sin \alpha x$; further, in the 'diagonal-restriction' the equations $(x_h - x_k)^2 + (y_h - y_k)^2 + (z_h - z_k)^2 = 0$ for $x_h = x_k$, and we have always to exchange a triplet $x_h y_h z_h$ with a triplet $x_k y_k z_k$.

II. In order to show that the impenetrability of the walls and for the molecules must really be expressed by the corresponding zero-conditions of the solutions of the Schrödinger equation, we approximate first this impenetrability by continuously varying forces of repulsion and then we go in the resulting solutions to the limit.

III. At the same time we get very simple models for the treatment of the question of how far the Pauli's exclusion principle holds for two electrons if they are in the same atom but not if they belong to distinctly separated atoms.

IV. The non-validity of Pauli's principle for 'light-corpuscles' should now perhaps be connected with their reciprocal *penetrability*, though the very provisional and symbolical character on one hand of the light corpuscles, and on the other of the multi-dimensional wave-equation (1), should specially be remembered here. These remarks and some connected statistical questions will be dealt with elsewhere.

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### The Imperial Forestry Institute.

SOME comment is called for on the note on the Imperial Forestry Institute which appeared in NATURE of Jan. 15, p. 96, and which is likely to produce a wrong impression in the minds of those unacquainted with the facts. With reference to a proposal to spend a sum of £75,000 on the erection of new buildings to accommodate the Imperial Forestry Institute at Oxford, the following observation is made: "On the face of it the scheme appears to be a laudable one. Nevertheless, it would seem to demand further careful consideration if this money or the bulk of it is to be provided from the Treasury." As there has been no suggestion that the Treasury should make any contribution towards the scheme, the fears expressed in regard to national expenditure may in this instance be set at rest.

The note concludes with the following passage: "Two points appear to demand a public and unbiassed inquiry before the Government is committed to the scheme; they are: (1) Are not the existing schools of forestry capable of giving all the education required, both up to the degree and post-graduate, and to undertake research? (2) Is it advisable to shut up forestry education in a water-tight compartment?" The writer is apparently not aware that such an inquiry was carried out a few years ago by an Interdepartmental Committee on Imperial Forestry Education, which issued in 1921 a report published as Command Paper 1166. In this report both the above questions are definitely answered in the negative. In proposing the establishment of a central institution for higher training and research in forestry, the Committee made it clear that there was no intention of interfering with the work done by university schools of forestry, and provided the training of these was maintained at a required standard, it recommended that selected students from these schools should be eligible for admission to the central institution. The Committee may be presumed to have conducted its inquiries in an impartial manner; it visited the universities of Oxford, Cambridge, Bangor, and Edinburgh, and also took evidence from other universities, as well as from institutions and societies interested in forestry, and in selecting Oxford as the site of the future forestry institute we may assume that it selected that place which it considered most suitable for the end in view.

Apart from the Interdepartmental Committee, the question was carefully considered by two separate Empire Forestry Conferences, one held in London in 1920 and the other in Canada in 1923. At both conferences the inadequacy of the existing arrangements for higher training and research in forestry was commented on, and the necessity for establishing a central institution for the needs of forestry in the British Empire was urged. The Interdepartmental Committee's recommendations were endorsed by the second Empire Forestry Conference and also by the Imperial Economic Conference held in London in 1923. The Imperial Forestry Institute was accordingly established at Oxford and started work in October 1924. Should any readers of NATURE be interested in the progress actually made so far, I shall be pleased to send them a copy of the second annual report.

R. S. TROUP.

Imperial Forestry Institute,
Oxford, Jan. 19.

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IF under "Treasury" Prof. Troup includes the Colonial Office and Forestry Commission (the latter two offices defraying the bulk of the expenses of the Institute at present), the tax-payer, whether in Britain or overseas, will be relieved to have the assurance.

Prof. Troup's somewhat *ex parte* account of the proceedings leading up to the inauguration of the Institute in 1924 has in one form or another appeared on several occasions in the Press. He does not, however, appear to realise that a growing body of scientific opinion is at the back of the representations which the authorities of the Universities of Cambridge and Edinburgh placed before the Secretary of State for the Colonies and members of the Forestry Commission on the subject of the concentration of (State-subsidised) post-graduate forestry work of all kinds at one university. The authorities of the two universities stated quite definitely that they had no intention of giving up the post-graduate courses they had already inaugurated, and all they asked for was an 'open door.' It is understood that the Secretary of State accorded a sympathetic hearing, and intimated that whilst nothing could be done at the moment, the experiment was only made for a five-year period and would be open to a reconsideration at the end of the period.

THE WRITER OF THE NOTE.

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### Ionisation in Hydrogen Chloride Vapour.

BEFORE a meeting of the American Physical Society in April 1925, I reported some preliminary results of an investigation of ionisation by electron impact in hydrogen chloride vapour at low pressures, using the familiar method of mass spectrum analysis to identify the ions produced. I had observed in large numbers both positive and negative ions of which the ratio of mass to charge was about 36 times that of the hydrogen nucleus. At relatively high pressures I had also detected positive ions of $m/e$ about 72 times the same unit. At all pressures the ions $H^+$, $H_2^+$, and $(H_2O)^+$ had been present, although in general there were fewer of these than of the other types.

Since then the study has been extended, using a new apparatus of higher resolving power. The ions at '36' were resolved into four separate types of positive ion, namely: $(Cl^{35})^+$, $(HCl^{35})^+$, $(Cl^{37})^+$, and $(HCl^{37})^+$; and only two types of negative ion, presumably $(Cl^{35})^-$ and $(Cl^{37})^-$. The ratios $(Cl^{35})^+/(Cl^{37})^+$, $(HCl^{35})^+/(HCl^{37})^+$, and $(Cl^{35})^-/(Cl^{37})^-$ were equal, within the limits of error, to the computed abundancy ratio of the isotopes based on the atomic weight of chlorine. The heavier ions previously mentioned were not observed at the lower pressures necessarily used in the new apparatus, and therefore could not be precisely identified.

Comparisons of the relative numbers of the different ions under many different conditions of pressure, energy of striking electrons, etc., have led to the conclusion that the only type of ion produced by an impact of an electron of between 4 and 75 volts energy on a hydrogen chloride molecule is $(HCl)^+$. This is the type of ion to which corresponds the ionisation potential of about 13·8 volts observed by others.

A widely held conception of ionisation by impact in hydrogen chloride assumes that the primary process consists of the formation of $H^+$ and $Cl^-$ ions. The conclusion reached in these experiments is contrary to this assumption, though it was difficult to disprove the possibility, since both $H^+$ and $Cl^-$ ions were produced. However, (1) it was observed that at low pressures there were always more $H_2^+$ ions than $H^+$; (2) neither of these showed any reproducible quantitative relationship to the $(HCl)^+$ ions; (3) their number was always small compared with the latter, except when the apparatus had been evacuated only recently; and (4) they diminished and *finally disappeared* with

time, as the apparatus stood for days continuously evacuated.

These results and others led to the conclusion that the hydrogen ions came not from HCl molecules but from $H_2$ molecules formed probably by some process requiring the presence of the hot filament and of water vapour given off by the walls of the tube. Furthermore, the arrangement of the electrodes and fields in the tube permitted the discovery that the $Cl^-$ ions observed came from close to the filament and that none came from any region in which electrons of more than three or four volts energy were available for impact. It thus seems possible not only to account for the existence of the $H^+$ and $Cl^-$ ions but also to eliminate them definitely as the products of inelastic electron impacts of 13·8 or more volts with HCl molecules.

A detailed report of the experiments is being prepared for publication.

HENRY A. BARTON
(National Research Fellow).
Jefferson Physical Laboratory,
Harvard University,
Cambridge, Mass., U.S.A.,
Dec. 16.

## A New Pressure-Temperature Formula for Vapours.

ABOUT forty formulæ have been proposed to represent the relation between the pressure $p$ and temperature $t$ of saturated vapours. The suggested formulæ reproduce the experimental results only on a limited part of the vapour-pressure curve, and not on the whole of it. Many of them give inexact results at very low temperatures or in the proximity of the critical point. Finally, none of them reproduces the critical point as the singular point (end-point, *le point d'arrêt*) of the pressure-temperature curve.

I have succeeded in finding a formula which satisfies all the claims both in respect to precision and in respect to correct reproduction of the conditions on the limits.

The formula may be written as follows:

$$t + c = k\left(\sqrt[4]{p} - 10^{\alpha - \frac{\beta}{\log p_k - \log p}}\right), \quad . \quad . \quad (1)$$

where $p_k$ is the critical pressure, and $c$, $k$, $\alpha$, $\beta$ are constants, different for different substances.

At pressures $p$ sufficiently high (for ordinary liquids, throughout the range from 1 - 3 atmospheres up to the critical pressure), the difference $\log p_k - \log p$ is small. The exponent $\alpha - \frac{\beta}{\log p_k - \log p}$ is therefore a negative number with a large absolute value, so that the exponential term practically does not differ from zero. The formula thus becomes simply

$$t + c = k\sqrt[4]{p}. \quad . \quad . \quad . \quad . \quad (2)$$

Such a linear relation between $t$ and $\sqrt[4]{p}$ was found in 1883 by Jarolimek.

At $p = p_k$, $t$, as given by the formula (1), changes discontinuously; thus the formula reproduces the critical point. When $p$ is extremely small (therefore at very low temperatures) the term $\sqrt[4]{p}$ disappears in comparison with the exponential term, and the formula becomes

$$\log p = \log p_k - \frac{\beta}{\alpha - \log\left(-\frac{t+c}{k}\right)}. \quad . \quad (3)$$

Formula (1) represents with sufficient accuracy the experimental data for the most varied substances; for example, for liquid metals (also for mercury in the whole explored interval from 0° to 880°), for organic liquids studied by S. Young, and for permanent gases.

The constant $c$ has usually the values lying between 0 and 273. Helium shows a remarkable peculiarity: it has $c = 273$; thus, for helium the fourth root of the vapour pressure, in virtue of formula (2), appears to be approximately proportional to the absolute temperature.

Water, as usual, shows an anomaly: the index of the root is here 13/3 instead of 4.

A detailed account will be published in one of the physical journals.

A. BATSCHINSKI.
Thermotechnical Institute,
Moscow, Dec. 18.

## 'Hard Seeds' in Leguminosæ.

IT may be of interest to Mr. Alexander Nelson and to other readers of NATURE (Dec. 4, 1926, p. 804) to know that sulphuric acid has been used industrially for the promotion of germination in hard leguminous seeds for some years. The substitution on an extensive scale of *Indigofera arrecta* for the previously cultivated *Indigofera sumatrana* by the indigo planters of Bihar during the early years of the century was, in fact, made possible largely by the introduction of the sulphuric acid method of seed treatment into their agricultural practice. The seed of *Indigofera arrecta* grown in Bihar was found to possess a very hard coat and to fail to germinate almost entirely under the conditions of soil moisture prevailing in northern India. Treatment with sulphuric acid led to perfect germination in a well-ripened sample of seed, and the method was used for many years and is, I believe, still used by the Bihar planters. The procedure differs slightly, however, from that indicated by Mr. Nelson in that concentrated, instead of dilute, acid is employed. A full description of the method as used in Bihar may be found in my report to the Bihar Indigo Planters' Association for the year 1906–7.

I reported the successful application of the procedure to other hard seeds, those of a series of fibre-yielding jungle plants not exclusively Leguminosæ, in collaboration with R. S. Finlow in the *Proceedings of the Asiatic Society of Bengal* (New Series, vol. 3, No. 10) in 1907. Some of these seeds withstood the action of the concentrated acid for surprisingly long periods and germinated satisfactorily after it.

In the same year a paper in which an attempt was made to explain the cause of hardness in the seeds of *Indigofera arrecta* was published by D. L. Day and myself (*Annals of Botany*, vol. 21, No. 81). Our findings, as regards hardness being due to a surface deposition on the seed-coat, were in accordance with those of Mr. Nelson; we were, however, unable to determine the precise nature of the coating. Information on this point will be most interesting.

C. J. BERKELEY.
The Biological Station,
Nanaimo, B.C., Dec. 27.

## Television.

As Mr. J. L. Baird, in NATURE of Jan. 29, mentions my name in connexion with 'television,' it may be of interest if I give a brief résumé of the demonstrations Mr. Baird has given to me at Motograph House. Last June he gave a demonstration of the transmission of the images of living people, showing gradations of light, shade, and detail. An account of this demonstration was published in NATURE of July 3.

The images, naturally, were not comparable with those shown on a modern cinema screen, but the likenesses were unmistakable. The person whose image was transmitted sat in a flood of brilliant light. Mr. Baird has now developed a method by which the image of the person is transmitted although he is in complete darkness. This result is obtained by flooding the 'sending' room by infra-red rays. On Nov. 23 last, Mr. Baird gave a demonstration to Mr. W. R. Crookes and me. One of us stayed in the sending-room with a laboratory assistant in apparently complete darkness. In the receiving-room, on another floor, the image of the assistant's head was shown brilliantly illuminated on a screen, and all the motions he made could be readily followed.

These images were not outlines or shadowgraphs, but real images by diffusely reflected rays. The application of these rays to television enables us to see what is going on in a room which is apparently in complete darkness. So far as I know, this achievement has never been done before.

We had the impression that the image on the screen was not quite so clearly defined as when visible rays were used, but we easily recognised the figures we saw, and made out their actions. The direct application of Mr. Baird's invention in warfare to locating objects apparently in the dark seems highly probable, but I hope that useful peace applications will soon be found for it.

ALEXANDER RUSSELL.

Faraday House,
Southampton Row, W.C.1,
Jan. 28.

### Relativity and the Observer.

IN Mr. Bertrand Russell's article in the new volumes of the "Encyclopædia Britannica" entitled "Relativity: Philosophical Consequences," there occurs the following sentence: "The 'observer' who is often mentioned in expositions of relativity need not be a mind, but may be a photographic plate or any kind of recording instrument." I should like to know how far Mr. Russell can claim to be in agreement with physicists on this point. For my own part it would seem to make complete nonsense of the theory. As I understand the principle of relativity, every object which can be observed, including the measuring rods and clocks which are used to observe, not excepting the retina of the observer's eye, undergoes transformation when the observer passes from one system of reference to another. If it is not so, if there be one piece of matter which can claim to be privileged, be it only a single electron, what, I ask, is the use or meaning of the principle?

However, I propose a simple test. Will Mr. Russell—and any one who thinks he is right—read the article by Mr. J. H. Jeans on "Relativity" which immediately precedes his own article, and wherever he finds the word observer, make the substitution "photographic plate or any kind of recording instrument," and see if he can make sense of the principle.

I agree that the observer need not be a mind if by mind is meant anything over and above the simple spiritual or ideal act of observing, but the observer most certainly cannot be the observer's body or a part of his body or the instrument he uses, for no particle of such material structure possesses any privilege in the physical world. Surely if it did the principle of relativity would be superfluous, for the privileged object would itself provide an absolute system of reference.

H. WILDON CARR.

405 West Adams Street,
Los Angeles, California, Dec. 22.

### The Continuity of Existence.

RECENTLY, in an address to the British Academy, Prof. T. Percy Nunn propounded the idea that the existence of an electron is not necessarily continuous, and that when an electron revolving in an orbit about a nucleus changes to another orbit, it is possible that the electron goes out of existence in the first orbit and comes again into existence in the second orbit. It is of interest that Planck's theory that action is not a continuous entity but consists of discrete quanta leads to a similar conclusion.

A point of our ordinary space has in Einstein's fourfold world a record that is called its world line. As a bundle of energy such as an atom or electron or nucleus has extension, it is appropriate to call its record in the fourfold its world-filament. Since energy integrated through an interval of time is action, this filament of the atom is action; and the atom or energy is the section in which our space cuts the filament.

In this picture action is represented as a continuous filament. This representation contradicts Planck's theory, and the picture must be amended in order to conform. The filament must be replaced by a series of quanta dotted along a line.

Consider now what happens as our space travels through the fourfold world. In some positions it will intersect a quantum of the series dotted along the line; in other positions it will miss. The atom or bundle of energy, being the intersection of the action by our space, will exist when our space intersects a quantum, and will not exist when there is no intersection with a quantum. In other words, as our space travels through the fourfold (that is to say, as time passes) the atom or bundle of energy keeps flashing into existence and out again. D. B. MAIR.

### Double-Image Effect in Transparent Microscopic Spheres.

IN a paper published by us in the current number of the *Proc. Roy. Soc.* on the "Scattering of Light by Individual Particles in Smoke," we have directed attention to a double image effect exhibited by transparent microscopic spheres. As a result of further experiments we have found that the explanation of the effect given requires some modification. One of the images is due to reflection from the surface of the sphere instead of to internal reflection. As was suggested to us by Prof. Tyndall, this can be seen by placing a small bulb containing a gold sol in the beam of light from an arc, when one image is coloured red and may be seen to be due to refraction through the sol, whilst the other is white and is produced by reflection from the surface of the sphere.

H. S. PATTERSON.
R. WHYTLAW-GRAY.

### Helium or Helion?

MAY I invite the opinion of readers of NATURE as to the desirability of changing the name of element No. 2 from helium to helion? This element was christened at a time (1868) when its existence was recognised on the strength of the $D_3$ line in the chromosphere, and when, in view of the proximity of this line to the D lines of sodium, it appeared not improbable that it was a metal. Now that helium has been isolated, liquefied, and even solidified, we know that it is typically non-metallic, exactly like argon and the other inert gases discovered in later years, and now placed in group O of the Periodic System. Its present name, therefore, is anomalous.

J. NEWTON FRIEND.

Municipal Technical School,
Birmingham, Dec. 9.

## Changes in the Length of the Day.

By Prof. ERNEST W. BROWN, F.R.S.

AT the present moment the answer to the question as to whether the rate of rotation of the earth is fluctuating, depends almost wholly on the interpretation which shall be given to certain differences between the observed positions of two or three bodies in the solar system and their positions as calculated from the laws of motion and gravitation. Owing to the unavoidable errors of observation, usually greater in the past than now, a detailed discussion of the astronomical data is necessary in order to discover, if possible, the extent to which the astronomical evidence is reliable. To me it has appeared to be sufficiently good to warrant full consideration of its consequences and to suggest further search for confirmation of the results.

Although these fluctuations appear to be physically independent of the well-known progressive change due to tidal friction, the latter is included with the former in the astronomical observations, and this fact requires a knowledge of the amount of the progressive change in order to isolate the fluctuations.

The progressive change is mainly determined from a comparison of material deduced from ancient eclipses with modern observations. Dr. J. K. Fotheringham's latest determination of the frictional portion gives an amount the cumulative effect of which at the end of a century is to change the apparent longitude of the moon by 4″·5; since it varies as the square of the time, the accumulation in a decade is less than a twentieth of a second of arc. An apparent displacement of the sun of the same character had been deduced earlier by Dr. P. H. Cowell; for this Dr. Fotheringham gets a century accumulation of 1″·5, but states that any values between 1″·1 and 1″·7 will satisfy the observational material.

The hypothesis that these amounts were due to tidal friction was first placed on a numerical basis by Prof. G. I. Taylor, who showed that shallow seas must be mainly responsible, and that, in particular, the Irish Sea produced about one-fiftieth of the observed amount. Shortly after, Dr. H. Jeffreys, from such data on tides, currents, and ocean depths as were available, deduced in the same manner from all the shallow seas of the globe an amount not very far from that obtained by astronomical observation; in fact, the two values agreed well within the errors due to the uncertainty of the data.

The apparent solar effect bears, however, a relation to the apparent lunar effect, which depends mainly on the amounts of the friction which are to be attributed to the solar and lunar tides respectively. Jeffreys showed that if we accept Fotheringham's figure for the apparent lunar effect, the maximum apparent solar effect in a century, namely, 0″·9, is obtained when we attribute all the friction to the lunar tides. This is somewhat less than the least figure, 1″·1, admitted by Fotheringham.

While the discrepancy exists and is in need of explanation, too much stress should not be placed upon it in view of the uncertainty of much of the material used to deduce the results. The hypothesis of continental drift has some bearing on the question. Practically the whole of the ancient astronomical observations were made in a restricted area on the earth's surface. If this region had drifted relatively to the rest of the earth in the direction opposite to the tidal drift, that is, east, by a sensible fraction of the total tidal retardation, the discrepancy would disappear. In this sense the drift could scarcely be tidal; if its existence be postulated, an internal source seems to be necessary.

