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Science and Religion.

AT the recent Church Congress held at Southport, several papers dealt with the relations between science and religion. This is a subject of the deepest interest to students of natural science, for the ultimate objects of religious study and of scientific research are the same. This was finely expressed by no less a person than Sir Ray Lankester, whom no one will accuse of a bias in favour of theology, when he was president of the British Association at the York meeting in 1906. In his presidential address he claimed the sympathy of the Church for the scientific student, saying that the churchman and the student agreed in this: both had turned aside their gaze from the fleeting and temporal and had fixed it on the enduring and eternal; both, in a word, sought for the absolute and everlasting beneath the never-ending flux of things.

There are, it is true, many students of science, and especially of biology, who consider religion to be a name for a mass of outworn and discredited superstitions, and think that the best hope for the progress of mankind lies in getting rid of such beliefs entirely. This, however, is a view which biologists of wider outlook find it impossible to accept. For they recognise, on one hand, that the progressive evolution of man is bound up with the evolution of society, and, on the other, that every society is, and always has been, held together by religious sanctions, even when those sanctions are submerged in the subconscious stratum of our existence. Hence the conclusion is inevitable that religious belief performs an important biological function, and that it will endure so long as society itself endures. But religion can only exercise its proper influence so long as it is believed in sincerely; and hence the importance of reconciling, if possible, such beliefs with the scientific view of the universe.

The functions of religion and science are, in fact, correlative: one strives to hold fast and preserve the flashes of insight into the real nature of things which have been granted to mankind in the past; the other is ever seeking to gain new light on Nature. The reverence of religion for what is old is justified, because great discoveries of truth, or, as our fathers preferred to call them, 'revelations,' come but very rarely, and between them are interposed many generations of ordinary men to whom no new light is vouchsafed.

Every 'revelation,' however, is necessarily framed in a background of the current beliefs of its time about the universe; and as this background changes the 'revelation' comes to be expressed in obsolete language. The reconciliation consists in finding appropriate modern language in which to express it, and in the search for this expression the modernist school of Anglican theology will have the sympathy of every student who reflects deeply on the ultimate mysteries which he encounters in his study of science.

Amongst the papers read at the congress, none excited more interest than that from the pen of the late Dr. Adami on "The Eternal Spirit in Nature." Many of our readers and contributors to our columns were friends of Dr. Adami, and sadly miss his bright cheery optimism and his infectious scientific enthusiasm. It will surprise many of them to learn that Dr. Adami, whose interests they had imagined to be confined to the technicalities of science, had reflected so deeply on the ultimate nature of things. His paper attempted the stupendous task of trying to prove from a consideration of scientific facts that there was one God Who was the author of the universe, that the nature of God was good, and was ultimately expressed in the character and teaching of the Founder of Christianity, and that the human soul was immortal. Dr. Adami's method was not that of the *a priori* philosopher: like all true scientific men he was a pragmatist, and he felt that these beliefs were justified, because when applied to the phenomena they yielded satisfactory results.

If, indeed, Dr. Adami had been successful in his attempt, then the complete reconciliation of science and religion would have been achieved: we fear, however, that we are unable to go the whole way with him. His argument for the existence of God is the presence of order and law in Nature: this order must have its ground in one grand unifying Will. Was it not Huxley himself who said that "Law, order, and abiding Force are more stupendous miracles than any to be found in our mythologies," and who ridiculed that heterodoxy which regarded the world as "a mud-pie made by two blind children, matter and force." The argument really comes to this: the human intellect, through the action of which alone religion, science, or any other kind of knowledge is possible, recognises amidst phenomena an order and regularity which it feels to be akin to its own deepest nature. Either that recognition is valid or it is illusory. If it is valid, then the ultimate nature of everything must be a Mind in some ways akin to the human mind. If it is illusory, then we are thrown back on a total agnosticism, and conclude that we learn from phenomena nothing of the real nature of things, and that our intellect, as Bergson has maintained, is only a tool-making and food-getting mechanism.

Although it is persistently ignored by shallow thinkers amongst 'practical' scientific men, there is a subjective element in all knowledge which cannot be neglected. We do not begin with 'matter,' which is an abstraction, but with 'something presented to my mind,' and the 'mind' to which it is presented is as fundamental as the 'something.' The qualities with which we endow matter are all mental, and can be expressed only in terms of perception, which is a mental function. Surely no one imagines that 'redness,' 'hardness,' and 'sweetness,' for example, exist outside of and independently of us. To describe the mind as the mere result of molecular movement is to commit an error beside which the wildest Irish bull must sound like common sense.

Dr. Adami's argument that God must be good is that the evolutionary process has led to the production of human nature, the highest aspect of which is goodness. This, again, is the old argument that the stream cannot rise higher than the fountain. "He that planted the ear, shall He not hear? Shall not the judge of all the earth do right?"

Against this argument, however, there are ranged the terrible facts of the struggle for existence and the slaughter of the unfit. If God be the author of Nature, how is this condition to be accounted for? If with Dr. Adami we reply that there is some end to be gained by this which we cannot understand, then the objector justly rejoins that every conscious-suffering individual is an end in itself, and has rights which it is wrong to sacrifice even for the well-being of another.

If, indeed, not only the human soul, but also the soul of all that suffers, survives bodily dissolution, then the ultimate satisfaction of the individual may be enhanced by suffering in some of the preliminary phases of existence. We fail completely, however, to see how Dr. Adami can prove the immortality of the soul from the facts of natural science; the utmost that can be said is that the vitalistic conception of biology leaves the possibility open. It seems to us that the essence of religious faith is the hope that God may turn out to be good, and the resolve to order our lives on this assumption. We hope, but we do not and cannot know. Dr. Adami's assertion that the highest expression of the nature of God is to be discovered in the Founder of Christianity leads us into the realm of special theology, which it is outside the province of this journal to discuss. This much, however, all will admit; that so far no finer conception of God has been presented to the human intellect than that embodied in the sayings of Christ and of some of His early followers. In the field of natural science, it may not be necessary to postulate God; but in religion, as in science, the workings of an evolutionary process are now recognised. It is through the acceptance of the idea of evolution in the spirit as well as in the body of man that the partition which formerly separated religion and science is being dissolved.

The Evolution of Voles and Lemmings.

Monograph of the Voles and Lemmings (Microtinæ), Living and Extinct. By Martin A. C. Hinton. Vol. 1. Pp. xvi+488+15 plates. (London: British Museum (Natural History), 1926.) 30*s*.

THERE is no group of mammals so likely to throw light on the manner in which new species arise as the Microtinæ, a subfamily of rodents represented by voles and lemmings, and there is certainly no one so well qualified as Mr. Martin A. C. Hinton, of the Zoological Department of the British Museum (Natural History), to bring together and to systematise all that is known concerning the distribution in space and time, the structure and habit, of this highly specialised group. It may be said at once that Mr. Hinton is producing a monograph—for the volume noted here is only the first part—of the very highest order, one which will serve the needs of systematic zoologists for many years to come. In the present volume 14 genera, including 120 species, are defined and described, a score of the species having been discovered and named by the author. Great and abiding as is the service which Mr. Hinton is thus rendering to systematic zoologists, he is doing even more for the student of evolution, and it is to this aspect of his inquiries which we desire to direct attention now.

In the common water vole, Mr. Hinton finds that although sexual maturity is attained at a comparatively early age, yet growth never ceases; growth changes are continued so long as the individual lives, so that aged animals may have the appearance of being specifically distinct from younger adults. There is, in particular, a continual transformation of all those parts of the skull which are concerned in mastication. In the water vole there is a tendency for the growth discs of long bones to remain open. More remarkable still are the growth changes in the teeth. As is well known, the development of a tooth begins with the formation of a crown and ends with the production of a root. The incisor or gnawing teeth of rodents remain perpetually young; they never proceed to the formation of a root but go on producing crown as long as the animal lives. This retention of an infantile stage in the growth of incisor teeth took place at an early stage in the evolution of rodent mammals. In the course of time this tendency spread from the incisor to the cheek or molar teeth of rodents. Mr. Hinton has demonstrated that a tendency to a delay in the formation of roots and an inclination to continue the growth of crowns has appeared in the molar teeth of various members of the Microtinæ, and at different horizons of the geological record. The molar teeth of the water vole never cease growing. Mr. Hinton also emphasises the fact that in the production of new specific forms the whole apparatus of mastication and of digestion—teeth, jaws, skull, temporal and masseter muscles, great bowel and cæcum—undergo a simultaneous and co-ordinated hypertrophy.

