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Primitive Races within the British Empire: A Problem in Adaptation.

DURING the coming months Wembley will present itself under many aspects to a multitude of visitors drawn from all parts of the world. Whatever may be their final impression, and however their interests may guide them among its varied attractions, it can scarcely escape the least imaginative that the British Empire Exhibition embodies a great ideal. To a multifarious variety of exhibits representative of all sides of a complex and highly organised civilisation is added the colour derived from differences of race and culture, of climate and of soil. Yet beneath the obvious appeal of a bewildering variety is a dominant sentiment —the consciousness of Imperial unity which has grown up largely during the present century, and, quickened by two wars, has now attained its greatest material expression in peace time in the present exhibition.

It would be superfluous to stress this more obvious aspect of Wembley if it were not for the fact that in bringing our Dominions and Dependencies together, each to take its share in a common expression of an Imperial ideal, it has been made clear how very imperfectly in many respects the implications of that ideal have been grasped by the general public. This is perhaps most marked in the way the public regards those sections of the Exhibition in which the more backward races—the native races, as they are loosely called—take part. The attitude of mind, unfortunately too common, which looks upon these peoples and the exemplification of their daily life and activities merely as part of the "show," indicates only a very partial grasp of the obligations as well as the privileges of Empire. Presumably it was a desire to warn the public against regarding the natives as mere exhibits, irritating to those who know them best, which animated the writer of a recent article in the *Times*. He emphasised the intelligence of the natives of Africa at Wembley, and their skill as craftsmen, and concluded by pointing out that the Fourah Bay College of Sierra Leone had graduated 43 M.A.'s and 138 B.A.'s of the standard of the University of Durham, with which the College is affiliated! If to some his final argument may appear mistaken and inconclusive, it should at least give pause to those who regard all members of native races without discrimination as intellectually inferior.

The case of the native highly educated on European lines is exceptional, although as experience has shown, in India, which stands apart, and elsewhere, it presents a serious problem. It is not so immediately urgent as that of the common run of the population, which is either just coming into contact with a higher civilisation or has retained its own culture to a greater or less degree while under its influence. If it accomplished nothing more, the British Empire Exhibition would attain a great object did it bring home to the public the urgent call for measures to preserve our backward races, and for the study of their culture and their racial peculiarities and affinities. Anthropologists never cease, both in and out of season, to urge the necessity for scientific study of these peoples. To the trained mind, all research which adds to the sum of human knowledge appears eminently worth while; it is for such minds merely a question of degree. Scientific investigations, however, which involve expenditure upon anything more than a modest scale—as is the case with the study of primitive peoples, which can only be prosecuted in remote parts of the earth—require some measure of public recognition and support. In science, to obtain such recognition, not only is it necessary that the problem which anthropological study would hope to solve should be clearly stated, but it is also essential either that it should strike the imagination of the public or that it should possess a practical appeal. It cannot be said that public interest in the subject-matter of anthropology is lacking, but it has not yet passed the stage which looks for entertainment in a "traveller's tale." The examples of native arts and crafts, as well as the people themselves, at the Exhibition should instil a lesson of deeper significance into the mind of the public, and should awaken a consciousness that the interdependence which is recognised to subsist between the civilised communities of the Empire extends also to more backward societies and, equally, involves an obligation to secure, so far as possible, conditions favourable to their survival, as well as the just administration of their affairs by rulers of the more highly civilised race.

It has frequently been pointed out that successful administration of native affairs requires a sympathy and understanding on the part of the administrator which can only be acquired either as the result of a long experience of the people in question or as the outcome of some study of native customs on scientific lines, for which a training in anthropological method is necessary. This, however, in a sense is a static point of view which takes insufficient account of the results which must necessarily follow from an increasing contact with civilisation as a country is opened up to trade and its resources developed. Throughout the world, whenever a primitive race is brought into contact with European civilisation, the result is normally, though not invariably, for the inferior race to lose its vitality and to die out. If this consequence can be averted, it is an obvious obligation of the more highly civilised to take effective measures to protect the more backward. Further, in an Empire like ours, with its wide range of climatic conditions, in many of which the manual burden of development must depend, not upon the white race, but on a people adapted to the environment, failure to preserve the native population is neglect of an asset of which the full value may not be immediately apparent, but will only be adequately appreciated when necessity, at some day perhaps not far distant, forces upon us the development of the material resources of our Empire to the full.

In a recent lecture at King's College, which formed part of a course on Problems of Empire, organised in view of the British Empire Exhibition, Prof. C. G. Seligman pointed out that the problem of our native races was one ultimately of adaptation. He showed that these races fall into a classification of hunting, pastoral, and agricultural communities, and that failing adaptation, the hunting communities, which include the most primitive peoples, such as the Veddas of Ceylon and the wild tribes of the Malay Peninsula, must die out as conditions favourable to a hunting community pass away. This opens up a wide field for research which is obviously of more than academic interest, for although we know that adaptation to changed circumstances has taken place, it is by no means certain how and in what conditions. It is common knowledge that the essential characteristic of a primitive community is its conservatism. It has been found that even such limited interference as is customary under our administration, which aims at curtailing only such practices as are utterly at variance with civilised sentiment, such as head hunting, human sacrifice, raiding, and the like, affects the social complex and the mental habit of the people to their detriment. So much so that it has been suggested that the diminution in numbers of our primitive races is to be attributed to the mental inertia following the curtailing of these activities, which were an essential stimulus to their interest in life.

In a community of this type which, presumably, in a long period of time has maintained a form of existence suited at all points to its environment, spontaneous adaptation to changed conditions is scarcely likely. It seems to require the introduction of a new strain from outside—an antecedent which is known to have been present in most cases in which a change to a different and usually a higher type of culture has taken place. Miscegenation in the human races, however, is a subject of which we have little knowledge, and, as Prof. Seligman pointed out in discussing its influence on adaptation, there is an obvious danger that cross breeding may favour undesirable qualities. This is also the popular view of half-breeds, which is not entirely without foundation; but it requires much more detailed and careful investigation than it has yet received.

It is neither necessary nor desirable to pursue further this aspect of the question here. It deals with one factor only in the problem, though that is fundamental. For the solution of problems of administration, as has been said on many occasions, the necessity for study of the people themselves on scientific lines is equally urgent, while on no other conditions will it be possible to attempt a decision of their ultimate place as members of the Empire. An approach to this problem has been made in South Africa, and the conditions in which the agriculture of Kenya province in East Africa is being developed suggests that it is not insoluble. The British Empire Exhibition, in affording an object lesson of what our native races are and of their attainment in culture, serves at once as a warning against their extinction and an exhortation to realise and grapple, on scientific lines, with the problem they present before it is too late.

Art-forms in Nature.

Kunstformen der Natur. Von Ernst Haeckel. Zweite, verkürzte Auflage. Niedere Tiere. Pp. iii + 12 + 30 Tafeln. (Leipzig: Bibliographisches Institut, n.d.) 16*s.* 4*d.*

IT is not a simple matter to form a conjecture as to what has prompted the selection of the thirty plates contained in this "Second, abbreviated edition" out of the hundred contained in the first edition of Haeckel's monumental work "Kunstformen der Natur." By no means all of the most striking and beautiful plates in that edition are here reproduced. The explanation given by the publishers in their foreword introducing this volume, five years after Haeckel's death, and in honour of the ninetieth anniversary of his birth (Feb. 16, 1924), is that "the necessity of the times compels curtailment," but it may well be that in twenty years many of the plates have become damaged or deteriorated. It is explained that this edition is confined to plates bearing upon Haeckel's special study, the lowest forms of life.

The original edition was issued in ten parts, each containing ten plates, commencing in 1899, and in 1904 Haeckel brought his work to a close with a "General Introduction" which he had promised in Part I. The keynote of his intention is struck in his original preface, where he says: "In the rendering of the figures I have always kept before my eyes the combination of exquisite beauty with the closest possible truth to Nature. All the Art-forms here represented are therefore, in truth, real Nature-forms; all idealisation and 'touching-up' (*Stilizierung*) have been sedulously avoided."

It is pointed out that Nature produces in her bosom an inexhaustible profusion of wonderful forms by the beauty and multiplicity of which all art-forms created by man may be far eclipsed. Familiar as is mankind with the beauties of form among the higher orders of creation, the flowering plants and vertebrates, the immeasurable realm of the lower animals is an unknown country, by reason of the fact that they exist for the most part in the depths of the sea. Moreover, they are invisible to the naked eye, and have only been revealed by the perfection of microscopic aids to vision during the nineteenth century, and by the systematic exploration of the ocean at all depths. This is particularly the case with the Protozoa, and these are principally figured in rare and costly works inaccessible to the layman. Haeckel's object was to familiarise with their beauty an extended circle of students, both of Nature and of art, and industrial workers, who may find in his work a profusion of new designs; but he claimed to have reproduced only actualities, leaving style, modelling, and decorative elaboration to the workers themselves. He, in fact, reiterated the ambition of Paul von Ritter, who, when he founded his school of phylogenetic zoology in the University of Jena, expressed the hope that, apart from academic studies, it might awaken an interest in the wonders and beauties of Nature among the people at large, by making them the common property of widely scattered art-circles.

The "allgemeine Einleitung," published in 1904, is divided into sections dealing (*a*) with the relationships and connexion of art- and Nature-forms, particularly with regard to their gradual development; (*b*) with the geometrical arrangement and æsthetic significance of primitive organisms, and the meanings and motives of their symmetrical laws, a subject which recurs constantly in Haeckel's voluminous works. In section (*c*) he gives us a systematic survey of the art-forms to be found in individual classes of the organic world, the development of primitive types and their æsthetic significance.

Haeckel devoted himself in this work mainly to the lower forms of life, which he studied for half a century, and in illustration of which his works contain more than four hundred plates, especially dealing with Radiolaria, Medusæ, Siphonophoræ, and Corals. To what an extent Haeckel "specialised" in the first of these groups alone may be seen in his *Challenger* monograph, in which he estimated the number of species at 4314, included in 739 genera. It may, however, be said at once that this number has been greatly reduced in recent years by the elimination of a mass of "species" which have been recognised as growth-stages and minor varieties of the same form. In conclusion, Haeckel tells us that his hundred plates constitute a popular biological atlas to his "Naturlichen Schopfungsgeschichte" (10th edition, Berlin, 1902).

It behoves us to consider to what extent these beautiful plates justify the author's contention that his figures are in no sense diagrammatic, are true to Nature, and not "touched up" (*stiliziert*). An inquirer can judge to some extent by examining the plates dealing with his own subject. The three plates of Foraminifera (2, 12, and 81)[1] in the original issue are not reproduced in this second edition, but it may be said at once that his figures are, so to speak, "counsels of perfection," and one would feel inclined to say that they are "too beautiful to be true" were it not for the fact that we do frequently have the good fortune to find specimens which are well up to the Haeckel standard of elaborate beauty. We noted such specimens in our *Terra Nova* Report[2] in the case of *Lagena plumigera*, Brady (Haeckel, Pl. (81), Fig. 10), and though we can readily recognise the sources from which Haeckel took his figures, and the fact that he has sometimes distorted them to suit the general arrangement of his plate, the characteristic features of the forms reproduced are shown with perfect accuracy. We can honestly say that we should merely be pleasurably excited—not surprised—at finding specimens so typically perfect as the figures given of them by Haeckel.

After this personal note we may pass to the work as a whole. The scientific interest of many of the plates of minute organisms is diminished by the absence of any magnifications, and in many cases no microscopist can hope to see what Haeckel shows him, for he shows the entire organism in perspective, whereas under the microscope one can only appreciate the marvellous structure—especially is this true of Radiolaria and the floricome spicules of certain sponges—by focussing down from one plane to another. As might be expected, the Radiolaria and Medusæ bulk largely in Haeckel's art-forms, the mathematically regular construction of the former peculiarly adapting them to his taste in art, and this is furthermore heightened by the skilful introduction of coloured protoplasm and symbiotic algæ. It is practically impossible to convey the delicate transparency of these siliceous skeletons, though this is well shown in Pl. 5 (31), especially in (31), where, however, the absence of magnifications gives a misleading impression. No doubt the state of the plates led to the exclusion—or non-selection—of Pls. (21) Acanthometra, (61) Phæodaria, and (91) Spumellaria, which are of striking beauty.

The Mycetozoa, Pl. 7 (93), will come rather as a shock to those familiar with the plates in Lister's monograph;[3] a comparison of the highly idealised fig. 2 of *Trichia varia* Pers. with Lister's figure 164 a.c. might evoke the quotation (which cannot fail to recur to one's mind throughout the work) "crimine ab uno disce omnes." But, exquisite as are Haeckel's figures, they may be said to fail in doing justice to the beauty of many of these organisms.

We have referred to the misleading effect of the perspective in the figures of hexactinellid sponge spicules in Pl. 8 (35), and those of Holtenia and Euplectella give an impression that these organisms are growing upon a rocky surface, the long anchoring spicules of the latter being artistically spread out in "curves of beauty." In Nature these sponges are ooze-dwellers, and the object of the long basal "wisps" of straight spicules is to keep them securely rooted in the ooze. Holtenia, as dredged, is anything but pretty, but if Figs. 3 and 5 are supposed to represent cleaned museum specimens, they have received but scant justice at the hands of the artist. It is a pity that Pl. (5) Calcispongia has not been included.

Pls. 9-14 (46, 26, 16, 17, 59, 88) are selected from a dozen or more fantastically beautiful plates of Medusæ in the original work. It is really impossible to reproduce the living loveliness of these creatures, but in these plates the brilliant colour schemes are highly exaggerated, especially in the Siphonophoræ, Pl. 12 (17). The selection here leaves much to be desired; Pls. (8) Desmonema, etc., and (98) Aurelia, etc., are remarkable colour-plates, and several of the monotone plates sc. (28, 48, 78) are more striking than those we find in the volume before us.

Pl. 15 (39) Gorgonidæ is poor, compared to its original reproduction, and in this plate the artist does lay himself open to an accusation of diagrammatisation, the spicules being too regular and ornate. Pl. 16 (49) Actinia is one of the most successful and compares favourably with Gosse's wonderful drawings in "Actinologia." We do not think that Sir Sidney Harmer would accept the figures of Polyzoa in Pl. 28 (23). The artist "lets himself go" in Pl. 19 (85), which represents "counsels of perfection" among the ascidians. The representations are possible, but certainly not probable, and we should like to have Prof. MacBride's views on the larval forms of echinoderms in Pl. 21 (40). "Haeckelism" reaches its height with the Ophiodea, Pl. 22 (70), which in this edition cannot compare with the original plate; we doubt whether any zoologist has ever seen *Astrophyton darwinii*, Haeckel, as here represented. It is a pity not to have reproduced Pls. (60) Cidaris and (90) Cystoidea.

[1] In this article numbers in brackets refer to the plates in the 1899–1904 edition. When the plate is in both editions, both numbers are given.

[2] E. Heron-Allen and A. Earland. British Antarctic Expedition, 1910. Zoology, vol. vi., No. 2, Foraminifera, p. 147. London (Brit. Mus.), 1922.

[3] A. and G. Lister. "A Monograph of the Mycetozoa." London (Brit. Mus.), 1911.

When we reach the Mollusca, Pls. 23-25 (55, 53, 44), the work reaches perhaps the high-water of perfection both as regards beauty and truth to Nature. In Pl. 27 (96) we find chætopods in all their most fantastic and almost impossible beauty of colour and form, and the marine zoologist must view the sea-mouse (Fig. 7) with helpless envy. The Copepoda, Pl. 28 (56), are, again, " counsels of perfection," and the Thoracostraca in Pl. 29 (76) might represent a nightmare of Dr. Calman.

The only land animals figured in this collection are the spiders in Pl. 30 (66), which might with advantage have been replaced by another of the marine-zoological plates—for example, the Hexacoralla of Pl. (69).

In the original work there are many plates of art-forms from higher realms of the animal and vegetable kingdoms, some of which are of striking excellence; one may instance the pitcher-plants (62) and orchids (74), frogs (68), fishes (42, 87), lizards (79), birds (99), butterflies (58), the mosses (72), lichens (83), and ferns (92)—and even antelopes (100)—and it may be hoped that the publishers will be encouraged to issue a further selection from the original " Atlas."

A critical zoologist has said of the work, " It is not 'art,' it is 'art-ificiality,' " but in our opinion such artificiality as appears serves at the same time a useful and an æsthetic purpose, and one can truly say of the author, " miscuit utile dulci."

This may not be the place to enter upon the biological significance of these " art-forms in Nature." The matter is one which has occupied the attention of biologists, and as Prof. Gamble has said, of the Radiolaria, " so complex and diverse a tracery seems utterly beyond the needs of simple Protozoa . . . its variety still evades a biological treatment. The results of recent investigations justify the hope that, as we come to regard the skeleton as a response to the varying media, stresses, and strains . . . its utilitarian character will be more completely recognised." [4]

It is a serious matter to attempt, within the limits of a review, to consider, however superficially, the significance of form in Nature. Darwin in putting forward his theory of natural selection remarked that " every variety of form and colour was urgently and absolutely called upon to produce its title to existence, either as an active useful agent, or as a survival of such active usefulness in the past"; and again, what can one say when confronted with the marvellous " selective" habits of many of the lowest forms of life? Long before I raised a storm (in 1915) in propounding the phenomena of purpose and intelligence exhibited by the Foraminifera,[5] Max Verworn had suggested an incipient psychology in dealing with the behaviour of Difflugia,[6] and Prof. J. Arthur Thomson, in a remarkable review of my work,[7] concluded his observations upon *Technitella legumen*, Norman, with the words, " It is a psycho-analytical individuality whose experiments in self-expression include a masterly treatment of sponge-spicules, and illustrate that organic skill which came before the dawn of art."

Three notable works have been devoted to the problems dealt with by Haeckel in the volume under review, by Theodore A. Cook,[8] S. Colman and C. A. Coan,[9] and D'Arcy W. Thompson.[10] The two latter especially deal with the matter from a purely mathematical point of view. The keynote of Prof. Thompson's work is struck when he says, " The harmony of the world is made manifest in Form and Numbers, and the heart and soul and all the poetry of Natural Philosophy are embodied in the concept of mathematical beauty"; and again, " The perfection of mathematical beauty is such that whatever is most beautiful and regular is also found to be most useful and excellent" (pp. 778-79). Messrs. Colman and Coan, in " Nature's Harmonic Unity," are at one with him, and have produced what, to a non-mathematical mind, is a bewildering book. Mr. Cook, on the other hand, contests this view *stricto sensu*, and justly observes that he might, in reply, have called his work " Nature's Geometric Diversity." He reiterates his *leitmotif*, which is " Nature abhors mathematics," and observes that nothing that is simply mathematically correct can ever exhibit either the characteristics of life or the attractiveness of beauty. For him, living beauty lies in variation from rule; he gives an illustration of an artist's model, " who exhibits a great number of variations because she is not only alive, but beautiful"; and he says:

> " What I want to see, after comparing a given nautilus with a given logarithmic spiral, is a statement of the difference between the two; for in that difference lies something which I cannot make, something which has never been defined—the mystery of life in the shell, the immortal spell of beauty, in the artist's rendering of his masterpiece" (p. 427).

It comes to this, that a law only approximates to the facts, and every time we use it we have to make appropriate additions and corrections; the real value of deviations is not that they make it necessary to

[4] F. W. Gamble. In Lankester's " Treatise on Zoology," vol. i. (fasc. 1), 1909, p. 130.

[5] (*a*) Beauty, Design, and Purpose in the Foraminifera. Roy. Inst. Gt. Britain. Friday, May 21, 1915. (*b*) Bionomics and Reproductive Processes. Phil. Trans. Roy. Soc. B, ccvi., 1915. (*c*) Purpose and Intelligence. J. R. Micr. Soc., 1915, pp. 547-57.

[6] M. Verworn. " Psychophysiologische Protisten-Studien." Jena, 1889.

[7] J. A. Thomson. " Before the Dawn of Art," *New Statesman*, Oct. 23, 1915; and " Secrets of Animal Life" (London, 1919), p. 278.

[8] T. A. Cook. " The Curves of Life." London, 1914.

[9] S. Colman and C. A. Coan. " Nature's Harmonic Unity." New York, 1912.

[10] D'Arcy W. Thompson. " On Growth and Form." Cambridge, 1917.

discard a theory, but that they enlarge our laws and thereby advance our knowledge.

This, it seems to me, must be kept clearly before us when we read Colman and Coan's study of geometrical constructions, based on the molluscan shell; the (to me at least) bewildering calculations of Mr. W. Schooling on the "ϕ progression," and Prof. D'Arcy Thompson's hundred pages upon the logarithmic spiral (ch. xi.), suggest the breaking of a butterfly upon the wheel, and we may pass this by without brushing aside Sir Thomas Browne's dictum in the "Garden of Cyrus," where, in dealing with hexagonal symmetry, he says, "it doth neatly declare how nature Geometrizeth and observeth order in all things."

Prof. Thompson's book is a very orgy and riot of spirals, and all one can say in reading it has thus been put by Cook: "There may be underlying all these cases, the working of some still more fundamental law, which finds expression in a similar mathematical form, in that same spiral which seems perpetually assumed both by growth in living organisms, and by energy in lifeless things, such as the nebulæ" (p. 409).

Both Thompson and Cook deal at length with the spiral features of such mollusca as Isocardia and Congeria (C. p. 455), Spirifer, and Atrypa (T. p. 569), which find a place in Haeckel's plate of Spirobranchia (97), whilst his plate (100) Antelopes might serve as an illustration to Thompson's ch. xiii. on the spiral formations of horns. Of course, the spiral formations of Foraminifera occupy a prominent place in all three works under discussion, and Cook makes use of Haeckel's Pl. No. (3) of Ciliata to illustrate the spiral stems of Carchesium, which, he observes, "looks like a cauliflower growing on a corkscrew."

After all, as Cook has said:

"It is the unspent beauty of surprise which Nature can always offer her best lovers, though she works at the bidding of the majestic harmonies of some universal law we are unable yet to recognise (p. 413). . . . The emotion roused in us by the beauty of a shell or flower is due, both to the unconscious but continuously instinctive efforts made by the growing organism to adapt itself to its environment, and to the fact that those efforts have been sufficiently successful to express that organism's fitness to live" (p. 425).

Though, as Janet has said, "chaque chose finit toujours par s'accommoder à son milieu,"[11] we must recognise that mechanism and teleology are inextricably interwoven, and we must not cleave to one and despise the other. Structure—I quote from memory from David Sharpe—will ultimately be found to be due to the reactions between simple physical causes and the physiological processes of the creature, whilst, as Herbert Spencer has said, function is, from beginning to end, the determining cause of structure.

The problems of form and structure bequeathed to us by our forbears are in the nature of a *damnosa haereditas*, and the speculations of æsthetic philosophers are apt to cause the brains of specialists to reel. For example, the suggestions of Prof. D'Arcy Thompson that Lagena derives its shape from being, at some part of its existence, a surface organism hanging to a surface-pellicle by surface-tension, is a fully matured instance of the *tegula cadens*, and its surface ornamentation is *not* uniformly vertical; *conf. Lagena sulcata* (W. and J.), the bulk of which is ridged vertically and the neck horizontally. The influence of surface tension has been beautifully demonstrated by Rhumbler,[12] who produced artefact arenaceous Foraminifera with a paste of powdered glass and chloroform dropped into water, which can be improved upon by dropping a paste of oil and fine sand into 70 per cent. alcohol. Prof. Thompson devotes 130 pages to "explaining" the amazing skeletons of Radiolaria, and 60 to the mathematics and causes of hexagonal symmetry, as illustrated by corals, honeycombs, and the microscopic structure of molluscan shells.