In extrapolating these results into the past or future, it is to be remembered that the astronomical observations cover less than 4000 years, while the frictional calculations depend only on modern data. The discussion of the latter by Jeffreys showed that two-thirds of the whole amount was due to the Bering Sea alone. This sea is bordered on the south by the Aleutian Islands, which now constitute a region of considerable seismic and volcanic activity. From what we know of changes of ocean depth in such regions, there is no security that changes in the depth of this sea may not have taken place, even within historic times, sufficient to modify sensibly the total amount of tidal friction. While a retardation of the rate of rotation by tidal friction has certainly existed throughout the geologic history of the earth, its amount has probably been subject to considerable variations, and the same may be said of the future.

The results contribute nothing to a hypothesis which demands a sliding of the crust as a whole over the nucleus if the assumed angular velocity of relative shift be constant. While a retarded or accelerated effect is not excluded, the substantial agreement of the observed and computed friction indicates that it is probably, if existent, quite small. The same reasoning can be applied to other frictional effects; for example, that of an assumed general average circulation of the atmosphere relative to the earth's surface.

We now come to the fluctuations in the earth's rate of rotation which are indicated by the astronomical evidence. There are accelerations and retardations of an order of magnitude quite different from that of the frictional effect. There have been decades in which the accumulated apparent change from uniform motion has been several seconds of arc, while that due to friction in similar periods is less than one-twentieth of a second, as pointed out above. Since the frictional effect has always the same sign, while these fluctuations have both signs, they cannot be due to variations in the amount of friction, or indeed to any frictional effect caused by attractions of bodies outside the earth. Before discussing their origin further, however, I shall give some indication of the evidence on which their existence is postulated.

Briefly stated, the astronomical evidence comes

mainly from a comparison of the deviations of the moon and sun from their gravitational orbits, with confirmatory evidence from the transits of Mercury. The earth is the clock by means of which the rates of motion of these bodies are measured. If the rate of the clock varies, the apparent changes in the rates of motion of other bodies will be substantially proportional to the rates themselves. The best test of the clock is the fastest moving body which has been sufficiently observed, namely, the moon. The latter exhibits apparent variations which are much too large to be attributed to defects either in the observations or in the gravitational theory. When we examine the observations of the sun, after applying all known corrections, including the secular acceleration, we find a similar set of variations of the right order of magnitude. But as the angular motion of the sun is less than 1/13 that of the moon, the variations are less in this proportion, and consequently are observable with a corresponding degree of uncertainty. In fact, it is only by combining all the existing material that we can feel any degree of confidence in their existence.

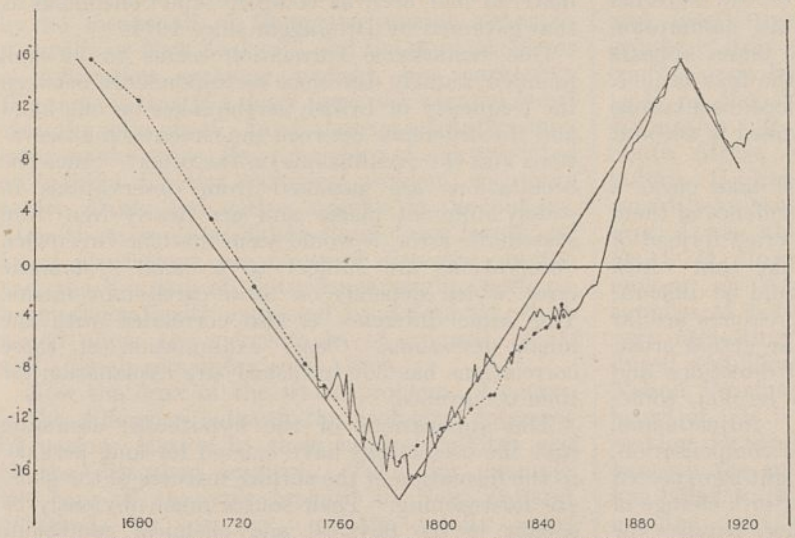


FIG. 1.—Fluctuations of the moon's mean longitude from Greenwich meridian observations (full line), and from occultations (broken line). The inclined straight lines are guides for the eye.

While the motion of Mercury round the sun is four times as fast as that of the earth, the relative lack of observational material more than offsets the advantage gained by the speed of motion. Nevertheless, the valuable work done by Mr. R. T. A. Innes in discussing these observations, the results of which led him to revive Newcomb's original hypothesis, constitutes an important addition to the evidence furnished by the moon and sun.

Fig. 1 exhibits the deviations of the moon in longitude from its gravitational orbit (which latter includes the frictional effect) as judged by the Greenwich meridian observations (full line) and the occultations (broken line); the inclined straight lines are merely guides for the eye. After 1850, the two sets and other observations so nearly agree on the scale of this figure that the Greenwich material is alone shown. The main outlines of the fluctuations with a minimum near 1790, a maximum close to 1898, and a marked change near 1917, are evident. Details before 1850, and in particular between 1810 and 1850, are doubtful; it seems that one set was subject to systematic errors which lasted for many years.

Fig. 2 shows (full line) the corresponding deviations of the sun as obtained from Greenwich, on a much smaller scale; the broken line is the full line curve of Fig. 1 with each ordinate divided by 13·3—the ratio to be used for the hypothesis of a change in the earth's rate of rotation. The coincident changes about 1898, 1917, are well marked; that at 1790 is doubtful, on account of the large deviations which follow this date. Comparison with other places appears to indicate defects in the Greenwich material for the sun in this period, and, judging by the occultations, for the moon also. The same comparison indicates systematic errors of observation throughout the whole range which, while not large enough to change the principal correlations, are large enough to account for the differences between the second halves of the curve in Fig. 2.

The evidence thus favours the hypothesis of changes in the earth's rate of rotation rather than that of unknown forces affecting the motions of the bodies in this particular manner. If it be adopted, it is easy to prove that, owing to the nearly spherical distribution of the earth's mass, the causes of the change must almost certainly be internal. Since the angular momentum of the earth remains constant, we are reduced to the consideration of changes in the distribution of its mass, with respect to the axis of rotation. An idea of the magnitudes involved can be obtained from the supposition that

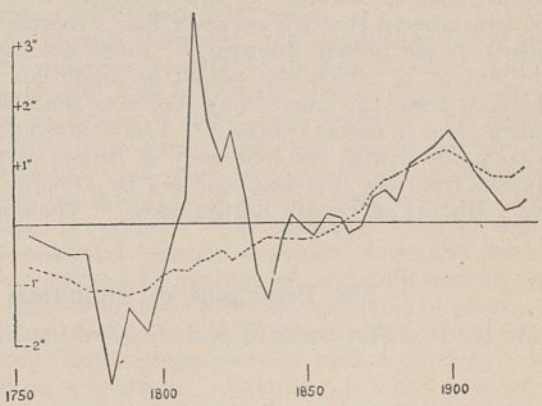


FIG. 2.—Full line curve: Greenwich tabular minus observed errors of the sun, including the secular acceleration. Broken line: 1/13·3 of the lunar fluctuations.

the effects are due to successive raising and lowering of the whole crust. If the maximum change of the outer radius be twelve feet, the thickness of the crust which must be moved vertically by this amount, in order to explain the astronomical observations, is fifty miles. If uniform expansions and contractions throughout the whole earth be assumed, the maximum change of the external radius necessary is five inches. An assumption somewhere between these extreme limits appears to be the only way of explaining the fluctuations. It will be seen at once that, while local oscillations may be present, they cannot be invoked to account for the main phenomenon.

If oscillations of the whole crust take place, a natural procedure is to search for evidence of them in terrestrial phenomena. With a crust formed of uniform and unbroken material like that which composes the surface, detection would be difficult, because the resulting strains and pressures are far within the elastic limits. From the actual crust, of unequal heights, fissured in all directions and undergoing constant change from erosion, something observable may be expected. Adjustments, especially those needed for isostatic compensation, are continually taking place, and might be expected to be more frequent with or soon after a change of radius. The interpretation given here requires the earth's radius to be below its mean value from about 1790 to 1898, and a change near this latter date from the minimum to the maximum value taking taking place within a very few years, as well as a further sudden change to the mean value about 1917. Other sudden changes may have occurred in the past, but the observations lack the accuracy needed for definite statements.

Some attempts to correlate the observations with seismic phenomena have been made. Prof. H. H. Turner some years ago deduced a period of between 200 and 300 years from the records of Chinese earthquakes, and suggested that it might be related to the lunar deviations. In this connexion it must be remembered that the curve of Fig. 1 represents nearly all our present knowledge; we do not know the extent to which the period or amplitude as deduced from this curve may represent what has taken place in earlier centuries. I have attempted a comparison with the frequency of British earthquakes from the material collected by Davison in his "History of British Earthquakes." There are indications of some correlation, but as they depend partly on the curvatures at different places of the curve in Fig. 1, there is doubt as to their reality. Correlation with the intensity of volcanic action was also briefly examined without success. The records of Kilauea as gathered by Dana and others would probably have served as a test if the material had been as complete and continuous as that gathered by Dr. Jaggar since 1911.

One remarkable correlation seems to be well founded, namely, the close correspondence between the frequency of British earthquakes on one hand and the difference between the Greenwich observations and the occultations on the other. Since the occultations are gathered from observations in widely different places and are nearly free from systematic error, it would seem that the Greenwich observations are subject to a small systematic error which depends on local earth movements. This same difference is also correlated with the lunar deviations. Closer examination of these correlations has not furnished any explanation for their occurrence.

The applications of the hypothesis, assuming that the oscillations have existed for long periods, to the formation of the surface features of the globe are far-reaching. Their source must obviously be sought in the physical and chemical conditions of the earth below the outer crust. It follows that a large supply of energy is available for external use. Adjustments to relieve the strains indirectly caused by erosion will be more frequent than without the oscillations, and the accumulated strains will be smaller. General statements of this character, however, do little more than furnish a basis for detailed investigations of specific problems. Can such oscillations, for example, constitute a factor of importance in the building of a mountain chain bordering a deep depression, as in the Pacific area? Will there be vertical or horizontal differential movements of continental areas, and, if so, can such movements be detected in variations of sea-level or of deposition of sediments? As to the latter, an inch of deposit in 200 years is 400 feet in 1,000,000 years, or 80,000 feet in 200,000,000 years, so that the magnitudes involved are of the right order for observation if the phenomenon exists. Many other questions of a similar character will occur to the geologist and the geophysicist.

## The Principles of Biological Control in Economic Entomology.[1]

By Dr. R. J. TILLYARD, F.R.S., Chief of the Biological Department, Cawthron Institute, Nelson, N.Z.

### I.

### THE CONTROL OF INJURIOUS INSECTS.

IN considering the possibilities of success of the method of biological control of injurious insects, we have to take into account a number of factors, the most important of which are the climatic conditions and the amount of economic disturbance in the affected area. The most striking successes in control have been made in countries with a warm and equable climate, in which new beneficial insects can be introduced with greater ease and, when introduced, flourish and spread more rapidly, than in countries in which either a marked change of seasons or a severe winter has to be faced. But this climatic factor, important as it is, must rank only second to another factor, which may be termed the *amount of disturbance* of the affected

[1] From the Trueman Wood Lecture of the Royal Society of Arts, delivered on Oct. 27, 1926.

area. To illustrate this point, let me take the case of an apple orchard in Australia or New Zealand. Ecologically speaking, one is no more a part of Australia than the other is of New Zealand; both are little pieces of Old England translated to a new environment with the same plant, the apple-tree, attacked in the same manner by the same pests, codlin-moth, woolly aphis, and the rest (fortunately by no means all of them are present either in Australia or New Zealand), and the same problems of cultivation, spraying, picking, and marketing. The same is true of a dairy farm or a planted forest area of exotic pines. In all these cases, before man came on the scene, the same piece of soil presented an entirely different ecological problem, with only native plants and native animals in the picture. Thus these apple orchards, these dairy farms and forest plantations, are pieces of *disturbed country*, and the amount of disturbance might, perhaps, be mathematically expressed by a formula which would show the percentages of original plants and animals remaining on the area.

Now the crux of the whole problem, of course, is the difference between the ecological interplay of various factors in their natural habitat and in the disturbed country. Take, for example, the case of an apple orchard in New Zealand, attacked, let us say, by the woolly aphis, *Schizoneura lanigera*. The original home of this pest was North America; in many countries it is still called 'American blight.' The pest, when studied a few years ago in New Zealand, was found to be almost unbelievably virulent, and was really threatening the continuance of the apple industry. In America, on the other hand, it has never attained anything like the same degree of severity. The more favourable climate of New Zealand is evidently one of the factors making for increased severity of the pest; but the main cause of it is clearly to be seen as arising from the incomplete balance of Nature in a piece of thoroughly disturbed country. In other words, man, after destroying the original association of plants and animals on the area, had proceeded to introduce (1) the apple tree, and (2) (unwittingly of course) the woolly aphis, without balancing this association by (3) the natural enemies of the woolly aphis in the form of parasitic and predatory insect enemies.

Let us now note carefully the effect of the scientific attempt to redress this lack of balance. The task was given to me six years ago, as the most pressing problem of the moment, when I joined the staff of the newly formed Cawthron Institute in Nelson. In the course of a visit to America, undertaken with this as one of its main objects, I found that there were three kinds of insects which attacked woolly aphis successfully enough to make them worthy of consideration. These were (1) syrphid flies of the genus Pipiza, (2) the Californian ladybird beetle *Hippodamia convergens*, and (3) the chalcidoid wasp *Aphelinus mali*. In considering which of these to introduce into New Zealand, I rejected the syrphid flies because of the abundance of allied native forms in New Zealand and their inability to make headway owing to severe parasitism from Ichneumonidæ. As regards the other two insects, all the evidence seemed to point in favour of *Hippodamia convergens*. It had a wonderful record in California and was rightly regarded as one of the most valuable of known beneficial insects. Large sums of money have been spent in rearing, collecting and distributing it, and every Californian fruit-grower is fully convinced of the benefits which it confers upon him. Opinions regarding *Aphelinus mali*, on the other hand, were not so uniformly favourable. It had already been introduced into South Africa, where it was considered to be a failure. If I had had to make a choice, the evidence would have been in favour of Hippodamia. However, I was able, through the great kindness of Dr. L. O. Howard, chief of the Bureau of Entomology at Washington, D.C., to obtain good supplies of both these insects. The results were very interesting. *Hippodamia convergens* was introduced and liberated in thousands throughout the Nelson Province, but has not since been seen or heard of. It is probable that its known habit of seeking the tops of high mountains and hibernating beneath the snow has proved its undoing, for it has failed to establish itself permanently in every country into which it has been introduced. *Aphelinus mali*, on the other hand, after being kept alive with great difficulty during the first winter in New Zealand (the period corresponding with the *summer season* in North America which it should normally have experienced), became acclimatised and increased with great rapidity and vigour in the insectaries. In the course of three or four years it was distributed in large numbers to all commercial apple orchard centres in New Zealand. The result has been that woolly aphis is now under satisfactory control in New Zealand and is no longer regarded as a serious pest. The New Zealand strain of this insect has also been sent over to various parts of Australia and is proving highly beneficial there.

As regards Australia, the conditions there are very different from those in New Zealand, but I do not wish it to be thought that biological control has no future in that great country. California is part of a great continent almost as big as Australia; yet good results have been obtained there by the method of biological control. The reason is, perhaps, that California itself is really an ecological 'island,' separated from the rest of the continent by barriers of mountain and desert. If that be so, then there is great hope of successes in Australia. First of all, the whole country is an island, both geographically and ecologically, as well as a continent. Secondly, it is made up of a large number of diverse areas separated from each other, as California is from the rest of North America, by mountain barriers or great stretches of desert. Looked at from this point of view, Western Australia, for example, should provide almost as perfect a field for biological control as New Zealand, while many parts of eastern Australia, such as the elevated apple lands of South Queens-

land, should be ideal for application of the same methods.

I now wish to emphasise the advantages which the biological method of control has over the chemical method. First of all, control of an insect pest by spraying or fumigation is only *annual* control, not *permanent* control, and it only extends to those areas in which it is faithfully carried out. Let there be any slackening, either in place or time, of the strict spraying schedule, and the insect pests immediately take advantage of it. Further, the cost of chemical control is a continuous annual drain on the industry, whereas the cost of biological control is a definite amount, terminating when the beneficial insect has been successfully established.

I think it would be of interest to give a short account of the principal researches in biological control of insect pests which are at present being carried out in Australia, New Zealand, and Fiji.

1. *Control of Woolly Aphis.*—The New Zealand strain of *Aphelinus mali* has been sent across to all six Australian states, and is now being reared and distributed over there. Reports indicate that success is being steadily attained in Queensland and Western Australia, while in the other States the work is not sufficiently advanced to say what the result will be.

2. *Control of Pear Leaf-Curling Midge* (*Perrisia pyri*).—Mr. David Miller, Government Entomologist of New Zealand, is now engaged on the problem of introducing beneficial parasites on this bad pest. Supplies of *P. pyri* are being forwarded by the Imperial Bureau of Entomology in London, and attempts are being made to establish species of Inostemma and Platygaster known to be present. Judging by latest reports, considerable progress is being made with the species of Platygaster, and a favourable result to this important investigation may reasonably be looked for.

3. *Control of Earwig* (*Forficula auricularia*).—This insect is a very serious pest of peach and apricot orchards in the irrigation areas of Teviot and Central Otago, New Zealand. An attempt was made to introduce the parasitic tachinid flies, *Digonochæta setipennis* and *Racodineura antiqua*, through co-operation between the Imperial Bureau of Entomology, Rothamsted Experimental Station, and the Cawthron Institute, Nelson. Considerable progress was made, but the work came to an untimely end through the long illness of Mr. H. M. Altson, who had charge of the work in England. The work is now again to be taken up, and the experience gained in the previous attempt should be of great value in this very difficult problem. One great advantage which New Zealand possesses over America in this case is the absence of the secondary parasites of the tachinids. The most abundant of these, *Dibrachys boucheanus*, is already present at Portland, Oregon, where the earwig infestation is worst, and renders the problem almost hopeless so far as control by tachinid parasites goes.

Parenthetically, a curious illustration of the unforseen difficulties which arise in this highly specialised work may be here mentioned. The waxmoth, *Galleria mellonella*, is becoming a serious pest in New Zealand, and a request has been made that the Cawthron Institute should endeavour to introduce a natural enemy to check it. Now it so happens that the only parasite which appears to be at all promising is *Dibrachys clisiocampæ*, which is so closely allied to *Dibrachys boucheanus* that it must be kept out of New Zealand at all costs if the experiments in controlling earwigs are ever to succeed. Consequently either the fruitgrowers or the bee-keepers must be disappointed. I have no hesitation in deciding that the earwig is by far the worse pest of the two insects in question ; and so, if the waxmoth is to be controlled by its natural enemies, some species which will not attack the tachinid parasites of the earwig must be used instead of Dibrachys.

4. *Control of Oak Scale* (*Asterolecanium variolosum*).—This insect, never a serious pest in Europe, has become so abundant on British oaks in parts of New Zealand that it is actually killing them. The only known parasite is *Habrolepis dalmanni*, of which several consignments have been received at the Cawthron Institute from Dr. Howard. A large number of females were reared from the last consignment, and, if it turns out that this species is parthenogenetic, there will be a very good chance of establishing it and so checking the scale.

5. *Control of Introduced Aphids in General.*—Only one or two very rare native species of aphids are known in New Zealand, but there are a considerable number of injurious introduced species. One of the most curious gaps in the New Zealand insect fauna is the complete absence of the green lacewings or Chrysopidæ, which are such a valuable check on aphids in other parts of the world. An attempt is therefore being made by the Cawthron Institute to acclimatise these insects in New Zealand. A fine consignment of 1900 hibernating adults of an undetermined Canadian species has been received in excellent condition, through the kind offices of Mr. Gibson, the Dominion Entomologist of Canada, and Mr. Downes, the State Entomologist of British Columbia. Three generations have already been reared and a fair number have managed to survive the rather too warm winter of Nelson. There seems to be a reasonable prospect of the final establishment of this or some other similar species throughout New Zealand.