Now, changes of an exactly similar kind to those which Mr. Hinton has noted in the evolutionary history of voles and their allies have come under the observation of medical men. In acromegaly—a disorder of growth which occasionally overtakes men and women—jaws, muscles of mastication, skull and skeleton, and the various parts of the alimentary canal undergo just such changes as those which occur normally in adult water voles. Such growth changes in the human body are always accompanied by a disordered enlargement and action of the anterior lobe of the pituitary gland. Medical men also meet with cases in which the growth lines of bones tend to remain open, and although they cannot identify the exact part of the growth mechanism which is at fault, yet the evidence already collected leaves no doubt that the defect lies in the hormone system which regulates growth. These growth changes, with which medical men are familiar, have nothing to do with 'use and wont,' but are disordered manifestations of a growth mechanism which is resident in all living tissues.

Nowhere does Mr. Hinton mention the name of Lamarck, yet from statements he makes it is clear he must be placed amongst the followers of that great naturalist.

"Every mammal," he writes, "is the product of two distinct and sometimes conflicting forces; a compound of relatively essential characters, fixed for the time being in each group by inheritance, and of more or less plastic characters which yield like potter's clay to the thumb of stern necessity. It is the special use which an animal makes of its various organs that results eventually in a more or less perfect adaptation of form and structure to particular functions, no matter whether the special use is called into being by tempting opportunity or by the compelling stress of circumstances. Use and habit, and all that goes to make environment in its widest sense, have thus made species what they are." (p. 4.)

In this extract Mr. Hinton leaves his readers in no doubt as to the factors which he conceives as being the most important in bringing about the evolution of new species. We may take one of his remarkable examples of adaptation in order that we may probe more deeply into what his beliefs imply. In a Greenland lemming (Dicrostonyx) the fur becomes very thick as winter sets in and at the same time the claws

"of the third and fourth manual digits become highly modified for digging and subject to a remarkable and unique seasonal change; with the approach of winter these two claws grow to an extraordinary size and develop a peculiar supplementary ventral portion which sometimes surpasses the main part of the claw in length; but with the return of spring this ventral portion is shed and the main part of the claw is then worn down to normal length. The bones of the fore-arm, particularly the ulna, are greatly strengthened for the attachment of the powerful muscles which move the fossorial hand."

Now the utility of all these changes, which permit Dicrostonyx to burrow in a frost-bound soil, is very apparent, but how 'use and wont' can bring about such a series of growth changes is not at all clear. The more we come to know of the machinery of growth, the less likely does it seem that 'use and wont' can effect any direct change on structure; use and habit can bring out of the claws of the Greenland lemming just such growth responses as are already resident in them. If these responses are lacking, no matter how the lemming burrows or how hard the soil may be, its efforts will only wear the claws away. Here again we may fall back on observations made in the human body. If a hundred young recruits are submitted to the same course of hard physical training, a certain number will respond readily and fully, their muscles taking on a quite Herculean contour; others scarcely respond to the trainer's efforts. Between these extremes all intermediate stages occur. The environment has been the same for all; the response has depended on the degree to which the muscles and bones, heart and lungs, of the recruits have been endowed with the machinery which underlies the processes of growth. What is true of men is likely to hold for lemmings and voles. Environment can select, but there is no evidence that it can produce new forms.

Especially valuable is the contribution which Mr. Hinton makes to our knowledge of the evolution of the cheek teeth of the various members of the Microtinæ, for it is the characters of these teeth which give a clue to the identification of fossil species and to the evolutionary lines of their descent. The splendid series of drawings of skulls, jaws, and teeth by Mr. Terzi, and figures of the chewing surfaces of the teeth made by Mr. Hinton, render the reader's task easy. In interpreting the nature of the dental changes, Mr. Hinton has been influenced by the teaching of the late Dr. Forsyth Major, but most of his inferences are based on a first-hand study of extensive series of molar teeth. As to the accuracy of the facts observed by Mr. Hinton in the cheek or molar teeth of voles, lemmings, and their allies, there cannot be any doubt, but whether or not his interpretation of these facts will hold good, one may legitimately doubt. Indeed, Mr. Hinton has anticipated such a criticism, for in a footnote to p. 34 he states: "As long ago as 1914 Winge and I were comparing our views on this subject and he told me that I had got everything upside down. No doubt others will be of the same opinion to-day."

Voles and lemmings have three molar teeth on each side of their jaws; the middle molar is sheltered, and, in the opinion of the majority of students of dental evolution, would be regarded, on the evidence produced by Mr. Hinton, as the most conservative and primitive of the three. Mr. Hinton is of an opposite opinion. What he has demonstrated is that the free ends of the dental series, the front end of the first molars and the hind end of the last molars, are the plastic points of the dental series. One cannot see how an appeal to a multi-tuberculate theory of dental origin can explain the remarkable additions which have been made at the terminal points of the molar series of voles; the anterior 'loop' of the first lower molars and the hinder ends of the last upper appear to have in them the germinal properties possessed by the terminal sprout of a growing tree. From time immemorial crowns of teeth have been fully formed before they come into use. It is difficult to see how the manner of chewing or the degree of force exerted in this act can have brought about the changes noted by Mr. Hinton in the evolution of the molars of the Microtinæ.

We have reserved for a final paragraph a mention of the important contributions which Mr. Hinton has made, and is making, to our knowledge of the recent geological history of Britain. For the past twenty-five years he has searched the later geological deposits of England for fossil traces of the less conspicuous and smaller mammals. In the late pliocene deposits of East Anglia he has identified 13 species belonging to 4 genera of Microtinæ, the genus Mimomys being the oldest and Microtus the most recent of the pliocene forms. The high terrace of the Thames valley is evidently of the same age as the later Cromerian deposits, for in it Mr. Hinton has identified three of the genera of Microtinæ found in the late pliocene deposits of East Anglia. In the deeper or older deposits of the middle terrace of the Thames valley, fossil remains of three microtine genera occur, two of them—Evotomys and Microtus—being continued from the Cromerian horizon, while one—the genus Arvicola, to which the modern water vole belongs—appears for the first time. Mr. Hinton regards this genus as having arisen by modification from the pliocene genus Mimomys. In the upper or later deposits of the middle terrace an altogether different microtine fauna is found—one associated with a cold climate. Two forms of lemming make their appearance, and three forms of vole belonging to the genus Microtus, one being the snow vole.

No doubt this change in fauna corresponds with the maximum phase of glaciation; nowhere else in the recent geological deposits of Britain does Mr. Hinton find any sudden faunistic change—only in the later deposits of the middle terrace and of deposits of the same age, such as those found at Ightham in Kent, and in the deposits of caves in the centre and west of England. In the lowest or third terrace of the Thames valley the microtine fauna of the cold period is continued. Traces of the modern water vole appear for the first time in quite recent deposits, but it is clearly closely related to a late pleistocene vole, distinguished by Mr. Hinton as *Arvicola præceptor*, which in turn is closely related to the late pliocene genus—Mimomys. Already the water vole of Britain is showing signs of breaking up into several local varieties—the first phase in the production of new species. Clearly Mr. Hinton is justified in regarding the Microtinæ as being in a state of evolutionary plasticity, and he has also demonstrated that the fossil remains of this inoffensive and unobtrusive group of mammals supply geologists with trustworthy data on which to assign recent deposits to their proper horizons in time. The Microtinæ in their evolutionary history serve as geological clocks. Beyond a doubt the Trustees of the British Museum were well advised when they undertook the publication of Mr. Hinton's monograph.

Modern Photometry.

Photometry. By John W. T. Walsh. Pp. xxvii + 505. (London: Constable and Co., Ltd., 1926.) 40*s*. net.