Again, it is obvious that many spicular structures depend for their forms upon the characteristic crystallisation of their chemical constituents, and wheel-like forms are produced in colloids where the action is sluggish or delayed. The form of a spicule may begin under control of the organism, but outside the organism it must progress by further chemical deposition beyond it, as Prof. Thompson says: "continuing in any direction or orientation which has been imposed upon it" (p. 590); and he pregnantly observes with regard to sponge-spicules:

"It is, in fact, a crystal under restraint, a crystal growing, as it were, in an artificial mould; and this mould is constituted by the surrounding cells, or structural vesicles of the sponge" (p. 444).

It is to be hoped that Haeckel saw Cook's work before he died—it forms a corollary to, and seems to be the outcome of, his "Kunstformen der Natur," with its voluminous and extremely interesting study of Nature-forms in Art, which occupies the major portion of the book. Leonardo da Vinci is the Thaumaturgus and Cook is his Prophet. By a series of deductions worthy of Mr. Sherlock Holmes he shows that Leonardo built the open staircase in the Château de Blois (Loire, 1517–19), the design being suggested by the shell of *Voluta vespertilio* (he points to the internal spiral enshrined in an exterior which suggested sloping balconies held up by columns), which leads to the deductions that the architect was an Italian; that

[11] J. Janet. "Les Causes finales." Paris, 1876, p. 350.

[12] R. H. Rhumbler, *Arch. für Entwickelungsmechanik*, vii. pp. 279-335. 1898.

he must have closely studied shells and leaves; that he was left-handed; that he must have been appointed architect to the King of France; and that he must have lived at Blois between 1517 and 1519. Haeckel would have loved this! Among innumerable other instances, Cook directs attention to the Ammonites in the hair of Leonardo's Leda, and in the helmet of his Scipio Africanus, and he concludes:

"Many have studied those principles of growth and beauty which inspired so much of the great Italian's deepest researches. But of all his modern successors not one has left such visible monuments of insight and creative power as the Leonardo who saw the same problems both in Nature and in Art so long before them" (p. 432).

In conclusion, we come back to the inseparable forces of mechanism and teleology, after reading these painstaking and voluminous researches. Beauty can serve no useful purpose in Nature where the beauty lies in ornament beyond the limit of ordinary vision, or is invisible owing to absence of light, and its presence, as in the Radiolaria, the Foraminifera, and the sponges, can only be due to the mechanical requirements of the organism, and the practical purposes to which it is subservient. EDWARD HERON-ALLEN.

The Electro-deposition of Metals.

(1) *A Treatise on Electro-Metallurgy.* By Walter G. McMillan; revised by W. R. Cooper. (Griffin's Scientific Text-books.) Fourth edition, revised and enlarged. Pp. xv+449. (London: C. Griffin and Co., Ltd., 1923.) 21*s*. net.

(2) *Modern Electro-plating.* By W. E. Hughes. (Oxford Technical Publications.) Pp. vii + 160 + 18 plates. (London: Henry Frowde and Hodder and Stoughton, 1923.) 16*s*. net.

(1) THE late W. G. McMillan's "Treatise on Electro-Metallurgy" was first published in 1890. The second and third editions appeared before the War. Since 1919 it has been out of print. The fourth edition has now been published with the revision of Mr. W. R. Cooper. Since the publication of the last edition, many advances have been made in the subject. The reviser points out that most of these have been of a minor character, but that in the aggregate they are important, and their inclusion in the new edition has necessitated a good deal of alteration of the text. There has, however, been remarkable progress in certain directions, particularly as regards the electro-deposition of cobalt and the electrolytic extraction of zinc. These advances have been duly chronicled in the present edition. Considerable additions have been made to the section on the refining of copper. In spite of revision in these directions, and the omission of the section on electric welding, the book preserves in the main the characteristics of the first edition.

We doubt whether it is worth retaining Chapter ii., which deals with very elementary physics and chemistry. The introduction to these subjects would be much better studied in any suitable text-book. The same remark applies to Chapter xvii., which is concerned with analysis. Chapter xix., which is placed towards the end, would be more appropriately placed in the earlier section of the book dealing with the theory of electro-deposition. We do not think that Chapter xx., which consists of a glossary of substances commonly employed in electro-metallurgy, adds to the value of the book; at any rate, if it is retained, it should be brought up-to-date. Temperatures are given only in degrees Fahrenheit, which is surely an anachronism. There is no mention of the melting-points of iron, nickel, or cobalt. These had not been determined at the time of the publication of the first edition, but they are now well established, and should be included. On the whole, we doubt the wisdom of trying to maintain the same general treatment of a subject such as electro-metallurgy in a book the first edition of which was published thirty-three years ago, and we think the reviser would have been wiser to have recast the material at his disposal and written a new book.

(2) Mr. Hughes has written a book on electro-plating which, he is careful to say in his preface, is not a text-book. It is described as a guide-book for platers, works' chemists, and engineers. In reality, it consists of an edition in book form of a number of articles on the electro-deposition of metals which have been published from time to time in the journal *Beama*. The first two chapters contain a general review of the subject and the theory of electro-deposition. Chapters iii. and iv. deal with practice, and relate to the preparation of the work, the deposition process, and the finishing process. Then follow six chapters dealing severally with the characteristics of iron, nickel, zinc, lead, tin, chromium, and copper. We think that cobalt might have been considered more fully than in the brief reference on pages 4 and 5. Chapter xi. contains an interesting review and discussion on the structure of electro-deposited metal, while Chapter xii. deals briefly with the literature of the subject.

In turning over the pages of Mr. Hughes's book, we were interested to find a footnote on p. 126 relating to Prof. Whitehead's "Introduction to Mathematics." The quotation from it is as follows: "When an author writes with a misty profundity it is a safe rule to assume that he is talking nonsense." Whatever criticisms may be made of Mr. Hughes's book, no one will be able to say that he has written with a "misty profundity." He has a clear mind, he thinks honestly, and he expresses himself, from one end of the book to the other, with remarkable lucidity.

His point of view in considering the structure of electro-deposited metal is that it is, with few, if any, exceptions, crystalline. This being so, the same general laws governing the formation of crystals of other substances such as salts, igneous rocks, and metals, as formed in ordinary metallurgical processes, may be expected to hold in the case of metal formed during electrolysis. In another publication, "The Electro-deposition of Iron," he has examined this idea in considerable detail. We recommend this chapter, which gives a summary, as one of the best in the book. The author's photographs of the structure of electro-deposited metals are among the best that we have ever seen, and they constitute a valuable feature of his publication. The book is written in an easy and conversational style, and we commend heartily the last sentence of the foreword, which runs as follows: "It is an author's duty to make clear his meaning, not to puzzle his reader with linguistic conundrums." We think that the author has succeeded in the task he set before himself, and we recommend the book to those for whom it is intended.

The Violin scientifically analysed.

Bow Instruments, their Form and Construction. By J. W. Giltay. Issued into English by the author in co-operation with E. van der Straeton. Pp. x + 129. (London: William Reeves, 83 Charing Cross Road, n.d.) Paper, 6*s.* 6*d.*; cloth, 8*s.* 6*d.*

THOUGH the violin has been in use for more than three centuries, its position is still unassailed and many of its secrets still remain unfathomed. Though outstripped in fullness of tone by the trumpet, the human voice, and even the clarinet, the violin by virtue of other qualities retains its leading position in the orchestra. Thus, whereas the organ excels in sustaining musical sounds and the piano offers perfect freedom for instant emphasis, the violin is equally at ease in sustaining sounds and accenting any desired rhythm. Again, the violin is capable of those graces or embellishments, the *portamento* and the *tremolo.* It is also susceptible of a special refinement of expression and individuality of tone.

These qualities bring the violin perhaps nearer to the human voice than any other man-made instrument can claim to approach. Yet how simple the violin is! Indeed, in the ordinary acceptance of the phrase, it has no *working parts* beyond the bow used to play it. Thus, from the professional player, the enthusiastic amateur, and those scientifically inclined, the violin has elicited unique admiration and it challenges the fullest inquiry. The history of its development is at first obscure and the progress made seems to have been largely empirical. The reasons for certain innovations have not always been disclosed, if indeed understood. In reviewing this development, attention has often been given to the model, the wood, and the varnish; but much remains to be done before we can explain precisely why certain instruments are so excellent in tone throughout the compass and others so poor although almost identical in outward appearance.

Helmholtz has shown how a well-bowed string vibrates, but the sounds heard are not received immediately from the strings. Further, they are not necessarily an exact copy of those which the strings originate. In taking up and amplifying those original vibrations, either (1) a bad instrument spoils them by distortion, or (2) a good instrument improves them, or (3) both processes occur in the two opposite types of instrument. It is evident that the vibrations pass from the strings to the bridge, and so to the belly and the enclosed air. The vibrations may also pass by the sound-post from the belly to the back. But with what distortion, fidelity, or amelioration do these various processes occur? What points in the model, the wood, or the varnish, ensure the desired and justly prized results?

In the work under notice, the violin is subjected to a systematic analysis with the view of answering questions of the above character. The authorities for the various views which have been held are quoted with references to their works, and their statements are given with translations where necessary. These authorities range over several centuries coming down to the present time. The work is divided into ten chapters dealing respectively with the strings, the bridge, the belly, the sound-post, the back, the enclosed air, the F-holes, the bass-bar, the influences of age, and the mute. Thus the various factors of the problem are taken into consideration in logical order and are very carefully and lucidly treated. The author sometimes differs from previous writers, but then always shows clearly that he has good cause to do so. In some cases it is experimental work by the author himself that has materially assisted in clearing up a knotty point, *e.g.* as to the motion of the bridge. Savart's flat violin of trapezoidal shape is treated at some length with a number of explanatory diagrams. Considerable space is also devoted to the resonance pitches of the belly, the back, and the enclosed air, and their effects on the tone quality of the instrument. The back of a violin is often much prized for its beauty of grain and supposed importance in contributing to the tone quality, but this is somewhat discounted by the author's experiment of making five large holes in the back of a violin. Three of these holes were of 75 mm. diameter each and the other two of 48 mm. diameter each! After cutting these holes, the two lower strings were of poor quality, but the two upper strings were not noticeably changed in tone or power.

The book is illustrated throughout and makes a notable contribution to the treatment of the violin on somewhat novel lines. It will well repay careful study by all interested in the violin or the other bowed instruments. E. H. B.

Our Bookshelf.

Elements of Storage Batteries. By Prof. Cyril M. Jansky and Prof. Harry P. Wood. (Industrial Education Series.) Pp. x+241. (London: McGraw-Hill Publishing Co., Ltd., 1923.) 12*s.* 6*d.*

STORAGE batteries are now used for many and varied purposes, and the methods employed for their maintenance have altered appreciably of recent years. There is therefore a demand for a simple account of these methods and for descriptions of the best types of batteries. So far as the non-technical reader is concerned we can recommend this book. The descriptions are clear and the recapitulations given at the end of each chapter are very useful, as they help the reader to remember the facts. The examination questions are simple and instructive, and will assist the student to test his knowledge. The authors lay stress on the fact that the cause of the bad working of a storage cell cannot in general be determined by making a few simple tests. It is necessary to know the conditions of service and the rates of charge and discharge at which the battery has been working before a correct diagnosis can be made. As a rule most battery troubles can be avoided if the cells are kept fully charged and if an overcharge is occasionally given to them. Full descriptions and working rules are given for the nickel-iron-alkaline cell, and the data and tray dimensions of the various types of Edison storage batteries are shown in tabular form.

Bacteriology: a Study of Micro-organisms and their Relation to Human Welfare. By Dr. H. W. Conn and Dr. Harold J. Conn. Pp. 441. (Baltimore, Md.: Williams and Wilkins Co., 1923.) 4 dollars.

THIS work has been designed to give an account of bacteriology and its applications to industry and medicine. Intended primarily "for college classes composed of students, some of whom intend to specialise later, and others who desire a general knowledge of the subject," the book can be strongly recommended as one suited to the needs of the educated public, giving as it does a survey of the subject without technicalities. Divided into four parts, Part I. deals with the history of bacteriology and with the activities of micro-organisms in general. In Part II. an excellent account is given of dairy, soil, and industrial bacteriology; and in Part III. the disease-producing organisms are described—human, animal, and plant—with brief descriptions of vaccines, antitoxins, and immunity, together with the bacteriology of water and sewage. An appendix (Part IV.) contains a short account of culture, staining, and other methods employed in the study of micro-organisms. Save for an occasional slip, the information is accurate and the book most readable. It is illustrated with 48 figures, which are adequate, though several of them are rather crude in execution.

Biologie der Tiere Deutschlands. Herausgegeben von Prof. Dr. Paul Schulze. Lieferung 2. Pp. 28+10+17. 8*d.* Lieferung 3. Pp. 29-97. 1*s.* 4*d.* Lieferung 4. Pp. 37+39. 1*s.* 8*d.* Lieferung 5. Pp. 12+40. 9*d.* Lieferung 6. Pp. 64. 1*s.* 2*d.* (Berlin: Gebrüder Borntraeger, 1923.)

THE first part of this useful and well-written elementary account of animal biology, based on the German fauna, dealt with the sponges and cœlenterates. Those now noticed include the Turbellaria, Gastrotricha, leaf-mining insect larvæ, thrips, flies, mites, spiders, and fishes. The treatment follows closely that of the first part. The central idea underlying the work is to give a simple account of the relations between the animals and their environment, their rôle in the economy of Nature, and only so much of their internal structure as will help to elucidate their ecology. Each section is paged separately, so that, while the parts are appearing when ready, it will be possible to bind the whole work in zoological sequence later. The book is well illustrated by clearly reproduced diagrams and half-tones, not stinted as to number. The work is admirably suited for use by school teachers in Great Britain, for the German fauna is largely represented in the British fauna, often by identical species, at any rate by all the groups covered by this book.

Revision Arithmetic and Mensuration. By Dr. Terry Thomas and J. J. P. Kent. Third edition, revised. Pp. vii+128. (London: Mills and Boon, Ltd., 1924.) 3*s.* 6*d.* net.

IT is refreshing to find a book, frankly produced for examination work, with some educational merits. The object of this little revision arithmetic is to prepare candidates for the Army and Navy entrance examinations, but the authors have succeeded in avoiding the artificial atmosphere usually associated with such tests, by a selection of examples never far removed from the practical problems of life. The conditions of income tax relief, for example, are explained in detail, and any student who works out completely the set of examples provided, should be a match for any income tax assessor.

Mathematical Principles of Finance. By Prof. Frederick Charles Kent. Pp. xi+253. (London: McGraw-Hill Publishing Co., Ltd., 1924.) 15*s.*

THIS book is not a mathematical analysis of the monetary and banking systems, but merely a very comprehensive treatment of the algebra and arithmetic of interest and insurance calculations, with copious examples suitable for students of commerce and business administration.

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.*]

Starvation Life Curves.

FOR some years past I have been occupied with the experimental study of duration of life. Nine papers dealing with the subject have appeared in the *American Naturalist* (vols. 55-58). The particular suitability of *Drosophila melanogaster* for the experimental study of this problem arises chiefly from three considerations: (1) The duration of life of this fly in *days* is very nearly the same as that of man in *years*, and the form of the life curve over the biologically equivalent life span is almost precisely identical in the two forms; (2) Drosophila can be easily and successfully grown under controlled laboratory conditions, by means of a technique in many respects the same as that used in the cultivation of bacteria; (3) the genetics of Drosophila have been more completely worked out, thanks to Morgan and his collaborators, than in the case for any other organism whatever.

Normally the living organism gains its energy for the conduct of life, and material for the repair, within limits, of the wastage of its tissues in the business of living, by the process of taking food. In other words, the regular re-winding of the vital clock is accomplished by feeding. If this renewal of the re-winding process is defective in any particular, the result will be to shorten life below what would have been attained under more perfect metabolic functioning. But always when we study duration of life under normal conditions, we are dealing with the combined effects of two variable complexes—inborn organisation, on one hand, and environment, including renewal of available energy and substance by food, on the other. Suppose, now, we eliminate the effect of as much as possible of the second complex experimentally. We shall then be in a better position to estimate how much of the normal variation in duration of life observed among different individuals is due to differences in their inborn make-up, their physico-chemical organisation.

How can this be done experimentally? Clearly by doing two things: (*a*) preventing completely access to food of any sort; (*b*) keeping temperature, moisture, and as many other variables of the physical environment as possible, constant throughout life. Such differences amongst individuals in respect of duration of life as then appear will be almost wholly due to innate protoplasmic, structural, constitutional differences, since the small residue of uncontrolled environmental variables will be unimportant ones, trivial in their effect upon the organism. The form of the life curve so obtained will be in a sense that which is basic to the species or variety. The idea of controlling the food factor of the environmental complex by starvation is methodologically of importance. It is extremely difficult to ensure experimentally that two different animals get identical food, quantitatively and qualitatively. But, with some care, it is easy to see that neither gets any food at all. In short, by complete starvation, we can make constant the most difficult of all environmental variables to control accurately in an experiment.

These considerations suggest that such starvation life curves may furnish a powerful analytical tool for the more penetrating study of the biology of life duration. Consider specifically the case of Drosophila. We have shown in this laboratory (*American Naturalist*, vol. 56, p. 174; vol. 57, p. 153; vol. 57, p. 289) that certain genetic constitutions are invariably associated with certain definite forms of life curves. Wild type Drosophila has a characteristic life curve with a definite absolute mean duration of life and with a characteristic shape. These attributes of the life curve are constant under constant environmental conditions. Under the same environmental conditions, flies which carry the gene for the recessive wing character *vestigial*, whether alone or pure, or in combination with other mutant genes, exhibit life curves which differ widely in every important respect from the curves which describe the duration of life of wild type flies. They have a much shorter absolute duration of life than the wild type, and the shape of the life curve when put upon a comparable basis by measuring age in centiles of the equivalent life span (*cf.* Pearl, *American Naturalist*, vol. 56, p. 398) is widely different from that for wild type flies. All this is clear. But do these differences depend upon (*a*) differences in the inborn physico-chemical organisation, solely and *per se*, of the two sorts of flies, or upon (*b*) differences in the effective reactions of these two kinds of flies to the *same* environment, including most particularly food? Or to put the experimental question, will wild type and vestigial strains of Drosophila show the same kind of differences in their life curves when these curves are determined under conditions of complete starvation, that they do when both sorts of flies are fed the same kind of food?

A rather elaborate and precise technique was worked out to ensure complete absence of food from the moment of emergence as imagos. Observations were taken every six hours until the last fly had died. The duration of life of 3632 individual flies under complete starvation was recorded.

The net result was that under complete starvation the mean duration of life and the form of the life curve *are almost identically the same* in vestigial as in normal wild type flies, though under conditions of full feeding the wild type flies live roughly three times as long as the vestigials. Actually the vestigials have a slightly *longer* mean duration of life under starvation than the wild type flies. This fact would seem to be of considerable importance from the point of view of genetics. It is a specific example of the general principle that the somatic expression of any genetic factor in any particular case is in part a function of the general environmental level which prevails in that case. It has been demonstrated, as already stated, that *under the standard feeding conditions for laboratory bred Drosophila* the gene for vestigial has as a part of its somatic expression a very considerably reduced duration of life as compared with the wild type. There are few cleaner-cut cases of Mendelian segregation to be found in the whole literature of genetics than that upon which the above statement is made. Yet the present study shows that the whole of that part of the somatic expression of the vestigial gene which is differential in respect of duration of life disappears under another system of "feeding" wild type and vestigial flies (namely, complete starvation). This fact does not in the least invalidate the earlier results cited on the inheritance of duration of life. Those results are *facts* just as much as the present observations. It merely emphasises once more, in a rather striking way, the extraordinary caution which is always necessary in interpreting the results of genetic experiments. It also, of course, points the way to new and very promising lines of further experimental attack upon the problem of duration of life.

The complete account of these experiments is in press, to appear shortly in the *American Naturalist*.

RAYMOND PEARL.
Department of Biometry and Vital Statistics,
School of Hygiene, Johns Hopkins University,
Baltimore, Maryland, U.S.A.

The Complexity of the Solid State.

IT is a well-known fact that if we distil off a part of a quantity of pure water, no physical or chemical property is changed by the process; for example, the vapour pressure of the remaining liquid, the vapour tension of the distillate, and the vapour tension of the original quantity of liquid are identical. Precisely the same result is obtained if we distil a quantity of the crystalline aggregation of water, namely, ice. But if we take a mixture of water and alcohol, the result of a partial distillation is quite different; for now the vapour tension of the remaining portion is lower and that of the distillate higher than the vapour tension of the original mixture. This phenomenon is caused by the fact that alcohol is more volatile than water, so that the vapour which is being condensed is richer in alcohol than the evaporating liquid. Consequently the evaporating liquid becomes poorer and the distillate richer in alcohol than the original liquid. Distillation effects, as we see here, a partial separation, and that explains the observed changes in vapour tension. Now there are also crystalline mixtures, which differ from the liquid mixture of the same substances therein only in that the state of aggregation is a crystalline one. Every crystal in this case contains the substances, being mixed, and is named a mixed crystal. If we submit now such a mixed crystal to distillation, the effect is exactly the same as in the case of the mixture of alcohol and water.

On the basis of the above facts, it was of course thought that, taking not a mixture but a pure simple substance, distillation would never effect any changes in vapour tension. Our experiments, however, have shown otherwise. By partial distillation of most carefully purified crystalline violet phosphorus at 360° we got a residue showing a much lower vapour tension than the original quantity, while the distillate had a much higher vapour pressure. While the vapour tension of the original violet phosphorus at 460° was 3 atmospheres, the vapour tension of the residue at the same temperature was only 1 atmosphere, that is, 1/3 of the original value.

How is this result to be explained? The old considerations of the different states of aggregation are completely powerless to give an explanation. The theory of allotropy, however, offers no difficulty. On the contrary, this result is a valuable confirmation of this theory, because it assumes that every state of aggregation is complex, so that every crystalline state consists of mixed crystals, built up from molecules of different kinds. These different kinds of molecules can change one into the other; the transformation can lead to a chemical equilibrium, and only when this equilibrium (inner equilibrium) is always established, does such a pure substance behave as a real single one. If this equilibrium is established slowly, or if the transformations are stopped, then a pure substance will behave as a mixture.

The velocity with which this inner equilibrium between the different kinds of molecules is established seems to be a very characteristic property of substances, so that there are "rapid" and "slow" substances. Rapid substances can undergo rapid changes without coming out of inner equilibrium, but slow ones can be disturbed. It is clear that in the light of these considerations the results obtained with violet phosphorus can be explained easily. Violet phosphorus is a "slow" substance and therefore evaporation at relatively low temperature will cause the residue to become poorer in the most volatile molecular species, thereby decreasing its vapour tension.

This explanation is borne out by the following fact. It is to be expected that a substance will become "less slow" or "more rapid" at higher temperatures. In agreement with this it was found that the vapour tension of the distillation residue of violet phosphorus above 470° was no longer constant but slowly rising. Further, it is clear that if the theory is true, a catalyst will bring the violet phosphorus into inner equlibrium and give it the normal vapour pressure. This also was found, for after heating the distillation residue with 0·1 per cent. iodine for five hours at 410°, the vapour tension had become completely normal again.

As is mentioned above, behaviour as a mixture will be complete if all transformations between the different molecular species are stopped, and Baker has showed us how to reach that. The intensive drying seems to be the right method, and that is why, in continuing our experiments, we have applied the drying method of Baker.