6. *Control of Pear Slug* (*larva of Eriocampoides limacina*).—This pest is bad on pear, quince, plum, cherry, and hawthorn throughout New Zealand and Tasmania, and in parts of Australia. An attempt was made to introduce from England the ichneumon parasites of the genus Perilissus. Consignments were sent to the Cawthron Institute from Rothamsted Experimental Station. Nearly two years elapsed before the insects hatched out. They were then carefully paired in special cages and liberated into an insectary containing plenty of pear slug, which they attacked with vigour. It seemed almost certain at that point that success would be attained. But, alas ! one of the unknown bionomic factors intervened, for the entire succeeding brood proved to be males, and so the race died

out. This extraordinary example of the difficulties attending this kind of research may fittingly be used as an extra argument in favour of giving the strongest encouragement to those engaged in pure entomological research. Until we know for certain the factors governing the production of single sex broods in Hymenoptera, and also far more about parthenogenesis in this order than we do at present, we may not be able to succeed with the introduction of many valuable parasitic insects into Australia and New Zealand.

7. *Control of Sheep-Maggot Flies.*—This immense problem, of the utmost importance to Australia and other sheep-raising countries, need not be dealt with at all fully here, because up to the present no satisfactory method of biological control has been discovered. Much work has been done with several well-known chalcidoid parasites of the blow-fly larvæ and pupæ, but in no case has the percentage of parasitism produced been high enough to warrant the continuance of the work. At the present time, the interesting parasitic hymenopteron *Alysia manducator* is being collected in England by Dr. J. G. Meyers for shipment to Australia, and it will be interesting to watch the progress of the attempt to acclimatise and spread this very active insect in a warmer climate and new conditions of life.

8. *Control of Coco-Nut Moth* (*Levuana irridescens*).—This very serious pest, the original home of which is still unknown, is a small zygænid moth the larva of which feeds along the midrib of the leaflets of the coco-nut palm. In the island of Viti Levu, Fiji, it increased enormously during the past ten or twenty years, until its depredations had so weakened the trees and reduced the yield of copra that the very foundations of the industry were tottering. During the past few years scientific workers have been engaged on the problem of discovering and introducing the natural enemies of species closely allied to *Levuana iridescens* from Malaya. A parasitic tachinid, *Ptychomyia remota*, has been introduced and successfully established with very promising results, and it would appear that this formidable problem is now in process of solution.

(*To be continued.*)

## Whither?—a Footnote.

"*What, then, is Life? Is it . . . a . . . possibly quite unimportant by-product of natural processes, which have some other and more stupendous end in view? . . . Or, throwing humility aside, is it the only reality, . . .?*"—J. H. Jeans, NATURE, Dec. 4, 1926.

RIBBED, breathing flesh thrice often crucified!
Veined vase of Life! lo, whether for bliss or curse
A wondrous thing the wheeling universe,
Engendering thee, lifts shapen from scarred Earth's side!
Reared in primeval war of rock and tide,
Thence hither—by what wayfaring perverse!
Thy fashioning? runs it ended more than theirs,
The stars in flow that sphere from vapours wide?
How camest thou by that strange gift ungiven
To aught else earthly, the old fruit forbidden,
To know thyself, as part to glimpse a whole,
And, that within thee, clasping earth and heaven
For comrades of like faring, to—storm-ridden—
Confront, brow raised, the incognisable goal?

C. S. S.

## Obituary.

### PROF. A. DE QUERVAIN.

THE death of Prof. A. de Quervain at the comparatively early age of forty-seven years, which occurred at Zurich on Jan. 13, is a serious loss to European meteorology. His fellow-members on the different international commissions to which he belonged will miss a colleague who had endeared himself to them by his earnest enthusiasm and by his lovable disposition.

de Quervain was born on June 15, 1879, in the Canton of Berne. After studying at Neuchâtel and Berne he went to Paris as assistant, from 1898–1902, in the Observatory at Trappes, where the late Teisserenc de Bort was developing the exploration of the upper atmosphere by means of *ballons-sondes*. This led, in 1899, to the discovery of the stratosphere. In 1901, Teisserenc de Bort made arrangements for observations with *ballons-sondes* in Russia. Prof. de Quervain was placed in charge of the work and obtained observations of temperature in the upper air both at St. Petersburg and Moscow up to heights of 10 kilometres. After leaving Trappes, de Quervain went to Strasbourg, where the results of the international investigation of the upper air were collected and published under the direction of Prof. Hergesell. de Quervain acted as secretary to the international commission, and became impressed with the advantages which would accrue if the balloons which were used for carrying the recording instruments could also be observed during their ascent, so as to give information about the upper wind. Physical difficulties in the way of making these observations for an hour or more with an ordinary theodolite had formed a practically insuperable obstacle. de Quervain overcame this difficulty by inventing, in 1905, the theodolite with the reflecting prism, which is now practically universally adopted for observations with pilot balloons: no invention has contributed more than this to our knowledge of upper wind. It was exceptionally fortunate for meteorology that de Quervain came, during these eight years, under the influence of two such pioneers in the investigation of the upper air as Teisserenc de Bort and Hergesell. They were both inspired with the conviction that the exploration must be world-wide, and themselves carried out investigations in different parts of the oceans.

Prof. de Quervain returned from Strasbourg to Zurich, where he continued his investigations of the upper air, publishing in 1908 a thoughtful contribution on cloud studies and some notes on

the connexion between clouds and the actual conditions of temperature in the upper air. In 1909 he was the leader of a joint German-Swiss expedition to Greenland, and the experience which he then gained enabled him, three years later, to lead a Swiss expedition successfully across Greenland from west to east. This was the first time the interior of the country had been traversed. (A short crossing nearer the southern extremity had been made in 1888 by Nansen.) The highest point reached was 2510 metres (about 8200 feet), 260 miles from the west coast and 150 from the east coast. The scientific results of the expedition, prepared jointly by de Quervain and his companion Mercanton, were published in 1920, and constitute the observational basis of our knowledge of the meteorology of the interior of Greenland.

When the international meteorological organisation resumed its work after the War, de Quervain became a member of the Commission for Weather Telegraphy. He had a profound knowledge of the observational side of meteorology, which proved most valuable in the difficult work of extending the international exchange of observations to meet post-War conditions. He spoke frankly when he saw the risk of a wrong decision being taken, but in a way which not only convinced his colleagues, but also endeared the speaker to them.

One project dear to de Quervain's heart was the establishment of an observatory on the Jungfraujoch at a height of 3500 metres, and for this he gained the warm support of the Commission. After the recent meeting last September at Zurich, many members of the Commission went to see the observatory, but to his great regret de Quervain was too ill to lead them. Owing to his unique knowledge of clouds he was chosen to be chairman of the subcommission appointed in 1923 at the conference at Utrecht to consider the revision of the method of reporting observations of cloud and weather in the international code. Before this task could be completed he was unfortunately seized, in 1924, by an illness from which he never completely recovered. He was, however, able to be present for a short time at one of the meetings at Zurich in September 1926, when the Commission gave its approval to a new trial code based on his work and showed its warm appreciation of his services and its sympathy with him in his illness.

de Quervain's death, when it came, was quite unexpected. He is survived by his wife and four children. It is fitting to record that Mme. de Quervain, imbued with a like enthusiasm for exploration, and resolute in face of the danger and hardship, went to Angmagsalik on the east coast of Greenland in 1912 to meet her husband after his perilous journey and to accompany him on his return to Europe. E. G.

## M. M. Delafosse.

WE regret to record the death, on Nov. 13, in his fifty-sixth year, of M. Maurice Delafosse, the distinguished ethnologist and authority on African languages. Maurice Delafosse was born at Sancergues (Cher) on Dec. 20, 1870. On completing the usual educational course, he became a student at the École des Langues Orientales Vivantes, where he obtained his diploma in 1894. In the following year he was appointed to the French Government service in West Africa. This was the beginning of a distinguished official career, during which he held a number of important appointments: Consul in Liberia, 1897; member of the Anglo-French Boundary Commission on the Ivory Coast-Sudan-Gold Coast Frontiers, 1903; administrative officer of the Ivory Coast; political officer of the Government at Dakur, 1915; Governor of Oubangui-Chari, 1918.

In 1918, Delafosse retired and thenceforth devoted himself to the linguistic and ethnographical studies to which he had given considerable attention throughout his official career. He became professor of native customs and languages at the École Coloniale, and of Soudanese languages at the École des Langues Orientales Vivantes. He was also appointed Membre du Conseil Supérieur des Colonies and Membre Effectif of the International Colonial Institute at Brussels, Member of the Commission de l'Esclavage at Geneva, and Director of the Institut International pour l'Étude des Langues et Civilisations Africaines. He was one of the founders of the Institut d'Ethnologie.

Delafosse was a frequent contributor to *L'Anthropologie*, *La Revue d'Ethnographie*, and other specialist periodicals, and was the author of a number of books dealing with African languages and peoples. Among these were manuals of Dahomian, Agni, Haussa, Mende, and a comparative vocabulary of more than sixty languages or dialects spoken on the Ivory Coast. His ethnographical work included studies of the Sara (Chad) and the peoples of Liberia and the frontiers of the Ivory Coast, Sudan, and Gold Coast, the Senufi, and the peoples of the Upper Niger. Of a more general character were his "Les Noirs de l'Afrique" and "Les Civilisations Négro-Africaines." He was greatly interested in the recently formed International Institute of African Cultures and Languages, of which he became joint director. His death at a comparatively early age, which was largely due to ill-health contracted during his residence in Africa, is a great loss to ethnographic and linguistic studies, not in France alone, but wherever primitive, and especially African, races are a subject of serious study.

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WE regret to announce the following deaths:

Sir Digby Pigott, Controller of H.M. Stationery Office from 1877 until 1905, an authority on the birds of London, aged eighty-six years.

Prof. E. H. Rennie, professor of chemistry in the University of Adelaide, known for his work on the chemistry of Australian plant products, aged seventy-four years.

Dr. Walter Seton, secretary of University College, London, and also secretary to the Ramsay Memorial Fellowship Fund established in memory of the late Sir William Ramsay, on Jan. 26, aged forty-four years.

## News and Views.

IN his article elsewhere in this issue (p. 200), Prof. E. W. Brown makes out a strong case for the belief that the chief outstanding anomalies in the motions of the moon, the sun, and the inner planets are due to errors in time-keeping arising from variations in the earth's rate of rotation. A set of the most puzzling departures of astronomical observation from gravitational theory has therefore been brought into harmony. The ratio of the chief inequalities in the longitudes of the sun and moon is such as to indicate that the variations of the rate of rotation are not associated with any corresponding transfer of angular momentum to the moon's orbital motion, and therefore Prof. Brown attributes them to changes in the earth's moment of inertia. Symmetrical swellings and contractions of the earth would certainly give rise to effects of the type observed. But elastic vibrations of the earth of this type would have periods of the order of minutes, not years, and it is difficult to think of any geological or seismological process that could give simultaneous expansion or contraction over the whole earth. An alternative explanation resting on a phenomenon already known to occur may be found in variations of the thickness of the polar ice-caps. Partial melting of the polar ice and redistribution of the water over the ocean would give changes of the moment of inertia such as are required, and the amount does not seem prohibitive. A small secular increase in the amount of ice would also give a secular acceleration of the earth's rotation, which would go some way towards explaining the outstanding discrepancy between theory and observation with respect to the ratio of the secular accelerations of the sun and moon. There is evidence of a warm climate in Europe about 2000 B.C., which would fit this suggestion.

A COMMITTEE consisting of representatives of the Royal Society, the Royal Colleges of Physicians and Surgeons, the Royal Society of Medicine, the British Medical Association, the universities, and other institutions interested, has been formed to organise a celebration in London of the centenary of the birth of Lord Lister, which falls on April 5 next. Representatives of learned societies, universities, and medical bodies in Great Britain, and delegates from the Dominions and principal foreign countries, will be present. The delegates will be received by H.M. the King at Buckingham Palace on Monday, April 4. The programme so far arranged is as follows: April 5.—Reception and short addresses by some of the delegates in the large hall of the British Medical Association; conversazione at the Royal College of Surgeons of England: dinner given by the Merchant Taylors' Company, of which Lister was a member. Apr. 6.—Memorial service in Westminster Abbey, and an address by the Bishop of Birmingham; discourses in the Robert Barnes Hall of the Royal Society of Medicine on "Lister as Physiologist, Pathologist, and Surgeon," by Sir Charles Sherrington, Prof. W. Bulloch, and Sir Berkeley Moynihan; and a conversazione at the rooms of the Royal Society.

FEW individual acts can have had more unforeseen consequences than when Gordon Bennett sent Stanley to find Livingstone. That was in 1869. In 1875 Stanley set out on his second expedition into Africa, financed by the *New York Herald* and the *Daily Telegraph*. That same year Stanley wrote from Uganda: "Nowhere is there in all the pagan world a more promising field for a mission than Uganda." The challenge thus thrown down was taken up by the Church Missionary Society, which has just been celebrating the jubilee of the Uganda Mission. To-day the church in Uganda has a membership of 165,000 baptized Christians, while one of the important industries of the country, namely, cotton growing, was due to a missionary. At the celebration, in which the Archbishop of Canterbury, Lord Burnham, and other distinguished men took part, it was announced that a tablet to the memory of Stanley is to be erected in St. Bride's Church, Fleet Street, one of the inscriptions to read: "To the Glory of God. In memory of Sir Henry Morton Stanley, Bula Matari (Rock Breaker), Explorer, Author, Newspaper Correspondent. 1841–1904. Challenged the Christian Church to Evangelise Uganda. 'Here is your opportunity: embrace it.'"

ON Feb. 8 occurs the bicentenary of the birth of Jean André De Luc, F.R.S., the Swiss physicist and geologist who for more than forty years was reader to Queen Charlotte, consort of George III. Born in Geneva in 1727, he was well educated and took up a business career. Having a taste for study, however, he worked at meteorology and geology and made excursions among the Alps. In 1773 he came to England, and it was apparently the publication of his "Recherches sur l'Atmosphere," published the previous year, which gained him admittance to scientific circles. He afterwards made tours on the Continent, but England was his permanent home, and he died at Windsor in 1817. In physics, De Luc is credited, among other things, with noting that when a mixture of ice and water is melted the temperature remains constant until all the ice is melted. It was for his writings on geology he was principally known, and though these, to-day, are only consulted by the curious who, as Geikie said, have "leisure and inclination to dig among the cemeteries of geological literature," De Luc's devotion to science was lifelong and sincere. His "Lettres Physiques" of 1778 contains one of the earliest examples of the use of the word 'geology' in its modern sense. He is frequently mentioned in the memoirs of the time, such as Madame D'Arblay's; it is to him Watt speaks his mind about the water controversy, while Queen Charlotte refers to him as the "good old De Luc."

IN an article on electrification and the Electricity Act in the *Quarterly Review* for January, Sir Charles Bright makes a strong plea for electrical progress. He points out that industrial success is largely based on the possession of an abundant supply of cheap and efficient power. He thinks that too much stress is

often laid on having great hydro-electric resources. Although America's potential resources in water power are enormous, the bulk of its electricity is produced by coal. The compact nature of the load in England makes it an ideal country for the development of electrical power. In Germany, brown coal production is rapidly outstripping the production of black coal. There seems no reason why peat, of which he declares we have a superabundance, should not be similarly employed by us. If conservatism and a narrow care for established interests should hamper the future wide electrification of Great Britain, the generations to come are sure to suffer from our shortsightedness. The Electricity Act gives us a great opportunity of increasing our industrial efficiency. The technical work will be in the hands of the Electricity Commissioners. The Central Electricity Board, of which Sir Andrew Duncan is the chairman, will be concerned merely with administration; its functions will be very similar to that of a board of directors. It seems certain that the successful working of the scheme will add to the national well-being, and useful constructive criticism will help greatly towards this end.

A LARGE and representative meeting of British botanists was held at the Linnean Society's rooms on Thursday, Jan. 27, to initiate arrangements for the fifth International Botanical Congress, which is to be held in England in 1930. Dr. A. B. Rendle, who presided, announced the acceptance of the invitation extended to the botanists meeting at Ithaca last August on the occasion of the fourth Congress, to meet in Great Britain in 1930. The meeting having constituted itself a general committee, it was decided that the coming Congress should deal with pure botany only, applied sciences such as agronomy, forestry, horticulture, and pharmacognosy being excluded. An executive committee was appointed as follows: Sir David Prain, Prof. A. C. Seward, Prof. A. G. Tansley, Prof. V. H. Blackman, Prof. W. Neilson Jones, Prof. Walter Stiles, Prof. Dame Helen Gwynne-Vaughan, Dr. A. W. Hill, Dr. A. B. Rendle, and Mr. F. T. Brooks. The committee was empowered to add to its number as might be found advisable.

AN earthquake, that must have been of great strength near its origin, was felt in the eastern and north-eastern counties of Scotland at about 5.20 A.M. on Jan. 24. The disturbed area includes the Orkneys, the counties of Caithness, Nairn, Elgin, Banff, Aberdeen, Kincardine, Forfar and Fife, and at least the eastern half of Perthshire. The boundary, so far as it can be traced from the early reports, is a nearly north-and-south line concave towards the east, and therefore pointing to an origin outside the country and either in the south of Norway or just west of the Norwegian coast. At the same hour it appears that an earthquake was felt over a large part of southern Norway, and there can be little doubt that this shock was connected with the tremors felt in Great Britain. As the shock reached an intensity of 6 (Rossi-Forel scale) at Banff and Aberdeen, and 5 at Kirkwall and at Ladybank in Fifeshire, it is probable that later reports will show that the earthquake was felt over the greater part of Scotland and possibly in the extreme north of England. It was recorded by seismographs in the observatories of Edinburgh and Kew. In Morayshire and Nairnshire an earlier shock was felt at 11.5 P.M. on Jan. 23. It is worth recalling that on previous occasions—for example, on Mar. 9, 1866, and Jan. 4, 1879—Norwegian earthquakes were felt in Great Britain, but never before, so far as known, over so wide an area.

AT a meeting of the Newcomen Society, held at the Science Museum on Jan. 26, Mr. A. Titley read a paper on Trevithick and Rastrick, and the single acting expansive engine. About a year ago an old note-book, dated 1813, belonging to Rastrick, came to light. This contained sketches, dimensions, and calculations regarding a 6-H.P. engine, but a great many dimensions were given in cipher. Mr. Titley found the clue to the cipher, and from the note-book was able to make working drawings. The engine however, proved to be very like the Trevithick engine preserved in the Science Museum, South Kensington, which was built under the patent of 1802 of Trevithick and Vivian, and is evidence of the close co-operation of Trevithick and Rastrick. At the same meeting Mr. Jenkins was able to announce that during a search by Mr. Watkin of the archives of Dartmouth, deeds bearing the signature of Thomas Newcomen had been discovered. These are the only specimens, in England, of the inventor's handwriting, and they go far to establish the authenticity of a letter of Newcomen's preserved in Berlin.

PROF. A. S. EDDINGTON, in his second Gifford Lecture in the University of Edinburgh on Friday, Jan. 28, considered certain problems of time and space. He said that two distinct questions arise: first, what is the true nature of time? and secondly, what is the nature of that quantity which has, under the name of 'time,' become one of the main foundations of the whole scheme of experimental and theoretical science? As physicists we are interested in the latter quantity, and this turns out to be relative and is mixed up with space. Einstein's theory, having cleared up this point, was able to approach the first question, and was able to rediscover—not in the three-dimensional but in the four-dimensional world—the time which we feel is essentially distinct from space. This is called 'interval,' because the vested interests have otherwise appropriated the name 'time.' We have every right to object in the name of common sense to a confusion of two things so obviously distinct as space and time, but that means we must abandon the partially unsuccessful attempt made in classical physics to divide them, and go into the four-dimensional world where we can make a more satisfactory separation of them.

VIEWING the world, said Prof. Eddington, we see distant events happening 'now,' and this has led us to conceive an instant 'now' not confined to 'here' but spread through all space, so that we regard the

enduring world as stratified—composed of a succession of world-wide instants. This conception ought to have died in 1667, when it was discovered that light takes time to travel; it is not the event but the seeing of the event which is 'now.' The idea of world-wide instants is firmly rooted, however, and the scheme has to be patched up by placing these distant events in some past instant. But the construction of the world-wide 'now' became a matter of artificial calculation, and it turned out that the resulting construction was different for observers with different motions, so that 'now' relative to one was not 'now' relative to another. The absolute structure of the enduring world contains nothing corresponding to world-wide instants; it is not stratified. The physical nature of the world is seen more clearly and simply when this stratification, arbitrarily imposed, is removed—it appears simpler though less familiar.