IN his delightful book "With Nature and a Camera" Mr. Richard Kearton wrote (a few years ago): "It is wonderful to think that within the confines of the British Isles, on the eve of the twentieth century, it is still possible to find a man sitting on Friday night in a rude semi-underground house lighted only by the primitive stone lamp of his fore-fathers of prehistoric times." He was referring to the primitive customs of Borrera in the Outer Hebrides. It is only yesterday that *light* of any sort, however feeble, was a great achievement. Then come demands for *more light*, and for *enough light*. Finally, the request is for *enough light of the right quality* which, by its approach to the properties of daylight, will show objects not only in form but also in their true colours.

In our modern world these questions of illumination are of the highest importance, and the relative illumination necessary for various purposes has been studied, so that in building a factory, say, it will be equipped with lamps so arranged as to yield the necessary light in the right quantity. The factory owner does not, of course, purchase light directly; he must pay for energy delivered by gas or electricity. Nevertheless, the study of the most economical production and distribution of the light calls for the development of accurate methods of measuring light quantities.

The human eye is, fortunately, a very accommodating organ. It will function more or less satisfactorily over a wide range of brightnesses. Hence the question of high precision in photometry is not likely to be of very much concern to the ordinary user, who will not experience much effect from a four or five per cent. variation of illumination unless he is trying to work with nearly the minimum of light. The demand for precision comes rather from the requirements of industrial competition in lamp manufacture; in testing various lamps for efficiency and the effects of ageing; in the investigation of the various reflectors and screens. Precision spectro-photometry is, however, of considerable importance to the user who requires light of daylight quality, and also it is important from many scientific and industrial points of view.

Photometry is by no means a purely physical operation. Although the modern tendency appears to be towards the elimination of visual methods, this can only be done by a thorough study of human vision. After all, the sensation of light is a purely subjective phenomenon, and it is not to be confounded with the radiation capable of evoking it.

Mr. Walsh's latest work on photometry reflects the enormous growth of the subject during the last few decades. In his capacities of senior assistant in the Photometry Division of the National Physical Laboratory, and of general secretary of the International Commission on Illumination, he has had unequalled opportunity of becoming acquainted with all sides of the subject; his treatise is in many respects the most complete and thorough-going which is at present in existence. The chapters include discussions of all the usual principles of photometry in addition to historical notes, the eye and vision, heterochromatic photometry, colour, physical photometry, and stellar photometry. Each chapter is concluded by a large and complete bibliography furnishing references to many original papers and books dealing with the subjects under discussion. Without doubt it will be of the greatest value as a work of reference for those who have to carry out photometric operations. The text is concisely and clearly written; the reader may place confidence in its accuracy. In addition, the diagrams are numerous and well drawn.

An adequate criticism of the book is extremely difficult to give on short acquaintance. The scope is probably wide enough to cover all the interests of a photometric laboratory, but it seems also to make a bid for the interest of the physicist and astronomer. These will, however, find the treatment of photographic photometry somewhat disappointing and brief.

One of the problems of greatest interest in modern spectroscopy is the measurement of the relative intensities of the lines in line spectra, and a fuller discussion of the photographic methods would have been very acceptable. On the other hand, the book includes many paragraphs which are quite out of place; such as those giving a highly condensed version of the derivation of Maxwell's electromagnetic equations, the thermodynamic discussion of radiation laws, and so on. Nobody turns to a book on photometry for matters of this kind, especially when they are discussed with the aid of complex equations written in the ordinary lines of text, where they are hard enough to see, let alone to understand.

The reader must not object to change. Spectrum diagrams are all plotted to wave-number; in some cases the wave-length diagrams are given as well. There are obvious advantages for some physical discussions in using the 'wave-number,' but for many of the present purposes the familiar 'wave-length' is entirely suitable and adequate; there seems no obvious reason for the change from the familiar to the less familiar.

This is not the place to discuss fully the vexed question of nomenclature. The reader will, of course, find the terminology adopted by the International Commission, but in the writer's view the British section made a great mistake in translating the French 'intensité' by the English 'intensity.' In scientific English the word 'intensity' always connotes something analogous to 'energy per unit area,' but we are now asked to exchange the easily understandable phrase 'candle power' (as applied to a source) for the words 'luminous intensity.' Another recent innovation is the term 'luminous flux,' to be substituted for the term 'light.' Surely it would have been better simply to be more careful and definite regarding the use of the word 'light' rather than to introduce terms which, in the judgment of the present writer, show small signs of being generally adopted by the English-speaking scientific world, whatever is the case amongst photometric workers. Time and experience must decide, but evolution is preferable to revolution, even in this connexion. Cannot our specialists be a little more Fabian?

We may speculate in conclusion that the author of such a text-book has at the present time a very difficult task. He has a vast accumulation of material, very heterogeneous in composition, and a necessarily limited personal experience. Although some things stand out as secure and stable, there are many methods and ideas which are ephemeral and unsound. One plan is to include all the information possible, and leave it to the reader to take his choice; another is to adopt a severely critical attitude and reject all that is apparently non-essential. Mr. Walsh has at the present time avoided both extremes, but it may be hoped that the whole subject will henceforth gain in coherence and simplicity, and that this may be reflected in books of the future. The present book will, we feel sure, contribute materially to the healthy development of photometric theory and practice.

L. C. M.

Philosophy of Emergence of New Qualities.

Life, Mind and Spirit: being the Second Course of the Gifford Lectures delivered in the University of St. Andrews in the year 1923 under the general title of "Emergent Evolution." By Prof. C. Lloyd Morgan. Pp. xix+316. (London: Williams and Norgate, Ltd., 1926.) 15*s*. net.

THIS is the second course of Gifford Lectures delivered by Prof. Lloyd Morgan, and continues the first volume published under the title of "Emergent Evolution." It should be read in conjunction with the earlier volume, otherwise there are parts of the argument which might be found difficult to follow. Indeed, even with this aid, it is, it must be confessed, by no means easy reading. But the difficulty arises, in the main, from the difficulty of the subject and the profundity of the thought; and those who will make the effort to master the argument will find themselves amply rewarded. They will be encouraged in this task by the appeal that the tone and style of the writing must make to all readers, for the book, as a whole, is marked to an impressive degree by the dignity and urbanity of ripened wisdom.

Both books deal with that question of the emergence of new qualities which is so much in the centre of philosophical discussion at the present time. There are significant differences in Prof. Lloyd Morgan's treatment of the subject from that with which we are familiar in other writers, such as Prof. Alexander. We may, to begin with, get the impression that Prof. Lloyd Morgan recognises many more cases of real emergence than most writers. Even within the inorganic world he finds several stages. There are distinctively new modes of action in the behaviour of the molecule as compared with that of the atom, and again in the crystal as compared with the molecule. The novelty that occurs on the emergence of life is no different in principle from these cases. Then within the living organism we have the emergence of cognitive and reflective reference—we must not say mind—and, finally, the emergence of the spiritual or religious attitude, which consists in the acknowledgment of the working of Divine Purpose in the universe. The differences in detail of these different levels are worked out with all the wealth of knowledge and reflection that we expect of the author.

If we continue our comparison with other writers we find that, for Prof. Lloyd Morgan, if there are more emergents, they are less emergent. What emerges in general appears to be rather a new pattern of what is already there than any positively new entity. We see this when we consider what is said about the place of mind in the process. Prof. Lloyd Morgan will not allow that mind emerges at any point in the evolution of life. On the contrary, mind is there from the beginning. He maintains the doctrine of "the unrestricted concomitance of life and mind," and will only allow the emergence of new types of action of mind and new relations between the mental and physiological sides of the vital process. Mind, by which he implies more particularly the enjoyment, apparently the conscious enjoyment, of the activity of the organism, is there at the lowest stages of life. But it is not there as a separate entity, with a substantial existence of its own, coming in, as it were, from outside and introducing new forms of energy. That is the animistic or 'hormic' theory, to which Prof. Lloyd Morgan is most resolutely opposed. As against it, he maintains that mind and body are merely two aspects of the same process, "two stories," as he phrases it, about the same series of events. This, in its turn, throws some light on what happens in the passage from the inorganic to the organic. It must be confessed that on this point we should like a good deal more information about Prof. Lloyd Morgan's point of view. But it is at least clear that there is, for him, no new entity or new form of energy which emerges.