The behaviour of sulphur trioxide was studied after drying with freshly distilled fine phosphorus pentoxide. Since sulphur trioxide itself possesses a strong self-drying power, it seemed probable that after a short drying, and perhaps even before that, sulphur trioxide would show distinctly its complexity. During our investigations, there appeared a publication by Leblanc and Rühle entitled "Sulphur Trioxide, a Chemical Chameleon," the title of which shows already the difficulties offered by the behaviour of this substance. Now we found that sulphur trioxide, dried for one month or longer, with the purest very fine phosphorus pentoxide, is so "slow," that it behaves distinctly as a mixture. Since the range of temperature and pressure within which that behaviour reveals itself is much more easily approached than in the case of phosphorus, it could be studied more closely. Thus we could change the vapour pressure of a crystalline state of aggregation continuously by evaporation, so that, for example at 0°, the vapour pressure changed from 208 mm. of mercury to 22 mm. of mercury. Further, it was also possible to get liquids of different vapour pressures, for example at 20°, between 200 and 172 mm. of mercury. Finally we were able to show that the behaviour of sulphur trioxide is that of a mixture, in which one or more compounds are formed.

In connexion with these phenomena, it is interesting to recall that for several years methods have been used which enable us to determine the atomic centres in the space lattice of a crystal, but nothing about an inner equilibrium has been discovered. This would astonish us if it had not turned out that the X-ray analysis of a mixed crystal of different substances gives a diffraction image which does not differ essentially from that of the components. Thus it is not yet possible to conclude from the X-ray diagram, whether or not we have a mixed crystal. It is just because, in the case of a simple substance, the identity of all crystal cells was postulated, that the character of mixed crystals of these substances was never found. Indeed, the identity of the crystal cells excludes a crystal of continuously changeable composition. At present, however, the picture of the complex inner state, supposed by us, is not exact enough to be tested and elaborated by X-ray analysis.

A. SMITS.
Laboratory of General and Inorganic Chemistry,
University of Amsterdam, May 17.

Atmospheric Electricity and Atmospheric Pollution.

I HAVE read with especial interest the summary, in NATURE of April 5, p. 493, of Prof. Nolan's recent work on the relation between the potential gradient and the number of large ions in the atmosphere, because the problem he refers to is at least closely related to one that has been under investigation at Kew Observatory: namely, the relation between the potential gradient and the impurity in the atmosphere. In a recent paper (Roy. Soc. Proc. A, vol. 105, p. 311), discussing the observational results of 1921 and 1922, Mr. R. E. Watson and I found that the potential gradient at Kew is much enhanced by the impurity present in the air, being apparently on the average about double what it would be if the atmosphere were pure.

A closely allied and perhaps even more important question is the influence of atmospheric impurity on the air-earth electrical current. It has been suggested that this current is the really fundamental thing, and that variations in the potential gradient normally arise from the variations in the electrical resistance of the atmosphere. It is clear that if a uniform electrical current had to pass between the upper atmosphere and the earth, and if the atmosphere at one level were everywhere of the same conductivity, then a fall in that conductivity near the earth's surface would imply a corresponding rise in the potential gradient. If, however, the fall in conductivity is confined to the air over limited areas, while a rise in potential gradient is to be expected at these areas, it is unlikely to compensate fully the fall in conductivity. Thus *a priori* we should, I think, anticipate a decline in the local air-earth current as pollution increased.

This point was not considered in the recent paper by Mr. Watson and myself, but it received some attention in an earlier paper (Roy. Soc. Proc. A, vol. 95, p. 210) devoted to the relation between the increased opacity (diminished visibility) of the atmosphere and the electrical phenomena at Kew Observatory. The conclusion then reached from 3½ years' observations was that a small increase in opacity had little if any effect on the current, but that a substantial increase in opacity reduced the current decidedly.

With the introduction in 1921 of Dr. Owens' atmospheric pollution recorder the problem admits of more precise treatment, and I have recently reconsidered it, making use of the measurements of the air-earth current and the corresponding pollution data accumulated from January 1921 to March 1924. The measurements of the current are unfortunately confined to one hour, 15h. G.M.T., and it happens to be one of the cleanest in the day at Kew Observatory. The consequence is that heavy pollution is very insufficiently represented, especially in summer.

The pollution scale 0, 1, 2 is a linear one. With the usual arrangement "1" represents 0·5 lb. of dirt per million cubic yards. But from May to October 1921, which included a time of quite abnormal purity of the atmosphere resulting from the coal strike, the apparatus was altered so that scale "1" answered to only 0·2 lb. per million cubic yards. The results from these six months, not being comparable with the others, had to be omitted from the general comparison. The current is really measured in the unit 1×10^{-16} ampere per cm.^{2}, but it requires the application of a (constant) factor to allow for the disturbing influence of apparatus and observer, and so had better be regarded as expressed in an arbitrary unit. The number of observations on which each result is based is given in brackets. Winter includes November to February; Summer, May to August, and Equinox the four remaining months.

Each of the complete years 1922 and 1923 agreed in making the current increase in each season as the pollution declined, but in 1923 pollution "0" was unrepresented in winter and pollution "2" in summer.

MEAN VALUES OF AIR-EARTH CURRENT.

Pollution Figure	≮ 2.	1.	0.
Winter	0·50 (64)	0·62 (136)	0·62 (17)
Equinox	0·58 (18)	0·84 (118)	1·01 (27)
Summer	0·66 (6)	0·83 (95)	0·87 (36)
All months	0·53 (88)	0·75 (349)	0·87 (80)

The results derived from all months combined probably exaggerate the influence of pollution. The current is larger in summer than in winter, and this seems partly due to some cause other than diminished impurity. As pollution "2" is mainly confined to winter, and pollution "0" is then rare, the seasonal influence tends to enhance the difference between the mean currents under these two pollution figures.

When the seasonal results are considered separately, it will be seen that the difference between the mean currents answering to pollutions "0" and "1" is trifling, except in the equinoctial months. The natural inference that a small amount of pollution has no great influence on the current is in harmony with the results of my previous paper. It is also supported by the results obtained from May to October 1921 with Dr. Owens' apparatus in a more sensitive state, and with the atmosphere abnormally clean. No certain difference was then found between currents answering to the pollution figures "0," "1," and "2." At that time "2" represented only ⅘ of what "1" represented at other times, and the number of days which attained to even that pollution was too small for a satisfactory mean.

For a full investigation of the subject it would be necessary to have air-earth current results from several hours of the day, including at least one hour (*e.g.* 9h. or 18h.) when pollution is high; but there seems little room for doubt that atmospheric pollution does reduce the air-earth current. If, as some people think, that current serves a useful purpose in agriculture or horticulture, the phenomenon may possess some economic importance.

CHARLES CHREE.

Kew Observatory, May 2.

Recent Results obtained with the Mass-Spectrograph.

OWING to an exceptionally favourable setting of the apparatus for generating accelerated anode rays, I have now been able to settle some doubtful points and obtain results with several more elements. Anode rays of iron have been obtained strong enough to demonstrate beyond doubt the occurrence of its light isotope 54 previously suspected. The intensity of this line relative to the predominant 56 is estimated roughly as 1 to 20. The most probable value of mass for the latter has already been given as 55·94, so that the results of the mass-spectrograph are now in excellent agreement with the figure 55·84 obtained by the most trustworthy chemical methods.

Experiments with strontium have been repeated under better conditions. The conclusion that it consists almost entirely of atoms of mass number 88 has been confirmed, but the greater sharpness of the mass spectra has now revealed two points which explain to some extent the low value 87·62 assigned to its chemical atomic weight. In the first place, a very faint constituent at 86 has been discovered which appears to be present to the extent of about 3 or 4 per cent. In the second place, accurate comparison between Sr^{88} and Br^{81} indicates that the former is definitely less than a whole number. The very exact equality of intensity of the two bromine lines on all occasions combined with the certainty of the chemical value of its mean weight (79·916) justify the use of its heavier line in this connexion as a reference line of mass 81·9. Taking this value, the strontium line comes out 87·8 and hence its most probable mean atomic weight rather more than 87·7, a value higher than the chemical one but not seriously discordant.

Experiments with barium, employing long exposures, have resulted in the identification of its strongest line as 138 with a most probable mass of 137·8. There is certainly no other line comparable with this in intensity. Search for lighter isotopes suggested by the chemical atomic weight 137·37 is prevented for the time being by the penumbra of the enormously strong line of iodine, with which element parts of the present apparatus are saturated.

Although mass rays of the heavier rare earth elements are exceedingly difficult to produce, and the resolving power of the present instrument also limits the possibility of work in this field, some progress has been made. Lanthanum (138·91) gives a single line of satisfactory strength at 139 and may therefore be taken as a simple element. A commercial sample of praseodymium (140·92) showed the same line strongly but with indication of one at 141, so the experiment was repeated with a highly purified sample prepared by Auer von Welsbach. This gave only one line at 141, indicating that praseodymium is most probably simple. The results with rare earth elements of even atomic number are much less definite. Neodymium (144·27) gives an indistinct band 142 to 150, suggesting several isotopes not differing greatly in relative proportion. Erbium (167·7) shows a similar faint effect from 164 to 176, doubtless due to its isotopes and those of other rare earth elements present as impurities.

Further attempts to obtain results with zirconium, niobium, and molybdenum have again been completely unsuccessful. F. W. ASTON.

Cavendish Laboratory,
Cambridge, June 2.

John Harrison.

I REGRET that I have been prevented by illness from expressing an opinion previously as to the nature and value of John Harrison's horological inventions, which have been recently discussed in the columns of NATURE by "R. A. S." and Mr. A. R. Hinks (April 19, p. 570). Having had more opportunities than most people of examining and analysing Harrison's work and writings, I should like, if it is not too late, to have an opportunity of placing on record a considered opinion.

Harrison's five marine timekeepers, the construction of which occupied a period of forty-two years (1728–1770), afford ample evidence of a steady progress towards mechanical efficiency and improved timekeeping. Wooden wheels appear in No. 1 only, and while certain features, such as the train, become complicated by the addition of a remontoir, others, such as the pivoting and control of the balances, etc., are notably simplified. The finished product, No. 5 (and its predecessor, No. 4) is certainly not "clumsy," although too complicated and delicate to allow of being reproduced in quantity at a paying price.

The passage which "R. A. S." quotes from my book as to the comparative merits of Harrison and Le Roy fully expresses my opinion of their *relative* merits; but surely it would be no valid detraction of, say, Barrow's work on the theory of limits to say that Newton's was based on broader principles. Barrow paved the way for Newton; and, similarly, Harrison paved the way for Berthoud, Arnold, Earnshaw, and even for Le Roy himself—in that he showed that a marine timekeeper was not, as hitherto thought, a mechanical impossibility.

It is not quite fair to Harrison to suggest that he loved complication for its own sake (although it is a valid objection against some of his successors, such as J. G. Ulrich); and it is necessary, before passing a final judgment upon his work, to remember that all his devices, gridiron pendulum, grasshopper escapement, large pendulum arcs, cycloidal cheeks, remontoirs, etc. form part of a harmonious system, which should be judged as a *whole*. Any one who has the patience to read through his last pamphlet, "A Description of such mechanism . . ." (1775), will be convinced of this fact. That this system is no longer used is proof that it was too complicated and delicate to be commercially practicable; but it does not prove that it was not efficient. Harrison was, like many pioneers, a man who combined genius with imperfect education. That professional watchmakers should have scented a chance of profit in marine time-keepers and superseded his work (except in the maintaining power, still used in all chronometers) is not surprising; but they would never have moved in the matter had it not been for Harrison's example.

I entirely concur with Mr. Hinks's view—that since Harrison accomplished, by his comparatively amateurish mechanism, what no professional watchmaker could do, it is scarcely fair to decry it because it is now obsolete. Nor is it fair to suggest that all Harrison's work was "retrograde." He tried, for example, to make a compensation balance, and that he failed is no proof that he did not appreciate its superiority over his (perfectly practicable) compensation curb. Witness this passage from the pamphlet previously referred to.

". . . and I can now boldly say, that if the Provision for Heat and Cold could properly be in the Ballance itself, as it is in my Pendulum, the Watch . . . would then perform to a few seconds in a Year. . ."

With regard to the grasshopper escapement, which "R. A. S." refers to as retrograde, I can only say that I have recently had occasion, in connexion with the repairing of Harrison's No. 2 timekeeper, to go into the theory and action of this contrivance, and that my opinion of it has been considerably enhanced. Although I would not be understood as advocating the use of so complicated and delicate an escapement in anything but a very perfect and well-attended clock, I think that its performance would then considerably surprise the supporters of either the deadbeat or gravity escapements. I should add that the "grasshopper" escapement, as generally figured in horological works, is but a faint travesty of Harrison's own design. RUPERT T. GOULD.

A Test for Possible X-ray Phosphorescence.

IN examining photographs of the β-ray tracks produced in air, C. T. R. Wilson (Proc. Roy. Soc. A, vol. 104, p. 1, 1923) found that two tracks which were undoubtedly pairs were not alike: one was sharp and the other was a diffuse track; that is, pairs exist of which the two components have been ejected with an appreciable time interval. He roughly estimates this time interval to be of the order of 0·001 of a second. The first track he attributed to the photoelectron ejected by the primary X-ray, and the second track to an effect of the resulting fluorescent radiation. It was decided to search by a more direct method for the existence of such phosphorescence in the secondary X-rays from solid radiators.

A beam of X-rays from a tungsten X-ray tube, after passing through a series of lead slits, strikes a rapidly moving disc of aluminium or iron. The secondary rays from the disc are recorded on a photographic film (Eastman "speed" film) in which a hole is cut to allow the primary beam to pass through. With this arrangement, if the secondary radiation is emitted instantaneously the spot on the film should appear in the same position when the disc is spinning as when at rest, whereas any displacement of the spot in the direction of motion would indicate an appreciable time interval between the primary and the resulting secondary X-radiation.

The width of the lead slit next to the disc and also of the hole in the film was 2 mm. The distance of the film and the lead slit from the disc was about 1·5 mm. The thickness of the disc was 0·5 mm., and its linear velocity at the lead slit was varied from 100 to 6000 cm. per second.

The results were affected by the presence of the β-rays and the scattered X-rays which always accompanied the fluorescent rays the emission time of which was being investigated. The β-radiation is less penetrating, and was reduced by inserting various thicknesses of paper between the disc and the film. The effect of the scattered radiation was reduced by using a thin disc for the radiator and by using the lowest voltage, about 18,000 volts, which would excite sufficient intense primary X-rays. Some photographs were taken, however, with voltages up to 80,000 volts. Under these conditions the fluorescent rays of both aluminium and iron disc must have been responsible for a considerable part of the blackening of the film.

In all, about twenty photographs were taken under varying conditions; that is, variations in the voltage on the X-ray tube, speed of the disc, material of the disc, and thickness of paper between the disc and the film. By examining the density of the photographs, a displacement of 1 mm. could have been detected, which would have given a measurement of a time interval as small as 1×10^{-5} of a second between the primary and secondary radiation. No displacement could be detected in any of the photographs, the density being the same on both sides of the slit. Thus the time interval between the incident X-rays and the fluorescent rays excited in iron and aluminium must be less than 1×10^{-5} second.

In these experiments the elements used were of higher atomic number than were those used by C. T. R. Wilson, and they were also solids instead of gases. These results are thus not necessarily inconsistent with Wilson's conclusion that in his experiment a time interval of about 10^{-3} second elapses between the receipt of the primary ray and the emission of the fluorescent ray.

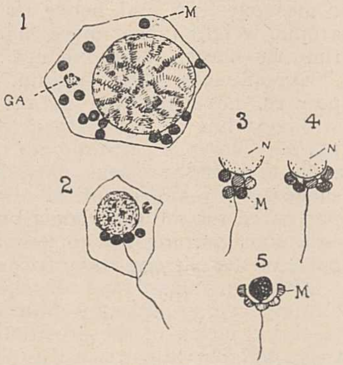
J. A. Bearden.

Ryerson Physical Laboratory,
University of Chicago,
May 8.

Spermatogenesis of an Indian Scorpion.

The spermatogenesis of the Scopionidæ has been of special interest since E. B. Wilson's description of the remarkable behaviour of the mitochondria in *Centrurus exilicauda* (Wood). In this species the mitochondria of the spermatocyte form a ring, which is divided out among the spermatids in a regular manner. In another American scorpion, Wilson describes a different and scarcely less remarkable spermateleosis in which the number of individual mitochondria vary from five to seven in the spermatids.

We have recently examined the spermatogenesis in an Indian scorpion (Palamnæus). Fig. 1 shows a spermatocyte with Golgi apparatus (GA) and mitochondria (M). The latter are very large discrete spheres, whereas the Golgi apparatus is small. In Fig. 2, the spermatid is shown. The mitochondria of the spermatids vary from at least four to eleven, though we have not counted many examples. In Figs. 3, 4, and 5, spermateleosis stages are shown.



We have established in this Indian scorpion that (*a*) the mitochondria are sorted out whole during the maturation stages; (*b*) the number of mitochondria varies in the spermatid; (*c*) the mitochondria form the sperm tail directly as claimed for moths by Meves and Gatenby, for cockroaches by Duesberg, for annelids by Gatenby, for other scorpions by Sokolow and Wilson, and for mammals by Duesberg, Regaud, and others.; (*d*) a Golgi apparatus is present and described for the first time, we believe. The apparatus is in the form of batonettes, is small, and, as described first by one of us in Lepidoptera, it appears to take part in the formation of the acrosome.

A fuller account will be published shortly.

D. R. Bhattacharya.
J. Brontë Gatenby.

Zoological Department,
Trinity College, Dublin.

A Device for using Mercury Seals on Ground Joints in Horizontal or Inverted Positions.

While working with Dr. Anderson's vacuum spark apparatus recently, I used mercury seals on certain ground glass joints, not all of which could be upright. It was found that, by turning the apparatus so that an inverted or horizontal joint became upright, and flowing over the mercury some fairly thick solution of celluloid or collodion in amyl acetate, the film so formed over the mercury adhered well to the glass when dry, and would hold the mercury in place whatever the position of the joint. The film should be rather thick, but it is very easily removed and is sufficiently elastic to stand ordinary handling of the apparatus without rupture or separation from the glass.

J. A. Carroll.

Pasadena, California.

The "Bleeding" of Cut Trees.

Several letters have appeared recently in Nature on the "bleeding" of trees in spring. Every farmer in Eastern Canada knows that the sap flows most freely from his tapped maples (*Acer saccharum*) when there is frost at night and bright warm sun during the day. But the flow can scarcely be due to a heating of the soil and a consequently increased root activity, for there may be an excellent run of sap while the winter snow is still on the ground.

The yellow birch (*Betula lutea*) of this country yields even more sap than the sugar maple. As the sugar content is small it is never now boiled for syrup or sugar, but as it readily turns sour it was used by the early settlers to make vinegar.

Chas. Macnamara.

Arnprior, Ontario, Canada,
May 13.

Thermodynamics in Physiology.[1]

By Prof. A. V. HILL, F.R.S.

UNIVERSAL APPLICATION OF PHYSICAL LAWS.

FORTUNATELY for physiology, several of the generalisations of science appear to be strictly true, even when applied to the living organism. Although such exact experiments are not possible on man, or animals, or plants, as may be made on non-living objects, there is little evidence—indeed, I would be bold and say there is no evidence—that such living creatures can, in any manner or degree, evade the ordinary laws of mechanics, chemistry and physics, the principles of the conservation of energy and mass. At intervals we hear stories of table-turning, of levitation, of ghosts shifting the furniture around, of so-called "electronic" reactions for diagnosing disease, of spirit photographs, of homœopathic medicines which can cure in concentrations about equal to that of a single molecule dissolved in the visible universe. If one is liberal-minded one occasionally examines the evidence—a disheartening process and subversive of liberalism; it is generally of the kind which requires a dark room, incense, and holy music, or a medium who is too shy to answer criticism, or a stream of special cases, or a faculty for explaining away all the examples which do not confirm the theory.

There really is *no* evidence that momentum and kinetic energy, that chemical transformations, that electrical and magnetic phenomena, occur in the living body in any manner, or to any extent, which differs from that obtaining in the more readily investigated non-living world. It is true that physics and chemistry are still only skimming the surface of the world of natural phenomena. No doubt we shall find new theories necessary, new limitations, new corrections, new adaptations of old theories. It is probable that in the very simple tasks (my words are intentionally provocative) which lie before them, physicists and chemists will always attain a much higher degree of exactness than we poor physiologists—even had we their skill—could aspire to, when investigating the very refractory and fugitive objects which Nature supplies. No doubt the faint-hearted, or those with a preference for the miraculous, will still be at liberty to assert that the generalisations of physics and chemistry have not been proved to apply to the material manifestations of the living creature. We can at any rate answer that they have not been proved *not* to apply, and that our function, or profession—or calling—is to apply them; we cannot, and we do not if we are reasonable, predict what the result will be; but we continue to face the future with hope.

The transformations of matter in the living creature and the chemical dynamics of living events are the study particularly of biochemists. Their task is more messy, more difficult, than that of their cousins—or shall we say uncles—the chemists; there is no evidence, however, that it does not rest on precisely the same basis. The transformations of energy are the study of biochemists and physiologists alike. If we study the exchanges of energy in living creatures or cells, we find, not indeed with the same precision as in physics and chemistry, but with cumulative evidence, that these exchanges also rest on precisely the same fundamental laws as in the other sciences. Not many will dispute the application to the living cell of the principles of conservatism of energy and mass; few would suppose that, by taking thought, one could add either a cubit to one's stature or a kilowatt to one's output. These principles can be, and are, accepted. Philosophically speaking, the Second Law of Thermodynamics, dealing with the limitations of the availability of energy, is more liable to doubt. It is known to rest on a statistical basis, and when we are dealing with units, complete, self-reproducing, yet as invisible and intangible as the filter-passing or other micro-organisms, it is, theoretically speaking, possible that some means may be available of evading the statistical relations which govern the behaviour of larger systems. But here again we must ask for evidence—and there is none of a precise and definite character which suggests, in the least degree, that the living cell can escape the jurisdiction of the Second Law.

THE MEANING AND SCOPE OF THE SECOND LAW OF THERMODYNAMICS.

The Second Law is a statement of the limited "availability" of energy. In physiology the unit—the living cell—with which we deal is so small that we may safely regard it as a purely isothermal system. This makes the statement of the law much simpler. In any isothermal system there exists a quantity called the free energy, which is, mathematically speaking, a single-valued function of the co-ordinates of the system; when the system is isolated in an infinite isothermal medium, any reaction which goes on in it will tend to diminish the free energy; when the system passes from one state to another, the loss in free energy A is equal to the maximum external work which the system could have done in the change; in a position of equilibrium the free energy is a minimum. The maximum work is very seldom, if ever, attained. That fact need not disturb us. The conception of the maximum external work enables us, by means of imaginary, though reasonable and consistent, reversible changes, to calculate the free energy, that quantity which we know to exist as a single-valued function of the co-ordinates of the system. Furthermore, if we imagine our system to be warmed up, but otherwise unaltered except by such consequential changes as of pressure and electromotive force, the maximum work A of any given process will be increased or diminished, according to the equation $dA/dT = Q/T$, where T is the absolute temperature and Q is the heat absorbed in the process.

FREE ENERGY IN THE CELL.