THE third assembly of the International Federation of Intellectual Unions met at Vienna on Oct. 18, 19, and 20, 1926. A report which has reached us in multiplex typescript includes a cordial invitation to more active participation by British intellectuals. The Federation originated as a post-War French-Austrian *rapprochement*. The Vienna assembly has endorsed, and carried forward, the resolutions of an earlier assembly at Milan. Some preliminary contacts have already been made with the P.E.N. Club, the English League of Nations Union, the Carnegie Foundation, the Institut International Intermédiare in Holland, the Institute of International Education in New York, and the Intellectual Relations Committee of the Société des Nations. Other countries are forming 'intellectual unions,' and those who seek the co-operation of Great Britain are a little baffled by the absence of any general British Intellectual Union, and inquire as to the possibility of starting one. Communications would also be welcomed from North America, Latin America, Americans travelling in Europe, and Soviet Russia.

THE secretary of the International Federation of Intellectual Unions is Prince Charles de Rohan, Schloss Albrechtsburg, Post Loosdorf, bei Melk, Lower Austria. The most general object of the Federation is the supra-national organisation of Europe on an intellectual rather than on a political basis. It is assumed that the success of the more general conversations on peace, reconciliation, and fellowship now justifies the organisation of co-operative work. The programme includes the promotion of lectures in other countries by representative exponents of their own national cultures (thus, Rabindhranath Tagore has lectured in Italy), the discussion of some of the general problems of the evolution of civilisation, the arrangement of 'passeports intellectuels' or personal introductions for savants travelling abroad, and the planning of family hospitality for younger students. There is a proposal for a European press agency exchanging magazine articles and promoting the translation of new and significant works into various languages. Already on an independent business footing there is *L'Europäische Revue*, published in Leipzig. For some words like 'nation' and 'democracy,' which have different implications in French and German leading to continual misunderstandings, it is proposed to prepare a special dictionary.

THE Federation complies with one of the conditions of permanence in public international organisations; it offers an open door and a warm welcome, but should be on its guard against not impossible risks of intellectual snobbishness. It is already difficult enough to try to interest socialists in international scientific societies, which are felt to be bourgeois. It is not so clear whether the Federation satisfies a second condition, that of definite purposes clearly laid down in articles of association. At the moment there is an impressive imprecision. But whatever form the political organisation of Europe may take, there is a place for thinking organisations exploring the way to the future far in advance of what statesmen call practical politics.

IN his presidential address to the Indian Science Congress which met recently at Lahore, Sir J. C. Bose briefly summarised the results of his many years of research on the physiology of movement and irritability in plants. He dwelt upon the important conclusion that the physiological mechanism of the plant is essentially similar to that of the animal: in both there are contractile, rhythmic, and nervous tissues. In particular he expressed his conviction that the 'automatic' or 'spontaneous' movements of plants are to be attributed not to 'internal stimuli' but to the accumulated energy of stimuli acting from without. He concluded by pointing out how, by the gradual evolution of will, it has become possible for man to control the action of, and his response to, external stimulation, so that he is now no longer merely a passive subject of his environment.

A COMMITTEE has recently been formed in Paris to raise funds for the erection of a monument to the memory of the famous French engineer, Gustave Alexandre Eiffel, the builder of the Eiffel Tower. Born in Dijon on Dec. 15, 1832, Eiffel was trained as a civil engineer at the École Centrale des Arts et Métiers in Paris and became known as a great bridge builder. The contract for the tower which formed such a feature of the International Exposition of 1889 was signed in Jan. 1887, and the full height was reached on Mar. 13, 1889. The steel lattice work reaches a height of 984 feet, 580 higher than St. Paul's Cathedral in London. It has served many purposes, and during the War proved invaluable as an anti-aircraft station, while General Ferrie, the Inspector of Military Telegraphs, said that as a radio station the tower served so many purposes that if it had not existed it would have been necessary to build it. Eiffel died on Dec. 28, 1923, at the age of ninety-one years.

IN a pamphlet entitled "The Present Status of the Wild-Fowl of Europe," Dr. P. R. Lowe, of the British

Museum (Natural History), presents the case for further legislation for the increased protection of wild-duck (including swans and geese) and waders (plover, snipe, curlew, woodcock, sandpiper, etc.) in Great Britain and Ireland. Exploitation of these birds for commercial and other purposes in Europe has increased to such an extent that the rate of destruction exceeds the rate of reproduction. The position has become so serious as to cause the Swedish Government to move in the matter and to suggest international regulations for the more effectual protection of wild-fowl on migration. A committee was appointed at the International Ornithological Congress held at Copenhagen last May to consider the proposals of the Swedish Government, and a resolution was submitted to the General Congress, and passed, supporting the proposal for an international conference and asking delegates to prepare reports dealing with the facts as they affected their own countries. These reports will be considered at the International Congress which it is hoped to hold before the end of the present year. Dr. Lowe's report represents the British case, and deserves the careful consideration of ornithologists. While it appears from Dr. Lowe's detailed analysis that the situation in Great Britain is less serious than in other European countries, it is made abundantly clear that international co-operation is called for if European ducks and waders are to be saved from a steadily approaching doom.

In order to mark the end of the fiftieth year of publication the *Chemiker-Zeitung* has published a special jubilee number (Dec. 29). The issue contains many messages of appreciation from eminent technologists and from distinguished foreigners. Amongst the latter we note the names of Profs. E. Cohen of Utrecht, Mme. Curie of Paris, G. Georgevics and J. Stoklasa of Prague, A. E. Holleman of Amsterdam, W. A. Noyes of Illinois, F. Ullmann of Geneva, and R. Wegscheider of Vienna. Articles of special interest are contributed by many well-known authorities. Prof. Ostwald writes on the future of chemistry in Germany, Prof. Oppenheimer of Berlin on enzyme oxidations, Prof. E. Laqueur of Amsterdam on the three hormones, thyroxin, insulin, and menformone, Dr. A. Weinberg and Prof. F. Mayer on different aspects of the dyestuff industry, Dr. Bergius on the utilisation of coal, etc. Several contributions by prominent authorities, including one by Prof. H. E. Armstrong, are to follow shortly.

The *Chemiker-Zeitung*, which is well known not only throughout Germany but also in other countries, has rendered important service to the rapid development of industrial chemistry, both by reason of its valuable survey of scientific and technological progress and by the wide publicity of its advertising columns. Founded in 1876 by the bold enterprise of Dr. G. Krause in his native town of Cöthen, it rapidly achieved success. The first four-page 'specimen-number' was published on Dec. 4, 1876; on Jan. 5 in the following year the first part of Volume 1 duly appeared, and before 1882 two weekly parts began to be issued. After passing through some critical periods, drastic changes were made in 1906. Publication was then handed over to the firm of Otto von Halem and the editorship to Baron von Vietinghoff-Scheel. On the resignation of the latter in 1913, Dr. Walther Roth was appointed editor-in-chief. In 1920 the usefulness of the journal was increased by the creation of a special section, entitled *Die chemische Praxis*, which is soon to be enlarged. The annual reports on progress, which in some form or other have always been a feature of this newspaper, will henceforth appear as a special quarterly issue entitled *Fortschrittsberichte der Chemiker-Zeitung über die wichtigsten Gebiete der Chemie und chemischen Industrie.*

In making a plea for the adoption, especially in scientific communications, of the metric units, Prof. R. A. Gortner, of the University of Minnesota, refers in particular to the following expression used by Messrs. H. J. Page and W. Williams, of Rothamsted Experimental Station: "The land is typical strong wheat and bean land which can ordinarily be expected to give a yield of four to five quarters of wheat per acre" (*Jour. Agric. Sci.*, vol. 16, part 4, pp. 551-573). Prof. Gortner was unable to discover exactly how much a 'quarter of wheat' signified. Reference to "Webster's New International Dictionary" shows that 1 quarter, as applied to grain, is equivalent to 8 bushels. In annuals, almanacks, and in books of tables such as the "Smithsonian Physical Tables," the quarter is also defined as equal to 8 bushels. The "Encyclopædia Britannica," under "Acreage and Yield of British Crops," supplies the additional information that the imperial quarter is 480 lb. of wheat, so that the imperial bushel is the same as that in use in the United States, namely, 60 lb. of wheat. Mr. Page has also informed us that in "Recueil decoefficients et d'é quivalences," published by the International Institute of Agriculture at Rome, where the metric equivalents are given of all weights and measures, it is stated that 1 quarter = 8 bushels = 2·90942 hectolitres, and that 1 quarter of wheat = 480 livres = 2·17724 quintals. Conversion tables are also available in the "Smithsonian Physical Tables." Mr. Page defends his original expression, stating that the information conveyed thereby is agricultural rather than scientific, and as such is more intelligible to those familiar with British agricultural conditions in its present form. For others, the conversion tables available must suffice while the present unscientific system of British weights and measures remains in common use.

The paper by P. Dunsheath on 33,000-volt cables, which was read to the Institution of Electrical Engineers on Jan. 20, discusses a question which is of the greatest interest at the present time. It is well known that the ordinary high-tension cables for three-phase working, each of which contains three conductors, have in several cases broken down with consequent financial loss and interference with the continuity of supply. This breakdown is generally attributed to air spaces developing in the insulating material. As the electrostatic field is very strong, these spaces get ionised, and this results in the slow

destruction and ultimate breakdown of the insulating material. To get over this difficulty, cables are often made with metal sheaths wound round each of the conductors. This makes the electrostatic field in the neighbourhood of the conductors radial to them, and the insulating material has greater strength to resist radial stresses than to resist tangential stresses. The assumption is made that the tangential stress is the dangerous one. We do not think this reasoning is very convincing. Approximate expressions for the electrostatic forces inside a three-core cable can easily be obtained, and they show that the tangential stresses are small. The calculations of the sheath losses, by calculating the tangential and radial eddies separately, may be true, but it wants a more rigorous proof. The experimental results given are of value. It is stated that the introduction of metal sheaths round the conductors enables them to get rid of their heat more readily and thus enables them to carry greater currents. Assuming that the same quantity of insulating material is used in the two cases, this may be true, but the increase due to this cause would be very small.

THE numerous problems that arise in connexion with the working of oil-fields have been studied closely by electricians for many years. About twenty-five years ago the South Russian oil-fields at Baku used electric power. Now practically all the important oil-fields in the world are electrified. An interesting account of several of these installations is given in *A.E.G. Progress* for October, which is published by the Allgemeine Elektricitäts-Gesellschaft of Berlin. The main advantages in electric driving are the saving of the fuel effected and the large reduction in the working costs. Other advantages are that there are fewer breakdowns and that the cost of the necessary mechanical equipment is appreciably reduced owing to the even turning moment of the electric motor. Two years ago the A.E.G. secured the contract for the 25,000 H.P. station required for the Comodoro Rivadavia oil-fields in the Argentine. Careful calculations were made to find out whether Diesel engines, working with either gas or oil, or steam turbines would be the more economical. It was proved conclusively that the turbine scheme was the more desirable, and this has now been completed. The drawbacks to the Diesel scheme were its high capital cost and the high depreciation and interest charges. In addition, there were the higher maintenance costs and a more expensive fuel consumption when the station had only a partial load. The turbines are supplied by water-tube boilers heated by gas- and oil-firing. It is noteworthy that the air required for cooling the generators and ventilating the engine-room passes through special oil-mesh filters. The air in the engine-room is always at a definite pressure above that of the air outside, so that dusty or sandy air, which owing to the nature of the site has to be specially considered, cannot penetrate into the engine-room through the doors and windows. Accounts are also given in this paper of the Baku naphtha industry and of the Roumanian and Galician oil-fields.

THE Department of Scientific and Industrial Research has just issued the Report of the Fuel Research Board for the year 1925 (London, H.M.S.O.; 1*s.* 3*d.* net), including the report of the Director of Fuel Research. At the present time it seems a somewhat belated document, but is interesting as showing the wide range of problems which this organisation touches upon. The experiences with the vertical metal retorts for low temperature carbonisation show that such a problem is largely metallurgical, namely, the production of a cast iron not given to 'growing' at a dull red heat. Considerable space is devoted to the history of and progress made with the Physical and Chemical Survey of Natural Coal Resources, which is rightly regarded as of prime importance to the scientific use of coal in Great Britain, and to the promotion of the export trade, in connexion with which the standardisation of methods of sampling and analysis is also valuable. A memorandum of the Director prepared for the Royal Coal Commission gives an interesting survey of the fuel problem of Great Britain in its general form.

NUMBER 5 of the *Transactions of the Optical Society* for 1925–26 contains Prof. von Rohr's account of the position of the optical industry at the beginning of the nineteenth century and of Fraunhofer's optical work in the early years of the century. Mr. D. Baxandall adds some interesting facts about the ancient glass works at Ratcliff, near the Royal Mint, and the difficulties of Dolland and of Ramsden, his son-in-law, in obtaining optical glass after the closure of those works. At the beginning of the nineteenth century the best instruments appear to have been produced by the English makers, and Voigtlander, before establishing his works in Vienna in 1808, spent some years with London masters. Fraunhofer was engaged as a journeyman optician by a Munich firm in 1807 and by 1809 had attained a directorship of the firm. He aimed at scientific accuracy in his instruments, and found it necessary to learn glass-making himself. By 1813 he had made sufficiently accurate measurements of the dispersion of the glasses available and could calculate the details of an objective so that the grinder had merely to work to data supplied. He also improved the homogeneity of his glasses by having large meltings, and devised grinding and polishing machines and methods of testing his surfaces. Details of some of his instruments are given.

PROF. HENRY E. ARMSTRONG will deliver the Horace Brown Memorial Lecture of the Institute of Brewing in the lecture theatre of the Institution of Electrical Engineers at 8.15 P.M. on Friday, Feb. 25. The Horace Brown Medal will be presented to Prof. Armstrong during the course of the evening.

MR. E. GUY DAWBER, president of the Royal Institute of British Architects, Sir John Reith, managing director, British Broadcasting Corporation, and Prof. G. I. Taylor, Yarrow research professor of the Royal Society, have been elected members of the Athenæum Club under Rule II., which provides for election by the Committee of "persons of distinguished eminence in science, literature, or the arts, or for public services."

THE International Hydrographic Bureau, Monaco, has issued a Circular-Letter (No. 38-H of 1926) upon international uniformity in quarantine signals for ships, the outcome of proposals submitted to the International Sanitary Conference at Paris in May 1926. It is proposed (1) that the colour *yellow* shall be used exclusively for quarantine; (2) that international code flags Q, I, and L shall be used to signify respectively "I have a clean bill of health," "I have not a clean bill of health," "I have (or have had) dangerous infectious disease on board." Another proposal suggests the use of particular lights in definite arrangement for night use. The Directing Committee of the Bureau urges the adoption of these proposals by all governments; the signals are already in very general use.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A professor of bacteriology in the University of Cairo—Sir H. J. Waring, 37 Wimpole Street, W.1 (Feb. 11). A lecturer in physics and mathematics in the Portsmouth Municipal College—The Secretary, Offices for Higher Education, Municipal College, Portsmouth (Feb. 15). An assistant in the Bradford Natural History Museum—The Town Clerk, Town Hall, Bradford (Feb. 17). An instructress in dairying and poultry-keeping under the Agricultural Education Sub-Committee of the Herefordshire County Council—The Organiser of Agricultural Education, Agricultural Education Office, High Town, Hereford (Feb. 19). An assistant inspector in the Department of Fisheries, Irish Free State—The Secretary, Civil Service Commission, 33 St. Stephen's Green, Dublin (Feb. 19). A professor of education in Victoria University College, Wellington, New Zealand—The High Commissioner for New Zealand, 415 Strand, W.C.2 (March 1).

## Our Astronomical Column.

COMETS.—Another new comet, 1927 *b*, is reported from South Africa. It is of the eighth magnitude and was found by Mr. William Reid, of Cape Town, Jan. $26^d\ 19^h\ 43^m{\cdot}5$ U.T. in R.A. $22^h\ 30^m\ 40^s$, S. Decl. 57° 49′, daily motion $+44^s$, S. 4′.

This is Mr. Reid's sixth cometary discovery, in addition to his detection of d'Arrest's periodic comet in 1923. He has lately been in poor health, so astronomers will be glad of this evidence of his ability to resume observing.

We are already assured of four perihelion passages in 1927 (Neujmin, Blathwayt, Comas Sola, Reid, assuming that it did not pass perihelion last year). There is little doubt that comets Grigg-Skjellerup and Pons-Winnecke will be added to the list in a month or two.

M. J. Polak has just published his definitive orbit of comet 1893 I. Brooks in the *Annals of Moscow Observatory*, vol. 8, No. 1. The comet was observed from Nov. 19, 1892, until Mar. 11, 1893. The following hyperbolic orbit was found:

$$\begin{aligned} T &= 1893\ \text{Jan. } 6{\cdot}52847\ \text{Berlin M.T.} \\ \omega &= 85^\circ\ 13'\ 5{\cdot}4'' \\ \Omega &= 185\ \ 39\ \ 16{\cdot}6 \quad 1893{\cdot}0 \\ i &= 143\ \ 51\ \ 28{\cdot}3 \\ \log q &= 0{\cdot}077436 \\ e &= 1{\cdot}001586 \end{aligned}$$

The residuals with a parabolic orbit are not very much greater than those with the hyperbolic one, so the departure from a parabola is not quite demonstrated.

SOLAR RADIATION.—In *Smithsonian Miscellaneous Collections*, vol. 78, No. 5, Dr. C. G. Abbot answers criticisms advanced by Moll, Burger, and Van der Bilt (*Bulletin of the Astronomical Institutes of the Netherlands*, No. 91, 1925) with respect to his investigations on the distribution of energy over the sun's disc. The observations were made primarily for the purpose of testing the suspected variability of the solar radiation, and only differential accuracy was required. Abbot proceeds to show that even as regards absolute values the errors of the drift-curves do not exceed 0·3 per cent. at a distance of 0·95 of the sun's radius. Observations were not carried nearer the limb because of inherent difficulties, and also because they were not required for his immediate purpose. He points out that his critics' statement regarding accidental error rests on one curve made at Washington prior to 1908, though the work went on under highly satisfactory conditions at Mt. Wilson from 1913 until 1920. Abbot considers, therefore, that the Dutch investigators have drawn a too hasty conclusion in criticism of his results, and suggests ways in which two independent investigations might give different results unless certain observational details are made strictly comparable. He also mentions that, whereas he used a solar image of 40 cm. and 20 cm. in diameter, the Dutch observers used one of only 3 cm. Possibly further experiments proposed by the latter may clear away the discrepancies.

STATISTICAL PROPERTIES OF GALACTIC CEPHEIDS.—In the *Astrophysical Journal*, vol. 64, p. 149, J. Schilt discusses the proper motions, periods, and magnitudes of the Cepheid variables, and their galactic distribution. In the Sagittarius-Aquila region the period of maximum frequency is about 7 days, but in the remaining regions it is considerably shorter. The portion of the galaxy directly opposite the Sagittarius-Aquila region possesses comparatively few Cepheids, and the frequency curve of periods shows no decided maximum. There is, however, a slight indication of a maximum at an even shorter period (about $4\frac{1}{2}$ days), in which case this region would closely resemble the small Magellanic cloud. Results based on the data at present available seem to indicate a discontinuity in the absolute magnitudes and other characteristics of Cepheids, at the stage corresponding to a period of about 10 days. This suggests the division of the Cepheids into two classes; but the data are too uncertain to warrant any definite pronouncement, and attention is directed to the urgent need for additional work on radial velocities and proper motions. This necessity is further emphasised by the considerable discrepancy which exists between the absolute magnitudes of Cepheids deduced from the parallactic motions of 13 Boss stars and from the motions of 28 fainter stars. The mean absolute magnitude of the former is $-2{\cdot}5$, and of the latter $+1{\cdot}3$.

## Research Items.

COLOUR SELECTION AMONG NEGROES IN THE UNITED STATES.—An interesting investigation in sexual selection among negroes in the United States has been carried out by Mr. Melville J. Herskovits, who describes his results in vol. 12, No. 10, of the *Proceedings of the National Academy of Sciences of the United States*. It appears that a definite type of selection, based largely on skin colour, is practised by American negroes in many aspects of their life, but especially in marriage. Students who were being measured at Howard University were asked to state whether their mother or father was the lighter. In 30·3 per cent. of the cases the father was the lighter, in 13·2 per cent. the parents were about the same, and in 56·5 per cent. the mother was the lighter. Later 400 negro families were measured in the Harlem District of New York City. Of 176 married couples available for this investigation, 29·0 per cent. showed a lighter father, 14·5 per cent. the same colour in both parents, and 56·5 per cent. a lighter mother. Further analysis shows that the men who are party to the matings are darker than the females, though in unselected series of males and females there is practically no sex difference in colour. It would therefore appear beyond question that there is a social selection in operation through the tendency of males to marry lighter females. Selection on the basis of other negroid traits, thick lips or broad noses, does not appear to be operative. If this selection on the basis of skin colour continues, as the children of each generation will tend to be darker than the mother, the American negro population will become nearer the negro type, since the relative amount of negro blood will be increased, though there is too much Indian and white blood in it to permit reversion to the pure negro type.