The novelty of Prof. Lloyd Morgan's theory of emergence is seen most clearly when we come to deal with his view of the object of the religious consciousness. For Prof. Alexander and his followers, Deity is a new quality that emerges beyond the human level. For Prof. Lloyd Morgan, Deity does not emerge—though human acknowledgment of it does—but pervades the whole from beginning to end. Divine Purpose *is* "the rational order of the cosmos." There is no supernatural and transcendent Being who intervenes at certain times or stages. But there is a purpose which is present in all that happens in the universe, and is none other than the "rational order" of the whole. Similarly, there is no particular point at which a naturalistic or scientific account becomes inadequate. That is always one way of looking at the facts. But, equally, there is always the other way of looking at the facts, which we call spiritual, and when we reach this point of view we have reached religion. We cannot pursue further the subtle, but difficult, argument in which Prof. Lloyd Morgan attempts to explain the sense in which he ascribes objective reality to the object of religious worship. Nor can we discuss here the degree to which his point of view is susceptible of being brought into accord with the ordinary assumptions of the religious consciousness.

The significance of the whole book is very great. To the philosopher it will, perhaps, lie mainly in the tendency which it shows not to remain contented with the simple acceptance of emergence as a mere brute fact, but to try to explain what is involved in it. Some might think that the explaining of it here comes very near to explaining it away. At any rate the main purport of the argument appears to be to reconcile the acceptance of some form of emergence with the monistic doctrine of the substantial identity of all that is, in which Prof. Lloyd Morgan is such a convinced believer.

G. C. FIELD.

Our Bookshelf

Reports of the Progress of Applied Chemistry. Issued by the Society of Chemical Industry. Vol. 10, 1925. Pp. 725. (London: Society of Chemical Industry, 1926.) n.p.

THE main impression conveyed by this compendious work is the enormous activity that is being displayed in applying chemistry and physics to the whole gamut of the arts and crafts. There may be signs here and there of radical advances, but, generally speaking, elaboration or *Ausarbeitung*, as the Germans say, seems to be the main feature of present-day work. The few who make a business of studying and card-indexing abstracts of technical literature may not require reports of this kind—for in the main they are little more than collated summaries of abstracts and patents—but the great majority of chemists who desire to keep abreast of the times will find them very valuable.

The present volume covers twenty-three of the somewhat arbitrary but necessary sections into which applied chemistry has been classified by the Society of Chemical Industry; reports on sanitation and water-purification and explosives are omitted, but the section on non-ferrous metals which was absent last year has been restored to its place in this year's volume. A considerable number of changes has been made in the authorship of sections, one of the most important being the collective contribution on paints, pigments, varnishes, and resins, by members of the Oil and Colour Chemists' Association. This innovation has much to commend it, and might usefully be extended to other sections of an omnibus character; but care must be taken that such contributions do not become inordinately long. The fact that every year sees an extension in bulk prompts the suggestion that it would be worth while to make the experiment of asking authors to deal more generally with their subjects: to lay aside their abstracts as they write, but refer to them for filling in gaps and necessary figures after writing. In this way, it is thought, the contributions would be more readable and savour more of original thought and treatment than of paraphrasing the abstract literature.

The book under review contains many contributions of high merit, and the general effect is undoubtedly good, though, as usual, there are minor points that evoke criticism. In altering the title of the first chapter by inserting the word 'General' before 'Plant and Machinery,' an attempt has been made to justify the inclusion in this section of information on beet-sugar and artificial silk production and on nitrogen-fixation, topics that are also treated in their appropriate chapters. If this report were labelled 'Chemical Engineering,' and the material of it were supplied by members of the Chemical Engineering Group, its value would be greatly improved, especially if line-diagrams were used to clarify, or obviate, verbal descriptions of plant. Unnecessary errors in spelling and hyphenation are less numerous than in previous reports, but the inclusion of such eccentricities as 'steam-line filter' (p. 12), 'electroultrafiltration' (p. 18), 'Pittsburg' for Pittsburgh (p. 14), and 'Haüsser' for Häusser (p. 189) show the need of better editorial supervision. The opinion (p. 87) that synthetic methyl alcohol "will solve the motor spirit from coal problem" appears to betray ignorance of the fact that methyl alcohol is a very poor motor-fuel; and the following statement (p. 59) bears witness to confusion of thought and style: "The decrease in the amount of tar now being distilled in the country may be gathered from the fact that the 1923 and 1924 quantities were approximately 326 and 353 million gallons respectively." In conclusion, we suggest that each volume should contain a list of the errors in its predecessor, and also the full titles of many, if not all, of the technical journals referred to in the text. How many chemists, for example, could decipher the abbreviations: S. & I. P., R., and J. Inf. Dis.?

Le magnétisme. Par Prof. Pierre Weiss et Gabriel Foex. (Collection Armand Colin: Section de physique, No. 71.) Pp. viii+215. (Paris: Armand Colin, 1926.) 8·40 francs.

ALL who are interested in the important subject of magnetism must feel that they owe a debt of gratitude to the authors of this little book. They are both distinguished for the researches which they have carried out on the subject, and as their work shows, combine skill in exposition with the imaginative faculty which belongs to the successful investigator. In this volume they have aimed at putting the reader in touch with recent researches which for the most part are to be found only in the original memoirs. Consequently they have confined themselves to a rapid summary of the definitions and fundamental laws of magnetism, though even here the careful reader will find much to repay study. Questions, such as the experimental technique and industrial applications, which have been discussed in previous works, have been left on one side.

To present the results of research in a coherent form is no easy task when they cover such a wide domain, but the authors have been successful in a high degree, and have shown how the experiments are to be interpreted by means of thermodynamics, statistical mechanics, and the anisotropy of crystals. A study of the magnetic properties of matter leads inevitably to the problem of the constitution of the atom, and thus is related to the most fundamental questions of present-day physics. To a certain extent the phenomena of magnetism are in good agreement with the atomic models which are demanded by the facts of radioactivity and radiation, but there are still unsolved problems. The theory of quanta leads to an elementary magnetic moment which is almost exactly five times the magneton deduced by Weiss from the experimental results. As the volume under notice bears the date 1926, we might have expected some account of the recent work of Sommerfeld and others, which serves to throw some light on the discrepancy. The final chapter does, however, contain a description of the quantisation of orbits in three dimensions and the confirmatory experiments of Gerlach and Stern. Though most students of physics are able to read scientific works in French, an English translation, if accompanied by some additional matter, would probably be welcome.

Kalkfrage, Bodenreaktion und Pflanzenwachstum. Von O. Arrhenius. Pp. vii+148. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1926.) 8 gold marks.

A LIST of those who have set forth their views on some aspect or other of the reaction between lime and soil would be an almost complete list of the world's soil chemists. It is not only—perhaps not chiefly—because of the economic importance of the liming of soils that so much scientific work and thought have been given to the matter. Economic considerations undoubtedly brought about the inception of the work (and still remain in some quarters the diplomatic excuse for its pursuit), but the enormous development of the work is in large measure the result of the sheer fascination of an elusive problem, which seems to be more complicated with each step taken towards its solution.

In his survey of the problem, Dr. Arrhenius gives a brief and somewhat critical review of the opinions held by soil chemists and ecologists on the relation between plant growth and soil acidity, and of the multiplicity of experimental methods which have been invoked in the study of the subject. We recognise the difficulty of giving an account of a subject with so many aspects, particularly when there is great divergence of opinion about the relative significance of those aspects, but it is not easy to understand the omission from the book of an account of the work of Hissink and of Gedroiz on the relation of exchangeable calcium in the soil to the liming problem. The conceptions which have arisen from this work are well known to be playing a prominent part both in the scientific study of the liming question and in the solution of economic problems of farming. It is to be hoped that in a future edition some account of this aspect of the work will be given and the appropriate additions made to the otherwise valuable and extensive bibliography.

A feature of the book is a concise account of the work—to which the author has himself made important contributions—of the observed relation between the weight of crop and the hydrogen ion concentration of the soil. Not all soil chemists and ecologists are able to agree with Dr. Arrhenius about the significance of this work and the validity of the conclusions drawn therefrom, but this account will be valuable both to its exponents and its critics. N. M. COMBER.

Colloid Chemistry: Theoretical and Applied. By Selected International Contributors. Collected and edited by Jerome Alexander. Vol. 1: Theory and Methods. Pp. 974. (New York: The Chemical Catalog Co., Inc., 1926.) 14.50 dollars.