The living cell requires energy to carry out its processes; how can it get this energy? The plant can

[1] Extracts from the third Joule Memorial Lecture of the Manchester Literary and Philosophical Society, delivered on March 4. The lecture will be published in full in the Memoirs and Proceedings of the Manchester Literary and Philosophical Society, vol. lxviii. Pt. 1.

store radiant energy by means of chemical synthesis; apart from this, however, there is no evidence that any cell can obtain energy by other than chemical means. Now energy, in itself, is of no particular value; what the animal needs is provision for carrying out movement, for growing and reproducing, for secreting and excreting, for transmitting impulses, for correlating reactions, for purposeful or intelligent response. It requires the means of doing external or internal work: *it requires free energy*. A reaction which can release much heat, but can do little work, would be of no particular value to animals. Perhaps for that reason the reactions which animals employ, namely, oxidations of the ordinary food-stuffs, appear to yield a large proportion of free energy; their maximum work is of the same order of size as their total heat. Hence the animal, or the cell, on its ordinary diet, is not likely to be deprived of the means of doing work; it has plenty and to spare; the limits to its "efficiency"—if we may use that word for the ratio of work done to total energy used—are set, rather by the irreversible nature of its processes, by the friction in its parts. In calculating the maximum work we have to suppose that our changes are very slow, that they are without friction, that no leakage occurs, that a small alteration in the conditions would send the machine equally well in the opposite direction.

Irreversibility of Living Processes.

Such a state of affairs does not obtain in the living cell. More important considerations than "efficiency" and reversibility, in the thermodynamic sense, have played their part in evolution: quickness and readiness of response, a strict and specific inheritance of bodily and chemical structure, the precise maintenance of an internal medium ensuring continuity and individuality, all these have proved far weightier factors than the need of conserving energy. An animal might be efficient thermodynamically—this would profit it little if a bigger, quicker, less economical but more powerful animal came and ate it up. Hence, when we consider the whole cycle of an animal's behaviour, we find a relatively poor utilisation of its energy. A frog's muscle never shows an actual working efficiency of more than 10 per cent. of the total energy which it liberates in contraction; it never turns more than 10 per cent. into work; the remaining 90 per cent. appears as heat—and is wasted, for the frog has no use for the heat. Had it learnt to employ reversible processes, it might perhaps have attained an efficiency of about 100 per cent.; but then it would have been the more likely—after digestion—to provide energy, less efficiently maybe, but more quickly for some one else. Even man, whose food supply is a more urgent and insistent problem, never attains an efficiency higher than 25 per cent. It is far more important, biologically, to be a better man in a fight, in a struggle with Nature, in captivating or capturing the other sex, than it is to approximate to a condition of thermodynamic reversibility.

It would seem, therefore, that a consideration of the actual thermodynamic efficiency of living processes is not likely to lead us far. There may be creatures, very possibly there are, the conditions of whose lives make possible a closer approximation to the type of process which we call reversible. Indeed, it is conceivable that cells can exist in which a means is available of bettering even a reversible process. A one-sided, selective permeability, maintained by an active, "purposeful," but molecular mechanism in the cell, something like Maxwell's demon with his trap-door, might enable the cell to evade the statistical rules which govern larger systems. Philosophically, perhaps even practically, the discovery of such a mechanism, if ever made, will be the greatest step taken by science; if life and matter are co-equal and co-eternal, as some believe, it may be that life is maintaining the entropy at a reasonable constant level, to enable the universe to evade the dilemma of a finite future and a finite past. But, alas, there is no evidence. All the processes which living cells are known to conduct are wasteful and inefficient, very far from reversible. In the thermodynamic sense they are fully representative of a viscous, leaky, inefficient, wasteful—not to say a wicked—world. The Second Law leads us nowhere yet in that direction.

Application to Labile Equilibria.

The most striking verifications and applications of thermodynamic reasoning occur in quite another direction, namely, in connexion with what are called labile equilibria. The free energy is employed, not for its own sake, but to enable us to calculate the conditions of equilibrium. Many and varied are the equilibria which occur in the living cell and body—and hence the importance of the Second Law. The equilibrium of water with its vapour, of a solution with the vapour of the solvent, of an acid with its ions, of the ions on two sides of a membrane, of chemical bodies in an interface, such are simple examples of the application of the Second Law.

Consider such a simple thing as a blood corpuscle. A membrane, permeable to water and oxygen and carbon dioxide, to some ions, but not to others, filled with a complex solution of hæmoglobin and salts: much too large and sober to be able to evade the Second Law; much too small, however, for us to examine individually by any available physical or chemical technique. This corpuscle is in equilibrium; it exists, at any moment, in a reasonably steady state; its surface indeed is so large, relative to its mass, that a new equilibrium is attained (when the conditions alter outside) with sweeping rapidity. We do not know exactly what the conditions of equilibrium are. We have permeability and impermeability; we have charged and uncharged bodies in solution; univalent and multivalent ions; electrostatic forces, and electrical potentials; precisely the conditions which require thermodynamic treatment. There cannot, I insist, be much real understanding of the nature of the equilibrium at the surface of such a cell without a thermodynamic basis. We do not know the cause of the impermeability and permeability of the cell envelope; maybe it is a matter of solubility in a fatty film. We do not know the molecular constitution of many of the reacting bodies; probably we shall some day. From the point of view of thermodynamics, however, such details are inessential. Given the actual facts, of permeability and impermeability of the membrane, of valency and "activity" of the reacting ions, certain conclusions are inevitable; the conditions of equilibrium are defined.

Electrical Phenomena in the Cell.

Almost every manifestation of activity in a living cell is accompanied by a change of electrical potential, sometimes slow, often very rapid. These electrical potentials are relatively large: they may reach several hundredths of a volt; in certain organs indeed, *e.g.* in the electric organ of Torpedo, they may amount to many volts, though here it is supposed, in order perhaps to put less strain on one's credulity, that the units are linked up in series, like a high-tension battery, to produce an enhanced effect.

These electric changes have long provided one of the chief, perhaps the chief, of the physical problems of physiology. They were attributed at one time to living electromotive molecules—whatever those might be: that was before the days of thermodynamics; then to diffusion potentials such as those described by Nernst as existing at the contact of two different solutions. Unfortunately no diffusion potential possible in the body, strong acids and alkalies being out of the question, could be nearly large enough to explain the potential differences actually observed; all the ions available in any quantity have much the same mobility, and the positive and negative ions destroy each other's effects. To avoid this difficulty Beutner has suggested, much as Bernstein did before him, but with stronger physico-chemical evidence, that these electromotive changes are due, fundamentally, to just the same causes as operate in the case of the glass electrode—the highly specific permeability of a membrane by one ion.

Thermoelastic Phenomena in Muscle.

The study of the heat-production of muscles has led to interesting results of many kinds, in regard to the working of the muscular machine. These results imply and require the First Law of Thermodynamics, that of the Conservation of Energy; usually, however, they do not introduce the Second Law, and it is better perhaps to retain the term "thermodynamics" for studies in which both laws are applied. The application of thermodynamics in this stricter sense to muscle physiology is made in a curious and unexpected way.

If a piece of ordinary metal wire be stretched its temperature falls; if it then be released its temperature rises again. The process can be made reversible, and the result may be deduced, by thermodynamical reasoning, from the known facts concerning the thermal expansion of metals. Other substances show the same phenomena. If an india-rubber strip be stretched its temperature rises; if it be released its temperature falls. These results are the converse of those with metal—a corollary of the fact that the coefficient of thermal expansion of rubber is negative. In the case of rubber, however, the process is not strictly reversible in the thermodynamic sense; in the complete cycle a certain amount of heat is lost, owing to the internal friction, the viscosity of the rubber; only if the stretch and the release be infinitely slow will thermodynamic reversibility be attained. Similar phenomena are shown by inactive muscle, alive or dead: stretching warms, and releasing tends to cool it; in the complete cycle, carried out infinitely slowly, the total effect is nil.

These phenomena are not small and unimportant; it is conceivable, indeed likely, that they play a part in the sequence of thermal events known to occur in active muscle. The trouble, however, about an active muscle is that it is so very unsuitable a medium for studying reversible cycles; the force due to its activity is like the pressure exerted in a bombardment by inelastic particles, it is caused by a rapid succession of completely irreversible events. It is probable, nevertheless, or at least possible, that so long as the muscle is retained in a constant state of activity by a rapid succession of shocks, each of which liberates a certain known amount of energy, it may be regarded as a fit vehicle for thermodynamical reasoning: certainly—to take an analogy—a leaky rubber balloon, kept filled to an exactly constant degree by an electric blower, would provide a reasonable—if not a satisfactory—object on which to study the laws of expansion of a gas. That, alas, is the kind of object—a leaky rubber balloon—which we poor physiologists have to employ when we try to make accurate observations and to think precisely!

Now it has recently been found by Fenn that an active muscle allowed to shorten and do work, requires an extra amount of energy, about equal to the work done, over and above the much larger amount required to set up and maintain its activity. Conversely, stretching it causes it to absorb some of the heat released as a result of the stimulus. Shortening causes a liberation, lengthening an absorption of heat; the exact converse of the process which occurs in a resting muscle or an indiarubber strip, but the analogue of that which happens in a metal wire. Can it be that the much less extensible body, the active muscle, has quite different thermoelastic properties from the more extensible one, the resting muscle? May we suppose that the coefficient of thermal expansion of active muscle is positive, while that of inactive muscle is negative? Unfortunately it is impossible to try experimentally; the experiment would take too long; the state of activity would have passed away and the muscle would have become fatigued; and probably the rise of temperature would have its effect, not only on the length of the muscle, but on the magnitude of the individual explosions, the resultant of which is the state of activity as we see it. The problem is an obscure one, but it is difficult at present to see any explanation of the thermal phenomena produced by stretching and releasing an active muscle, unless they be thermoelastic in their nature.

The difficulty is enhanced by further observations made on a muscle while it is undergoing the physiological process known as relaxation. When the stimulus to a muscle ceases it relaxes, its state of activity disappears at a certain definite rate. If it be allowed to lengthen under a load, to lower a weight, in relaxation, there is an extra production of heat, over and above that which would occur if it relaxed unloaded. Conversely, if it be hindered from shortening throughout the contraction, and then released and allowed to lift a load only during relaxation, the extra production of heat will be negative, the total heat will be less than if it relaxed unloaded. Lengthening during relaxation causes a production, shortening during relaxation an absorption of heat. If we are to explain this on thermoelastic grounds we need a negative coefficient of thermal expansion during relaxation, a hypothesis which one can see no means of testing experimentally. Yet, unless we accept the thermoelastic explanation of both sets of phenomena, we are reduced to attributing them to "Nature," or to some unknown "adaptations" inherent in the cell—in other words, to admitting that we can give no kind of rational solution of the problem.

FUNDAMENTAL DIFFICULTIES OF PHYSIOLOGY.

This is the kind of difficulty with which, as physiologists, we have to deal. Our problems are prescribed for us. We cannot sit down and invent a reversible cycle, we cannot investigate some special and simplified case of our own choosing. What would a student of thermodynamics say if his machine had perforce to have food and drink and oxygen, to prevent it from collapsing while he put it hurriedly through its Carnot cycle? How pleased would he be with an elastic body which had one set of properties at one moment, another set at another? What accuracy would he attain if his membranes began to leak as soon as he deprived them momentarily of oxygen? There are very fundamental difficulties in our way. These difficulties cause some of us to become careless, many of us to become pessimists; some of us to perform bad experiments, all of us to make bad theories; some to affirm, as an act of faith and on insufficient evidence, that living cells are nothing but ordinary electrons and atoms, to deny the existence of that fundamental organisation which is called "life" by wiser and more commonplace folk; others, equally perverse, to attribute it all to "Nature" and to the inherent "adaptability" of the cell.

Amid all these difficulties and perversities, these bad experiments and these bad theories, it is something to have a reasonable point of support. Thermodynamics may be hard to understand, but not so hard as the living cell; it may be an imperfect tool, but it is better than none: and it enables us often to evade the part which we do not understand in the mechanism of the cell, to draw conclusions directly from observed fact, and to predict the consequences of phenomena which we may not understand but of the existence of which we are sure. Conjecture and surmise, imaginative thought, are required of such as would adventure in physiology, as in any other science: a method, however, which can yield certain results, can allow precise deduction, as thermodynamics properly applied can do, even though comparatively seldom, is an invaluable asset in a study such as physiology, where, at present, alas! so little is surely known, so little is susceptible of exact and logical analysis.

Physiology, which is beginning to claim its place as an exact science, can learn much from Joule's work. From the first Joule appreciated the value of accurate measurement: precise measurement, precise definition, more than anything else, are the present needs of physiology. In his day the study of electricity was just emerging from the indefinite state of any early science: physiology is just emerging from that state now.

SUMMARY OF LECTURE.

There is no good evidence that the ordinary laws of physics and chemistry, including those of thermodynamics, do not apply to the living cell and animal. When proof to the contrary is alleged it is always found to be of the kind which requires a high degree of credulity, an emotional preference for the miraculous, an imperfect appreciation of the canons of scientific thought, or an ignorance of the actual principles involved. The First Law of Thermodynamics—that of the Conservation of Energy—has been shown, directly and indirectly, to apply to living cells and bodies, with an accuracy equal to that of any experiments which may be made to test it. The Second Law, that which deals with the availability of energy, is more difficult to test, but there is no evidence of any value that it also does not hold. The Second Law is founded, in principle, on a statistical basis; it deals with the average behaviour of systems containing very many fundamental units. It is conceivable that the ultimate minute mechanism, especially of the smallest living cells, may somehow be able to evade the statistical rules which govern larger systems; it may, for example, like Maxwell's demon, be able to sort molecules, to utilise the energy of the more rapidly moving, to employ a uni-directional permeability, and so to avoid the general increase of entropy which appears to be the governing factor in all other material change. Such an evasion, if established, would be of ultimate philosophical, biological, and practical importance; there is no evidence, however, of any value, that it really occurs.

The free energy, the maximum work, of a system undergoing an isothermal change is a mathematical conception which is of little direct importance in physiology; the conditions of an animal's existence render its transformations of energy very far from "reversible" in the thermodynamic sense. It is valuable indirectly, however, since it enables one to predict the characteristics of the many labile equilibria which are present everywhere in the body and cell, without properly understanding, or even being aware of, their ultimate nature. In a subject so difficult, experimentally and theoretically, as physiology, a method which has such certainty of application as that of thermodynamics should appeal, as G. N. Lewis says, to all those who, while they do "not wish to reject all inferences from conjecture and surmise . . . will not care to speculate concerning that which may be surely known." The method of thermodynamics enables us to draw definite and quantitative conclusions from accurately observed facts, even though we know nothing of the mechanism involved.

The lecture dealt with the characteristics of several equilibria occurring in the body or cell. The potential differences at interfaces, the properties of systems involving indiffusible ions, the principles of electrometric measurement, certain properties of colloidal solutions, and the various equilibria occurring in blood during the cycle of respiration, were discussed from the point of view of thermodynamics. The curious thermal effects associated with stretching, or releasing, an elastic body also were discussed, and applied to some recent observations on the behaviour of contracting muscles. Finally the lecturer, "as in pious duty bound," referred to the great influence which Joule had exerted on all such work as had been discussed, and pointed out that the guiding principles in the life and labours of this great citizen of Manchester—those of precise measurement and accurate definition—are the essential needs of physiology at the present time. The hour would come when physiology would demand its Einstein, its Maxwell, its Laplace; to-day, however, physiology requires a Joule—a dozen Joules—to carry out the accurate measurement, and to formulate the precise definitions, which are essential if it is to secure its promotion from the nursery of observation and wonder to the schoolroom of exact science.

The British Empire Exhibition.

EXHIBITION OF PURE SCIENCE ARRANGED BY THE ROYAL SOCIETY—I.

AS part of the scheme for the participation of H.M. Government in the British Empire Exhibition at Wembley, an Exhibition of Pure Science has been organised. The arrangements are in the hands of a strong committee appointed by the Royal Society under the chairmanship of Sir Richard Glazebrook, Mr. T. Martin being the secretary, and the funds have been provided through the Department of Overseas Trade. A valuable little handbook dealing with the physical and biological exhibits has been issued at the price of one shilling, and a notice of this appeared in NATURE of May 24, p. 756. The exhibits which it describes will be found in the Government Pavilion not far from the railway station inside the Exhibition grounds, but the committee is also responsible for certain exhibits in the scientific section of the Chemical Hall in the Palace of Industry, which has already been described in NATURE. Owing to the limited space available the exhibits and demonstrations cannot all be shown at once, but this difficulty has been met by arranging a rotation, and visitors can find out from the handbook during what periods it will be possible to see items in which they are specially interested.

The space available bears in fact a very small proportion to the total area occupied by "Wembley," but the thoughtful visitor will recognise that the two rooms devoted to pure science represent the seed from which has sprung the material civilisation so lavishly represented elsewhere; or rather, let us say, the hormone which has stimulated that growth of prosperity which is such an important element in Empire. He will be insensible indeed if he can leave them without feeling profound pride in the contributions which British men of science have made and are making to modern knowledge, for it is these that are illustrated by the exhibits in question.

Between science and the Empire there is a connexion which is not far to seek. The precautions against plague and famine, which constitute an important function of the British Raj in India, the treatment of tropical diseases, which is bringing advantage to others of our fellow-subjects, and the industries the products of which are displayed in various parts of the Exhibition grounds—these and other benefits of British civilisation would be condemned to a stunted empiricism but for the debt they owe to the laboratory investigator. We may even go further and trace a by no means imaginary connexion between the spirit of science and the political ideals of the Empire—the uncorrupt administration of justice, the maintenance of public order, the education of the component peoples in the art of democratic government—for these things are closely akin to that frank search for truth and ascendancy of reason over passion which are necessary to success in science, and must progress with every advance in influence which accrues to scientific men. In its mission of bringing peace to the world and keeping the peace within its own borders, the Empire receives from science the most powerful instrument it possesses in the development of transport and signal communication which is constantly bringing all races into closer touch with one another: and the same cause is served by commerce, which depends through industry and applied science on the researches of men of science. Such facts are familiar to every reader of NATURE, but it is well that the Royal Society's exhibition should bring them home to the general public, for the latter is still capable of the ridiculous inference that because men of science performed a patriotic duty during the War, they must be assumed to spend their whole time in the occupations which then brought them unwontedly into the field of view.

By directing attention to the methods of science, the exhibition helps the public to grasp the difference between discovery and invention, a distinction which is always confounded in the popular mind with undesirable consequences: and by illustrating the laborious steps, necessitating the co-operation of many minds, by which knowledge has to be won, it fortifies the visitor against the extravagant claims of the pseudo-scientific person, whose success in enlisting popular attention must adversely affect the prestige of science in the long run. It is far easier to explain the results and conclusions of science to the uninitiated than to convey a serious conception of its methods: yet it is the methods that are of real importance, for the results are often provisional and embryonic, and it is in the introduction of scientific method into common affairs that the body politic can most profitably learn from science at the present time. By confining his attention to some limited part of the available subject-matter, examining the relevant apparatus, studying the descriptions in the handbook, and making full use of the demonstrators' services, a non-scientific inquirer will be able to get a very good idea of the way a scientific worker goes about his work.

In the physiological section it is interesting to notice the extensive use which is being made of the refined methods of the physicist for the study of living reactions. The electric changes associated with muscular action are demonstrated with a string galvanometer, by which the action of the heart can be indicated in a most interesting way. A hot-wire microphone of the kind originally invented for sound-ranging in war is also applied to the study of heart phenomena, the air displacement caused by the pulse in a rubber tube applied to the neck being measured with great sensibility. Such methods, with which the name of Prof. A. V. Hill is associated, are also of value in diagnosis. Thermopiles are used for measuring the heat liberated during muscular work, and Prof. E. P. Cathcart exhibits a walking platform (until July 31) and a bicycle ergometer (from August 1) by means of which the physiological effects of a man's exertions can be studied under constant but controllable conditions. For example, the exhaled gases can be collected in a Douglas bag and analysed in a Haldane apparatus, whence the total production of carbon dioxide corresponding to a given amount of work can be found, and it is stated that the energy input and output for the human body can be accounted for and balanced to within one per cent. The katharometer also is used for the estimation of carbon dioxide. Two examples (due to Dr. H. Hartridge and Mr. F. J. W. Roughton) are shown of chemical apparatus devised for physiological purposes, but applicable over a wider field, namely, a reaction-velocity apparatus and the "reversion spectroscope," both of which were intended in the first instance for research on the oxygenation of the blood.

Plant physiology is represented by some experiments of Prof. Blackman on plant growth and respiration and the effect of gravity and light on plants. Physiologists seem to have a lingering predilection for smoked paper for chronographic purposes: one would think that the cleanlier methods common in physics would be less troublesome and a great deal less messy. Of greater scientific than æsthetic value is Prof. Starling's heart-lung apparatus, in which the blood stream from the heart and lungs of a living animal is diverted from the trunk into an artificial circulatory system where conditions as to pressure, etc., can be controlled for studying the behaviour of the organs in question. This apparatus affords a good opportunity for explaining to the public (in view of what is done in the name of science abroad) what the practice of British investigators is as regards the use of anæsthetics in such cases. An interesting modern topic is illustrated by a demonstration due to Dr. D. T. Harris of the effect of ultra-violet light on isolated tissue. The tissue is kept alive by immersion in Ringer's fluid and its tone is indicated by the movements of a lever attached to it. The normal rhythmic movements are disturbed as soon as ultra-violet light falls on the tissue. Dr. L. T. Hogben's study of colour change in frogs and salamanders in response to changes of temperature and other external factors, apparently due to a secretion of the pituitary body, is of great interest.

A number of exhibits, largely on loan from the Natural History Museum, indicate the nature and extent of biological research in its wider aspect, and bring out some striking facts bearing on the evolution of species. Methods of preserving plants are illustrated by some beautiful specimens (Mr. R. D'O. Good), and the vast amount of work that has been done by organised expeditions and by individuals in biological exploration is shown by a tabular statement of the increase in some of the collections at the Museum. As an example of this kind of achievement the *Terra Nova* expedition is specially represented by means of charts, reports, and specimens.

The vast field of evolutionary theory is represented by series of specimens chosen to exemplify certain of its more important aspects. There are fossil series showing the evolution of elephants and oysters, and evolution with divergence of character in the case of chalk polyzoa. Recapitulation is illustrated by Prof. J. P. Hill's admirable examples of egg-laying mammals in various stages of development, and by a collection of carboniferous corals which show the relation between ontogeny and phylogeny in a particularly obvious way. Man is represented by models of the Piltdown and other skulls, the actual and the reconstructed parts being shown in different colours. Collections of butterflies and beetles, for which Prof. E. B. Poulton and Dr. C. J. Gahan respectively are responsible, are strikingly arranged to illustrate mimicry, models being shown side by side with their various mimics, while the variation with locality of such a species as *Papilio dardanus* is fully brought out in relation to the distribution of the relevant models.

The key to the mystery of evolution lies with genetics, and it is perhaps a matter for criticism that in this admirable exhibition the subject of Mendelian inheritance, which owes so much to British workers, is represented by only a single example, that of the synthesis of a white breed from coloured breeds of fowls (Prof. R. C. Punnett). Biologists appear to differ strongly as to the extent and significance of this type of inheritance, but as the standard examples are definite and readily understandable, and illustrate well the application of rigorous numerical principles, they would seem to be particularly appropriate to an exhibition of the present kind—especially in view of the great social as well as theoretical importance of heredity. Attention is directed to one of the most remarkable of current problems in Dr. F. A. E. Crew's exhibits in connexion with sex-reversal in fowls, the unmaidenly conduct of forty old hens providing much food for reflection. The occasional assumption of the male plumage has long been known, but it is here shown that this is accompanied by profound internal changes, the study of which must illuminate the whole subject of sex differentiation.

Mr. C. Tate Regan, by means of specimens showing the remarkable effect of environment on isolated specific characters in fish, challenges thought on a fundamental evolutionary problem for which one hundred and twenty-three years of controversy does not appear to have provided a generally accepted solution.