A VITRIFIED FORT AT DUNAGOIL, BUTESHIRE.—Excavations carried out at a fort at Dunagoil, Buteshire, from 1913 until 1915 and again in 1919, have yet to be described in detail; but a summary of the results has been published by Mr. L. M'Lellan Mann, in the *Transactions of the Buteshire Natural History Society* for 1925. The exploration of the fort is not quite complete. Vitrified forts are so called from the fact that the rubble core of the walling has been intentionally burned to form a hard vitrified mass to which the stones of the external walls adhere, thus giving great strength and power of resistance. Such structures are almost entirely lacking in fortified sites outside Scotland, where they occur chiefly near the seashore, ranging from the Solway up to the central west Highlands and thence in a belt across country to Inverness-shire as well as on a portion of the north-east coast. Dunagoil fort is entirely pre-Roman and was occupied from about 200 B.C. until A.D. 100. It is situated on a knife-edge ridge at the south end of the island of Bute. The construction of a crescentic wall on the less precipitous side, in order to give a fairly secure platform for the habitations of the occupiers, caused an accumulation of refuse which afforded a rich harvest for the excavators. The walls of the building were some twelve feet thick. They were built in stages of two or three feet, the rubble being burned at each stage until a height of fifteen feet had been reached. The rampart probably had two parapets and the fort two entrances, protected apparently by massive timber doors held by wooden bars which, when not in use, lay in horizontal holes in the interior of the walling. The objects found, which are very fully illustrated, included stone axes, hammers, knives, anvils, and other tools of stone, saddle querns imperfectly converted into rotary querns, utensils and personal ornaments of imported soapstone and lignite, an inferior hand-made pottery, many objects of bone and antler including a peculiar pin or bodkin, square in section with ornamented sides; bracelets of jet, lignite, and glass, the last-named multicoloured, and a large variety of iron objects.

MARINE BIOLOGY AT THE ISLE OF MAN.—The report of the Biological Station at Port Erin, Isle of Man (fortieth annual report of the former Liverpool Marine Biology Committee, now the Oceanography Department of the University of Liverpool), drawn up by Prof. J. Johnstone, indicates satisfactory progress in all directions. The fish cultural work carried out for the Manx Government shows a good average yield of young plaice, and the lobster hatching still improves, the numbers being considerably higher than before. More than a million plaice larvæ and more than six hundred lobsterlings, besides a large number of younger stages, were liberated into the sea. In the Bio-Chemical Laboratory Mr. J. R. Bruce has completed his investigations into the seasonal variations of the gaseous metabolism of the common mussel (*Mytilus edulis*), and the results have been published in the *Biochemical Journal*. He also continues his interesting researches on the metabolism of shore-living dinoflagellates. In the appendix, Mr. A. Scott describes the plankton of the spawning ponds and its seasonal variation. Mr. H. C. Chadwick, in his "Natural History Notes," mentions the occurrence of the diatom *Rhizosolenia robusta*. This is interesting, as the usual northerly limit of this species is the English Channel. It is to be noted, however, that in the last two years this diatom has been particularly abundant in the autumn at Plymouth. Being such a large form it should be of more than usual importance for feeders on the phytoplankton. A list of publications based on work done at the Laboratory shows a number of important papers dealing with fishery problems, physiology, and natural history, and includes Prof. Johnstone's book, "A Study of the Oceans." In the introduction to the report it is stated that the Laboratory is little used by visitors in the late summer, and a glance at the list of research workers shows this very plainly. It is curious that there is not more eagerness to undertake studies in these important months.

THE FLORA OF THE TALYSH.—Under the above title Mr. A. A. Grossheim, botanist of the Tiflis Botanical Gardens, has recently published an interesting volume (273 pp., 16 plates, map; text in Russian, summaries in English and in Turkish) dealing with the vegetation and flora of the little-known country at the south-western corner of the Caspian Sea. The author gives vivid and detailed descriptions of various types of vegetation, ranging from that of marshes (which harbour the endemic water nut *Trapa hyrcana* G. Wor.) to the deserts, and from lowlands forests of *Parrotia persica* and *Zelkowa carpinifolia* to the rocky, woodless, semi-desert formations of higher mountains. An analysis of the flora enables the author to arrive at some interesting conclusions as regards the history of the vegetation of the region in question. In Tertiary times the country was covered with forests of tropical character, and genera like Albizzia, Gleditchia, etc., have survived even until the present day. Later on, with the advent of a drier period and the development of a powerful centre of xerothermic flora in Persia, that flora (Hyrcanian) began to invade Talysh from the south, while about the same time an invasion began

of the Mediterranean flora from the west. Further intensification of the dry and hot conditions resulted in the appearance of numerous endemic xerothermic forms, which are clearly younger than the actual autochthonous elements. The glacial period, which brought great changes to the flora and vegetation of other parts of the Caucasus, left no traces whatever in the flora of Talysh. Later influences were of little importance, and only the activity of man was responsible for the introduction with the culture of rice of a fair number of typically tropical lowland plants, which misled previous students of the flora to conclude that it is essentially sub-tropical in character, whereas it is not so. A formal division of the country into botanico-geographical districts concludes the memoir.

FIELD TRIALS WITH COTTON.—M. A. Bailey and T. Trought, in Technical and Scientific Service Bulletin No. 63, report on experiments conducted by the staff of the botanical section of the Egyptian Ministry of Agriculture, under the ægis of the Cotton Research Board, to determine the amount of variability that might be expected in field trials with cotton, and the technique which would best reduce the experimental error. For comparative trials, it is recommended that no paths should be left between the beds, but that adjacent ridges should be uprooted at picking time. Variety beds are best repeated ten times, while all trials should be extended over a period of at least three years. The most suitable form for the beds is that of long, narrow strips, situated along the lengths of the ridges to facilitate sowing, the area being one-fifth feddan where possible (1 feddan = 4200 sq. m. or 1·038 acres approximately). The results should be computed by the method of differences. The procedure to be followed in the event of insufficient land or seed is also dealt with. A special feature of the report is the inclusion of various frequency curves, charts, and tables, which allow of a more exhaustive analysis of the data by other workers if desired.

JUNIPER IN NORWAY.—The half-yearly issue (Oct. 1926) of the *Transactions of the Royal Scottish Arboricultural Society* opens with an interesting article on "The Nordfjord of Norway," a long arm of the sea extending 60 miles eastwards from the North Sea, with several subsidiary fjords. The author, Mr. F. R. S. Balfour, treats of both the agricultural and forestry aspects of the country, showing the interdependence of the population on the two pursuits. An interesting item in this article deals with the use of the juniper, which grows into a small tree of 30 feet high, for fencing work. Fences are almost exclusively made of this wood, which lasts as long in the ground as the North American *Juniperus virginiana*. The author saw a fence erected one hundred years ago, and still perfectly serviceable.

COAL IN SOUTH AUSTRALIA.—The Mining Review of the South Australian Department of Mines for the half-year ending June 30, 1926, recently issued, contains an interesting summary of what is known regarding the coal and lignite resources of South Australia. Apparently the only true bituminous coal so far discovered lies at very considerable depths covered with highly water-bearing Tertiary sediments, which appear to render its economic exploitation impracticable. There are three occurrences known of sub-bituminous coal, apparently of Triassic age; this coal appears to be only of moderately good quality, the moisture as mined ranging from nearly 9 per cent. to more than 30 per cent., and the ash from more than 6 per cent. to more than 18 per cent.; a sample which has been tested gave 7460 B.Th.U. per lb. as mined, a figure which compares very unfavourably with ordinary bituminous coal. A number of occurrences of Tertiary lignite are known; apparently the only attempt at actual mining has been done in the Moorlands field, and the coal has been extensively tested, but the results do not appear to have been satisfactory. It would appear that up to the present, imported coal can be used to better economic advantage than any of the mineral fuels hitherto discovered in South Australia.

GRANITE DOMES OF VREDEFORT AND ARRAN.—The recent monograph on the Vredefort Mountain Land, by Hall and Molengraaff, has aroused world-wide interest among geologists, mainly because of the wonderful and almost incredible structure of the sediments on the flanks of the granitic dome which lies in the heart of the region. The sediments have not only been heaved up but they have also been carried through the vertical and overturned. For this reason, Hall and Molengraaff rejected the idea that the structure might be due to the upward surge of magma. Their problem is further complicated by the possibility that the Vredefort granite is, in the main, older than the overtilted sediments; and their tentative conclusion is that the balance of evidence favours the conception of centripetal pressure as the cause of the dome. In the *Geological Magazine* for November, Mr. E. B. Bailey summarises the evidence, and points out in detail the striking analogies presented by the granite dome of North Arran. Although in Arran the surrounding schists are rarely overturned, the evidence is conclusive that they were powerfully uplifted by the intrusion of the granite complex, and that the upheaval was accompanied by an outward movement that succeeded in overturning a boundary of Old Red Sandstone. Mr. Bailey points out that an upward magmatic push must develop an outward centrifugal push. Combining this tectonic necessity with the evidence of its existence elsewhere, and the difficulty of imagining a mechanism to explain the suggested centripetal pressure, he strongly advocates central upheaval by upward magmatic pressure accompanied by centrifugal pressure as the explanation of the updoming and back-tilting of the formations bordering the Vredefort granite.

PHYSIOGRAPHY OF THE VIRGIN ISLANDS.—The New York Academy of Sciences has nearly completed the publication of its detailed "Scientific Survey of Porto Rico and the Virgin Islands." One of the most recent parts to appear is vol. 4, pt. 1, which deals mainly with the physiography of the northern Virgin Islands, British and American, by Messrs. H. A. Meyerhoff and J. F. Kemp. The conclusions of most interest are those with regard to the submarine platform from which the islands arise. This has generally been accepted as due to marine erosion in Pleistocene times, when the sea-level was lowered in tropical latitudes, but Mr. Meyerhoff is convinced, after a detailed study of its features, that river action has played the chief part in its formation. He found numerous remnants of horizontal coastal plain deposits, presumably of Tertiary age, lying on the submerged platform. These are evidence of river erosion before Pleistocene time. The action of the waves in Pleistocene times was effectual, if at all, only in modifying the surface. The evidence is discussed at length in the monograph, which is well illustrated with maps, diagrams, and photographs.

RAINFALL OF MORAVIA.—Some relation between the amount of precipitation and altitude above sea-

level are discussed by Dr. Fr. Rikovsky in Part 78 of *Publications de la Faculté des Sciences de l'Université Masaryk*. On the plateau of Moravia the rainfall is 530 mm. at 200 m. and increases some thirty-three millimetres for every 50 metres up to 650 m., above which the increase grows rapidly. In the eastern or drier part of the Moravian Carpathians the fall is 561 mm. at 200 m., and the increase up to 600 mm. is much more rapid than on the plateau, while at higher elevations it is much slower. The explanation is that on the Carpathians the air currents, owing to the steep slope, are forced to rise abruptly, and so lose much of their humidity at low altitudes, while on the plateau the rise is gradual and the loss of moisture steady. In the western part of the Moravian Carpathians, precipitation is much greater and increase is steady and continuous. Statistical tables and diagrams show these relationships.

RESISTANCE OF METALS AT LOW TEMPERATURES.—Supplement No. 58 to the Communications from the Physical Laboratory of the University of Leyden consists of a collection of all the known data concerning the electrical resistance of metals at temperatures below − 80° C. made by the late Prof. Kamerlingh Onnes and Dr. W. Tuyn. A large proportion of the data comes from the Leyden Laboratory, but in all cases references are given to the original sources. 42 pages of tables and curves are devoted to the influence of temperature, 4 to that of pressure, and 28 to those of impurities, heat treatment, and other factors. Of the large number of formulæ which have been suggested for the relation between the resistivity and the temperature only a few are noted. For monatomic metals the resistivity seems to be proportional to the product of the absolute temperature and the atomic heat at constant pressure. There is some divergence of opinion as to the validity of a law of 'corresponding resistances' which has been suggested.

IMPACT TESTS OF STEEL AT LOW TEMPERATURES.—Impact tests have been made by Ryonosuke Yamada (*Sci. Rep.*, Tohoku Imp. Univ., Ser. 1, vol. 15, No. 5, Nov. 1926) on a large number of steels at temperatures from that of the room down to that of liquid air. The main results obtained are: In general the impact value falls as the temperature is lowered, though in a dead-mild steel, for example, this value actually rises down to about − 40° C., when it suddenly falls to almost zero. Quenched and tempered steels, or any steels with a sorbitic structure, are much tougher at low temperatures than are pearlitic steels. The addition of nickel and chromium retards appreciably the increase of brittleness as the temperature is reduced. As the latter falls there is a progressive tendency for the fracture produced to pass around, instead of through, the crystals, and the fracture in pearlite to take place in all directions irrespective of the orientation of the lamellæ.

A NEW PHENOMENON IN THE ABNORMAL DISCHARGE.—When the distance between the electrodes is decreased in a tube in which a normal discharge is passing, the potential difference between the electrodes gradually decreases, until the anode approaches so close to the cathode inside the Faraday dark space that some of the fast primary electrons from the cathode reach the anode, and then the potential falls somewhat rapidly. If the distance between the electrodes is still further decreased, the potential remains practically constant until the anode penetrates approximately to the middle of the negative glow, when it increases very rapidly, owing to the fact that the fast primary electrons and the secondary electrons they produce have not sufficient space in which to form considerable numbers of positive ions. In investigating this phenomena during the passage of an abnormal discharge, Guntherschulze (*Zeit. für Phys.*, 40, 414, 1926) found that the higher the applied potential, the sharper did it fall just before the rapid increase due to the close proximity of the electrodes occurred. The cause of this phenomenon is found to be that the fast primary electrons from the cathode are able to form larger numbers of positive ions in the layer of gas and water vapour absorbed on the surface of the anode than they are able to produce in the body of the gas in the tube.

ISOLATION OF ELEMENT 61.—In their first paper on the isolation of element 61 (see NATURE, Dec. 4, 1926, p. 820, and Jan. 1, 1927, p. 27), Rolla and Fernandes stated that a sealed packet containing their results and a photograph of the X-ray absorption spectrum was sent to the Royal Academy of the Lincei so early as June 1924. In order to prove their claims to be the first to isolate the element, these preliminary results have been published in the November issue of the *Gazzetta Chimica Italiana*. Rolla and Fernandes have proposed the name 'florentium,' with symbol 'Fr,' for this element in honour of the University of Florence, where the research was carried out.

THE ATTEMPTED CHANGE OF MERCURY INTO GOLD.—The News Edition of *Industrial and Engineering Chemistry*, dated Dec. 10, contains a detailed account by Sheldon and Estey, of the New York University, of attempts to change mercury into gold by the method used by Miethe. The actual type of mercury arc lamp used by Miethe, which was obtained from Germany, as well as other lamps, were used, and the experimental conditions were reproduced so far as possible. Details of several experiments are given, but in no case was any amount of gold greater than 0·005 milligrams (the limit of detectability) produced. Various deposits were produced in the lamps, but these never contained any gold, and the residual mercury was also found to be free from that metal.

IGNITION TEMPERATURES OF SOLID FUELS.—In connexion with the subject of spontaneous combustion, the study of the ignition temperatures of fuels is of great importance. K. Nakamura and A. Shimomura have improved the ordinary form of apparatus, and have published the relative ignition temperatures of twenty-two kinds of solid fuels, including lignites, bituminous as well as anthracite coals of oriental origin, semi-coke, metallurgical coke, and wood charcoal, in the *Memoirs of the Kyoto College of Science*, Series A, Nov. 1926. Previous work by Wheeler has been confirmed, and it has been found that volatile matter and ash-content have a decided influence on the ignition temperatures of the fuels.

MECHANISM OF KOLBE'S ELECTROSYNTHESIS.—There are two theories as to the exact nature of the change by which ethane is produced at the anode during the electrolysis of a solution of potassium acetate. According to the 'oxidation theory,' the discharged anions react with water to give the acid which is oxidised by atomic oxygen to give the synthetic product, while the 'discharged ion' theory supposes that two discharged ions unite directly. A paper in the *Journal of the Chemical Society* for Dec. 1926, by D. A. Fairweather and O. J. Walker, describes some work on solutions of acetates and propionates which was carried out in order to obtain further data bearing on electrosynthesis. The results show that the synthesis can only be accounted for on the 'discharged ion' theory.

## The Technique of Vitamin Assay.

WHEN it was found that a diet of pure protein, fat, and carbohydrate with salts and water was incapable of maintaining life in animals unless small quantities of certain natural foods were added, quantities too small to supplement the energy value or the content of the diet in the other known constituents, the foundation was laid upon which has been built in the last fifteen years a vast store of knowledge about the properties and occurrence of these unknown accessory food factors or vitamins. At first investigators were concerned with the qualitative distribution of each vitamin, as it was discovered: only later was attention directed to its quantitative estimation in different sources, as the methods of assay became more perfected. These lines of approach to an accurate knowledge are in use to-day, when a new vitamin is discovered, as is shown by the work of Evans and his collaborators on Vitamin E, or the reproductive factor.

It is obviously important from the point of view of dietetics and medicine that the amounts of the vitamins in different food and medicinal products should be accurately known. Such knowledge can be obtained at present only indirectly, since the vitamins have not yet been isolated in pure form, and any fallacies inherent in such a method of assay are greatly enhanced by the fact that, in general, living animals must be used for the test. Hence improvements in technique relate to the use of a standardised animal, bred especially for the purpose, and placed on a diet either deficient solely in the factor to be assayed, or so designed as to enable the observer to obtain a clear-cut response on the part of the animal or even of a given tissue, when the missing factor is added to the diet. Recent improvements in technique are especially noticeable in the case of Vitamin A or the growth-promoting factor, and Vitamin D or the bone-calcifying factor. A further interesting development is the use of a colour test, which can be used for the quantitative estimation of Vitamin A, and bids fair in time to replace the laborious growth test on animals altogether.

The details to be followed in the production of a standard breed of rats for the assay of the fat-soluble Vitamins A and D are discussed by H. Chick and H. H. Smith and H. Chick (*Biochem. Jour.*, 1926, vol. 20, pp. 119, 131). The authors were led to their researches by finding unexplained irregularities in the behaviour of the young rats when placed upon the standard basal diet deficient in fat-soluble vitamins. In general, better growth and calcification of the bones were found in summer and autumn than in winter and spring. Neither the degree of illumination to which the animals were exposed nor the constituents of the standard deficient diet were found to be implicated in this variability. It may perhaps be mentioned here that the diet largely used in Great Britain consists of inactivated caseinogen, starch, a hardened vegetable oil, salts and water, together with 'marmite' and lemon juice to supply Vitamins B and C respectively. The caseinogen is inactivated, *i.e.* any fat-soluble vitamins present are destroyed by heating it to 120°-130° C. for thirty-six hours.

Examination of the diet given to the stock-breeding rats, however, disclosed the possibility of serious variations in the amount of Vitamin D, with smaller changes in the case of Vitamin A, dependent upon seasonal alterations in the content of these vitamins in the fresh milk of the diet. It is well known that the store of fat-soluble vitamins in young rats depends on the previous diet of the mother, especially during pregnancy and lactation. Hence the diet of the stock animals should contain, if possible, a constant and sufficient, but not excessive, quantity of fat-soluble vitamins. This ideal was approached by replacing fresh milk with a dried winter milk towards the end of pregnancy and continuing its use during lactation, and, in the case of the young, during the period elapsing between weaning and placing on the deficient diet. Earlier use of this milk in the mother's diet lowered the store of vitamins too much, so that it became difficult to rear the young. The other constituents of the diet, bread, whole cereals and seeds, fresh raw vegetables, and marmite, with meat twice a week, provided a steady supply of Vitamin A; so that the irregularities in the young rats were probably chiefly caused by variations in their stores of Vitamin D.