MR. ALEXANDER, with the aid of sixty contributors of a dozen different nationalities, has made a gallant attempt to produce a comprehensive treatise on colloid chemistry in English. His success may be measured by the mass of useful material which is here presented, though the arrangement does not always make it readily available. The more general papers, for example, Harkins on surface energy, Hardy on lubrication, Freundlich on adsorption, Gibbs on aerosols, and Hatschek on viscosity, are models which might with advantage have been followed by some of the less eminent authors. The detailed discussion of any particular piece of experimental work is only permissible in a book of this kind when some very general principle is thereby illustrated, and on these grounds some half-dozen of the papers here printed should be relegated to the ordinary journals; their inclusion tends to produce the atmosphere of a *Festschrift*. Again, the actual matter of some of the articles is already available elsewhere; for example, that of Millikan on measuring the electrons, and the unduly long account given by Von Weimarn of his theory of the colloidal state. It is to be hoped that in the two volumes to follow the editor will be less merciful, even though his contributors write without hope of reward.

The ingenuity with which this mosaic of essays covers the field of theory and method is remarkable, but it is curious to find that the fundamental process of dialysis receives only a casual mention in two places. Recent developments in the use of electrodialysis are also neglected. No pains have been spared to provide adequate bibliographies, diagrams, and indexes, and with some patience in use this volume will form a valuable addition to the shelves of the colloid chemist.

P. C. L. THORNE.

Pflanzen als Gesteinsbildner. Von Julius Pia. Pp. viii + 355. (Berlin: Gebrüder Borntraeger, 1926.) 19·50 gold marks.

THIS book, which is founded in part on lectures delivered at the University of Vienna, aims at providing a comprehensive treatise on plants as rock-builders. It is intended both for geologists and botanists, but the whole mode of treatment is botanical rather than geological. The account of the Bacteria and Algæ, with which the book opens, will be useful to many students, though the amount of botanical detail included seems scarcely relevant to the main purpose of the book. Indeed, before the Cormophyta are reached, the reader can scarcely fail to become aware of a certain lack of proportion in the scheme of the work; nearly half the volume is devoted to the Bacteria and Algæ, while about the same amount of space is deemed sufficient for the higher plants from Bryophyta to Angiosperms. Even within the latter section of the book, the space assigned to different topics seems to have been allotted with little regard to their relative importance. Less than a dozen pages, for example, are assigned to the Coal-measure flora, whereas more than forty are devoted to marsh and moorland plants of the present day, which are included on the strength of their function as peat-formers.

The book is lavishly illustrated, the figures being mostly taken from well-known sources, which are cited. It may seem ungrateful to quarrel with such a wealth of excellent drawings in a book which has, to a certain extent, a popular aim, but one cannot but regret the space consumed by figures of some fifty flowering plants of the present day. The student, whether of geology or botany, would willingly have dispensed with some of these pretty pictures in favour of fuller bibliographies, especially in connexion with the chapter dealing with coal and its origin.

The Psychology of Social Institutions. By Prof. C. H. Judd. Pp. ix + 346. (New York: The Macmillan Co., 1926.) 8*s.* 6*d.* net.

"THE purpose of this book is to concentrate attention on the fact that social influences are of the highest importance in determining the character of human thought and conduct." To instincts and other inborn traits the author attributes little importance. This point of view now meets with widespread approval, and it is not proposed to quarrel with it here. There can be little doubt that the older social psychology, founding itself upon observation of the individual, over-emphasised the rôle of the so-called instincts of gregariousness and acquisition and the like. Whatever may have been the case with regard to the origin of institutions in respect to the part played by instinct, there is no question but that the vast accumulation represented in our social heritage now predominates in determining social conduct in general. Prof. Judd's book is to be welcomed in that it provides for the student an examination of certain social institutions at some length, during the course of which this point of view is kept continuously to the fore. But it cannot be said that the book contributes anything definite towards the solution of the numerous problems connected with the whole subject. It may be replied that this was not its purpose, and if this is so, then it has certainly fulfilled its limited object in driving home this one important lesson. A. M. C.-S.

British Birds. Written and Illustrated by Archibald Thorburn. New edition. In 4 vols. Vol. 3. Pp. x + 168 + 48 plates. (London: Longmans, Green and Co., Ltd., 1926.) 16*s.* net.

THE third of the four volumes of Mr. Thorburn's new book on "British Birds" has now appeared, and fully comes up to the standard of its predecessors. It contains a further series of coloured plates of high merit, although a few, such as that of the lapwing, are decidedly less happy than the majority. We are glad to see that the female plumage is portrayed in very many cases, as is certainly necessary with such birds as ducks and game-birds, two of the principal groups dealt with on this occasion. Both sexes of the ptarmigan are shown in each of their three seasonal plumages. We could wish, however, that the nestlings also had more often been included in the plates, as has here been so successfully done in the case of the ringed and golden plovers.

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.*]

Early History of Gaseous Adsorption.

THE publication in a recent part of *Proc. Roy. Soc.* (A, Sept. 1) of excerpts from the memoir of 1863 by Dr. R. Angus Smith of Manchester, on " The Absorption of Gases by Charcoal—(i.)," by the initiative of Mr. S. Lenher, calls to mind Angus Smith's service in collecting, with the help of James Young of Kelly, the scattered scientific papers of his friend Thomas Graham, in 1876. No more attractive account of the history and philosophy of the atomic theory exists than the short introduction which he prefixed to that volume. Physical chemistry was then being born, and the relevant ideas about atoms and the aether were in the foreground.

The John Hunter whose paper (*Journ. Chem. Soc.*, 1865) is referred to by Mr. Lenher was, I doubt not, the assistant trained to this kind of work by Thomas Andrews at Belfast, who died young. In Andrews' address to the Chemical Section of the British Association in 1871 (" Scientific Papers," ed. Tait and Crum Brown, p. 348), which was a survey of the main recent advances, he devotes a paragraph to the work of his assistant.

" Hunter has given a great extension to the earlier experiments of Saussure on the absorptive power of charcoal for gases. Cocoanut-charcoal, according to Hunter's experiments, exceeds all other varieties of wood-charcoal in absorptive power, taking up at ordinary pressures 170 volumes of ammonia and 69 of carbonic acid. Methylic alcohol is more largely absorbed than any other vapour from 90° to 127° : but at 159° the absorption of ordinary alcohol exceeds it. Cocoanut-charcoal absorbs forty-four times its volume of the vapour of water at 127°. The absorptive power is increased by pressure."

One recalls that the late Sir James Dewar, who presented to science the technique of charcoal absorption at low temperatures, spent his earlier years at Edinburgh, where the work of Andrews would be familiar through his friends Crum Brown and Tait.

JOSEPH LARMOR.

Cambridge, October 1.

The Structure of the Continents.

IN his letter on this subject published in NATURE of September 25, Dr. Harold Jeffreys cautiously favours the possibility that " the basaltic layer below the granite may be in a glassy state, as Daly has suggested," and he goes on to add that the underlying layer may well be dunite. The evidence in favour of this view is based on:

(*a*) Earthquake records which show that compressional waves are transmitted through the upper layer with a velocity of 5·6 km./sec. ; through the lower layer with a velocity of 7·8 km./sec.; and through an intermediate layer with a velocity (measurable in one case only) of 6·2 km./sec.

(*b*) The work of L. H. Adams and R. E. Gibson (*Proc. Nat. Acad. Sci.*, May 1926, p. 275), which gives the velocities calculated from the observed compressibilities and densities, at pressures corresponding to depths of about 30 km., as 6·45 km./sec. for tachylyte (basaltic glass) and 8·2 km./sec. for dunite (peridotite composed mainly of olivine). As these results refer to ordinary temperatures, those corresponding to the temperatures below the granitic crust would be a little less.

The possibility of a layer of basaltic glass between granite and dunite—both crystalline rocks—seems improbable on general grounds. If the basaltic layer be glassy, then one would expect the dunite also to be glassy, in which case the velocity of compressional waves would probably be less, instead of greater, than that within the lower layer of the continents. On the other hand, if the dunite be crystalline, then the basaltic layer should also be crystalline, particularly as its existence is referred to differentiation due to the crystallisation and sinking of olivine ; for if olivine could crystallise it is difficult to imagine conditions which would inhibit the crystallisation of pyroxenes and felspars (or a high-pressure equivalent). But in this case the velocity of compressional waves would be 6·9 km./sec. or more. Evidently all that can be safely deduced from the evidence is that the basaltic layer is not mainly composed of gabbro.