The influence of climate and soil on vegetation is illustrated by a comparison of the Cretaceous and contemporary flora of Greenland (Prof. A. C. Seward). The fossil plants exhibited were collected from the muds and sands of estuaries and freshwater lakes of Disko Island, Uppernivik Island, and the west coast of the mainland (lat. 70° N.), and include species of Gleichenites scarcely distinguishable from Gleichenias now widely distributed in the tropics and other plant remains closely related to present-day plants of temperate and tropical regions. It seems that while conditions in Greenland to-day are very similar to those prevalent in the British Isles during the last great Glacial period, in former ages the climate must have been at least as genial as that of Central Europe at the present time. The accurate determination of the distribution of plant-groups is a very laborious proceeding if a survey has to be conducted on the ground over a large area, and, indeed, is frequently impracticable. In many such cases the aeroplane can now be pressed into service and the survey accomplished by aerial photography. The photographs exhibited by Mr. H. Hamshaw Thomas bring out the effects produced by stretches of different types of vegetation. They have been taken in various parts of the world, those from Blakeney Point, where new land is being recovered from the sea, being perhaps the most interesting.

In a later article an account will be given of the sections devoted to physics and geophysics.

C. W. H.

Obituary.

Mr. Henry Deane.

In his special study of Tertiary palæobotany, Henry Deane was pre-eminent amongst the more recent scientific workers in Australia, and his loss is felt by botanists and geologists alike. His love for natural history was inherited from his father, who had made friendships with men such as Alfred Russel Wallace, Dr. Harvey, Henry and Edwin Doubleday; the son interested himself in both entomology and botany. It was in the latter science that he specialised in his spare time during a busy life in the engineering profession; and his published papers on the Tertiary flora of Australia testify to his caution and painstaking verification of evidence as to the exact relationship of the abundant leaf remains found in the terrestrial and lacustrine deposits of south-eastern Australia.

Mr. Deane took his degree of M.A. at the Queen's University of Ireland (Galway), and later studied as an engineer at King's College, London. In 1867 he was associated with the late Sir John Fowler in the construction of the Metropolitan and Metropolitan District Railway, a part of which work consisted in bringing the broad-gauge Great Western Railway into the City of London. Later he was engaged with Waring Bros. on the East Hungarian Railway (Transylvania). Part of the time, from 1875 to 1879, he was working in London on bridge design under the direction of Sir Benjamin Baker, and during this period he visited the Philippines in connexion with the erection of Sir Robert Tooth's sugar works.

Mr. Deane finally decided, on account of indifferent health, to settle in Australia, and arrived in Sydney in January 1880. Here he was appointed surveyor in the railway construction branch of the New South Wales Railways, and in 1889 was made engineer-in-chief. After his official retirement from government employment in New South Wales in 1906, he continued his engineering work in a more or less private capacity, and was in 1912 appointed engineer-in-chief for the Kalgoorlie–Port Augusta Railway, a position which he resigned after two years, when he had initiated his successor into the work.

To show his wide interests in science, it is only necessary to mention that Mr. Deane was twice president of the Royal Society of New South Wales (1897 and 1907) and similarly of the Linnean Society of New South Wales (1895–96). During his residence at Hunter's Hill he made a special study of native timbers, especially eucalyptus, and published a series of botanical papers in conjunction with Mr. J. H. Maiden. He also became acquainted with Robert David Fitzgerald, the specialist on Australian orchids, and at the latter's death collated and wrote the remaining letterpress of Fitzgerald's great work.

Coming to Melbourne in 1912, Henry Deane again devoted himself to palæobotanical work, and at the time of his death on March 12, an important memoir on the leaves of the Tertiary Brown Coal of Morwell was passing through the press. Although he had attained the age of seventy-seven, he was still in the midst of scientific work. His genial and helpful disposition makes his loss all the more deeply felt by his colleagues. On a recent occasion the writer spent an enjoyable and profitable time with Mr. Deane in the Melbourne Botanic Gardens Seed Museum, for it was his intention to re-study the fossil fruits of the deep leads in the hope of finding their true relationships. Amongst his hobbies was horticulture, and his friends enjoyed the mutual pleasure of exchanging rare plants and seeds with him. As his daughter, to whom we are indebted for some of these notes, writes: "He was very successful in growing flowers, and his last earthly look was on the garden he loved so well." F. C.

Dr. G. H. Bailey.

Dr. G. H. Bailey, advisory chemist of the British Aluminium Company, Ltd., died recently at the age of seventy-two; and an appreciative account of his life and work appears in *Chemistry and Industry*, from which the following particulars have been taken. Dr. Bailey graduated at London and in 1880 became science master at Tettenhall College, near Wolverhampton. He left this post to go to the Owens College, Manchester, where he was engaged in research on spectroscopic analysis under Prof. (now Sir Arthur) Schuster, on chlorophyll under Dr. Schunk, and on vanadium compounds under Prof. (afterwards Sir Henry) Roscoe. During this period he held the Dalton Chemical Scholarship. For a year, 1884–1885, he went to Heidelberg, studying under Bunsen, Kopp, Quincke and Rosenbusch, after which he returned to the Owens College as demonstrator and lecturer in chemistry, remaining there for the succeeding twenty-four years.

Technical chemistry always appealed strongly to Dr. Bailey and he was closely associated for many years with the work of the Manchester section of the Society of Chemical Industry. In 1909 he was appointed chief chemist to the British Aluminium Company, Ltd., a post which he held until 1920, when he retired, though his services as advisory chemist were retained.

Dr. Bailey's contributions to chemical literature were many. They are to be found chiefly in the journals of the Chemical Society, the Society of Chemical Industry, and the Institute of Metals, the papers in the latter journal referring principally to the corrosion of aluminium. He was also the author of several text books on inorganic chemistry.

We regret to announce the following deaths:

Prof. S. Gabriel, honorary professor of chemistry in the University of Berlin, aged seventy-three.

Prof. V. Hensen, emeritus professor of physiology in the Christian Albrechts University of Kiel, aged eighty-nine.

Prof. R. Kennedy, St. Mungo professor of surgery in the University of Glasgow, on June 3, aged fifty-eight.

Mr. K. J. J. Mackenzie, reader in agriculture in the University of Cambridge, on June 5, aged fifty-seven.

Prof. R. A. F. Paltauf, professor of general pathology in the University of Vienna, the first president of the German Society of Natural Science and Medicine, on April 21, aged sixty-five.

Current Topics and Events.

SIR DAVID PRAIN discoursed recently to the Gilbert White Fellowship on "The Rev. Gilbert White and Moral History," and his address has been issued as a pamphlet. His aim is to show that Gilbert White was as much interested in human manners and customs as in the life of plants and animals. These were the days of all-round interests, and Gilbert was as much a moral as a natural historian. The term "moral history," which sounds strangely in our ears, used to be familiar as a name for the study of human "mores," but without sounding the ethical note. After all, the sociologist's "Folk, work, place" is at once the antecedent and the continuation of the naturalist's "organism, function, and environment." Sir David Prain gives many illustrations of Gilbert White's interest in man's customs. The letters show his curiosity about the different kinds of sheep on different parts of the Sussex downs, the superstitions regarding cleft-ashes and shrew-ashes, the possible causes of leprosy, the far-reaching effects of the sowing of grasses, which was probably introduced to Selborne when his grandfather was vicar. To the historian of the changes in man's habits and customs the "Natural History of Selborne" is good reading. The letters tell us of the "comparatively modern" use of linen changes next the skin, "the plenty of good wheaten bread," "how vastly the consumption of vegetables has increased," and how "the religious, being men of leisure, and keeping up a constant correspondence with Italy, were the first people among us that had gardens and fruit trees in any perfection." Sir David Prain has evidently found his theme congenial, and his account of Gilbert White's "Moral History" is as entertaining as it is instructive. He throws in a good deal of botanical and historical lore of his own. The gleams of subtle Scotch humour are very enjoyable. Perhaps it should be noted that though Gilbert White was much interested in "moral history," he does not himself use the term; we cannot hope that it will be revived.

IN the *Spectator* for May 31 there appears a letter entitled "Darwin and Evolution," in which Sir Oliver Lodge replies to a criticism of his book "The Making of Man," by Mr. Julian Huxley. Sir Oliver Lodge had inferred that some Divine activity and purpose is suggested by what we know of the course of evolution, to which Mr. Huxley replied that Darwin had provided a "rationalistic instead of a mystical or theological explanation of adaptation." In his letter Sir Oliver retorts that Darwin did not explain the origin of variations on which the efficacy of the theory of natural selection depends, and that he did not even discover the "mechanism of heredity," which was afterwards found out by Mendel. In this as in all similar discussions, there seems to be a considerable amount of misunderstanding between opponents. The efficacy of natural selection as the sole originator of species rests on the assumption that small variations in all conceivable directions are continually occurring and that these variations can be inherited. This assumption, when critically tested, as it has been by the "pure line" investigations, proves to be incorrect. But every organism, animal or plant, strives (that is, struggles) to adapt itself to its environment, and learns by experience; and the results of this experience are in part transmitted to its offspring. This fact is the basal assumption of Lamarckism, and there is a certain amount of experimental evidence in favour of it. This striving may be reasonably correlated with some degree of psychic activity; and so far Sir Oliver Lodge is justified. But the existence of a Divine Power which of deliberate purpose adapts each form of life to its place in Nature cannot be legitimately inferred from the facts of zoology and botany, and in objecting to such a deduction Mr. Huxley is on safe ground. Sir Oliver Lodge protests against the "popular fallacy" that Darwin discovered "why species arrived." Darwin maintained that species are only local races divided from one another by barriers which have cleft into separate portions a common domain once occupied by the common ancestors, and that each race owes its peculiarities to the adaptation of its members to local circumstances; and this explanation holds the field to-day.

THE problem of alternative fuel for internal combustion engines is one at all times a subject of interest, but its solution has so far got little beyond the stage of discussion and experiment. So long as petrol is obtainable in sufficient quantity and at a price suited to the consumer's pocket, there is little incentive to compete with it by placing on the market a synthetic fuel, even if, technically speaking, it should answer commercial and domestic requirements. Excluding benzol, the production of which is entirely governed by the extent of the demand for the associated products of destructive distillation of coal, alternative fuels of greatest promise include "tetralin" (tetrahydronaphthalene), which, mixed with benzol and alcohol, was used considerably by the Germans during the War, and also ethyl alcohol itself. The difficulties to be overcome in connexion with these are not merely those of altering the design of engine or carburettor; there is the more formidable problem of commercial (hence economic) production of an organic chemical compound such as tetralin on a large enough scale to be of general utility; and in the second case, so many legislative obstacles have to be surmounted, that until the marketable fuel is rendered unpalatable as a beverage, or is otherwise impaired for human consumption, alcohol is unlikely to become a serious rival to petrol. The subject is recalled by a particularly far-sighted presidential address by Mr. J. G. Rose, delivered to the Cape Chemical Society, South Africa, last year, a copy of which is only just to hand. In a country like South Africa the question of alternative fuel to petrol—all of which is necessarily imported—is probably more acute than in Europe, certainly than in America, and it is significant that the chemists there are giving close attention to what will sooner or later be a matter of world-wide consideration and research: the alternative to oil-fuel and the possibilities of synthetic chemical compounds, either as direct- or as by-products.

ONE of the expiring acts of the late Government was to appoint three leading economists—Prof. W. G. S. Adams, Sir William Ashley, and Prof. D. A. MacGregor, with Mr. C. S. Orwin as agricultural assessor, to be a tribunal of investigation to inquire into and report on the methods which have been adopted in "other countries" for promoting the prosperity of agriculture and the agricultural labourer. This body has now published a final report. Two interim reports were issued in the spring and autumn of last year. The final report is a bulky volume of some 500 pages. As might have been expected, it is largely devoted to the consideration of political and economic questions, such as the need for maintaining the arable area in the interests of national defence, the promotion of co-operative trading, the advisability of establishing a Wages Board, and so forth. Only a passing reference is made to education and research, and, under the latter heading, the advocacy of cost book-keeping is, with somewhat doubtful propriety, included. The general impression gained from this report is that, in the opinion of the authors, unless agriculture receives some state or other artificial aid it will be unable to hold its own with the manufacturing industries. Political economy has again justified its sobriquet of "the dismal science." The conclusion is one that a "tribunal" composed of scientific experts could scarcely accept. Less than a century ago agricultural practice was revolutionised by the discovery that "chemicals" could, to some extent, replace the "muck"-cart; and the present generation has seen the birth of a science through which, when applied to plant-breeding, equally material advances have resulted. There is no reason why still more epoch-making discoveries should not be made. The entertaining author of "Daedalus" has envisaged one, a potent nitrogen-fixing organism which, though it could not, perhaps, "the multitudinous seas incarnadine and make the green one red," as he has pictured, yet might, as any biologist would admit, prove so potent as a fertilising agent as to alter the whole agricultural outlook.

THE precise educational value of a short visit to the British Empire Exhibition is a subject upon which opinions differ widely. We hear of plans for taking schools, either *en masse* or in sections, for a one-day excursion to Wembley, and if we doubt whether the average pupil will go there with any other intention than that of obtaining pleasant excitement, nevertheless he will probably acquire there, *nolens volens*, an idea of the magnitude, value, and importance of our dominions overseas. Numerous visits to one or two selected sections would undoubtedly be more instructive as well as stimulating, but if these are impossible, a short visit under expert guidance appears to be the only alternative; and such a visit is now being arranged by the Institute of Chemistry for its incorporated students. On July 15, at 9.45 A.M., the students will meet in University College, Gower Street, W.C.1, to hear short addresses on the chemical exhibits at Wembley by Mr. W. J. U. Woolcock, who organised them, and by Prof. W. P. Wynne, president of the Chemical Society. At 10.45 a special train will take them to the Exhibition, where from 11.30-1.30 they will be shown round the Chemical Section. After luncheon in the Stadium Hall, members of the party will visit other parts of the Exhibition independently. Students who wish to take part in the excursion must apply before June 29 to the Institute of Chemistry, 30 Russell Square, W.C.1, for tickets (5*s*. each, inclusive of fares, admission, and lunch), and information regarding hotel accommodation, etc., may be obtained from the same source. On July 16 there will be an excursion to the Rothamsted Experimental Station at Harpenden, at the inclusive cost of 6*s*., and on the following day places of interest in London will be visited.

A GENERAL gathering of overseas electrical engineers, partly in celebration of the Kelvin Centenary, is to be held in London from July 10 to 15. Delegates have been invited, by the Institution of Electrical Engineers, from electrical engineering institutions in Canada, Australia, South Africa, India, America, France, Belgium, Italy, Switzerland, Norway, Denmark, Sweden, Holland and Spain. According to the provisional programme, the visitors will be received at the Institution of Electrical Engineers on Thursday, July 10, in the morning, when an address of welcome will be given by the president, Dr. Alexander Russell. This will be followed by a lunch at the Hotel Cecil. In the afternoon the Kelvin Centenary Oration will be delivered by Sir J. J. Thomson, and the Kelvin medal will be presented to Prof. Elihu Thomson, at the Institution of Civil Engineers. Friday, July 11, will be devoted to a visit to the British Empire Exhibition at Wembley, and the Kelvin Centenary Banquet will be held in the evening at the Connaught Rooms, with Lord Balfour in the chair. On Saturday, July 12, a visit is to be paid to Cambridge, where the Cavendish Laboratory and the Engineering Laboratories will be inspected and the company entertained to lunch in the Hall of Trinity College. A reception will also be given by the Vice-chancellor of the University. On the Sunday, facilities will be afforded for a visit to the Zoological Society's Gardens and Aquarium in Regent's Park. For Monday, July 14, a tour in the Midlands is arranged, including visits to the Engineering Laboratories of the University of Birmingham and the Nechells power-station of the Birmingham Corporation and a drive to Stratford-on-Avon and Leamington. Tuesday, July 15, will be devoted to inspection of the repair shops of the London General Omnibus Company, and a lunch at the invitation of Lord Ashfield, chairman of the London Underground Railways, at Chiswick, with a visit to Windsor in the afternoon and a conversazione in the evening at the Institution of Civil Engineers by invitation of the Councils of the Institutions of Civil, Mechanical and Electrical Engineers.

A PAMPHLET entitled "Notes on Iron and Steel," by Brig.-Gen. R. K. Bagnall-Wild, has been published by H.M. Stationery Office. These notes are based on some prepared in 1904 for officers of the Royal Engineers, but now comprise information obtained in the control of materials for aircraft. The pamphlet forms an elementary text-book of the metallurgy of iron and steel, the chief emphasis being laid on information which is likely to be of use to the military man who has to inspect materials, to undertake repairs, or to have charge of machines in service. It is most useful in connexion with the heat treatment of steels of the kind used in automobile and aircraft construction, and weakest in such sections of the subject as are furthest removed from the actual use of the steel. For example, the analyses of iron ores on p. 8 are not representative, and would give an exaggerated impression of the richness of British ores, and some of the equations given as representing chemical changes are incorrect. The outline of the processes of manufacture of steel is very brief, but will suffice to give an engineer a general indication of the differences in manufacture between steel of different kinds. The short theoretical account of steel is clear, and the sections on practical heat treatment of selected steels are based on experience. The pamphlet includes tables of properties required by a number of important specifications for engineering steels and a set of photo-micrographs illustrating the section on the transformations of steel during heat treatment.

THE report of the Council for the past session, presented at the annual meeting of the Illuminating Engineering Society on May 26, furnishes an interesting example of co-operation between kindred bodies. In these days few societies can carry out their work with complete success unless they call in the aid of others in connexion with problems of common interest. The Society has recently added to the list already represented on its Council the British Electric and Allied Manufacturers' Association, the National Institute of Industrial Psychology, the Institution of Public Lighting Engineers, and the Women's Engineering Society. It is also represented on the National Illuminating Committee, on the newly-formed Sectional Committee on Illumination of the British Engineering Standards Association, and on the Committee on Illumination working under the Department for Scientific and Industrial Research. It is in touch with other bodies such as the National Safety First Council in connexion with the relation of lighting to accidents in streets and factories. The movement for better lighting is also gaining impetus abroad. An Illuminating Engineering Society has now been formed in Austria, as well as those already existing in the United States, Germany, and Japan. The meeting of the International Illumination Commission in Geneva next July should afford an opportunity of judging progress being made in other countries. At present Great Britain is taking a leading part in the international treatment of illumination, and it is to be hoped that it will continue to do so.

THE *Marine Observer*, published by the Meteorological Office of the Air Ministry, is the organ of the Marine Division, and is issued under the superintendence of Capt. L. A. Brooke Smith. It is essentially for supplying information to the voluntary marine observers, to which there is so much indebtedness for observations in the different sea ways over the world, and it has now been before the public for six months. The meteorological data supplied by the mercantile marine varies considerably in degree of minuteness. Observers for the meteorological log are restricted to 120 ships in the mercantile marine and eight in the Royal Navy, the logs of all H.M. ships being largely meteorological. There are also wireless meteorological reports, restricted to 25 North Atlantic liners, these being of special use for weather forecasts, also meteorological reports on forms from vessels using their own meteorological instruments. The June number gives a biographical notice of Capt. Henry Toynbee, who was the first Marine Superintendent, although marine work was initiated by Admiral FitzRoy. Much of interest to seamen is given; there is an article on steamship routes from Colombo and the east, to Perim, dealing especially with meteorological conditions in the region of Sokotra and Cape Guardafui. Some years ago vessels in thick weather occasionally ran ashore on the north-east coast of Africa, mistaking Ras Hafún for Cape Guardafui. For a time it was surmised that the difference in the sea temperature would solve the difficulty, but there is no safe guide except the frequent use of the lead, which renders the course absolutely certain. Much wireless weather information is given, also wireless storm signals and wireless ice reports. Various maps are given of currents and ice. For a monthly publication the information seems somewhat crowded.

THE National Union of Scientific Workers has issued a strongly worded circular against the perpetuation of international passions raised by the War by the continued existence of the so-called International Scientific Unions founded in 1919 by the International Research Council and managed by an executive committee of which Sir Arthur Schuster is general secretary. The National Union points out that the Council exists not to promote international co-operation but to exclude ex-enemy nations, and maintains that it is the desire of the majority of scientific men in Great Britain to ignore the Unions so established. It instances the recent genuinely international Physiological Congress at Edinburgh and Psychological Congress at Oxford as signs of the growing opposition to the policy of the Research Council.

THE accidental death of Dr. C. LeRoy Meisinger, of the United States Weather Bureau, was announced in the *Times* of June 4. He and his pilot, Lieut. Neely, perished in a thunderstorm on the night of June 2, whilst in a balloon making observations of the upper air. The balloon is believed to have been struck by lightning; it is said that the flight, over Bement, Illinois, which commenced in the afternoon, was to test upper air conditions in storm centres. The probable time of the accident was at 11.15 P.M. The ascent was one of a series organised by the Weather Bureau, in co-operation with the Army Air

Service; the flights were arranged to take place in April and May, the starting-point in each case being Scott Field, Illinois, from the army large post for lighter-than-air craft. The principal objects of the ascents were strictly scientific, and especially for the determination of free air trajectories from the course taken by the balloon riding at relatively constant elevation. The results to be obtained were looked forward to with considerable expectation. Dr. Meisinger made very extensive studies of the upper air, and his death will be a great loss to the science of meteorology not only in America but also in other parts of the world.

THE new engineering laboratories at University College, London, were open for inspection on June 4, and a large number of representatives of engineering and education availed themselves of the opportunity to view the buildings and equipment, on which about 53,000*l.* has been spent. These now comprise an extensive hydraulic laboratory, the gift of the Hawksley family, a new workshop fitted with modern tools, and laboratories for study and research in wireless telegraphy and telephony, and the applications of various new developments of pure science such as X-rays and photo-elasticity to engineering. These extensions have been rendered possible by the contributions of a large number of donors, including Lord Cowdray, who gave an initial sum of 10,000*l.*, to be increased to £20,000*l.* when 70,000*l.* has been raised, while the London County Council has also contributed 10,000*l.* for building and equipment. The Committee, of which Sir Ernest Moir is treasurer, still requires 27,000*l.* to complete and equip the engineering laboratories, so as to afford engineering students the widest possible scientific training as a preliminary to their professional work. It is hoped that it will be possible to raise this further sum and to complete the scheme in time for the celebration of the centenary of the College in 1926.

PROF. RAYMOND PEARL, professor of biometry and vital statistics in Johns Hopkins University, Baltimore, will give a public lecture on "Some Recent Experimental and Statistical Studies on the Alcohol Problem," on Tuesday, June 24, at 5.30 P.M. Prof. Pearl is a very distinguished American statistician, and as his lecture will be on a topic which he has been personally investigating in recent years, it should be of particular interest. The lecture will be delivered in the Department of Applied Statistics and Eugenics, University College, Gower Street, W.C., and is open to the public without fee or ticket.

THE Institution of Automobile Engineers gave a dinner on June 2 to celebrate the eightieth birthday of Col. R. E. Crompton, the first president of the Institution. Mr. Burford, the present president, presented to Col. Crompton a scroll enrolling him as one of the four honorary life members of the Institution, while Sir Arthur Stanley made Col. Crompton an honorary life member of the Royal Automobile Club. At the conclusion of the dinner, Col. Crompton gave a lecture on "A Forgotten Chapter in the History of Road Locomotion," illustrated by lantern slides, in the course of which he rendered due honour to the memory of Mr. R. W. Thomson for the great part he had taken in the introduction of the rubber tyre in days long before it was generally used on automobile vehicles.