The fact that the latter vitamin may be responsible for variations in growth has only recently been realised, with the definite demonstration that Vitamins A and D are distinct accessory food factors. Its importance is demonstrated by the following considerations: the original standard diet deficient in fat-soluble vitamins is deficient in both: cessation of growth may then be due to exhaustion of either, and resumption of growth, on supplementing the diet with a material containing them again to either, or both, of the vitamins present. Hence titrations of Vitamin A may be considerably affected by the presence or absence of Vitamin D from the diet or body of the experimental animal.

This question has been carefully examined by J. C. Drummond, K. H. Coward, and J. Hardy (*Biochem. Jour.*, 1925, vol. 19, p. 1068). The authors found that irradiated cholesterol, which is now known to have marked antirachitic potency, that is, to contain Vitamin D, can, under certain conditions, cause resumption of growth in rats on the standard-deficient diet. But the authors show that this does not mean that by irradiating cholesterol, Vitamin A is generated. In the first place, the colour reactions of irradiated cholesterol are not those usually associated with Vitamin A (this subject is discussed more fully below); secondly, the addition of the irradiated material to the diet only produced resumption of growth when given soon after growth had ceased; later it was without this effect; and thirdly, the resumption of growth was only temporary and could not be maintained by increasing the dose, although small doses of cod-liver oil prevented the decline in weight, in fact, allowed growth to continue. The authors conclude that the store of Vitamin A in the animal is only available in the presence of Vitamin D, and that the irradiated cholesterol supplies the latter and not the former.

Hence in comparing the growth-promoting powers of two materials, one of which contains Vitamins A and D, and the other Vitamin A only, an erroneous idea of their relative contents in Vitamin A can easily be obtained if the animals at the time are suffering from a simultaneous deficiency of Vitamin D. With the former supplement, growth would be dependent on both vitamins together; with the latter, little growth would probably be seen, unless the animals still had a store of Vitamin D, although the Vitamin A content of both materials might be the same. The important conclusion is therefore reached that for the accurate assay of Vitamin A, Vitamin D must be always present in the basal diet. This can be ensured by the addition of irradiated cholesterol to the diet, or by feeding it separately as a daily supplement dissolved in liquid paraffin (Drummond *et al.*), or perhaps more conveniently by using an irradiated

hardened vegetable oil as one of the constituents of the diet (H. Chick and M. H. Roscoe, *Biochem. Jour.*, 1926, vol. 20, p. 632). Drummond excludes fats altogether from his latest standard diet, replacing them with starch, but other observers continue to use a diet of the type mentioned above. If the animals are given a diet deficient only in Vitamin A, they continue growing for a longer period than when Vitamin D is also absent; but when growth ceases, a decline in weight rapidly sets in and the supplement containing Vitamin A must be quickly given, if death is to be prevented.

So far we have considered the assay of Vitamin A by means of animal experiments. The difficulties and the time involved lend importance to an alternative possible method, such as a colour test, which can be performed quickly and accurately in a test tube. Two such have been recently described as specific for Vitamin A: the transient blue colour produced by arsenious chloride (Rosenheim and Drummond) and the stable red colour produced by pyrogallol in the presence of a light petroleum solution of trichloracetic acid (W. R. Fearon, *Biochem. Jour.*, 1925, vol. 19, p. 888). The latter, which seemed likely at first to be of great use, was modified by S. G. Willimott and T. Moore (*ibid.*, 1926, vol. 20, p. 869): resorcinol was uesd instead of pyrogallol, and a saturated solution of benzoyl peroxide in toluene was added to hasten the reaction, the trichloracetic acid being also dissolved in this solvent.

Preliminary experiments showed that the colour was produced by those substances, chiefly oils, in which the presence of Vitamin A is generally accepted, and not by others from which this vitamin is absent. However, a more extensive study by O. Rosenheim and T. A. Webster (*Lancet*, 1926, vol. 2, p. 806) has demonstrated that the test is not specific for Vitamin A: thus, on saponification of an active oil, Vitamin A remains in the unsaponifiable fraction, but the chromogen giving Fearon's reaction passes into the soaps formed, being associated with the unsaturated fatty acids. Again, only fish liver oils give the reaction, whereas the liver oils of birds and mammals contain Vitamin A: body fat may react positively, but negatively to the arsenious chloride reagent. In a biological test, a sardine oil, giving Fearon's reaction, was found to be devoid of the growth-promoting factor, whereas pig's liver fat, although reacting negatively with Fearon's reagent, yet gave as good growth as cod-liver oil—even when only half of the dose of the latter was used. In all cases vitamin A and the colour reaction with arsenious chloride were found to occur together, in fact, the latter appeared to give a depth of colour roughly proportional to the amount of vitamin disclosed by a growth test. Hence it may be concluded that the colour given by Fearon's reagent is due to some other constituent of the oil than Vitamin A. On the other hand, the arsenious chloride reaction appears to be specific, so far as our present knowledge goes. The drawbacks to the test are the transient nature of the blue colour produced, and the fact that the reagent cannot be used with a solvent.

F. H. Carr and E. A. Price, and T. T. Cocking and E. A. Price have therefore examined a large number of other compounds with the view of selecting a more satisfactory reagent (*Biochem. Jour.*, 1926, vol. 20, p. 497; *Pharm. Jour. and Pharmacist*, 1926, vol. 107, p. 175). At first the substitution of arsenious chloride by a saturated solution of trichloracetic acid in chloroform, as suggested by Rosenheim and Drummond, gave promise of satisfying the necessary requirements, but it was found that the colour production depended on the presence of an impurity in the acid, probably phosgene. The authors finally selected a 30 per cent. solution of antimony trichloride in B. P. chloroform as the most satisfactory reagent so far found: it can be used with a 20 per cent. solution of the oil under test in chloroform, enhancing the accuracy of measuring small quantities of oil. Moreover, the blue colour lasts sufficiently long for a match to be made against the standard glasses of a Lovibond tintometer, and is not interfered with by traces of water or alcohol in the reagents. The colour formed always contains traces of yellow and sometimes also of red.

The real problem which now faces investigators is whether the colour test always gives the same value as the growth test, when both are carried out on a large number of different oils. Some preliminary experiments carried out by S. W. F. Underhill (*Biochem. Jour.*, 1926, vol. 20, p. 500) lend hope that this parallelism may be invariably found, in which case the biological assay, with its difficulties of animals and time, may be rendered unnecessary, being replaced by the much shorter and probably more accurate colour test.

The titration of Vitamin D or the bone-calcifying antirachitic factor still requires the biological method. Moreover, rickets is not produced in rats on a diet deficient only in fat-soluble vitamins. Although the bones contain less calcium than normally, the picture is one of osteoporosis, so that such a diet is not suitable for this assay (H. Chick and M. H. Roscoe, *v. sup.*). But if the diet is deficient in phosphorus also, rickets occurs. Two such diets have been widely used: one was described by Sherman and Pappenheimer, and consists of patent flour with the addition of a few salts; the other we owe to McCollum, its chief ingredients being wheat, maize, gelatin, and wheat gluten with a few added salts. Rosenheim and Webster (*Biochem. Jour.*, 1926, vol. 20, p. 537), using the former, found that sometimes the control animals failed to develop rickets and traced this irregularity to a small quantity of fat present in the patent flour, which could become 'activated' if the flour was exposed to light. They therefore recommend an extraction of the flour with ether at room temperature for a short period, before it is used in the diet.

The degree of calcification of the bones on these diets can be determined radiologically, histologically, or by chemical analysis. Improvements in the presentation of results by the last method are described by Chick and Roscoe (*Biochem. Jour.*, 1926, vol. 20, p. 137, and with V. Kovenchevsky, *ibid.*, p. 622). More clear-cut results are obtained if, in addition to the ash, the fat of the bones is also estimated. Omission of this precaution may suggest that a substance under test has improved the calcification slightly, whereas it has only reduced the fat content, possibly by improving the nutrition of the animals quite apart from its content in Vitamin D, if any is present at all. Normal bones contained about 2 per cent. of fat, rickety 4 per cent., and osteoporotic 10 per cent.: the ash content respectively was found to be 34 per cent., 11 per cent., and 25 per cent. for comparable bones. The authors suggest that the ratio of the ash to the organic residue (that is, the difference between the weight of the bone and the sum of the weights of water, fat, and mineral constituents) may give a useful index of the degree of calcification and of rickets. Normally it is about 1·5, in osteoporosis 0·9–1·2, and in rickets 0·4–0·8.

The more accurate the methods of assay, the better is our knowledge of the value of different food or medicinal products, and the greater is the hope of developing methods for the isolation of the accessory food factors in a pure form.

## Tropical Cyclones of the Pacific.

By E. V. NEWNHAM.

REFERENCE was made in a recent article on "The Tropical Cyclone" (NATURE, Oct. 9, 1926) to the need for a more complete knowledge of the meteorological conditions in the regions where these storms form, in order to test the correctness of the various theories of the origin of cyclones that have been brought forward at different times. It might have been added that our knowledge is very incomplete even as regards the frequency of their occurrence, the paths which they follow, and the length of life of individual storms, and this is particularly true for the Pacific Ocean. A new work has recently been published, which fills up a few of the gaps in our knowledge.[1] The materials for this work were collected in 1921–1922, when the author spent a year in visiting tropical Oceania and the Far East in order to gather information about cyclones at first hand from resident white officials; he also visited the Meteorological Bureau of the Australian Commonwealth and the Japanese Marine Observatory, as well as various other meteorological centres in the East, in order to study local synoptic weather charts and to discuss his subject with those who have made a special study of the cyclones of those regions.

It appears from Visher's work that, in defining the two remote eastern areas of cyclone-formation, it would have been better not to have restricted the eastward extension of those areas, for although it may be true that more cyclones occur in the western than in the eastern half of the Pacific, many undoubtedly occur near the western coasts of America both north and south of the equator; so many must occur unrecorded in the Western Pacific, unrecorded because of the small number of islands inhabited by educated white men and because of the small number of ships that pass westwards beyond American coastal waters, that an accurate estimate of their average annual number and of their distribution is at present impossible. Visher, indeed, lays great stress on the under-estimation that has been made of the number of storms over the tropics as a whole. If attention is not confined to the most violent and destructive storms, the season of cyclonic activity expands from the summer and autumn to the whole year, and, judging from those regions near the western border of the Pacific for which reasonably detailed synoptic charts are available, for example, the regions around Australia and Japan, the annual number must be very large. Of these a considerable proportion appear to pass out of the tropics, and, by the large exchange of air between tropical and temperate latitudes to which they give rise, exert a big influence upon the weather of both zones, and upon the general circulation of the atmosphere of the whole earth.

The idea that tropical cyclones are of rare occurrence appears to have been held by many meteorologists, and has probably arisen because, on the average, only a small proportion of the total area within the tropics is affected annually by winds of hurricane strength, and a large part of this proportion is open ocean traversed only occasionally by ships. In considering the exchange of air between the tropical and temperate zones, the numerous lesser systems of low pressure are probably, in the long-run at least, as important as the relatively few destructive storms. Visher gives a table of annual frequencies of recorded tropical cyclones which is reproduced here. It should be noted that, in view of the large number of storms and disturbances that are not recorded, the figures are intended as conservative estimates, much below the true totals.

AVERAGE ANNUAL FREQUENCIES OF RECORDED TROPICAL CYCLONES AND CYCLONIC DISTURBANCES.

| | Severe Hurricanes. | Lesser Hurricanes and Cyclones. | Cyclonic Disturbances. |
|---|---|---|---|
| Western North Pacific (110° to 140° E.) | 10 | 20 | 50 |
| Central Pacific (140° W. to 140° E.) | 2 | 4 | .. |
| Eastern North Pacific (E. of 150° W.) | 2 | 3 | .. |
| Western South Pacific (130° W. to 160° E.) | 5 | 10 | 10 |
| Australian Region (110° E. to 160° E.) | 5 | 8 | 10 |
| South Indian Ocean | 8 | 5 | .. |
| Arabian Sea | 2 | 2 | .. |
| Bay of Bengal | 2 | 6 | >2 |
| North Atlantic | 3 | 2 | >2 |
| Totals | 39 | 60 | >74 |

These give an annual total for all classes of cyclone of more than 173.

Two other points of particular interest that are brought out in the paper under notice are:

(1) The unexpectedly large number of cyclones that occur within 8° of the equator in the Pacific, especially in the neighbourhood of the East Indies.

(2) The apparent absence of any kind of direct relationship between the number of cyclones that occur in the Pacific and the physical state of the sun, as revealed by the number of dark spots that are visible.

With regard to the first point, two cases of cyclones originating not more than 4° from the equator in the North Indian Ocean during the period 1900–1912 have been recorded.[2] Visher was informed by T. Okada, Director of the Japanese Imperial Marine Observatory, that the meteorological conditions at Jaluit (lat. 6° 8′ N., long. 170° E.) indicate typhoons west and south-west of that island, and in a table giving particulars of the place of origin of typhoons that were first reported within 8° of the equator, Visher gives one in latitude 4° N., and several in latitude 5° N. These cases are interesting in that they show that although some deflexional effect of the earth's rotation is necessary to prevent air from flowing directly into a centre of low pressure and so filling it up, the amount need only be very small.

The second point mentioned above requires little comment. All Visher's ingenuity in handling the available statistics, so as to bring out any connexion that there may be, gives negative results. Although several earlier investigators have claimed that there is a connexion, it appears very unlikely that there is a simple direct relationship, when it is remembered that the variations of the solar 'constant' of radiation between times of sunspot maximum and minimum,

[1] "Tropical Cyclones of the Pacific." By S. S. Visher. Bernice P. Bishop Museum Bulletin 20, Honolulu, Hawaii. Published by the Museum, 1925.

[2] "Hurricanes and Tropical Revolving Storms." By Mrs. E. V. Newnham, Geophysical Memoir No. 19, Meteorological Office, 1922.

if any systematic variations do in fact exist, must be very small, and the effect of a variation of the intensity of solar radiation upon terrestrial atmospheric processes is likely to be complex.

Another negative or almost negative result of some practical importance relates to the varying degrees of storminess experienced in different years in the Far East. Visher has studied the question as to whether unusual storminess in the early part of a storm season is an index to the probable storminess of the remaining part of that season, and finds that the storminess of June is little or no index, whereas that of July may be of some value. There seems, in general, to be some slight positive correlation between the number of cyclones in one month and the number in the remaining months of the season. This applies to the Far East as a whole, and not to one particular district. It should be noted, however, that variations in the completeness of the information about the number of storms that occur each year would give rise to a spurious positive correlation.

There are many other items of interest in this work which cannot be discussed here, among them a section on the effect of cyclones on the dispersal of life from island to island in the Pacific. The bibliography is very extensive, containing 209 references to other works and articles, and to interviews with other meteorologists.

## University and Educational Intelligence.

EDINBURGH.—We have already announced the gift to the University by the International Education Board of the Rockefeller Foundation of a sum of £74,000 for the purpose of assisting towards the establishment of a new Department of Zoology. Of this sum, £38,000 is set aside towards the cost of building, £10,000 is for equipment, and £26,000 for endowment. The University already had available from the gift of the late Dr. Laurence Pullar and from the Carnegie Trust a sum of £41,000 towards the cost of the building. The work will be proceeded with at once, and plans will be prepared by Sir Robert Lorimer in consultation with Prof. J. H. Ashworth. The new Department will be at the King's Buildings on the south side of the city, adjacent to the Departments of Chemistry and Geology.

LONDON.—The Laboratory of Civil and Mechanical Engineering at University College is to be named "The Cowdray Laboratory of Civil and Mechanical Engineering," in recognition of Lord Cowdray's generous gifts, amounting to £20,000, to the Faculty of Engineering at the College.

The title of reader in geology in the University has been conferred on Mr. George McDonald Davies, in respect of the post held by him at Birkbeck College. Mr. Davies studied at Birkbeck College. From 1908 until 1920 he was assistant, and latterly senior assistant, in the Mineral Laboratory of the Imperial Institute, and from 1906–20 he held part-time posts at Birkbeck College. Since 1920 he has been head of the Department of Geology at Birkbeck College. His published work includes "Elementary Crystallography" (with Dr. J. W. Evans, 1924), "Tin Ores" (1919), and numerous papers in geological journals.

The following degrees have been conferred :—D.Sc. in botany on Miss Nesta Ferguson (King's College and Royal Holloway College) for a thesis entitled "The Aloineæ—a Cytological Study, with especial reference to the Form and Size of Chromosomes"; D.Sc. in chemistry on Mr. J. W. Cook (University College and the Sir John Cass Technical Institute) for a thesis entitled "The Reactivity of *meso*- substituted Anthracenes"; on Mr. S. B. Dutt (Imperial College (Royal College of Science)), for a thesis entitled "(1) A Theory of Colour on the Basis of Molecular Strain. The Effect of Chromophoric Superposition; (2) Ring-chain Tautomerism, Parts I. and II."; and on Mr. W. G. Shilling (East London College), for a thesis entitled "The Temperature Coefficient of the Molecular Heats of Gases"; D.Sc. in statistics on Mr. Kazutaro Yasukawa (University College), for a thesis entitled "Contributions to the Mathematical Theory of Statistics." D.Sc. (*Economics*) on Miss M. C. Buer (London School of Economics), for a thesis entitled "Health, Wealth and Population in the Early Days of the Industrial Revolution"; D.Sc. (*Enginering*) on Mr. W. D. Dye, for a theses entitled "(1) The Piezo-Electric Quartz Resonator and its Equivalent Electric Circuit; (2) A Self-contained Harmonic Wavemeter," and other papers.

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A SPECIAL course of seven lectures on modern developments in regard to fuel is to be delivered at the Sir John Cass Technical Institute, Jewry Street, Aldgate, London, E.C.3, on Mondays at 6 P.M., beginning on Feb. 7. The lecturers include Mr. F. S. Sinnatt on low temperature carbonisation and Prof. J. S. S. Brame on liquid fuel.

THE Ellen Richards Research Prize of the value of 2000 dollars is being offered for award in 1928 "to a woman of any nation on the basis of distinguished scientific research." In countries where there is a national federation of university women this federation may appoint a committee of experts to nominate candidates. Where there is no such federation, nominations may be made by individual women holding university positions. Federations may each nominate three candidates, individuals one. Nominations must be in the hands of the committee before Jan. 15, 1928. Applications for information, circulars, or nomination forms should be sent to the secretary, Mrs. Samuel F. Clarke, Williamstown, Mass., U.S.A.

THE Free Place Scholarships Examination, 1926, in the County of Kent, formed the subject of a special investigation conducted, at the request of the Education Committee, by Mr. Andrew Bell. The results of the investigation have been published in a 55-page pamphlet obtainable from the Director of Education, Springfield, Maidstone (price 1*s.* post free). The examination, which is, in Kent, controlled in each secondary school district by the school headmaster, includes—in addition to a written examination, consisting of English, arithmetic, and intelligence test, for which the maximum total marks assignable are 250—an oral test carrying, as a maximum, 100 marks. The Kent County Association of Teachers put forward as one of a series of recommendations, which led to the demand for a special inquiry, a proposal that the oral part of the examination should carry as many marks as the written examination, and one of the objects of Mr. Bell's inquiry was to determine whether this proposal should be adopted. The chapter of the report dealing with this question is of special interest in view of its bearing on the pronouncements of the Board of Education Consultative Committee in paragraph 80 of its report on psychological tests of educable capacity, wherein emphasis is very strongly laid on the value of oral interviews as a means of discovering latent ability and promise. Mr. Bell's conclusion is that in the present state of our knowledge regarding the technique of the interview, it is undesirable that the marks for the oral examination (which each headmaster has full liberty to conduct according to his own ideas) should be increased.

## Calendar of Discovery and Invention.

**February 6, 1877.**—Davy was the first to produce a light by means of electricity, and to him we owe the term 'arc' light. His experiments were made in 1808 with a battery of 2000 cells. Fifty years later practical experiments were made with the arc light fed from magneto-electric machines. With the invention of the dynamo—especially of that of Gramme—further developments took place. Among notable inventions was that of Paul Jablochkoff, who on Feb. 6, 1877, took out the British patent for the so-called 'Jablochkoff candles,' consisting of two parallel strips of carbon separated by kaolin. These lights were installed in the Place de l'Opéra, Paris, and on the Thames Embankment, and with them begins the history of street lighting by electricity.