There is, however, an alternative interpretation of the intermediate velocity recorded by Jeffreys which should not be overlooked. L. H. Adams and E. D. Williamson (*Journ. Franklin Inst.*, April 1923, p. 520) have calculated the corresponding velocities in syenite and granodiorite at 6·2 km./sec., and in diorite at 6·4 km./sec. If, therefore, the granite of the upper levels of the continents passes down into diorite, a reasonable explanation of the intermediate layer is forthcoming. In a recent paper (*Geol. Mag.*, July 1926, p. 317) I presented chemical and petrological evidence supporting the hypothesis that the continents were originally of granodiorite composition, and that as a result of igneous processes, mainly in pre-Cambrian time, the upper levels have become more granitic, leaving a complementary differentiate of diorite in depth. This hypothesis is in accordance with the great abundance of diorites and andesites in zones of later mountain folding, and with the absence of any widespread intrusions of post-Cambrian granites comparable in their regional extent with those that preceded them in pre-Cambrian time.

If the intermediate layer of Jeffreys be identified with diorite instead of with basaltic glass, then the basaltic layer should exist in the high-pressure crystalline facies of eclogite. Unfortunately, the compressibilities of garnets or eclogites at different pressures have not yet been determined, but it seems probable that the velocity of compressional waves in eclogite would not differ seriously from that in dunite. A layer of eclogite passing gradually down into dunite at some unknown depth would then satisfy the seismic, petrological, and isostatic evidence. In view of the great importance of testing this interpretation in the most direct possible way, I have expressed to Dr. L. H. Adams and his colleagues my hope that they will add to their work on basaltic glass and dunite a similar investigation of the elastic properties of eclogite.

A further objection to the identification of the intermediate layer with basaltic material, whether glassy or otherwise, arises from its shallowness in the crust. If, as Jeffreys suggests, it extends from a depth of 10 or 15 km. to a depth of 20 or 30 km., then it is difficult to understand how it could ever be raised to the high temperatures implied by the great extrusions of plateau basalts which from time to time in geological history have overwhelmed enormous areas in different parts of the world. This difficulty is relieved by the conception of an eclogite layer extending downwards from a depth of 20 or 30 km. into a region where the temperature is higher and heat of radioactive origin can be accumulated.

ARTHUR HOLMES.

The University, Durham, September 25.

Science and Psychical Research.

As I shall be shortly leaving for New Zealand, perhaps a little space may be granted me to reply to a number of letters which have appeared in the recent issues of NATURE, from the pens of Sir Bryan Donkin, Mr. Campbell Swinton (3), and Mr. E. J. Dingwall.

Some of the confused thinking represented in these letters may perhaps be stopped if I explain the genesis of the original article which has provoked the discussion. The editor of NATURE asked me to write a review of Sir Arthur Conan Doyle's book *from a scientific viewpoint*, and I said I would try to do it. After reading through the two volumes very carefully, I concluded that there was nothing scientific about the book. I do not care for merely destructive criticism, as I think that a badly written book is its own worst condemnation. Also I am not yet so far removed from youthfulness as to have forgotten what I owe to the talented author, for giving us, long ago, " The White Company " and the adventures of the immortal Sherlock Holmes. So I told the editor that I had decided not to undertake the task. He then suggested to me that I should write an " essay review " ; that is, using the book as a peg, I should hang upon it a dissertation on a cognate subject of scientific interest, namely, psychical research. I accepted this offer, and chose the subject which has started the present discussion. Apparently it sufficed for some minds to draw the conclusion that, because my essay was hung upon a spiritualistic peg, therefore psychical research is the same thing as spiritualism ! No doubt, if I had written an essay review on the subject of evolution, hanging it upon a book on neo-Lamarckism, let us say, as a peg, the same type of mind would deduce that this indicated that evolution was the same thing as neo-Lamarckism !

That psychical research and spiritualism are not at all the same thing can be easily demonstrated, I think, if we take the cases of two famous exponents of psychical research already more or less discussed in these letters. I refer to Lodge and Richet. Both are admittedly psychical researchers of the first rank. Lodge is also a spiritualist, having come to the conclusion that survival is proved from his interpretation of the facts of psychical research. Richet, admitting the truth of the same set of facts, but interpreting them from a very different viewpoint, is still a kind of ' super-materialist,' absolutely and irrevocably opposed to the spiritistic hypothesis, which he holds is disproved by some of the very facts of psychical research ! Could anything be plainer, then, than that psychical research and spiritualism are two entirely different things ? What should we say of the mentality that confused biology with neo-Darwinism or with neo-Lamarckism ? What are we to think of those who confuse a line of experimental research with one of the hypothetical conclusions which, in the opinion of only a portion of the researchers, arises out of it ?

Let me now reply more particularly to Mr. Campbell Swinton, who has been a fair and, on the whole, courteous opponent, though sadly tempted at times, I fear, to let out and say what he really feels. Perhaps I may be ready to meet him half-way in his criticism that the medium is not absolutely comparable with the microscope or the chemical balance ; I ought perhaps to have used a closer simile and likened the medium rather to the catalytic agent, the presence of which is essential to the production of the phenomena in certain types of chemical change. What I wanted to bring out, and what I still maintain, is that a genuine medium is not *actively* a participant in the experiments ; the phenomena are produced *through some extended action of his subconscious mind*, but not by active volition on his part.

Mr. Campbell Swinton ought to know that a set of negative results in an experiment does not prove anything when confronted with even a single well-authenticated positive result from the same experiment. How many times have we, who have taught chemistry in schools, seen some of the most carefully prepared experiments fail to succeed, to the great delight of the assembled class ? Yet, once the positive result is obtained, the acute mind of the boy knows at once that the negative results are cancelled, and one good demonstration is enough for him. It is only muddled thinking of the adult mind which persists in quoting a series of negative results as decisive.

As regards psychic photography, the decisive positive result, in my opinion, has never yet been obtained. So, in this particular case, I entirely agree with Mr. Swinton that there is *a high probability* that there is nothing in it. Many psychical researchers think the same ; but spiritualists, on the whole, believe the opposite. The question could be settled once for all, to everybody's satisfaction, if one of the alleged photographic mediums would consent to experiment under absolute test conditions in which he would not be allowed to handle the plates or to have access to them at any stage of the proceedings. But I venture to think that it will be a very long time before any such thing as this is likely to happen.

I think it is rather hard that all my critics should waste so many words on trying to prove that I am a spiritualist and that spiritualism is a delusion. If any of them had come to the National Laboratory of Psychical Research last week they would have heard my address on this very subject, in which I took the stand that the spiritistic hypothesis does *not* fit in with all the known facts of the case, and pleaded for a more thorough and scientific study of the phenomena, with the view of finding a general theory " which should harmonise all the discoverable facts in the same way that Darwin's great theory of Evolution harmonised all the known facts of biology." Surely Mr. Swinton, at any rate, will concede that I have never diverged from that view in the whole of this long discussion ?

I am sorry that Mr. Swinton departed a little from the high level of his debate in the last paragraph of his letter in NATURE of September 25. The words *suggestio falsi* sound, to my ears, somewhat offensive, especially as the idea behind them has been derived from the second-hand information of mischief-makers, and has not been verified by Mr. Swinton himself. There are more than six hundred firms, associations, and companies in the London Telephone Directory having names beginning with the word ' national '. I think I need say no more than that we can justly claim to be quite as national in our organisation and outlook as most of them. But as an excuse for refusing my invitation the objection to the word is surely puerile. Why does not Mr. Swinton say that he has never in his life been to a séance and never intends to go to one ? I would have preferred this direct statement to the somewhat unkind and unworthy innuendo which he makes instead. But, in any event, Mr. Swinton stands self-confessed as an illustration of the type of scientific man about whom I wrote my article, namely, the man who presents " an unscientific attitude to the subject of psychical research." I claim that the letters written by him and my other correspondents fully prove my point.