THE report for 1923 by Dr. L. A. Bauer of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington summarises briefly a long record of notable work at home and in the field. The magnetic survey yacht *Carnegie* was not in commission during the year. The final computation of the magnetic results of its cruises from 1915 to 1921 is now completed. Field work was devoted chiefly to the determination of secular and diurnal changes. Except in a few stations in Haiti and the Dominican Republic and those on expeditions to the Xingu and Trombetas tributaries of the Amazon, all the stations occupied had been used for previous observations. In carrying out this work the observers of the Institution have travelled far afield in North and South America, Malaya, certain Pacific islands, and as far north as Etah in Greenland. The report concludes with a series of useful abstracts of published papers.

MESSRS. Subrahmaniam and Gunnaiya, of the Maharaja's College, Vizianagram, have written to us suggesting that the name Newton should be substituted for the term "horse-power." Whilst being in agreement with the general principle of attaching the names of men of science to the fundamental units with which their work has been associated, we do not consider that there is the smallest chance of the suggestion being accepted. The term "horse-power" has now been in use by many generations of engineers, and past experience of attempts made to alter the names of units widely used in the engineering profession leads us to consider that the change proposed could not be carried out. Most engineers who use the term are aware that it is due to Watt, and this appears to us to be an additional reason for opposition to a power unit denoted "Newton." It is true that Watt's name is already attached to an electrical unit, but Watt's work was on the side of mechanical engineering, and we consider that the term "horse-power," given by Watt and used so extensively by mechanical engineers, should be allowed to stand.

MR. L. V. COLEMAN, secretary of the American Association of Museums, has an article on "Museums in Relationship to Schools," in *School Life* (published by the U.S.A. Bureau of Education) for March. Though not long, the article deals with the subject in a comprehensive manner, and here we can indicate only one or two of the good points that are made. Contrasting school museums with loans from central museums, Mr. Coleman reminds us that objects kept for long periods in the school or classroom become uninteresting, and any object may lie idle for most of the time, whereas the same object may be utilised every day if sent out from a museum to various schools, and in each of them will arouse fresh interest. The museum should be used in connexion with the regular curriculum, and loans sent to the school should arrive in time for the lessons they are to illustrate. Museum lectures have their uses, but they are not a substitute for regular classroom work. When, however, a trained instructor is employed by the education authority, museum instruction becomes a branch of classroom work capable of great development. In such matters we in Great Britain are certainly not behind any other country, but we are all only at the beginning of things.

AN examination for a male cartographer in the Hydrographic Department of the Admiralty will be held shortly. Applications, upon a prescribed form, must be received by, at latest, July 10, by the Secretary, Civil Service Commission, Burlington Gardens, W.1.

IN *Phytopathology* for April 1924 (vol. xiv., No. 4) the American Phytopathological Society records its decision to dispense with the usual summer meeting during 1924, and to encourage its members to attend the meeting of the British Association at Toronto in August. British botanists attending the meeting are to be invited to visit the American laboratories.

THE Ministry of Agriculture and Fisheries is about to make certain temporary appointments of investigators in connexion with inquiries into methods of marketing agricultural produce. Candidates should, if possible, possess a university degree or its equivalent in economics, commerce, or agriculture. Applications, upon a prescribed form, should be sent to reach the Secretary of the Ministry, 10 Whitehall Place, S.W.1., by June 20 at latest.

THE summer meeting of the Newcomen Society is to be held on June 18-20 at Shrewsbury. A number of visits to places of interest in the neighbourhood have been arranged, and Mr. Rhys Jenkins will present a paper on "Mineral Industries in the Coalbrookdale District."

THE Marine Biological Board of Canada is about to establish a biological station at Halifax, Canada, and invites applications for its directorship. Candidates must be honour graduates in biology in either arts or science and have special knowledge of either bacteriology or biochemistry. They must send with their applications copies of any research papers which they have published in their special department of knowledge. Applications should reach the Chairman of the Board, Alice Street, Kingston, Ontario, Canada, by June 30.

Our Astronomical Column.

METEOR SHOWERS PROBABLY ASSOCIATED WITH COMETS.—Mr. W. F. Denning writes: "In June there are several radiant points of meteors the positions of which agree fairly well with the radiant points computed for comets. On July 8, Lexell's comet of 1770 has a radiant at $276° - 22°$, and this agrees approximately with a well-known meteoric display observed in June and July from $282° - 24°$. In several years I have seen a shower of Cepheids from about $312° + 61°$ which may correspond with the comet of 1850 I; the latter has a radiant at $313° + 60°·5$ on June 23. In this case, however, the date does not quite agree, the meteors having been seen chiefly during the first half of the month.

"There are several other possible resemblances which require further investigation. A shower from Pisces should be looked for at the end of June and early in July, and they may be associated with Comet II 1864.

"The month of June is sometimes fairly prolific in shooting stars. The earlier members of the great Perseid shower begin to appear, and it would be interesting if we could obtain duplicate observations of some of these. At this period the radiant point is in Andromeda.

"Another interesting point in connexion with June meteors is the occurrence of a shower in the last week from Draco and presumably connected with Pons-Winnecke's comet. It is probably a display of very short duration and of annual occurrence, though no doubt it develops greater activity at those times when the comet is not very far removed from that section of the orbit intersected by the earth. We may anticipate a fine shower in 1927, for in June of that year the conditions indicate a very near approach of the earth and comet."

THE PROPER MOTIONS OF THE SPIRAL NEBULÆ.—Mon. Not. R.A.S. for April contains a critical examination, by Mr. J. Jackson, of the proper motions of some spiral nebulæ deduced by van Maanen from large-scale photographs extending over an interval of some fifteen years. Mr. Jackson finds that the probable random motions of the comparison stars are of the same order as the deduced nebular proper motions, and so make the values assigned to the latter extremely doubtful. Since the latter had been used in conjunction with the line-of-sight velocities, to obtain estimates of the distances of the nebulæ, it would appear that these distances cannot be received with much confidence. On the other hand, the interesting internal motions in the spirals, announced by van Maanen, are shown to be of too systematic a character to be explained in this way, so that these are concluded to be real. Much of the reasoning in the paper is of general interest in connexion with all small proper motions determined by photography.

THE REDDEST STAR KNOWN.—H. v. Zeipel published in 1921, in collaboration with J. Lindgren, a catalogue of the magnitudes and positions of the stars in the cluster Messier 37 in Auriga. He contributes to *Astr. Nach.* 5288 a note on a remarkable red star which he has detected in the course of this work. It is No. 1817 of the catalogue, and is 5·8′ east, 21·0′ south of the centre of the cluster. Its photo-visual magnitude is 12·86 (system of Seares' polar sequence), determined from 19 photographs taken at Uppsala on isochromatic plates with a yellow screen in 1917 and 1918; these photographs show no variability of light. On the other hand, photographs taken at Uppsala with an ordinary plate, and 3 hours exposure, show no trace of the star (limiting magnitude of plate 16·5 mag.). It is also absent from a plate taken with the Yerkes 2-foot reflector, the limiting magnitude of which is 17·0. Its colour-index is therefore *at least* 4·1 mag., showing that practically all its light is at the red end of the spectrum. H. v. Zeipel requests the possessors of large reflectors to endeavour to photograph it with prolonged exposure on ordinary plates.

Being in a cluster, it is presumably a giant star, and at an earlier stage in its career than any yet recorded, so that its further study by those who possess the necessary means is likely to be instructive.

Research Items.

THE BARAS OF MADAGASCAR.—Dr. R. Verneau has published in *L'Anthropologie*, t. xxxiii., Pts. 5 and 6, the results of a detailed examination of eleven Bara skulls now in the Muséum national d'Histoire naturelle at Paris. The generally accepted view, based largely upon linguistic evidence, is that the numerous races of Madagascar, other than the Malayan Imerinas, or Hovas, are to be related to the negroid peoples of Indonesia and the adjacent area. A comparison with Papuan skulls, however, shows that they are clearly differentiated from this group, to which they might be expected to show resemblances, by certain features, such as the smaller size of the skull, less marked dolichocephaly, a relative narrowing of the frontal region in comparison with the breadth at the parietals, a lesser breadth of the face at the level of the cheek bones and the upper maxillaries. Further, not only do these characters exclude affinity with the Papuan, but they indicate a marked resemblance to an African type, although with our present inadequate knowledge of the physical characters of the inhabitants of Madagascar it is not possible to indicate to which group precisely they should be related.

PREHISTORIC SITE IN TENNESSEE.—In the report on the field work of the Smithsonian Institution in 1923 (Smithsonian Miscellaneous Collections, vol. 76, No. 10), some interesting details are given of a great prehistoric Indian town in Cheatham County, Tennessee. The remains are known as the Great Mound Group on account of the great central mound. The original summit of a bold projecting hill had been levelled until a great plaza, or public square, had been formed, 1000 feet in length and 500 feet in breadth. At the north-east corner of the plaza the Great Mound was erected with two smaller mounds on the eastern edge, and three broad terraces on the southern side of the hill. On one side it was protected by the cliffs of the Harpeth River; on the other sides was an elaborate system of earthen breastwork, wooden walls, and earthen bastions surmounted by semicircular wooden towers of which faint traces were found. No other mound in the south-eastern United States approaches the Great Mound Group in the artistic sense. Traces of a number of earth lodges were found, and there was evidence that the site had been occupied by four or five groups, possibly autonomous, of kindred peoples with a total population of possibly several thousands. All the buildings appear to have been destroyed by fire.

PAST EVENTS SEERSHIP.—In the Proceedings of the American Society for Psychical Research, January, 1922, Dr. Gustav Pagenstecher, a physician of repute in a Mexican city, gives an account of his experiments in "psychometry," and claims that his results establish the reality of "past events seership"—one of the forms of supernormal faculty to which Richet has applied the term *cryptesthesia*. The experiments were conducted as follows: The medium—a lady patient whom Dr. Pagenstecher had treated by hypnotic suggestion—was put into trance, and some object of which she had no previous knowledge was presented to her. She brought the tips of all her fingers into contact with the object and then described the "visions" which thereupon occurred to her. It cannot be said that the objects chosen for experiment were as a rule well adapted for testing the truth of cryptesthesia. A "piece of porcelain elephant made in China" produced the vision: "I see people with sharp-pointed straw hats on . . . coiled, braided hair. . . . These men are undoubtedy Chinese." "A mother-of-pearl shell" gave rise to the vision: "I am under water. I see many fishes of all sizes and of all colours. . . ." Nor can it be said that the conditions of the experiments are set out in sufficient detail to enable us to judge what explanation, other than cryptesthesia, might be possible. The arguments adduced to controvert the hypothesis of telepathy as a factor in the production of the phenomena are very unconvincing, and indeed show some misunderstanding of the relative importance of the parts played by the "agent" and the "percipient" respectively in experiments in thought-transference. On the other hand, Dr. Pagenstecher writes at some length on his hypothesis that "Psychometry is based upon the transmission of molecular vibrations stored in the 'associated object' and transmitted to a supersensitive sensorium, *i.e.* to an adequate medium." Such speculations are perhaps out of place in the present state of our knowledge. As Dr. Walter Prince says in his foreword to this volume, "What is now all-important is to gather more facts by experimentation with persons found to have psychometrical power, and to classify the facts."

FILARIASIS IN BRITISH GUIANA.—Filariasis—elephantiasis, inflamed lymphatics, and lymphatic glands and other affections—is caused by a helminthic parasite, *Filaria Bancrofti*, the embryos of which occur in the peripheral blood stream. The disease is met with in many districts in the tropics, and is conveyed by various mosquitoes, which are intermediate hosts and carriers of the parasite. In 1914 the Governor of British Guiana directed attention to the frequency of the disease in that colony, and in 1921 the Committee of the London School of Tropical Medicine commissioned Prof. R. T. Leiper and Dr. J. Anderson (with whom were also associated Drs. Lee, Khalil, and Vevers) to carry out investigations, the results of which have been now published (Research Memoir Series, vol. v. No. 7, 1924, London School of Tropical Medicine). Practically one-fifth of the inhabitants of the colony were found to be infected. The intermediate host is the domestic mosquito, *Culex quinquefasciatus*. A number of drugs was tried in treatment but none was found to be definitely curative. Eradication of the disease therefore resolves itself into prevention, which means the complete banishment of the particular mosquito carrier from the dwellings of the people. The filarial affections *per se* are not dangerous to life, but they are liable to secondary bacterial infections which not infrequently prove fatal.

PHOTOSYNTHESIS AND RESPIRATION.—The progress of researches on photosynthesis and respiration carried on in the Laboratories for Plant Physiology of the Carnegie Institution of Washington, situated at Tucson, Arizona, and Carmel, California, is briefly recorded in the report of the Director of the Laboratory in the Year Book, No. 22, 1923. Dr. Spoehr is still unable to obtain formaldehyde by the action of ultraviolet radiation either on carbonic acid or on carbamino- acids. The ultra-violet radiation of ice-cold solutions of calcium salts of glycocoll and alanine carbamino- acids resulted in the formation of slight traces of ammonia and formaldehyde together with small quantities of methyl alcohol. Interesting oxidation studies appear to be in progress in which glucose is oxidised to carbon dioxide and water by passing air through its solution in a buffer mixture of disodium hydrogen phosphate and sodium dihydrogen phosphate, containing also methylene blue. This solution decolorises methylene blue, but on passing air through the colour returns and carbon dioxide is liberated. A number of substances accelerate this reaction, the most effective being iron, and the most stable form so far found in which to add the iron is the complex salt formed by dissolving ferrous sulphate in sodium pyrophosphate.

MISTLETOES IN MALAYA.—Six species of parasitic Loranthus and three of Elytranthe, growing in Malaya, are described by W. N. Sands in the *Malayan Agricultural Journal*, vol. xii., March 1924. Five of these parasitic flowering plants are described as pests of cultivated trees, the parasites spreading mainly through the action of birds in feeding on the succulent berries and reproducing readily on individual tree hosts by means of long surface root runners. Some of these hemi-parasitic plants readily parasitise each other.

LINSEED SELECTION EXPERIMENTS IN INDIA.—In India linseed is grown commercially simply for the supply of oil seeds, and so far, experiments in fibre production, though attempted spasmodically over the last 150 years, have not established an Indian fibre industry. In the Botanical Series of the Memoirs of the Department of Agriculture in India, vol. xii. No. 4, Mrs. Gabrielle L. C. Howard and Abdur Rahman Khan report upon Indian strains of linseed as the result of hybridisation and selection experiments carried on with plants obtained from the Indian commercial strains. Two groups of these Indian linseeds are distinguished, the deep-rooted types grown on the soils of Peninsular India and the shallow-rooted, vigorous, compact plants of the Gangetic alluvial soils. An interesting point is the secondary flowering of some of the strains isolated and its correlation with a crop of fresh and active roots upon a deep root system. As a result of these intensive selection experiments, new strains suitable for the special soil conditions are being tried both in the Peninsula and on the alluvium, and some of these new strains have given very promising yields of seed.

"TUNG" OIL.—"Tung" oil has become of increasing importance in the varnish and paint industry of recent years, and therefore the notes in *Indian Forest Records*, vol. x. part 2, 1923, by R. N. Parker, Madyar Gopal Rau, W. A. Robertson, and J. L. Simonsen, upon the botanical sources of this oil and its varying chemical nature have technical as well as scientific value. The oils known in commerce under this name come from China, and it appears that the Hankow oil is derived mainly from the seeds of *Aleurites Fordii*, whilst the Canton oil is probably mainly obtained from the seeds of *Aleurites montana* Wils. The authors examine chemically the "tung" oil from *A. montana* and show that it consists mainly of the glycerides of β-elaeostearic acid, oleic acid, and probably linoleic acid, whilst the oil from *A. Fordii* was shown by Fahrion to consist mainly of glycerides of oleic and α-elaeostearic acids. Figures are given of the fruits, seeds, and leaf nectaries of these two species of Aleurites, permitting the ready recognition of two plants of commercial importance which have frequently been confused. Both species are at present rare in India and Burma, but readily admit of cultivation in these countries.

RUDIMENTARY PARTHENOGENESIS.—In a paper on rudimentary parthenogenesis in the meal-worm, *Tenebrio molitor*, in the *Journal of Genetics* (Vol. 14, No. 1), Dr. A. M. Frederikse directs attention to the fact that in animals belonging to various groups the unfertilised eggs have more or less power to develop. He refers to the papers of Lécaillon on this subject, but not to the observations of segmentations in unfertilised egg-cells of the rat. In the meal-worm, as in other animals, the development of such eggs does not proceed very far. It takes place slowly and shows various irregularities, such as tripolar spindles and other mitotic aberrations, with perhaps amitosis and budding. The chromosomes are often not of the usual form, and the resulting blastomeres vary in size and are irregularly distributed, the development finally coming to a stop. These irregularities make it all the more remarkable that chemical and other stimuli in artificial parthenogenesis enable the egg to complete normal development.

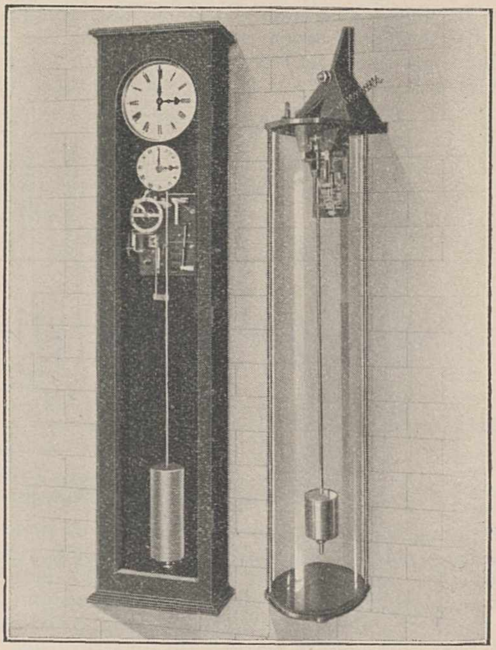
RIVER DISCHARGE MEASUREMENT.—The Egyptian Ministry of Public Works has published a report by Mr. E. B. H. Wade, Director of Research, on Investigations into the Improvement of River Discharge Measurements, Part V., which contains a description of an improved instrument for the measurement of the velocity of slow-moving waters. The instrument in use in Egypt for the measurement of discharge is the small Gurley current-meter, which is spoken of as an excellent instrument; but it has been found desirable to endeavour to design a special appliance which will give better results at low velocities. The instrument devised by Mr. Wade for the purpose is referred to in the Report as K.I., and is an improvement on an earlier instrument designated T.13. Sensitiveness to low velocity has been increased by the introduction of guide vanes for the purpose of giving a rotary movement to the water prior to impact on the propeller of the meter. Experiments carried out on the Blue Nile, particulars of which are given, have demonstrated the feasibility of employing K.I. under field conditions, but they have also shown that, while designed mainly with the view of removing frictional errors, it is unduly sensitive to turbulence, and until that objection is removed, the low velocity instrument problem cannot be regarded as solved. "For the present," concludes the report, "we must regard the Gurley as the most reliable current meter we possess."

THE OIL GEOLOGY OF SOUTH-WEST PERSIA.—Since the publication of Messrs. Busk and Mayo's paper on the Persian Oilfields (Journ. Inst. Pet. Tech., vol. v., 1918), much detailed geological survey has been done in this important region, especially by the Anglo-Persian Oil Co.'s geological staff, and Mr. R. K. Richardson's recent paper read before the Institution of Petroleum Technologists on May 13 is a welcome addition to our knowledge of the country. The chief features of scientific interest are (1) the publication of a detailed palæontology of the Tertiary rocks exposed, based on the work of Dr. Douglas, (2) the age of the Asmari Limestone, a long-disputed subject, and (3) the opinion expressed by the author regarding the stratigraphical horizon of the productive oil-measures. In connexion with (1) it is noteworthy the extent to which Foraminifera are developed, especially in the Asmari Limestone series, while their value as indices of correlation and differentiation of beds is evident. The Asmari Limestone has been assigned to the Oligocene-Burdigalian phase of Tertiary history, the *Nummulites intermedia* beds (Upper Oligocene) in the south, and *Lepidocyclina* beds (Lower Miocene) in the north, suggesting a mingling of two faunas as conditions of desiccation proceeded from south to north. Thirdly, the author holds the view that the Asmari Limestone is the mother-rock of the oil in the Maidan-i-Naftun field, and not the Fars series as generally supposed; an alternative theory suggests a Cretaceous origin followed by migration into the Asmari Limestone series. The paper concluded with a summary account of the famous Maidan-i-Naftun oilfield, from which it appears that since 1912 and up to last year more than 12 million tons of oil had been produced from it, that it has not as yet been troubled with water incursion, that no dry hole has ever been drilled in the field, that the extent of its untapped resources of oil is unknown, and that its areal boundaries are widening with every new well drilled.

SOLAR RADIATION.—In the April issue of the Quarterly Journal of the Royal Meteorological Society, a report is published which was presented by its author, Dr. A. Angström, to the 1923 meeting at Utrecht of the International Commission for Solar Research on Actinometric Investigations of Solar and Terrestrial Radiation. The first part deals with continuous registrations of direct and reflected solar radiation, which have been carried on at Stockholm since July 1922; the yearly and daily variations of the radiation-income have been computed separately for the direct and diffused radiation: the latter is found to be of great importance in these high latitudes. A simple formula is given expressing the total radiation-income Q_s on any day with Q_0, the value corresponding to a perfectly clear day, and S the duration of sunshine expressed as a fraction of the total possible duration; this formula is $Q_s = Q_0(0{\cdot}25 + 0{\cdot}75S)$. It holds almost exactly for Washington as well as Stockholm. The second part of the report deals with atmospheric and nocturnal radiation. About 25 per cent. of the radiation from a black surface of temperature between $-30°$ and $+30°$ C. can pass quite freely through the atmosphere without absorption, whatever the water content of the air. A further range of the same spectrum, corresponding to about 50 per cent. of the energy, is totally absorbed in a very thin atmospheric layer, probably about 30 metres thick for ordinary vapour pressures (about 10 mm.). A third group of waves, accounting for the remaining 25 per cent. of the energy, is very variably absorbed, according to the humidity. It is suggested that up to a height of about 15 km. the atmosphere radiates about 50 per cent. of the energy radiated by a black surface at the same temperature.

ABNORMAL WEATHER OF WINTER AND EARLY SPRING.—A short article dealing with the weather of the British Isles for the six months October 1923–March 1924, by Mr. C. E. P. Brooks of the Meteorological Office, is given in the *Meteorological Magazine* for May. The author is clearly aiming at long-period forecasting, an inquiry of profound interest to meteorologists and others. Monthly pressure maps showing the deviation of pressure from the normal are now available for Western Europe, North Atlantic, and North America. Any deficit or excess in the normal pressure in distant parts from the British Isles reacts on winds and temperature as well as other meteorological elements. It is shown how such differences of pressure have influenced weather in the British Isles of late. March 1924 is given as an illustration; there was a deficit of pressure amounting to 15·5 mb. in the Azores, whilst in Iceland there was an excess of 6·7 mb. These differences completely reversed the normal pressure gradient, and cold easterly winds prevailed over the British Isles. It is pointed out that the whole winter of 1894–1895 was rather similar to that of 1923–1924. The conditions of February this year resembled those of February 1895, but in 1895 the cold was more intense and skating was general in the east and south of England, while at Greenwich the mean temperature for the month was 29°, the lowest for at least 150 years. A notable feature of abnormal weather during the past winter was the remarkably high air temperature at Spitsbergen, where the excess on the normal amounted to 9° F. in October, 14° F. in November, 12° F. in December, 15° F. in January, and 20° F. in February. Naturally the ice conditions in the Arctic were similarly abnormal, there being generally much less ice than usual.