**February 7, 1817.**—The great coal gas industry of to-day had its birth in England and France. Gas lighting in America owed much to the artist Rembrandt Peale, who founded Peale's Museum in Baltimore, where he exhibited his pictures and gave lectures. Through his efforts Baltimore was the first American city to adopt gas, the streets being lit for the first time on Feb. 7, 1817. Boston was lighted by gas in 1821 and New York in 1823, but there was considerable opposition to the innovation, and so important a city as Philadelphia had no public gas lighting until 1841.

**February 8, 1841.**—In 1802, Thomas Wedgwood produced evanescent outlines of shadows on paper moistened with a solution of silver nitrate, but the first photographs of practical value resulted from the work of Daguerre and Niepce. Daguerre's process was described by Arago in January 1839, and in the same month Fox Talbot described his own discovery of photogenic drawing. Two years later, on Feb. 8, 1841, Talbot patented his 'Calotype' or 'Talbotype,' which laid the foundation of modern photography and led to his being called the 'father of photography.'

**February 9, 1832.**—In the 'twenties and 'thirties of last century a number of steam road-carriages were built and plied for hire. One of the inventors was William Church, whose patent, taken out on Feb. 9, 1832, included a vertical boiler and wheels with elastic rims and spokes. The efforts of Church and his contemporaries Hancock, Gurney and others were, however, rendered futile by the Road Locomotive Act of 1836, which imposed so high a tax on such vehicles that they could not be made to pay.

**February 10, 1906.**—A modern battleship is an epitome of the application of scientific discovery and mechanical invention, there being few branches of science or engineering which are not utilised in her design, construction, equipment, or maintenance. No battleship ever created more interest than H.M.S. *Dreadnought*, which was launched on Feb. 10, 1906. Designed by Sir Philip Watts, the vessel was 490 feet long, 17,900 tons displacement, mounted ten 12-inch guns, and cost £1,783,883. It was also the first battleship in the world to be driven by Parsons steam turbines, the adoption of which saved 1000 tons in weight and £100,000 in cost.

**February 11, 1853.**—Through Bence Jones, who had heard of his work in Berlin, Tyndall on Feb. 11, 1853, delivered his first lecture at the Royal Institution, the subject being "On the Influence of Material Aggregation upon the Manifestations of Force." The lecture, which dealt mainly with magnetism, made Tyndall famous as a lecturer, and four months later he was elected professor of natural philosophy, an appointment he held with distinction for thirty-four years. E. C. S.

## Societies and Academies.

### LONDON.

**Royal Society, Jan. 27.**—**S. A. Asdell** and **F. H. A. Marshall**: The effect of the ovarian hormone in producing pro-œstrous development in the dog and rabbit. Injections of follicular extract obtained from solution in alcohol produce typical pro-œstrous changes in the uterus of the bitch and of the rabbit during the anœstrous period (that is, at a time when the uterus is normally quiescent). There was also a growth of the vaginal epithelium, followed by a breaking down of the cornified cells. No definite œstrus was produced, so that in the actual production of œstrus a further factor may be involved.

**S. Dickinson**: Experiments on the physiology and genetics of the smut fungi: hyphal fusion. In investigating the cytology of the covered smuts of oats and barley in pure culture, the fusion, both within and across the species investigated, between the mycelia of different 'gender' derived from single sporidial isolations, was observed. The fusion-hypha is binucleate, and there is nothing suggesting nuclear fusion. The binucleate fusion-hypha gives rise to uninucleate hyphæ, which are of different gender, these being produced at different ends of the fusion-hypha.

**J. W. H. Harrison**: Experiments on the egg-laying instincts of the sawfly *Pontania salicis* Christ. and their bearing on the inheritance of acquired characters, with some remarks on a new principle in evolution. This gall-making sawfly possesses local races, each with its own special species of Salix as its food-plant. Direct experiment proved that the instinct to oviposit on such special species was inherited. By compelling a *Salix Andersoniana* race of *P. salicis* to lay its eggs on the hybrid willow *Salix purpurea* × *S. viminalis* over a period of years, the habit of choosing that hybrid as food-plant was developed and germinally fixed. This was proved by experimental attempts to throw it back once more on *Salix Andersoniana*. This is a case of the inheritance of acquired characters. Coupling these results with those on the induction of melanism in the Lepidoptera by chemical means, a new principle of evolution on the basis of direct chemical influences on the germ-plasm, whether in the form of the compulsory taking of new food-plants, changed soil conditions, or otherwise, is developed.

**L. A. Harvey**: The history of the cytoplasmic inclusions of the egg of *Ciona intestinalis* (L.) during oogenesis and fertilisation. Mitochondria are present as chromophobe vesicles with acidophil auræ in the youngest oocytes. They increase in number enormously, and practically all except those in the narrow peripheral layer swell to form yolk. After extrusion of test-cells the remaining mitochondria become granular and uniformly acidophil. The peripheral layer forms a deep cup, which becomes shallower and thicker at the time of fertilisation. The Golgi apparatus passes from primary diffuse to complex, and then to secondary diffuse stage. It consists always of small argentophil vesicles and irregular masses. It is suggested that the 'yolk nucleus' is secreted by the Golgi apparatus very early in oogenesis. It fragments and becomes dissolved in the cytoplasm. The test-cells pour lipoid materials into the egg during yolk formation. The cytoplasm passes from primary oxyphily to basophily and then to secondary oxyphily. These changes are correlated with changes in the Golgi apparatus, as described by Hirschler. The germinal vesicle bursts and the reconstituted nucleus reaches the metaphase of the first maturation division usually before the egg leaves the ovary.

**E. Ponder**: The measurement of percentage hæmo-

lysis (ii). Two methods for investigating the percentage hæmolysis curves are described; the first, a modification of the radiometer method published in 1924, and the second, using the resistance of selenium as a measure of the light passing through the cell suspension. The form of the curves, for systems in which the lysin is acting alone, can be exactly explained by the assumption that a monomolecular reaction proceeds among a population the resistances of which are distributed according to a frequency curve, usually of Pearson's Type II. The lysins dealt with are saponin and sodium taurocholate. The effect of the accelerators and inhibitors is to alter the resistance of the population to the lysin, the alteration of resistance being described by an expression containing the single resistance constant $R$.

Physical Society, Dec. 10.—Albert Campbell: A capacitance bridge of wide range and a new inductometer. A bridge is described by which quick measurements can be made of capacitances covering a range of from 1 $\mu\mu$F up to 30 $\mu$F, the power factor also being indicated. The unknown capacitance $C$ is put in parallel with a resistance $P$, and the effective self-inductance of the combination, which is approximately equal to $-P^2C$, is read on a mutual inductometer forming part of the bridge. By giving $P$ a series of suitable values, scale multipliers providing for a very wide range of capacitance are obtained. The inductometer has a circular scale extending to about 260°, the percentage accuracy of reading being almost constant over the greater part of the range. A small rheostat allows the power loss in the condenser to be balanced, and enables the power factor to be deduced. —Frank Wenner: A principle governing the distribution of current in systems of linear conductors. The principle applies to systems of linear conductors in which the currents are proportional to the impressed electromotove forces; the electromotive forces may be any function of time, and may be distributed in any manner throughout the system; and the branches may contain resistance, inductance, capacitance or any two or all of these in series, may be so arranged as to move with respect to a permanent magnet, thus developing counter electromotive forces, and may be connected by contacts or mutual inductances or both of these. For such a system of conductors the current in any branch is that which would result if all impressed electromotive forces were replaced by a single impressed electromotive force, located in the particular branch and equal to the drop in potential which originally would have appeared across the break had this branch been opened. While this principle is a logical consequence of well-known laws, it has been very little used. It may be used to advantage in practically all cases in which the conductors form a series-parallel combination or a network which may be changed to a series-parallel combination by opening the branch in which it is desired to determine the current.

## PARIS.

Academy of Sciences, Dec. 27.—H. Deslandres: The law of distribution of magnetic storms and of their elements. Consequences as regards the constitution of the sun. The notes on this subject published during 1926 are amplified and the general conclusions confirmed, mainly from an analysis of the magnetic observations made at Greenwich.—L. de Launay: Some geological applications of transmutation [of elements]. Examples are given of a certain number of constant ratios between two metals associated in the same deposit: silver and lead, gold and silver, platinum with rhodium, palladium and iridium, cadmium and zinc, cobalt and nickel.—Paul Vuillemin: New data on the supplementary folioles of strawberry plants.—Paul Montel: The series of meromorphic functions.—R. Wavre: Iteration by means of a symmetrical and singular nucleus of Fredholm.—Kolmogoreff: A divergent Fourier-Lebesque series.—Swyngedauw: The angular slip of pulleys and the slip of the driving and driven fibres of the strap.—Maurice Girault: A very general construction of the profiles of wings by conformal transformation of a circle.—A. Couder, A. Danjon, and A. Dufay: The astronomical quality of the sky of Haute-Provence. Details of studies in this region with the view of placing a large telescope there. The meterological data available suggest that this region should be a very favourable one for astronomical observations. This has been confirmed by direct telescopic work with four instruments.—Th. Vautier: Forms and deformations of explosive waves.—C. Raveau: The principle of Carnot and the principle of Clausius; various forms of enunciation.—Georges Déjardin: The spark spectrum of mercury in the extreme ultra-violet. Measurements of wave-lengths of the three spectra are given up to the limit of the Schumann region.—Herbert Brennen: The absorption of $\beta$-rays by matter.—Léon W. Collet and Robert Perret: Complements on the geology of the circus of Sales (Chaîne des Fis, Haute-Savoie).—Louis Dangéard: Current glaucon deposits in the neritic zone. —Paul Bertrand: The Mixoneura zone of the upper Westphalian.—E. de Wildeman: The yocco, a plant containing caffeine, originating in Colombia.—A. Hée: The variations of the respiratory intensity of *Sterigmatocystis nigra* in the course of development.—G. Mouriquand and A. Leulier: Does adrenaline exist in the completely free state in fresh suprarenal capsules? The experiments described appear to show that in the fresh suprarenal capsule (guinea-pig) the adrenaline behaves as though it were partly in combination.—Paul Wintrebert: Clearing up the eggs of the skate for the continuous observation of the development *in vivo*.—Y. Manouelian and J. Viala: Whence comes the virulence of the saliva in rabid animals?—René Leriche and R. Fontaine: Some new facts bearing on current theories of vaso-motor action.—A. Sartory, R. Sartory, and J. Meyer: The formation of the perithecium in *Aspergillus fumigatus* under the influence of radium.—Edm. Sergent, A. Donatien, L. Parrot, F. Lestoquard, and E. Plantureux: The virulence of the blood in South African theilerosis (*Theileria parva*).

## BRUSSELS.

Royal Belgian Academy, Jan. 9, 1926.—George Homès: Stable equilibrium in physico-chemical systems.—Seligmann and Maury: The geodesic work of the military cartographic institute.—Delporte: Minor planets discovered at the Royal Observatory of Belgium, at Uccle. Two new planets have been discovered since January 1924, when a Zeiss astrograph was installed. The elements of one of these (1925 VD) are given.

Feb. 6.—A. Gravis: Contribution to the anatomical study of the shortening of roots.—A. Demoulin: The method of the mobile bi-rectangular trihedron and some of its applications.—Th. De Donder and G. Van Lerberghe: The electromotive force of irreversible hydro-electric cells.—R. Moens: A new method of obtaining sustained electrical oscillations.—G. Chavanne: An inactive 1·3 dimethylcyclopentane.—Maurice Robert: The geology of the Katanga.—— Du Buisson: Observations on the tracheal ventilation of insects.—N. Saltykow: The application of integrable elements to the integration of differential equations.

Mar. 6.—Th. De Donder and G. Van Lerberghe: The maximum yield of the chemical reactions of gaseous systems.—J. Vincent: The theory of cyclones and anticyclones. An adverse criticism of the theory of V. Bjerknes.—Maurice Van Rysselberge: The preparation and study of some 1·2 dimethylcyclopentane compounds.—G. Balasse: Study of the luminescence of potassium vapour in the electrodeless discharge.

ROME.

Royal Academy of the Lincei, Nov. 21.—G. Scorza: A lemma on the prolongation in the complex body of certain real algebraics.—G. Armellini: The variation of the eccentricity in the problem of two bodies of variable masses.—Q. Majorana: A residual thermal phenomenon. When heated to high temperatures and then allowed to cool to the ordinary temperature, lead, iron, and copper exhibit rises in temperature incompatible with the known laws of the progressive cooling of bodies.—F. Zambonini and A. Stolfi: Double sulphates of rare earth and alkali metals. Investigation of a portion of the system $La_2(SO_4)_3 : (NH_4)_2SO_4 : H_2O$ at 25° indicates the formation of the double compounds, 1 : 1 : 2, 1 : 3 : 0, 1 : 5 : 0, and 1 : 6 : 0.—G. Krall: The infinitesimal deformation of the field of integration in Fredholm's equations.—E. Bompiani: Point and contact transformations in a plane.—B. Segre: A generalisation of Koenigs' transformation.—A. Masotti: Uniform translation of a round cylinder in a channel with plane parallel sides; second approximation.—G. de Mottoni: Control experiments for a new interferometric method for the measurement of microscopic and ultra-microscopic objects by means of diffraction gratings. The percentage error of measurements made by the method recently described has the mean value 3·2 and the maximum value 5·0 per cent.—E. Fermi and E. Persico: The principle of adiabatics and the notion of kinetic energy in the new undulatory mechanics.—D. Bigiavi: Reactions of nitroxyl with aromatic nitro-derivatives and with azoxy-compounds. When an aromatic nitro-compound reacts with nitroxyl, obtained as the sodium derivative together with sodium nitrite when a solution of the sodium salt of nitrohydroxylamine is heated, the nitroxyl is oxidised to sodium nitrite by the nitro-compound, which is transformed into nitroso-compound; the latter does not separate, but immediately reacts with the nitroxyl to give the nitrosoarylhydroxylamine. Azoxy-compounds react similarly with nitroxyl, azoxybenzene, for example, yielding azobenzene and the sodium salt, $C_6H_5 \cdot N : N(C_6H_5) : NONa$.—F. De Carli: Additive compounds of sulphur dioxide and aromatic hydrocarbons. Investigation of the diagrams of crystallisation shows that sulphur dioxide forms with toluene the compounds $C_6H_5 \cdot CH_3$, $2SO_2$ and $C_6H_5 \cdot CH_3$, $3SO_2$, with mesitylene the compound $C_6H_3(CH_3)_3$, $SO_2$, and with pseudocumene the compound $C_6H_3(CH_3)_3$, $SO_2$.—R. Fabiani: Remains of an eruptive apparatus of Jurassic age found in Sicily.—F. Rodolico: Crystallographic investigations on certain hetero-poly-compounds.—V. Ronchi: The optical function of the lachrymal liquid.

SYDNEY.

Royal Society of New South Wales, Nov. 3.—The late J. H. Maiden and W. F. Blakely: Description of fifteen new acacias, and notes on several other species. Of the new species described, eleven are indigenous to New South Wales, two to Victoria, and two to South Australia; twelve belong to series Uninerves, and one each to series Plurinerves, Juliflorae (Stenophyllae) and Bipinnatae (Botryocephala).—G. J. Burrows: The solution volume of a solute in liquid mixtures. When a solute is dissolved in a mixture of water with an alcohol or acetone, the contraction that takes place is smaller than that resulting from the solution of the same solute in either of the separate liquids. This result would indicate that there is some relationship between the compressibility of a liquid and the apparent solution volume of a solute in that liquid. By considering the actual contractions that take place when a liquid solute is dissolved in these liquids, however, it is found that the relationship is not quantitative, and it is concluded that volume changes in these cases cannot be reconciled with any simple mechanical theory of closer packing.—Miss E. M. Bartholomew and G. J. Burrows: The preparation of certain iodo-bismuthites. In an unsuccessful attempt to prepare iodo-bismuthates, the corresponding bismuthites of certain bases such as aniline, dimethyl aniline, phenyldimethyl arsine, etc., were isolated. These are all crystalline compounds which can be recrystallised from concentrated hydrochloric acid without change. They may all be regarded as derivates of bismuthous iodide. The anilinium, pyridinium, dimethyl anilinium, and *p*-toluidinium salts are all derivatives of hexa-iodo bismuthous acid, $H_3(BiI_6)$, whilst phenyl dimethyl arsonium tetra-iodo bismuthite is a derivative of the acid $H(BiI_4)$.—G. J. Burrows: The salinity of the water of the Gulf of Carpentaria. Samples of water collected at various positions in the Gulf of Carpentaria have been analysed for the chlorine content. In all cases the salinity is lower than would be expected if the sea water were not diluted with fresh water. The low salt content can be attributed partly to the discharge of fresh water from rivers such as the Roper or Mitchell. The results, however, also show the effect of dilution of the sea water by water from the artesian basin.—W. R. Browne: The geology of the Gosforth district, N.S.W. Part 1, General geology. The strata belong mainly to the Kuttung or upper division of the Carboniferous system, but the basal stage of the division is not revealed. A maximum thickness of about 8000 feet of strata is exposed, consisting mostly of lavas ranging from pyroxene andesite to rhyolite, felsite-tuffs, aqueo-glacial conglomerates, varve-shales and tillite. On top of these, with disconformity or slight overlap, lie the Permo-Carboniferous Lower Marine beds. The main structural feature is an irregular dome, of late Permo-Carboniferous age, which has been heavily faulted. The physiography is bound up with the evolution of the Hunter River and the dissection of the faulted dome.

VIENNA.

Academy of Sciences, Dec. 2.—A. Smekal: The optical proof of lacunæ in the molecular structure of actual crystals. There are deviations from the ideal lattice structure or pores in the lattice. The evidence is in the internal sensitiveness for wave-lengths which are greater than the resonance wave-lengths of the lattice. Alkali salts can be coloured by radiation with ultra-violet light.—H. P. Cornelius and M. Furlani-Cornelius: Geological researches in the upper Val Camonica.—H. P. Cornelius: Geological researches in the lower Veltlin and at the northern end of Lake Como.—E. Bersa: Radio-biological investigations; the question of Röntgen radiation of seedlings. Sinapis, Vicia, and Zea were used. A transitory depression was noted in the rate of growth of roots with later recovery.—S. Strugger: The influence of hydrogen ion concentration on the protoplasm of root-hairs in *Hordeum vulgare*. The velocity of the plasma streaming was studied between *p*H 6·80 and *p*H 5·50.—F. Hölzl: Organic acids and bases in non-aqueous solution. Combinations of amines with dicarbon and aromatic acids were submitted to conductivity measurements.

## Official Publications Received.

BRITISH AND COLONIAL.

Board of Education. Report of the Consultative Committee on the Education of the Adolescent. Pp. xxiv+339. (London: H.M. Stationery Office.) Paper, 2s. net; cloth, 3s. net.

Air Ministry: Meteorological Office, London. Southport Auxiliary Observatory (The Fernley Observatory of the Corporation of Southport). Annual Report, and Results of Meteorological Observations, for the Year 1925. By Joseph Baxendell. Pp. 28. (Southport: Fernley Observatory; London: Meteorological Office.)

Board of Trade. Catalogue of the British Industries Fair, 1927, The White City, Shepherd's Bush, London, W.12, February 21st–March 4th, Organised by the Department of Overseas Trade. Special Overseas Advance edition. Pp. xxxii+304+Ad. 180. (London: Department of Overseas Trade.)

Ministry of Agriculture and Fisheries. Miscellaneous Publications, No. 56: Clean Milk Competitions in 1924–1925. Pp. 16+1 plate. (London: Ministry of Agriculture and Fisheries.) 4d. net.

Aberdeen Public Library, Forty-second Annual Report of the Committee for the Year 1925–1926. Pp. 43. (Aberdeen.)

Journal of the Society for the Preservation of the Fauna of the Empire. New Series, Part 6, December. Pp. 98. (London: H. F. and G. Witherby.)

Proceedings of the Society for Psychical Research. Part 101, Vol. 36, January. Pp. 393–435. (London: Francis Edwards.) 3s.

The Physical Society. Proceedings, Vol. 39, Part 1, December 15. Pp. 97. (London: Fleetway Press, Ltd.) 6s. net.

The Observer's Handbook for 1927. Edited by C. A. Chant. Nineteenth Year of Publication. Pp. 72. (Toronto: Royal Astronomical Society of Canada.)

Department of Scientific and Industrial Research. Report of the Fuel Research Board for the Year 1925; with Report of the Director of Fuel Research. Pp. vi+79. (London: H.M. Stationery Office.) 1s. 3d. net.