Mr. Swinton's remarks in his last letter, published in NATURE of October 9, are entirely correct and in agreement with my own views, except for his last paragraph. I never classed Richet with Crookes and Lodge " as a spiritualist " but only as a psychical researcher. To do so would be " most misleading " if I had been dealing with spiritualism, but I was not. The title of my essay was " Science and Psychical Research," not " Science and Spiritualism." My plea to men of science is for a more scientific attitude of mind *towards psychical research*, not towards spiritualism.

Sir Bryan Donkin has gratuitously given his own interpretation to the words " supernormal phenomena," thereby ruling out all those manifestations which I consider to be the key to the whole situation. I have more than once stated that I do not know the difference between trance and sleep. If Sir Bryan does, will he please tell us ? If he does not, why does he take up an attitude which will forever prevent the problem being solved ? If some of our leading medical men would spare a little time, even though they be, as I am, hard-worked to the very limit, we should soon know something about this mediumistic state. But I have seen excellent supernormal phenomena produced with the medium wide awake and absolutely controlled and immobilised in good light ; so the question as to what trance may or may not be does not touch the essentials of my argument. Sir Bryan cannot have it both ways. If he is opposed to the scientific examination of the trance state, then he takes an unscientific attitude towards this phenomenon and is another of those to whom my article was addressed. But if he thinks it ought to be studied, then he should range himself on my side in this discussion.

Mr. Dingwall, I can surely claim, agrees with me, for he uses my very words in his last paragraph. He says, " There is a good case for the scientific study of what are called supernormal phenomena." That is exactly what I said too ! But the rest of his letter shows clearly what he wanted to imply, namely, that Dr. Tillyard had not seen enough supernormal phenomena to enable him to judge rightly. I concede readily that I have not seen anything like so much as Mr. Dingwall ; if he were logical, he would *a fortiori* exclude Mr. Swinton and most other men of science from this discussion, as they have not even seen as much as I have seen. Why pick me out and leave them in ?

Mr. Dingwall asks, very pertinently, " Can Dr. Tillyard tell us of any single medium who can produce some simple raps, under conditions which render their normal reproduction impossible ? " Yes, I can. Stella C. has repeatedly, both in my presence and in that of many others, produced such raps inside a close Pugh Table at a distance from herself. Mr. Dingwall will doubtless criticise this experiment, as he has done to me personally, on the ground that, as the box is closed, nobody could really see what was going on inside it. Yet, in his report on the Margery mediumship he says that he particularly requested that the phenomena should be done inside a closed box, and, when this request was refused, he regarded it as highly suspicious. In other words, Mr. Dingwall is always ready with an argument *against* any particular experiment, even though his objections mutually destroy one another.

I would like to assure Mr. Dingwall that it is not the number of séances that a man attends, but his capacity to draw definite conclusions, which really matters. Mr. Dingwall has attended hundreds, but he is still in a mental fog, just like the schoolboy whom we all know, who may be given an experiment to do many times over, but can never make a clear deduction from it. I am quite content with the eight séances which I have attended. In two of them, undoubted evidence of fraud was easily discoverable. In one other there was no analysable result. In the other five, with three different mediums, definite supernormal results followed under strict test conditions. In other words, I have obtained, *five times over*, a definite proof that supernormal phenomena do undoubtedly occur, and so I join the ranks of those who, like Lodge and Richet, are convinced of this fact. No amount of negative evidence can outweigh these positive results. Let me also assure Mr. Dingwall that I am not very likely to add largely to my psychic experiences, not being a hunter after sensations. I have seen Sir Ernest Rutherford's experiment on the bombardment of the atom demonstrated twice. It is enough. I accept the fact that the atom can be broken up, and no longer desire to go on attending lectures which keep on proving the same thing. I have seen supernormal phenomena in abundance produced at five controlled séances. It is also enough to convince me that they occur. What is the true explanation of them remains still to me at least a partial mystery ; according as the evidence may unfold itself in the future, I may yet find myself with either Sir Oliver Lodge or Prof. Richet.

Finally, let me again plead for a more scientific attitude of mind on the part of men of science towards psychical research. Perhaps I may live to see it, if I succeed in attaining the allotted span.

R. J. TILLYARD.

REFERRING to the discussion on this subject in previous issues of NATURE, might one ask : Is there not confusion regarding the aims of science and of psychical research, which at present are fundamentally dissimilar ? We know that the object of experimental science, as distinct from philosophy and mathematics, is to obtain control over the energies of Nature by learning the laws inherent in matter ; that science has never set a limit to the varieties of matter ; that, consistent with its purpose, it accepts facts as it finds them ; and that its function, *qua* science, has never been to prove *a priori* conceptions. Some of us forget, however, that the elementary conditions essential for the pursuit of its object are not compatible with the objects and conditions of psychical research. By way of contrast a simple statement of scientific requirements might be made as follows :

1. The first two indispensable and interdependent factors in any scientific problem are the trained research worker and *something to be examined*. The thing to be examined may not have been contacted by all the physical senses, as, for example, electricity ; but it must have been experienced by means of one sense-faculty, at least, before it will come to the attention of human beings or within the range of scientific research. (Scientific instruments are merely the extension of our physical senses.) It was not necessary to prove the existence of electricity ; the problem was first, how to induce, and second, how to control or direct it.

2. It is essential for real scientific research that the matter investigated be, to some extent at least, under the control of the investigator, and this is possible only through his knowledge of the laws which describe the action of energy under certain specified conditions.

3. Science has advanced each step in its progress on the knowledge of laws already ascertained. Much was known concerning the chemical elements and conductive materials before electro-chemical phenomena could be investigated. Every factor in an experiment cannot be new.

4. Science requires for each advance a working hypothesis or theory about what is next to be discovered. The theory may be proved wrong, but nothing at all can be attempted in fresh fields without

a tentative supposition, a temporary theory which suggests a particular line of investigation, or some reason for doing one thing rather than another.

Now, the phenomena described as 'psychic' cannot come within the purvey of science if we accept the conditions given above. Men of science cannot examine something non-existent to them, and of which, consequently, no data exist, for there is then no basis for a beginning. It is impossible to undertake to 'test' that about which we know absolutely nothing. Thus a Gilbertian situation arises when it is proposed to examine 'psychic phenomena' scientifically: (1) The matter to be tested has as yet no existence; therefore (2) we know no laws by which its action could be induced; (3) we have no theory regarding its nature, laws, or cause; (4) we cannot control its production; (5) we do not know the nature of the medium through which it is proposed to attempt to induce the phenomena; and (6) the investigator cannot control or direct the energies which supposedly must operate to produce results.

Before science can enter this field there would have to be (1) an acknowledgment, derived from experience, of the reality of psychic phenomena; (2) the formulation of a scientific theory or working hypothesis of the possible laws inherent in the matter of the phenomena; and (3) some means found by which the experimenter could control the operations of the experiment. One does not by this preclude the possibility of prediction by mathematical science of the existence of a kind of matter hitherto unknown, a hypothetical state of organic matter, acting under electro-magnetic laws, analogous to inorganic states of invisible electro-chemical matter. Such a prediction could arise only from a more exact knowledge of physiological and psychological activities; but the first step in a true scientific investigation of 'psychic phenomena' cannot be taken until some deduction or other is attempted. It is necessary, therefore, for serious investigators of this phenomena, who affirm its existence, to state a case, to enunciate a working hypothesis not contradictory of the fundamental principles of exact science. The collection of instances and theories thereon, or hit-and-miss experiments in the vague expectation that something will be discovered, have never, and could never, in themselves, evolve a science. Terms used should be defined in such a way as to conform to the 'uniformity of Nature,' which is the one great deductive theorem of science. We know, however, that, although man is included in Nature in the largest sense of that term, science has as yet gained control only of energies latent in the mineral forms of existence and of *states preceding mineral precipitation.* The energies of the forms that *succeed, i.e.* of plants, animals, and man, have not been made subject to exact science. We have no practical knowledge of the laws that originate organic forms and govern their growth. Further, no man of science can alter the temperament or constitution of a human being, nor can he *isolate sensations, emotions, or thoughts from exterior influence and regulate them according to prescribed formulæ.* Hence, scientific attempts to isolate a 'medium' are childish. Equally puerile are 'tests' by measuring instruments. The *vacuum tube* preceded the measurements of the phenomena of modern physics. What is to be the vacuum tube for psychical investigation?