THE FREE PENDULUM.—Much has been heard in scientific circles lately of the free pendulum, a development of the Synchronome system of electric clocks, which has surpassed every known record of accuracy in time measurement. It was the subject of a lecture by Mr. F. Hope-Jones at the Society of Arts on April 9, and was exhibited at the Royal Society's soirée on May 14. To those who have a knowledge of clock escapements, the idea of a perfectly free pendulum is fascinating. It would appear to be impossible, on the face of it, to devise a means of giving impulse to a pendulum, which shall not require that pendulum to unlatch or release a small instalment of the reserved store of energy; yet



Slave clock. Free pendulum.

FIG. 1.

this has been accomplished. The solution of the problem lies in the use of a slave clock to perform this duty for it. It is enabled to do so at precisely the right moment because its pendulum is kept in perfect phase synchronisation with the free pendulum. Two examples of the free pendulum (Fig. 1) are being exhibited at the British Empire Exhibition at Wembley, one in the Royal Society's exhibit in H.M. Government Building and the other in the exhibit of the British Horological Institution in the Palace of Industry. The latter is used as the fundamental timekeeper of the twenty large electric clocks which serve the Palace of Industry, the Conference Hall, and adjacent buildings in that part of the Exhibition. These clocks have been exhaustively tested at the Royal Observatory, Edinburgh, throughout the last two years by means of special apparatus, including a cinematograph which takes cognisance of thousandths of a second. It is only by such means that any error has been discovered, and the variations have never exceeded one-hundredth of a second in twenty-four hours.

The Quantum Theory of Band Spectra.

OPTICAL spectra present two main types of regularity, line series and band series. The two are very different in appearance: the line series is seldom recognisable by inspection, for it comprises as a rule comparatively few lines, the strongest of which are widely separated and usually confused with other lines; whilst band series are among the most striking and beautiful of spectral phenomena, containing large numbers of lines crowding together to so-called "heads" in the most obviously orderly manner. Their arrangement may be described by associating successive integers m with successive lines, when their wave-numbers are found to be given, to a near approximation, by an expression of the form $A + Bm + Cm^2$, where A, B, C are constants. Moreover, a law of the same general type was found by Deslandres to connect the wave-numbers of heads of associated bands when these occur in groups, as is commonly the case. Finally, there may be a number of these groups of heads constituting what may be called a system of bands, and these again are distributed in much the same way as the heads within a group or the lines associated with a head.

A system of bands is thus a very complex affair, containing, it may be, some thousands of lines and requiring much labour and powerful instrumental means for its complete analysis. Nevertheless, fairly comprehensive data have now been accumulated for the more intense band systems lying in the visible and near ultra-violet regions of the spectrum, and these offer a rich field of investigation to the theoretical physicist. It is proposed in this article to indicate in the broadest outline the present position with regard to the theoretical interpretation of band spectra.

A historical survey cannot be attempted; suffice it to say that the failure of the classical electromagnetic theory was just as complete here as in the case of line series, and the success of the quantum theory no less remarkable. The principles introduced by Bohr and extended by Wilson and Sommerfeld have been applied to the problem and have again proved extraordinarily fruitful. But the radiating systems here involved are molecules instead of atoms, and complications ensue—complications which are reflected in the complex structure of a band series as compared with that of a line series. For whereas an atom can only radiate energy associated with its constituent electrons, a molecule may possess, in addition to this type of energy, two other types, namely, those due to rotation of the molecule as a whole and to vibration of the constituent atomic nuclei. But it appears that each of the three types of motion is separately subject to the rules of generalised quantum mechanics, whilst the frequency of the radiation emitted in consequence of a change in the condition of the molecule is given by dividing the *total* decrease of energy by Planck's constant h.

The simplest case arises when the initial and final states of the molecule differ only in respect of rotation; that is to say, when the emission is solely due to a decrease of one unit in the angular momentum of the molecule. The energy change, and therefore the frequency of the radiation emitted, will depend upon the initial state, and the spectrum should consist of a number of nearly equally spaced lines. Calculations based on known molecular data lead us to expect that these lines will occur in the far infra-red region, and such series have in fact been observed; but work in this region is difficult, and the experimental data are as yet too fragmentary to permit of a conclusive test of the theory.

Passing next to the case in which the rotation change is accompanied by a change in the vibrational energy of the nuclei, the theory predicts a set of bands each of which should consist of two series of lines. One of these arises from an increase of rotational energy and the other from a decrease, and they should occur respectively on the low- and high-frequency sides of the "fundamental" frequency associated with the nuclear vibration. Bands of this character have been observed in a number of absorption spectra lying in the near infra-red, notably in that of hydrogen chloride, which has been studied by several workers under relatively high dispersion.

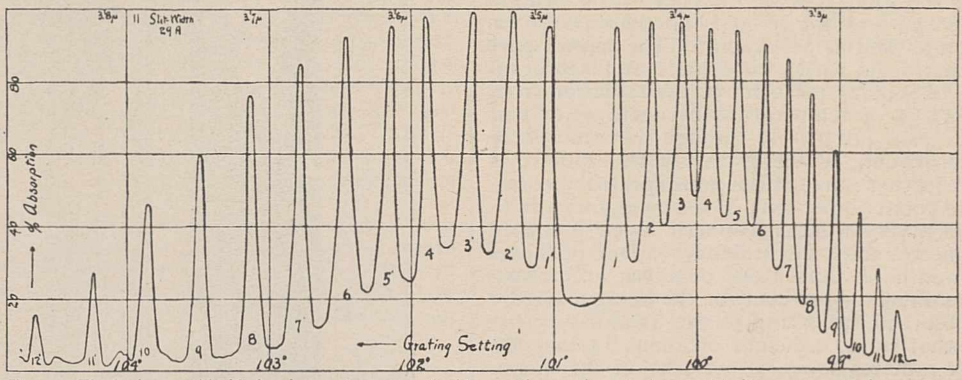


FIG. 1.—The hydrogen chloride band at 3·46 μ, mapped with 7500-line grating; hydrogen chloride at atmospheric pressure.

In Fig. 1, which represents results obtained by Imes, it will be noted that the lines are not quite equally spaced, but close up gradually in the direction of increasing wave-number. The theory provides an immediate interpretation of this feature; it is due to a difference between the moments of inertia of the molecule in its initial and final states, a difference which is to be expected when it is remembered that the nuclei occupy different mean positions in the two cases. Here also, although the theory in its main outlines is firmly established, much more extensive experimental data are wanted. Those available at present mostly relate to absorption only, and few of them are on a sufficiently large scale of dispersion to permit of the band structure being studied.

The third class of band is that in which the rotation change is accompanied by a change in the electron configuration, or, it may be, by a modification in the nuclear vibration as well. The energy liberated is here much larger in amount than in the previous cases, and the resulting emission is consequently of higher frequency, usually lying in the visible or ultra-violet regions. The theoretical problem is now one of great complexity, owing to the interactions between the various types of motion co-existing. For example, the configuration of the molecule, and hence its moment of inertia and rotational energy, may be considerably modified by the electron transition; again, the moment of inertia will be a function of the rotational velocity (owing to distortion by centrifugal force), and the latter may also affect the energy of vibration of the nuclei. At present, therefore, only conclusions of a somewhat general character are possible.

Nevertheless, important progress is being made, notably by Kratzer, who has succeeded, for example, in accounting for the well-known cyanogen band heads (the more refrangible group) in terms of various nuclear vibrational states. Thus the group of heads ranging from λλ4606 to 4515 is attributed to a quantum change of -2 units, that between 4216 and 4153 to one of -1 unit, and so on, whilst in each group the individual heads originate in different absolute values of the quantum numbers concerned. The individual lines associated with each head arise, as before, from transitions between successive states of rotational motion.

Now the correspondence principle leads us to expect the occurrence of the changes ± 1 (and, in special cases, 0) in the rotational quantum number, each of which would give rise to a separate series, so that each band should consist of two (or at most three) branches, the arrangement of which can readily be calculated. A structure of this nature was in fact discovered in a number of bands by Heurlinger in 1918, before the development of the theory; yet detailed study of these and other bands reveals some very important features the theoretical significance of which is at present obscure. For example, there may be many more than three branches constituting one band—as many as twelve sometimes exist; and even in cases where this unexpected multiplicity is not encountered other discrepancies become apparent.

It is safe to say that no band is yet known for which a complete theoretical explanation is available. Even the comparatively simple infra-red absorption bands (hydrogen chloride, etc.) present one important peculiarity of a very puzzling nature, namely, the absence of one line, and only one, in the centre of the band. This presumably corresponds to one of the two rotational changes $0 \rightarrow 1$ and $1 \rightarrow 0$, and its absence would naturally be interpreted as due to the non-occurrence, or, more strictly, the non-participation, of the rotationless state of the molecule in one of these two processes (there is as yet no means of distinguishing one from the other). But why, if one may occur, the other should be prohibited, has not up to the present received a satisfactory explanation.

A similar difficulty occurs in bands in the optical region of the spectrum, but here many other complications usually exist. The simplest case yet found, and one therefore of particular interest, is that of the band spectrum of helium. This is due to a highly unstable molecule which can only be formed by the union of "excited" atoms of helium, but persists long enough to emit a characteristic spectrum containing numerous bands. The constituent lines are in this case all single instead of double, as is often the case in other spectra, and each branch consists of relatively few lines (never more than about ten), so that there is little difficulty, such as usually occurs, due to overlapping of two or more branches. Further, the lines are much more widely spaced than in any other known bands, and their arrangement can thus be studied more conveniently, only moderate dispersion being necessary. The analysis of the spectrum is not yet complete, but the structure of one of the bands is illustrated in Fig. 2. It will be seen to consist of three branches, designated as P, Q, and R, in accordance with the nomenclature introduced by Heurlinger.

The theory in its original form indicated that these resulted from the rotational quantum changes $m \rightarrow (m+1)$, $m \rightarrow m$, and $(m+1) \rightarrow m$ respectively, but exact measurements show at once that some modification of this view is necessary. For example, if it were correct, the P and R branches should extrapolate over into one another, thus virtually forming one series, but for the suppression of some lines in the centre. In point of fact, their failure to do so could not be more pronounced, for the extrapolated lines

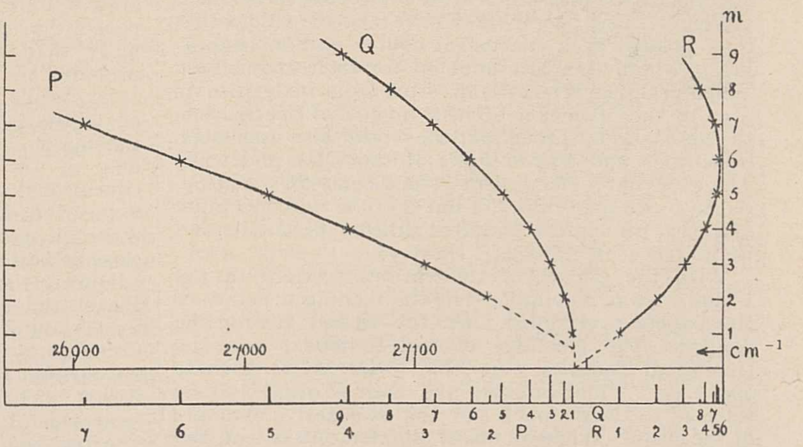


FIG. 2.—The helium band near λ3680. Wave numbers plotted against ordinal numbers. Intensity represented by vertical height of line. Note that P and Q curves intersect at $m=\frac{1}{2}$, and Q and R at $m=0$.

of one fall just midway between the lines of the other, and this behaviour is characteristic of every band in the spectrum which has been analysed up to the present. The conclusion from this seems irresistible. We must suppose that instead of one set of molecular states, as hitherto postulated, here exist two, their characteristic quantum numbers differing by about one-half. Thus, for example, the P branch might arise from the changes $1 \rightarrow 2$, $2 \rightarrow 3$, etc., whilst the R branch would then be due to the changes $1\frac{1}{2} \rightarrow \frac{1}{2}$, $2\frac{1}{2} \rightarrow 1\frac{1}{2}$, etc. It may also be remarked that the same kind of modification suffices to remove the difficulty mentioned above in connexion with the infra-red absorption bands. The necessity for it is probably connected with the effect of the structure of the molecule. In dealing with the rotation of the latter it is not permissible to treat it as rigid and structureless; the motion of the constituent electrons should be taken into account.

The problem is a difficult one, for exact knowledge of the structure of even the simplest molecule is entirely lacking, and apart from this it is even possible that the quantum theory in its present somewhat restricted form is not capable of furnishing a solution. However that may be, it is clear that we may look to work on band spectra to provide data of the greatest value in the investigation of the problems of molecular structure.

South-Eastern Union of Scientific Societies.

THE twenty-ninth annual congress of the South-Eastern Union was held at Guildford on May 28-31 inclusive, under the presidency of Sir Richard Gregory. The subject of the president's address was "Science in Civilisation," and his task was to show that for almost all the many benefits which the modern world enjoys we are indebted to scientific discoveries, made often without fee or reward in the laboratory, by those who are engaged on scientific work from pure love of the pursuit of science. He opposed strongly the view that scientific research is devoted to the discovery of death-dealing weapons and machinery, brutally expressed by Ruskin in the words, "The advance of science cannot be otherwise recorded than by the invention of instruments to kill and put down noble life." No one held more thoroughly the view that it was the debasement of science to utilise discovery for such an ignoble end. The utilisation of scientific discoveries in the home and in everything that makes life pleasant is often completely overlooked merely because people nowadays take the things that they possess as a matter of course without inquiring to whom they are indebted for their acquisition. When practical science is diverted from its legitimate uses to the invention of instruments of death, then the news-sheets throughout the world seize upon such inventions and scatter news of them far and wide. The view that "Darwinism" stands only for "Nature, red in tooth and claw," is but a crude misconception of a great principle, repudiated alike by its founder and by its powerful exponent, Huxley.

With the growth of the various sections of the Union, it was inevitable that the reading of many of the papers overlapped. On the second day of the congress, the meetings of the Botanical and the Geological Sections were held. Dr. A. B. Rendle spoke on "Plant-pitchers and their Work," and he referred to the common sun-dew as a native example of the class. When an insect alighted on the leaf, the tentacles turned over, the insect was captured, and the digestive juices in the plant enabled the insect to be absorbed. The properties of the liquid inside the pitchers had been the subject of study of a school of botanists at Philadelphia under Prof. Macfarlane, who had definitely proved that there was secreted by the walls of the pitcher a digestive ferment which had the property of bringing into solution the proteids of the insect. Dr. Rendle emphasised the point that the pitcher formation of leaves gave one no right to conclude that that plant was an insectivorous plant.

In a paper on "Teasel-cups," Mr. R. Paulson stated that he had been investigating this subject for years, and was not satisfied that the teasel was insectivorous. How did the water get into the cup of the teasel? Some may be rain or dew, but he commenced his observations in 1921, the year of the great drought, and yet on June 28, after twenty-eight days of consecutive drought, there was water in the teasel-cup. He was convinced that water was brought up from the roots by special water-pores.

Mr. C. H. Grinling, speaking as a Nature lover, pleaded that all of his hearers might become in an increasing measure transmitters and builders of truth and knowledge, and suggested that they could never hope to be effective transmitters unless they were willing to become builders also.

Dr. A. F. Tredgold, in speaking on "Evolution and Eugenics," came to the conclusion that though the lethal chamber would do more harm to the fit who imposed it on the unfit, because the former would lose in moral character more than they would gain by the elimination of the latter, yet he thought some means would have to be adopted by which the mentally and otherwise deficient should be deprived of the means of propagation. Altruism should guide us in dealing with the living, but it should prevent the increase of living deficients.

In the Regional Survey Section, Sir Francis Ogilvie read a paper on "The Educational Value of the Regional Survey." Prof. E. B. Poulton, in the Zoological Section, took for his subject "Some Modes of Protection in the Pupal Stage of Butterflies and Moths." Papers were read on the "Communal Life of Humble-Bees," by Mr. Ray Palmer, and by the Rev. S. O. Ridley on "Problems of Deep-Sea Life."

A paper on "The Pilgrims' Way," by Mr. Elliston Erwood, was provocative of much discussion. He adopted the theory now held by most thinking persons that the Way was in existence long before Becket's time, and that it was found useful for the pilgrims. He thought that it originally came into use in neolithic times. It was no doubt of prehistoric age. It was pointed out in the discussion by Mr. E. A. Martin that it was on the line which incoming immigrants always took, right away from the first comers in palæolithic times, and that there was probably always more than one track. The Way lies on what is probably the oldest road in the country.

Dr. William Martin lectured to a crowded audience of adults and children in the Woodbridge Road Cinema on "The Film as an Educator," and with the help of Dr. Clarence Tierney, showed some good educational films. It was agreed that as yet the value of the moving film is not adequately appreciated. Some thought that it never will be until a certain class of film is rigorously prohibited.

During the congress, visits were made to Sutton Place (the residence of the Duke and Duchess of Sutherland), Clandon Park (the seat of the Earl and Countess of Onslow), and to the Haslemere Museum. At Sutton Place, a paper was read by Mr. F. H. Elsley on the house, and at Clandon Place, a paper was read which had been prepared by the Earl of Onslow.

After many years of good and valuable service, Mr. H. Norman Gray retired from the hon. general secretaryship, and Comdr. Edward A. Martin was appointed in his place.

University and Educational Intelligence.

BIRMINGHAM.—The chair of civil engineering rendered vacant by the resignation of Prof. F. C. Lea has been filled by the appointment of Dr. Cyril Batho. Prof. Batho, after a distinguished career at the University of Liverpool, studied at Berlin and at the Technische Hochschule of Charlottenburg He has had teaching experience at the University of Liverpool, and at McGill University, Montreal, having occupied posts as assistant professor of civil engineering and as associate professor of applied mechanics and hydraulics in the latter University. Prof. Batho has published important papers on the strength of materials and structural engineering, and has had practical experience as assistant designing engineer to the St. Lawrence Bridge Company on the new Quebec Bridge. He is also a member of the Air Research Committee of the Advisory Council of Scientific and Industrial Research of Canada.

The Council of the University has decided to establish a readership in geography.

The annual degree congregation is to be held on July 5.

CAMBRIDGE.—Mr. C. T. R. Wilson, Sidney Sussex College, has been re-appointed reader in electrical meteorology.

Mr. F. W. Dootson, Trinity Hall, and Mr. W. H. Mills, Jesus College, have been re-appointed University lecturers in chemistry.

Mr. W. M. Smart, Trinity College, has been re-appointed John Couch Adams astronomer.

DURHAM.—Mr. J. E. P. Wagstaff, fellow of St. John's College, Cambridge, and lecturer in physics in the University of Leeds, has been appointed professor of physics.

Dr. B. M. Griffiths has been appointed reader in botany. Dr. Griffiths is a graduate of the University of Birmingham and has been lecturer in botany in University College, Reading, and in Armstrong College, Newcastle-on-Tyne.

Dr. Arthur Holmes has been appointed reader in geology. Dr. Holmes was formerly demonstrator in geology at the Imperial College of Science and is now returning to academic life after an interval of travel and field-work.

LIVERPOOL.—Mr. J. C. Burkill, director of studies at Trinity Hall and Fitzwilliam Hall, Cambridge, has been appointed professor of pure mathematics in the University.

Mr. J. Rice, senior lecturer in physics, has had the title of associate professor conferred upon him.

LONDON.—Mr. R. C. Richards, B.A. (Cantab.), M.Sc. (London), formerly of Trinity College, Cambridge, has been appointed Quain lecturer in physics at University College.

THE Toronto correspondent of the *Times* states that Sir William Mulock, Chancellor of the University of Toronto, has announced a gift of 650,000 dollars (130,000*l.* at par) to the University from the Rockefeller Foundation for the establishment of a School of Public Health in connexion with the Faculty of Medicine. The gift will permit of the extension of the Department of Hygiene and the Public Health, Nursing, and Connaught Laboratories, which are dealing with the manufacture of insulin. Mr. Ferguson, Premier of Ontario, has announced that the Province would grant 125,000 dollars (25,000*l.*) for the new forestry building of the University.

THE London County Council has now published particulars of the Robert Blair fellowships in applied science and technology. These fellowships, two of which will be awarded each year, carry a monetary grant of 450*l.*, and they are entitled to rank, therefore, among the most attractive scholarships available for young engineers. Applicants must be British subjects at least 21 years of age, preference being given to students of engineering science, and to those who have completed a course of study in London institutions or have been identified with the London teaching service. In selecting candidates, the London County Council will have the advantage of the co-operation of a distinguished consultative committee on engineering, the members of which at present are Sir Dugald Clerk, Sir John Snell, Sir Wilfred Stokes, Mr. C. P. Sparks, and Sir Charles Parsons. The successful candidates will be required to undertake an advanced course of study or research in the Dominions, the United States, or other foreign countries, and at its conclusion to submit a report upon the work accomplished. The London County Council reserves the right to publish this report. The Education Officer, the County Hall, London, S.E.1, will supply further particulars to those interested. Applications for the fellowships should be made on or before June 30 in each year, including the present year, when the first fellowships will be awarded.

Early Science at the Royal Society.

June 8, 1664. The validity of Dr. Dacres's election into the place of professor of geometry in Gresham College being questioned, upon information given, that the lord mayor of London was not of the committee, and yet by his presence had carried the election by a casting vote; it was ordered, that Dr. Wilkins, Mr. Palmer, and Mr. Colwall be desired to consult Mr. Ellise about this business, how it might be redressed, to do justice to Mr. Hooke.

1681. Dr. Gale delivered in to the Society the copy of Domes-day book, which he had received from the heralds, being the gift of the Duke of Norfolk to the Society; which was delivered to the library-keeper to be registered, and safely kept in the library.

1682. Sir Christopher Wren, president, in the chair.—The Society discoursed further concerning the comparative measures of several countries, both of weight, length and capacity. The president inquired of Mr. Hooke the reason, why the measure of a degree upon the earth was not taken here in England, as had been formerly desired. To which he answered, that if the Society would defray the expence thereof, he was willing to take care of it; that the French in their experiments had made use of some of those means, which long before they had undertaken it, himself had propounded and discoursed of to the Society; and that in the use thereof they had doubtless been very accurate, as appeared from the account given in Mons. Picard's book. The president was of opinion, that the best standard would be a certain part of the length of a degree upon the earth, if, at least, upon several trials of the measure of a degree in several latitudes, it should be found the same, and not different, as it would be, if the body of the earth were oval, and not perfectly globular.

June 10, 1663. Col. Long communicated his observations concerning smut in corn, with the description of it, and its difference from other vices in corn; together with his conjectures of the causes of it, and the most probable means to avoid it. His paper was ordered to be registered.—It was ordered, that Mr. Packer should be asked, who it was at Billinghurst, in Sussex, that had the skill in marking those ears of corn in flowering-time, which would not smut afterwards in two or three years.

1685. A letter of Mr. Musgrave to Mr. Aston, dated at Oxford, June 6, 1685, was read, returning the thanks of the Philosophical Society, these for the Royal Society's remitting half of the weekly payments to such of their members, as resided at Oxford, and contributed to the making of experiments.

June 13, 1666. The experiments appointed for the next meeting were—The prosecution of the magnetical ones—The new watch with a circular pendulum—The application of sand to the pendulum with two balls, showing the motion of the earth and moon together.

1683. Count Zinzendorf, envoy from the elector of Saxony, having been introduced, there were first shewn the magnetical experiments made the last week by Mr. Haak. Then Dr. Slare tried an experiment of Bartholinus.

June 14, 1665. There was read a letter of Monsr. Huygens to Sir Robert Moray giving notice of Mr. Hevelius's having printed a treatise of the late comets, and expressing the difficulty of making Mr. Hooke's new grinding instrument succeed.

1682. Upon reading the account of the [so called] "Belland," a disease common among the workmen in the smelting mills of Derbyshire, which had been sent to Mr. Hooke from Manchester, by Dr. John Carte, a physician there, Dr. Grew said, that he had an account, which he was willing to produce.