Report on the Zoological Survey of India for the Years 1923 to 1926. Pp. iiii+3 plates. (Calcutta: Government of India Central Publication Branch.) 1.7 rupees; 2s. 6d.

South Australia: Department of Mines. Mining Review for the Half-year ended June 30th, 1926. (No. 44.) Pp. 63+5 plates. (Adelaide: R. E. E. Rogers.)

Bird Sanctuaries in Royal Parks in Scotland: Report of the Committee appointed by Viscount Peel to consider the Establishment of Bird Sanctuaries in the Royal Parks in Scotland. Pp. 10. (London: H.M. Stationery Office.) 6d. net.

The West of Scotland Agricultural College, Glasgow. Calendar for Session 1926–1927. Pp. xv+165. 1s. Annual Report and Appendices, 1925–1926. Pp. 121. (Glasgow.)

The Journal of the Institution of Electrical Engineers. Vol. 65, No. 361, January. Pp. 97-184+xxviii. (London: E. and F. N. Spon, Ltd.) 10s. 6d.

Australasian Antarctic Expedition, 1911–14. Scientific Reports, Series C: Zoology and Botany. Vol. 8, Part 3: Echinodermata Echinoidea. By Prof. René Kœhler. Pp. 134+plates 91-124. (Sydney, N.S.W.: Alfred James Kent.) 38s.

Government of the Gold Coast. Report on the Survey Department for the Period April 1925–March 1926. Pp. 27+5 plates. (Accra: Colonial Secretariat; London: The Crown Agents for the Colonies.) 2s.

Proceedings of the Royal Irish Academy. Vol. 37, Section A, No. 7: Atmospheric Ionisation. By Prof. J. J. Nolan and G. P. de Sachy. Pp. 71-94. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 1s.

Professional Schools Post-Graduation Courses: Specialist Studies in the Universities and University Colleges of Great Britain and Ireland, Session 1926–7. Pp. 39. (London: Universities Bureau of the British Empire.)

Students from other Countries in the Universities and University Colleges of Great Britain and Ireland in October 1926. Pp. 31. (London: Universities Bureau of the British Empire.) 1s.

The North of Scotland College of Agriculture. Report on the Work of the North of Scotland College for the Year 1925–26. Pp. 31. (Aberdeen.)

Proceedings of the Royal Society of Victoria. Vol. 39 (New Series), Part 1, November 11th. Pp. iv+52+6 plates. (Melbourne.)

FOREIGN.

Ministère de l'Instruction Publique et des Beaux-Arts. Enquêtes et documents relatifs à l'enseignement supérieur. 121: Rapports sur les observatoires astronomiques de Province. Année 1925. Pp. 89. (Paris: Imprimerie Nationale.)

The Danish Ingolf-Expedition. Vol. 5. 10: Medusæ. Part 2: Anthomedusæ. By P. L. Kramp. Pp. 105+2 plates+1 map. (Copenhagen: Bianco Lund.)

International Geodetic and Geophysical Union (Union Géodésique et Géophysique Internationale): Section of Terrestrial Magnetism and Electricity. Bulletin No. 6: Preliminary Reports on Subjects of Investigation. Pp. 40. (Baltimore, Md.: Johns Hopkins Press.) 50 cents.

United States Department of Agriculture. Department Bulletin No. 1426: The Clover Root Borer. By L. P. Rockwood. Pp. 48. (Washington, D.C.: Government Printing Office.) 10 cents.

Proceedings of the American Philosophical Society held at Philadelphia for Promoting Useful Knowledge. Vol. 65, No. 3. Pp. 141-243. (Philadelphia, Pa.)

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 72: Contribution to the Knowledge of the Coccidæ of Egypt. By W. J. Hall. Pp. iii+41+13 plates. (Cairo: Government Publications Office.) 10 P.T.

Calendario del Santuario e delle opere di beneficenza cristiana di Valle di Pompei, 1927. Pp. 256. (Valle di Pompei.)

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 78. Gabb's California Fossil Type Gastropods. By Ralph B. Stewart. Pp. 287-447+plates 20-32. (Philadelphia, Pa.)

Proceedings of the United States National Museum. Vol. 69, Art. 6: A new Sea Star of the Genus Evasterias. By W. K. Fisher. (No. 2632.) Pp. 5+2 plates. Vol. 69, Art. 20: Additional new Mollusks from Santa Elena Bay, Ecuador. By Paul Bartsch. (No. 2646.) Pp. 20+3 plates. Vol. 70, Art. 1: American Wasps of the Genus Sceliphron Klug. By Bennet A. Porter. (No. 2650.) Pp. 22+4 plates. Vol. 70, Art. 4: New Urocoptid Land Shells from Mexico. By Paul Bartsch. (No. 2653.) Pp. 13+1 plate. Vol. 70, Art. 10: On a Collection of Copepoda from Florida, with a Description of Diaptomus Floridanus, New Species. By C. Dwight Marsh. (No. 2659.) Pp. 4. (Washington, D.C.: Government Printing Office.)

Fish and Game Commission of California. Fish Bulletin No. 11: The California Sardine. By the Staff of the California State Fisherie Laboratory. (Contributions Nos. 52-56 from the California State Fisheries Laboratory.) Pp. 222. (Terminal, Calif.: State Fisheries Laboratory.)

Annuaire astronomique et météorologique Camille Flammarion pour 1927: exposant l'ensemble de tous les phénomènes célestes observables pendant l'année, avec revue astronomique et météorologique, notices scientifiques, tableaux et documents. 63e année. Pp. 330. (Paris: Ernest Flammarion.) 12 francs.

Denkschriften der Schweizerischen Naturforschenden Gesellschaft, Band 63: Mémoires de la Société Helvétique des Sciences naturelles, Vol. 63. Pp. iv+349. (Zürich.)

Department of Commerce: Bureau of Standards. Technologic Papers of the Bureau of Standards, No. 328: Tests of Large Columns with H-shaped Sections. By L. B. Tuckerman and A. H. Stang. Pp. 88+6 plates. 40 cents. Technologic Papers of the Bureau of Standards, No. 333: Transmission of Sound through Voice Tubes. By E. A. Eckhardt, V. L. Chrisler, P. P. Quayle and M. J. Evans; with a Note on the Absorption of Sound in Rigid Pipes, by Edgar Buckingham. Pp. 163-193+1 plate. 15 cents. (Washington, D.C.: Government Printing Office.)

United States Department of Agriculture. Department Bulletin No. 1423: Progress of Reindeer Grazing Investigations in Alaska. By Lawrence J. Palmer. Pp. 37+18 plates. 15 cents. Farmers' Bulletin No. 1503: The Horse Bots and their Control. By F. C. Bishopp and W. E. Dove. Pp. ii+14. 5 cents. (Washington, D.C.: Government Printing Office.)

CATALOGUES.

The 'Scholes' Bomb for Solid and Liquid Fuel Calorimetry. Pp. 16. (Manchester and London: G. Cussons, Ltd.)

A Catalogue of Books published by the Syndics of the Cambridge University Press. Pp. xv+272. (London: Cambridge University Press.)

## Diary of Societies.

*SATURDAY*, FEBRUARY 5.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 10.30 A.M.—Dr. C. P. Symonds: Cerebral Abscess; Some Points in Diagnosis and Localisation.—Dr. Farquhar Buzzard: The Treatment of Traumatic Facial Paralysis.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—W. de la Mare: Craftsmanship in Verse.

INSTITUTION OF AUTOMOBILE ENGINEERS (Western Centre) (at Law Courts, Cardiff), at 6.30.—J. Younger: Maintenance in the United States.

*MONDAY*, FEBRUARY 7.

BIOCHEMICAL SOCIETY (at Lister Institute), at 3.30.—Exhibits and Demonstrations:—W. T. J. Morgan: Apparatus for Pregl's Methods of Micro-analysis.—T. Lumsden and A. C. Kohn-Speyer: Simplified Method of Tissue Culture.—F. M. Burnet: Bacteriophage Phenomena.—M. Rhodes: National Collection of Type Cultures. Strains employed in Industry.—N. S. Lucas: Apparatus for determining the Coefficient of Absorption of Ultra-violet Rays for Skin.—At 5.—Papers:—C. Dorée and E. C. Barton-Wright: A New Type of Alkali Lignin.—F. Dickens, E. C. Dodds, W. Lawson, and N. F. Maclagan: Observations on the Purification and Properties of Insulin.—P. Eggleton and M. G. Eggleton: The Significance of Phosphoric Acid in Muscular Contraction.—I. S. MacLean and C. G. Daubney: The Lipins of Yeast.—W. T. J. Morgan: Methylated Derivatives of Hexosephosphoric Acids.—Prof. A. Harden: Meyerhof's Theory of Alcoholic Fermentation.—Prof. L. F. Hewitt: Proteins of the Cerebrospinal Fluid.—M. H. Roscoe: Nitrogen Metabolism Technique for Use with Small Animals.—H. W. Southgate: An Efficient Gas Scrubber.—O. Rosenheim and T. A. Webster: On the Nature of Provitamin D.—J. R. Marrack: The Effect of the Reaction on the Osmotic Pressure of Serum Proteins.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Rev. Dr. G. A. F. Knight: The Identification of the Pharaohs of the Pentateuch.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—D. C. Fidler: Presidential Address.

INSTITUTION OF AUTOMOBILE ENGINEERS (Bristol Centre) (at Merchant Venturers' Technical College, Bristol), at 6.45.—A. H. R. Fedden: The Supercharging of Aircraft and Motor Vehicle Engines.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—R. Grierson and others: Discussion on Some Interesting Features in Modern Installation Work.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—Dr. T. Slater Price: Photographic Sensitivity.

INSTITUTION OF THE RUBBER INDUSTRY (London and District Section) (at Engineers' Club, Coventry Street), at 8.—H. Turner: Set in Vulcanised Rubber.—H. Standring: Rubber Toys.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—J. H. Driberg: The Didinga Mountains.

MEDICAL SOCIETY OF LONDON, at 8.30.—Dr. F. Walshe, Dr. M. Gordon, and Sir Thomas Horder: Discussion on Poliomyelitis.

*TUESDAY*, FEBRUARY 8.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. S. Huxley: Problems of Animal Growth and Development (2).

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—The Secretary: Report on the Additions to the Society's Menagerie during the months of November and December 1926 and January 1927.—W. E. Le Gros Clark: Exhibition of Photographs of a Living Tree-Shrew (*Tupaia minor*).—Major S. S. Flower: Loss of Memory accompanying Metamorphosis in Amphibians.—Dr. H. H. Woollard: The Differentiation of the Retina in the Primates.—Dr. F. P. Stowell: Physical and Chemical Conditions in the Fresh-water Circulation of the Society's Aquarium.—Oldfield Thomas: The Delacour Exploration of French Indo-China—Mammals.—Edith M. Sheppard: Revision of the Family Phreatoicidæ (Crustacea) with a Description of Two New Species.—Chi Ping: On the Structures of the Hard Palate of *Felis tigris*.—R. Gurney: Some Australian Fresh-water Entomostraca reared from Dried Mud.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—J. G. Weir: Feed Water Circuits for Marine Installations.

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at College, Loughborough), at 6.45.—H. V. Field: Applications of the Oscillograph.

ELECTRICAL ASSOCIATION FOR WOMEN (jointly with Association of Teachers in Domestic Subjects) (at E.L.M.A. Lighting Service Bureau, Strand), at 7.—W. E. Rush: Electric Light in the Home and in the School.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—Informal Discussion on Electric Heating and Cooking.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—A. R. Cooper: Electrical Equipment of Track on the Underground Railways of London.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Kinematograph Group), at 7.

SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (at Birmingham University), at 7.15.—F. Twyman: Metallurgical Spectroscopic Analysis.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Centre) (at Broadgate Café, Coventry), at 7.30.—A. H. R. Fedden: The Supercharging of Aircraft and Motor Vehicle Engines.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at Technical College, Cardiff), at 7.30.—Prof. J. Mangan: Micro-organisms of the Soil.

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at McLellan Galleries, Glasgow), at 7.30.—Prof. W. M. Thornton: What is Electricity? (Faraday Lecture).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—O. Hurst: Some Notes on Naval Architecture.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—Annual General Meeting.

PHARMACEUTICAL SOCIETY, at 8.—W. Wyatt: The Acts of Parliament relating to Stamped Medicine.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Prof. W. J. Sollas: The Chancelade Skull.

*WEDNESDAY*, FEBRUARY 9.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at Holborn Restaurant), at 2.30.—J. L. Musgrave: Presidential Address.—Dr. Margaret Fishenden: The Effect of Weather Conditions upon the Heat Requirements of a House.

ROYAL SOCIETY OF MEDICINE (Surgery: Sub-Section of Proctology), at 5.—Dr. E. Spriggs (Medical), Sir Charles Gordon-Watson (Surgical), Dr. B. Shires (Radiological), and others: Discussion on Diverticulitis.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Midland Institute, Birmingham), at 7.—Prof. W. M. Thornton: What is Electricity? (Faraday Lecture).

INSTITUTION OF WELDING ENGINEERS (at Milton Hall, Deansgate, Manchester), at 7.—P. L. Roberts: The Welding of Cast Iron.

ROYAL SOCIETY OF ARTS, at 8.—Dr. E. F. Armstrong: The Romance of the Organic Chemical Industry.

*THURSDAY*, FEBRUARY 10.

ROYAL SOCIETY, at 4.30.—C. D. Ellis and W. A. Wooster: (*a*) The Photographic Action of β-Rays; (*b*) The Relative Intensities of the Groups in the Magnetic β-Ray Spectra of Radium B and Radium C.—A. Muller: An X-Ray Investigation of Certain Long-Chain Compounds.—*The following and other papers will be read in title only*:—Dr. G. M. B. Dobson and D. N. Harrison: Measurements of Ozone in the Earth's Atmosphere and its Relation to other Geophysical Conditions.—Part II.—L. H. Thomas: On the Capture of Electrons by swiftly moving Electrified Particles.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—Prof. S. Chapman: Some Problems of Terrestrial Magnetism (Lecture).—*The following papers will be communicated by title only*:—T. W. Chaundy: The Genus of an Algebraic Twisted Curve.—R. Cooper: The Behaviour of Certain Series Associated with Limiting Cases of Elliptic Functions.—P. J. Daniell: A Note on Schrödinger's Wave Mechanics.—Prof. G. H. Hardy, A. E. Ingham, and G. Pólya: Notes on Moduli and Mean Values.—Prof. G. H. Hardy and J. E. Littlewood: Some Problems of 'Partitio Numerorum': VIII. The Number $\Gamma(k)$ in Waring's Problem.—L. J. Mordell: A Tauberian Convergence Condition.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Sir William Bragg: Acoustical Problems treated by Lord Rayleigh (2): Echoes.

SOUTH LONDON ENTOMOLOGICAL AND NATURAL HISTORY SOCIETY, at 7.

INSTITUTION OF ELECTRICAL ENGINEERS (Dundee Sub-Centre) (at University College, Dundee), at 7.30.—D. Sclar: Three-Phase Power Measurement.

INSTITUTE OF METALS (London Local Section) (jointly with Electroplaters' and Depositors' Technical Society) (at 83 Pall Mall), at 7.30.—W. R. Barclay: Nickel Coatings—Methods of Production.

OPTICAL SOCIETY (at Imperial College of Science), at 7.30.—T. Smith: Some Uncultivated Optical Fields (Presidential Address).

CHEMICAL SOCIETY (at Institution of Mechanical Engineers), at 8.—Prof. E. Cohen: Kamerlingh Onnes Memorial Lecture.

INSTITUTION OF MECHANICAL ENGINEERS (Leeds Branch).—Prof. A. L. Mellanby and Prof. W. Kerr: Use and Economy of High Pressures in Steam Plant.

INSTITUTION OF THE RUBBER INDUSTRY (Manchester Section).—J. Lloyd: Proofing.

*FRIDAY*, FEBRUARY 11.

ROYAL SOCIETY OF ARTS (Indian Meeting), at 4.30.—Sir E. Denison Ross: The Arabic History of Gujarat (Sir George Birdwood Memorial Lecture).

ROYAL ASTRONOMICAL SOCIETY (Annual General Meeting), at 5.—Dr. J. H. Jeans: Address on the Award of the Gold Medal to Prof. Frank Schlesinger.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Literary and Philosophical Society, Newcastle-upon-Tyne), at 6.—Prof. F. Smith: Psychology as an Aid to Efficiency and Economy in Industry.

INSTITUTE OF METALS (Swansea Local Section) (at University College, Swansea), at 7.15.—J. S. Caswell: The Design of Annealing Furnaces.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Prof. K. Neville Moss: The Physiology of Work under High Air Temperature Conditions.

INSTITUTE OF METALS (Sheffield Local Section) (at Sheffield University), at 7.30.—R. T. Rolfe: Bronze.

OXFORD UNIVERSITY JUNIOR SCIENTIFIC CLUB, at 8.15.—Speaker: F. Mitchell Hedges: Primitive Tribes and Buried Cities in Central America.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. E. Law: Old Hampton Court Palace Revealed.

INSTITUTION OF MECHANICAL ENGINEERS (Liverpool Branch, jointly with Liverpool Engineering Society).—Prof. A. L. Mellanby and Prof. W. Kerr: Use and Economy of High Pressures in Steam Plant.

*SATURDAY*, FEBRUARY 12.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—W. de la Mare: 'Atmosphere' in Fiction.

MINING INSTITUTE OF SCOTLAND (at Edinburgh).

## PUBLIC LECTURES.

*SATURDAY*, FEBRUARY 5.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—V. Gordon Childe: The Aryans, our Linguistic Ancestors.

*SUNDAY*, FEBRUARY 6.

GUILDHOUSE (Eccleston Square), at 3.30.—Maulvi A. R. Dard: The Soul of Islam.

*MONDAY*, FEBRUARY 7.

UNIVERSITY COLLEGE, at 5.—Dr. A. S. Parkes: Reproduction. (Succeeding Lectures on February 14, 21, 28, March 7 and 14.)

KING'S COLLEGE FOR WOMEN (Household and Social Science Department), at 5.15.—F. Birrell: The Influence of Women on the Public Taste.

UNIVERSITY OF LEEDS, at 7.—Prof. C. T. R. Wilson: Thunderclouds.

*TUESDAY*, FEBRUARY 8.

BEDFORD COLLEGE FOR WOMEN, at 5.15.—Prof. E. G. Gardner: Conceptions of the Cosmos according to Dante.

KING'S COLLEGE, at 5.30.—C. E. M. Joad: Some Aspects of Vitalism: Vitalism and Emergence.

UNIVERSITY COLLEGE, at 5.30.—Dr. M. Wheeler: The Archæology of Great Britain, its Present and its Future. (Succeeding Lectures on February 15, 22, and March 1.)—At 8.15.—Miss E. Jeffries Davis: Some London Place Names. (Succeeding Lectures on February 15, 22, March 1 and 8.) (This course is a repetition of the one given in November 1926.)

*WEDNESDAY*, FEBRUARY 9.

UNIVERSITY COLLEGE, at 5.—Dr. E. D. Adrian: The Action of the Sense Organs. (Succeeding Lectures on February 16 and 23.)

*THURSDAY*, FEBRUARY 10.

KING'S COLLEGE, at 5.30.—Prof. F. A. Lindemann: The Mind: Physics.

UNIVERSITY COLLEGE, at 5.30.—Dr. C. Sisson: Americans and American Universities.

NORTHAMPTON POLYTECHNIC INSTITUTE, at 7.—R. Genders: Steel and its Thermal Treatment: Defects in Steel.

FULHAM CENTRAL PUBLIC LIBRARY, at 8.—R. Kearton: Wild Nature's Ways.

*FRIDAY*, FEBRUARY 11.

COLLEGE OF MEDICINE (Newcastle-upon-Tyne), at 4.45.—Dr. C. Singer: History of Medicine (2).

*SATURDAY*, FEBRUARY 12.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. Edith Durham: Some Old Montenegrin Customs.

*SUNDAY*, FEBRUARY 13.

GUILDHOUSE (Eccleston Square), at 3.30.—N. C. Sen: Brahmo Somaj.

## CONFERENCE.

FEBRUARY 10 TO 12.

CONFERENCE ON MATERNITY AND CHILD WELFARE (under auspices of the Society of Medical Officers of Health) (at Newcastle-upon-Tyne).—Papers on Infant Feeding, the Development of Maternity and Child Welfare Work, and the Prevention of Still-birth.