Societies and Academies.

LONDON.

Royal Society, June 5.—Sir Richard **Paget**: The nature and artificial production of consonant sounds. Human speech appears to be essentially a branch of human gesture which the ear has learnt to identify, without the aid of sight, by means of its secondary effect in modifying the resonance produced by air by or through the gesticulating members of the vocal cavity. Thus, the laughter sound, Ha, Ha! is essentially a smile, made audible and emphatic by the sudden passage of vibrating air. Acoustic observations confirm this view, and indicate that speech is essentially a specialised form of facial expression.—P. L. **Kapitza**: A method of producing strong magnetic fields. An accumulator, which gives a power of the order of 1000 kw. for a small fraction of a second, and time-switches for making and interrupting strong currents up to 12,000 amp., are described. An account is given of a high-frequency oscillograph (20-30,000 per sec.) for measuring strong currents occurring during a small fraction of a second. The construction and measurement of the magnetic constant of coils for producing magnetic fields is discussed.—N. **Ahmad** and E. C. **Stoner**: On the absorption and scattering of γ-rays. The results of previously reported experiments on the absorption of γ-rays from radium B+C, after filtration through 1 cm. lead, are further analysed, and the scattering is estimated from the apparent absorption with the absorbers close to and away from the ionisation chamber. The corrected total atomic absorption is given by $\mu_a = 1{\cdot}92 \times 10^{-25}Z + 1{\cdot}60 \times 10^{-31}Z^4$ (where Z is the atomic number), with close approximation, over a wide range of elements. The scattering per electron is approximately constant, which supports the view that the first term in the above expression corresponds to scattering absorption, the second to true absorption. Estimates of the mean effective wave-length based on the two terms indicate that, for a given wave-length, Compton's mono-electronic quantum scattering formulæ give values, both for the total scattering absorption and for the actual scattering, which are lower than those observed.—V. **Henri** and H. **de Làszlò**: The analysis of the absorption spectrum of naphthalene vapour: structure and activation of the molecule of naphthalene. There is a change in the absorption spectrum of a vapour on approaching high frequencies. For low frequencies we obtain narrow bands with a fine structure. After a first limit the bands become continuous without fine structure; after a second, we get broad continuous bands. The first limit indicates an intra-molecular change in distribution of electrons; the second corresponds to ionisation of the molecule. For naphthalene, the first limit of "intramolecular ionisation" corresponds to an increase of energy of 101,000 cal. gm./mol., the second, "ionisation of the molecule," to 230,000 cal. gm./mol. The absorption spectrum of naphthalene vapour consists of two groups of bands: A, 2820-2500 Å, narrow continuous bands; B, 3200-2820 Å, narrow bands with fine structure. There are more than 400 fine bands in this group. The distribution of the bands of group B can be represented by a single formula with three fundamental atomic frequencies: $\alpha = 474{\cdot}4$, $\beta = 203{\cdot}4$, $\gamma = 62{\cdot}7$ cm.$^{-1}$. The main frequency is about half that of benzene and its mono derivatives. This frequency appears to correspond to the vibrations of the two benzene nuclei in the molecule of naphthalene. The fine structure of the band is represented by the sum of three series, corresponding to a positive, negative and zero branch. The moment of inertia of the naphthalene molecule changes on activation. The distribution of the atoms in the activated and in the normal molecule is therefore different.—W. **Jevons**: On the band-spectra of silicon oxide and chloride, and chlorides of carbon, boron, and aluminium. The uncondensed discharge through silicon tetrachloride vapour develops a characteristic system of ultra-violet bands degraded towards the further ultra-violet, and consisting of two parts, one on each side of a dense cluster composed of chlorine lines and aluminium chloride bands near λ2610. The new system is attributed to a chloride of silicon. When air or oxygen is present a second system of ultra-violet bands is developed, with heads degraded towards the red. This is ascribed to an oxide of silicon. The oxide bands are developed also in the arc in air. The aluminium chloride uncondensed discharge also develops characteristic bands in the ultra-violet, the more prominent occurring together with chlorine lines in a dense cluster near λ2610. They are degraded towards the red, forming several groups, each exhibiting an arithmetical progression of first differences of successive wave-numbers. The same cluster of bands and chlorine lines occurs in $SiCl_4$ and BCl_3 discharge-tubes with aluminium electrodes. The presence of oxygen with the chloride vapour in the discharge tube has the same effect with CCl_4 and BCl_3 as with $SiCl_4$, namely, development of an oxide band-spectrum. Band-systems, attributed originally to boron nitride, but recently to boron monoxide, are not developed with oxide bands in the tube discharge through BCl_3 and oxygen mixture.—J. E. **Littlewood** and A. **Walfisz**: The lattice-points of a circle. We denote by R(x) the number of lattice points (points both of the co-ordinates of which are integers) lying within or upon the circumference of the circle with centre at the origin and radius $\sqrt{x}$, and by P(x) the difference between R(x) and its obvious first approximation πx. It is known that for large x, $P(x) = O(x^{\Theta+\epsilon})$ where Θ is some constant not exceeding $\frac{1}{3}$, and necessarily not less than $\frac{1}{4}$. It has been proved recently by van de Corput that Θ is less than $\frac{1}{3}$ (by some undetermined amount); it is now shown that $\Theta \leqq \frac{37}{112} = \frac{1}{3} - \frac{1}{336}$. The discovery of a different and simpler line of argument than van de Corput's general method leading to $\Theta < \frac{1}{3}$ is probably of greater interest than the actual reduction of the constant.—R. C. **Johnson**: Ultra-violet emission bands associated with oxygen. Of spectra attributed to oxygen the best known are the negative band-spectrum and a system in the far ultra-violet at $\lambda\lambda$1830-1930. A well-defined system of bands, degraded to the red and stretching from $\lambda\lambda$2280 to 5000, was found in pure oxygen tubes by Stark in 1914. This was attributed by him to ozone on the basis of a comparison with the known absorption bands of ozone. This band system is now attributed to an oxygen molecule. The bands have been found to fall into 9 series well expressed by the formula: $\nu = \begin{Bmatrix} 1620 \\ 1420 \end{Bmatrix} + 16{\cdot}945\,p^2 - 13{\cdot}37\,m^2$, where m takes values from 25 to 34, and p from 55 to 47.—H. S. **Allen**: The band-spectrum of hydrogen. The wave-numbers of the lines forming the first and second bands of Fulcher in the secondary spectrum of hydrogen have been tabulated in such a way as to bring out the relations between them. It is argued that the lines of the various series S_1 to S_7 in the first band are all derived from the same molecular system. These series can be represented by parabolic formulæ of the type required by the quantum theory of the band spectra. The values of the constants in the quantum formula depend on the system of numeration adopted, which makes it difficult to arrive at a definite conclusion as to the moment of inertia of the molecule. One assumption leads to a value in close agreement with Sommerfeld's estimate

$I = 1 \cdot 85 \times 10^{-41}$ gm. cm.^{2} If, however, the series S_1, S_2 and S_3 are treated as "half-quantum" series and the series S_4 to S_7 as "whole-quantum" series, the values for the moment of inertia are practically the same for all the series, being $I = 1 \cdot 761 \times 10^{-41}$ gm. cm.^{2} in the initial and $I = 1 \cdot 827 \times 10^{-41}$ gm. cm.^{2} in the final state of the molecule. In the case of the second band the constants of the formulæ correspond to smaller values of the moment of inertia.

Royal Anthropological Institute, May 20.—Prof. C. G. Seligman in the chair.—Mrs. Scoresby **Routledge**: The Austral Islands and Mangareva, S.E. Pacific. The object of the recent expedition of the author and her husband to the Eastern Pacific was to study the culture of those districts through which the inhabitants of Easter Island must presumably have passed on their way to that island. The party reached Tahiti in July 1921, and while awaiting the means of further transit studied the archæological remains in the adjoining island of Moorea. Here various *maraes* were discovered, similar both in plan—a "truncated pyramid" at one end of an enclosure—and also in structure to the great edifice on Tahiti described by Cook and Banks. On leaving Tahiti they traversed the four islands of the Austral group. In all of these, contrary to what has been asserted, were found numerous megalithic remains. The structure was entirely different from those of Tahiti, and consisted of rectangular enclosures formed by stone slabs up to some fourteen feet in height, set up as palisades, the ground within being paved, each island having its own particular variations of form. On the island Raivavæ are also the remains of various statues, but different from those of Easter; the two principal ones are still erect and measure respectively 6 ft. 6 in. and 7 ft. 3 in. in height. In the island of Rapa-iti *marae* may be said to be non-existent, but the hill-tops are crowned by striking fortifications. From Rapa the party proceeded to the Mangareva or Gambiers. The archæological remains on Mangareva itself were disappointing, but there is a surprisingly large amount of folk-lore, some of which has been recorded in writing. They record at least three expeditions to "Mata-ki-terangi," which the natives positively assert is Easter Island. There were also collected over one hundred native songs, divided into various classes, two of which bear the same names (the "Rongo rongo," the "Iau") as are borne by certain of the Easter script. In addition a large number of folk-tales are verbally transmitted, and these were gathered from the old inhabitants.

Linnean Society, May 22.—Dr. A. B. Rendle, president, in the chair.—Presidential address. The address dealt with the work of Linnæus in Holland, his connexion with Dutch naturalists, especially with George Clifford, and the *Hortus Cliffortianus* descriptive of Clifford's Herbarium. The president also referred to the Cliffortian Herbarium (purchased by Sir Joseph Banks in 1791) and showed evidence of its intimate relation with the *Hortus Cliffortianus*. Other instances of the importance of early collections for interpreting Linnæus's *Species Plantarum* were described, namely, Hermann's Herbarium, the basis of Linnæus's *Flora Zeylanica*, and John Clayton's American collection, of which Gronovius's *Flora Virginica* is an account. These, like Clifford's Herbarium, are now in the Natural History Museum.

PARIS.

Academy of Sciences, May 19.—H. Guillaume Bigourdan in the chair.—Emile **Picard**: On certain general theorems relating to analytical functions.—H. **Deslandres**: Registration of the explosive wave of La Courtine at the observatory of Meudon. A recording microphone showed two distinct waves, with an interval of 0·8 seconds between them.—A. **Haller** and L. **Palfray**: A new mode of preparation of phenyl oxyhomocampholic acid and its constitution. The formula attributed to the acid obtained in 1900 by the action of hydrobromic acid upon benzylidenecamphor is confirmed.—L. **de Launay**: The tertiary strata of Bourbonnaise Limagne.—Gabriel **Betrand**: The fumigation of silkworm cocoons by chloropicrin. This method of treating the cocoons is shown to have advantages over the usual stoving. There is less risk of damage to the silk, the cost is less, and very little supervision is required.—Charles **Richet**: Raw meat juice in the treatment of human tuberculosis and the reconstruction of the muscles. The dried juice of raw meat has given valuable clinical results in the treatment of tuberculosis: the steady increase of weight is the most marked symptom.—Ch. **Depéret** and P. **Russo**: A Senonian fauna of Mosasaurians and Crocodilians at the base of the phosphatic deposits of Melgou (Western Morocco).—Pierre **Weiss** and R. **Forrer**: The spontaneous magnetisation of nickel. Lines of equal magnetisation.—Dr. L. Johannes Schmidt was elected correspondent for the Section of Anatomy and Zoology.—René **Garnier**: Study of the general integral of a differential system, order $2n$, round its transcendental singularities.—F. **Carlson**: Some series of polynomials.—R. **Gosse**: Determination of the equations $s = f(x, y, z, p, q)$ which admit an intermediate integral of the first order and are of the first class.—René **Lagrange**: The reducible ds^2 of two forms of Liouville.—F. H. **van den Dungen**: The determination *a priori* of the true vibrations of torsion.—G. **Grèzes**: The resistance of fluids. Description of experiments on the resistance of fixed spheres in moving water. In earlier experiments the water was at rest and the sphere in motion: the present communication deals with the case when the sphere is immobile and the water in motion.—Paul **Stroobant**: Observation of the transit of Mercury across the sun on May 8, 1924, made at the Royal Belgian Observatory at Uccle: An account of visual and photographic observations taken with five instruments of apertures from 8 cm. to 38 cm.—D. **Eginitis**: Observation of the transit of Mercury across the sun made at the Athens Observatory with the Gautier 40 cm. equatorial.—Luc **Picart, Salet,** and **Schaumasse**: Observations of the transit of Mercury across the sun. Results obtained at Paris, Bordeaux, and Nice.—Louis **Roy**: Electric currents in continuous media in motion.—Léon **Brillouin**: Reflection and refraction of the quanta of light.—Jean **Lecomte**: Qualitative studies on the infra-red absorption spectra of organic bodies. Isomerism and homology.—Max **Morand**: The spectra of ionised lithium.—F. **Wolfers**: A new optical phenomenon: interference by diffusion.—Jean **Thibaud**: The γ-rays, of very high frequency, emitted by radium.—Georges **Kimpflin**: The permeability of synthetic resin to the infra-red radiations. Results of experiments on the transparency to infra-red radiations of bakelite, pure, or charged with colloidal iron or manganese dioxide.—P. **Lemay**, C. **Guilbert**, R. **Petit**, and L. **Jaloustre**: The influence of the X-rays on the leucocyte oxidases.—J. **Escher-Desrivières**: Adsorption of polonium, in soda solution, by various substances.—P. **Lasareff**: The relations between the atomic concentration and the mechanical, thermal, and optical constants of the elements.—H. **Pelabon**: The action of potash on mercuric iodide.—Marcel **Delépine**: A new form of fenchonoxime. The characterisation of fenchone in the presence of camphor.—M. **Tiffeneau** and Mlle. J. **Lévy**: The steric isomerism of the trisubstituted α-glycols, and the preparation of the two steric isomers by inverting the order of introduction of the substituting radicles.—W. **Vernadsky** and Mlle. C. **Chamié**: A pseudomorphosis of curite.—J. **Orcel**: A new type of white aluminous chlorite.—Th. **Négris**: A new objection to Wegener's theory concerning the drift of continents.—P. L. **Rothey d'Orbcastel**: The tectonic relations between the gneiss and schists of Montolieu (Aude).—Paul **Thiéry**: Does the Bartonian exist in the Ajaccio region ?—Léon **Moret** and F. **Blanchet**: The problem of the Cretaceous in the intra-alpine zones: the "Marbres en plaquettes" of the neighbourhood of Guillestre (Basse-Alpes), their age and transgressive character.—E. A. **Martel**: The universality and importance of the phenomena of caves or natural conduits of limestones.—A. **Dufour**: The acoustic disturbance, recorded at Paris, produced by the explosion of May 15, 1924, at Courtine. Clear records were obtained although no sound was heard.—Louis **Besson**: The probability of rain.—Octave **Mengel**: The rôle of the Alps in the genesis and morphology of the storms of the western Mediterranean.—J. **Bouget**: The influence on plants of a prolonged stay at a high altitude.—J. **Nageotte**: The subcutaneous grafting of living and dead cornea and the theory of the dead graft in general.—Marcel **Duval**: The relation between the molecular concentration of the blood of the Crustacea and that of the external medium.—Maurice **Nicloux** and Georges **Fontès**: The preparation and estimation of methæmoglobin.—A. **Vandel**: Geographical spanandry in a Branchiopod Crustacean, *Lepidurus apus*.—Marc **Treillard** and André **Lwoff**: An infusorian parasitic in the general cavity of the larvæ of Chironomes: its sexuality.

Official Publications Received.

Bernice P. Bishop Museum. Bulletin 6: Tongan Place Names. By Edward Winslow Gifford. (Bayard Dominick Expedition: Publication No. 7.) Pp. 258. Bulletin 7: Polynesian Decorative Designs. By Ruth H. Greiner. Pp. iv+105+29 plates. Bulletin 8: Tongan Myths and Tales. Compiled by Edward Winslow Gifford. (Bayard Dominick Expedition: Publication No. 8.) Pp. 207. Bulletin 9: The Native Culture in the Marquesas. By E. S. Craighill Handy. (Bayard Dominick Expedition: Publication No. 9.) Pp. iv+358+8 plates. (Honolulu, Hawaii.)

Proceedings of the Indian Association for the Cultivation of Science. Conducted by Prof. C. V. Raman. Vol. 8, Part 3. Pp. 181-230. Vol. 8, Part 4. Pp. 231-288+vii. (Calcutta.)

Department of Fisheries, Bengal. Bulletin No. 20: Statistics of Fish imported into Calcutta for the Year ending 31st March 1923. Pp. 2+15. (Calcutta: Bengal Secretariat Book Depot.) 13 annas.

Memoirs of the Indian Meteorological Department. Vol. 24, Part 5: The Free Atmosphere in India—Introduction. By J. H. Field. Pp. 133-166+13 plates. 1.12 rupees. Vol. 24, Part 6: The Free Atmosphere in India—Observation with Kites and Sounding Balloons up to 1918. By Dr. W. A. Harwood. Pp. 167-216+3 plates. 1.8 rupees. Vol. 24, Parts 7 and 8: The Free Atmosphere in India. 7: Heights of Clouds, and Directions of Free Air Movement. 8: Upper Air Movement in the Indian Monsoons and its relation to the General Circulation of the Atmosphere. By Dr. W. A. Harwood. Pp. 217-273+9 plates. (Calcutta: Government Printing Office.) 1.14 rupees.

University College of Wales, Aberystwyth: Welsh Plant Breeding Station. Series H, No. 3, Seasons 1920-23: Seasonal Productivity of Herbage Grasses, by R. G. Stapledon; The Nutritive Value of Grasses as shown by their Chemical Composition, by T. W. Fagan and H. Trefor Jones; Productivity of different Strains and Nationalities of Red Clover, by R. D. Williams; A Note on Subterranean Clover, by R. D. Williams and W. Davies; Grassland and the Grazing Animal, by R. G. Stapledon, T. W. Fagan and R. D. Williams. Pp. 168. (Aberystwyth.) 12*s.* 6*d.*

Journal of the Manchester Egyptian and Oriental Society. No. 11. Pp. 58. (Manchester: Manchester University Press; London: Longmans, Green and Co.) 7*s.* 6*d.* net.

Recherches astronomiques de l'Observatoire d'Utrecht. VIII. Première partie. Pp. iv+251. (Utrecht: J. Van Boekhoven.)

Koninklijk Nederlandsch Meteorologisch Instituut. No. 106: Ergebnisse aerologischer Beobachtungen. 11, 1922. Pp. xiv+87. 2 f. No. 108: Seismische Registrierungen in De Bilt. 8, 1920. Pp. xi+62. 1 f. (Utrecht: Kemink en Zoon.)

Stanford University Publications: University Series. Biological Sciences, Vol. 3, No. 3: The Osteology and Relationships of the Uranoscopoid Fishes; with Notes on other Fishes with Jugular Ventrals. By Prof. Edwin Chapin Starks. Pp. 36+5 plates. Biological Sciences, Vol. 3, No. 4: The Growth of Dragonfly Nymphs at the Moult and between Moults. By George D. Schafer. Pp. 36. (Stanford University, California.) 1 dollar each.

Bulletin of the Terrestrial Electric Observatory of Fernando Sanford, Palo Alto, California. Vol. 1: Summary of Observations for the Period May 1920-August 1923. Pp. 32. (Palo Alto, California.)

Department of the Interior: Bureau of Education. Bulletin, 1923, No. 50: Free Textbooks for Public-School Pupils. By William R. Hood. Pp. 14. Bulletin, 1923, No. 52: Schools for the Deaf, 1921-22. By Frank M. Phillips. Pp. 29. Bulletin, 1923, No. 57: Education Tests. By Stephen S. Colvin. Pp. 28. (Washington: Government Printing Office.) 5 cents each.

Norman Lockyer Observatory. Director's Annual Report, April 1, 1923-March 31, 1924. Pp. 8. (Sidmouth.)

The University of Leeds and the Yorkshire Council for Agricultural Education. Crown Rot of Rhubarb. By W. A. Millard. Pp. 28. (Leeds.) 6*d.*

The Royal Society for the Protection of Birds. Thirty-third Annual Report, January 1st to December 31st, 1923; with Proceedings of Annual Meeting, 1924. Pp. 92. (London: 82 Victoria Street, S.W.1.) 1*s.*

Diary of Societies.

MONDAY, JUNE 16.

ROYAL SOCIETY OF ARTS (Dominions and Colonies Section), at 4.30.—Dr. C. V. Corless: The Mineral Wealth of the Pre-Cambrian in Canada.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Rev. C. Gardner: The Philosophy of the Modernist Movement. (Annual Address.)

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 6.—D. K. Fraser: Some Modifications in the Teaching of the Three R's to Mentally Defective Children.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Prof. A. D. Lindsay: What does the Mind construct?

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Major-General Sir Cecil Pereira: Peking to Lhasa (from the Diaries of the late Brig.-Gen. G. Pereira.)

TUESDAY, JUNE 17.

ROYAL SOCIETY OF MEDICINE, at 5.—Special and General Meetings.

ROYAL STATISTICAL SOCIETY, at 5.15.—J. Hilton: An Inquiry by Sample: an Experiment and its Results.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Discussion on The Pictorial Group Exhibition and F. C. Tilney's Exhibition of Oil Paintings and Water-Colour Drawings.

THURSDAY, JUNE 19.

ROYAL SOCIETY, at 4.30.—*Probable Papers*:—Lord Rayleigh: (*a*) The Non-luminous Oxidation of Phosphorus in an Oxygen Atmosphere; (*b*) The Light of the Night Sky: its Intensity Variations when analysed by Colour Filters.—Rev. Dr. A. L. Cortie: The 27-Day Period (Interval) in Terrestrial Magnetic Disturbance.—Dr. E. K. Rideal and C. G. L. Wolf: The Destruction of Rennin by Agitation: A Case of Catalysis at an Air-Liquid Interface.—W. G. Palmer: The Use of the Coherer to investigate Adsorption Films.—W. G. Palmer and F. H. Constable: The Catalytic Action of Copper. Part IV.—R. J. Lang: The Ultraviolet Spark Spectra of some of the Elements.—W. T. Astbury and Kathleen Yardley: Tabulated Data for the Examination of the 230 Space-Groups by Homogeneous X-Rays.—J. W. Campbell: The Drift of Spinning Projectiles.—Dr. A. L. Narayan and D. Gunnaiya: Absorption of Lithium Vapour.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE, at 7.45.—Demonstration of Leishmania and other Allied Flagellates.—At 8.15.—Lieut.-Col. T. McCombie Young: Fourteen Years' Experience with Kala-Azar Work in Assam.

C.B.C. SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (Joint Meeting with Workers' Birth Control Group) (at Essex Hall, Strand), at 8.—Councillor Reed, Mrs. Malone, and others: Outline of Plans for Legislation if necessary to get Birth Control Information given at the Welfare Centres.

CHEMICAL SOCIETY, at 8.

FRIDAY, JUNE 20.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Geophysical Discussion.—Dr. Harold Jeffreys: Recent Work on the Properties of Matter at High Pressures. Chairman: Hon. Sir Charles Parsons.

PUBLIC LECTURES.

MONDAY, JUNE 16.

UNIVERSITY COLLEGE, at 5.30.—Prof. R. A. Millikan: Atoms and Ethereal Radiations. (Succeeding Lectures on June 17 and 19.)

THURSDAY, JUNE 19.

SCHOOL OF ORIENTAL STUDIES, FINSBURY CIRCUS, at 5.30.—Prof. S. Langdon: Excavations at Kish, 1923-24, by the H. Weld-Blundell (for Oxford University) and Field Museum Expedition to Mesopotamia. (Succeeding Lectures on June 25 and 26.)