W. W. L.

How can the methods of scientific research be applied to the subject of the spirit world, which is of such post-vital interest to us all? To do so under existing conditions is generally impossible and always difficult. Faraday wrote to a friend: "I have been busy turning the tables on the table-turners." That statement was based on the results of definite experiments carried out under his own conditions.

In present circumstances, to follow Faraday's example and apply science to psychics is not easy. Would any manager of importance take his medium to the Royal Institution and submit without reserve to laboratory conditions?

Cannot the difficulty, if it does exist, be overcome by the use of scientifically trained mediums? Suppose, for example, prominent spiritists were engaged, in the first instance, to examine the staffs of colleges and scientific institutions throughout the country. It is probable that from such plentiful material a sufficient number of mediums of even moderate power could be obtained, when it is remembered that from one family alone a father, two daughters, and a son-in-law were all able to practise successfully as mediums. It would be desirable to exclude all who already have committed themselves intensely, those whose interest is mercenary, writers of imaginative articles for profit, those who seek prominence, and those imbued with the spirit of mischief.

Given the willing medium whose sole interest is science, and given suitable laboratory conditions, it should be possible to test the scientific basis of the claims of spiritists. It might even be possible to entice a ghost between crossed Nicols.

JAMES WEIR FRENCH.
Anniesland, Glasgow, W.2,
October 6.

Transmission of Stimuli in Plants.

THE transmission of stimulation past a discontinuity has been demonstrated in Mimosa by Prof. Ricca and confirmed by Mr. Snow and others. On the other hand, Sir J. C. Bose has stated (NATURE, vol. 115, Jan. 10 and March 28, 1925, and also *Proc. R. S.*, Series B, 98, p. 290) that he was unable to obtain this result.

I have for some time past been engaged in work on the transmission of stimulation in *Mimosa pudica.* Apart from my main line of work, and more as a matter of interest than from any doubt as to its validity, I have attempted to repeat this experiment. The method used was that described by Mr. Snow (*Proc. R. S.*, Series B, 96, p. 349) in which the two parts of the shoot are connected together by a piece of water-filled rubber tubing.

The directions given by Mr. Snow were followed carefully, but for a long time I was not successful in obtaining the transport of the stimulus past the cut, although the experiment was repeated on a number of different occasions. The cause of the failures was finally found to be due to minute bubbles of air which emerged from the pith as the tension in the water increased. These bubbles collected in the space between the cut surfaces and interrupted the continuity of the water separating the two portions of the shoot. In Mr. Snow's experiments this effect does not seem to have been encountered, but possibly Sir J. C. Bose's failures are to be attributed to this cause. It may be of interest to describe a method which I have found successful in avoiding this difficulty.

A shoot was cut into two halves under water and the portions placed in a beaker of water in such a way that the two freshly cut surfaces were completely submerged. The beaker was then put into a large empty desiccator from which the air was exhausted by means of a vacuum pump. In this way air was removed from the intercellular spaces of the pith of the cut internode and, when air was readmitted to the desiccator, these spaces became injected with water. The two portions of the shoot were removed and connected with water-filled rubber tubing in the usual way, the two cut surfaces being brought very close together. The whole shoot was then supported in air in a horizontal position, the basal end being immersed in water. After a resting period of two hours, to enable the shoot to recover its normal condition, it was stimulated by the application of a flame to a basal internode.

On the two occasions on which the experiment was tried, using the above-mentioned method, the stimulus affected, first of all, the leaves on the basal portion of the shoot, and then, after a pause of more than one minute, it traversed the water-gap and affected the leaves in the apical portion. For example, in one case, the two leaves in the basal part moved after 4 sec. and 8 sec. respectively, while beyond the discontinuity the times at which the leaves moved were 1 m. 16 s., 1 m. 49 s., 2 m. 21 s., and 2 m. 29 s.

If Sir J. C. Bose will repeat his experiments, using the precautions mentioned above, I am sure that he will be able to convince himself of the need of modifying his statements (Nature, vol. 115, Jan. 10, 1925) "that the transpiration-current has nothing to do with the conduction of the excitatory impulse" and that "*the conduction is a phenomenon of propagation of protoplasmic excitation.*" There is no doubt that the stimulus can be carried across a discontinuity by means of the transpiration current, and that in this case, at any rate, the conduction has nothing to do with "the propagation of protoplasmic excitation."

It is somewhat surprising that Sir J. C. Bose (*Proc. R. S.*, Series B, 98) should have failed to obtain stimulation by applying extracts of the stem to the basal end of a cut shoot. This result, which was obtained originally by Prof. Ricca and amply confirmed by others, strongly favours the hormone theory. Personally, I have not found the least difficulty in obtaining stimulation in this way.

Nigel G. Ball.

University College, Colombo,
August 18.

Electric Television.

Invention appears to be multiplying in regard to this interesting subject, and I hear that more than one inventor in Paris is employing, for receiving, the cathode ray arrangement that I believe I was the first to publish in a letter to Nature of June 18, 1908. The ideas embodied in this arrangement had occurred to me several years prior to that date, indeed not long after the production of the Braun cathode ray oscillograph invented in 1897. I actually tried some not very successful experiments in the matter of getting an electrical effect from the combined action of light and cathode rays incident upon a selenium-coated surface, in which I was assisted by the late Prof. G. M. Minchin, himself a great authority on electric cells sensitive to light, and also by Mr. J. C. M. Stanton. The transmitting apparatus consisted of a home-made Braun oscillograph in which a metal plate coated with selenium was substituted for the usual fluorescent screen, the image to be transmitted being thrown by a lens upon the selenium surface, and the end of the cathode ray beam being caused electromagnetically to traverse the projected image. Experiments were also tried in receiving with a Braun tube which I purchased in Germany, but in its then 'hard' form it proved very intractable.

My ideas in regard to this cathode ray arrangement for the production of television were further detailed and illustrated in an address I gave to the Röntgen Society on November 7, 1911, and still further elaborated and brought up-to-date, with wireless methods applied, in a paper I read before the Radio Society of Great Britain on March 26, 1924.

My idea, which was to use cathode rays as employed in the Braun oscillograph, instead of moving material parts, both in the transmitting and in the receiving instruments, is, as I understand, only at present being applied for receiving, mechanical apparatus being still used for transmitting. I desire, however, to point out that when the cathode ray is also applied to transmitting it will be possible to dispense entirely with all moving material parts, as the alternating or intermittent electric currents employed for moving the two cathode ray beams synchronously at the transmitting and receiving stations respectively can be supplied by oscillating thermionic valves supplied by batteries.

In this way it should prove possible to have electric television of a satisfactory fine-grain description without the employment of any mechanical motion of material parts whatever, as cathode rays are practically without weight and inertia, and can be deflected with perfect accuracy and synchronism at almost incredible speeds, while the accuracy of oscillating valves properly tuned is also wonderful.

A. A. Campbell Swinton.

October 9.

Active Nitrogen.

In the "Research Items" in Nature for September 18, reference is made to the paper by Willey and Rideal in the *Journal of the Chemical Society* for July, in which the energy of active nitrogen is found to be 42,500 cal. per gm. mol. Now Strutt's photographs of the glow produced when active nitrogen acts upon iodine show that the iodine line 2061 Å.U. is produced, and this needs an amount of energy of at least 150,000 cal. It is unlikely that a series of successive impacts could give to the iodine a higher level of energy than that possessed by the nitrogen, or that simultaneous collisions of the iodine with more than one nitrogen molecule would suffice. The nitrogen glow is destroyed by iodine vapour in an exceedingly small fraction of a second, which indicates the probability of exchange of energy taking place directly between the active nitrogen molecule (if it *is* the molecule and not the atom) and the molecule of iodine.

E. B. Ludlam.
L. H. Easson.

University of Edinburgh,
October 5.

Copper at Low Temperatures.

In the August issue of the *Proceedings of the Royal Society* (A 112 [1926], pp. 136-151) a paper by Messrs. Lambert and Hartley on "An Investigation of the Effects of Variations in the Radiation Factor on the Efficiency of Dewar Vessels" records some interesting experiments which suggest that copper has unique radiating properties at about the temperature of liquid oxygen. In this connexion a peculiar phenomenon came to my notice some months ago, and it is possible that the two sets of observations may be related.

When present at a public lecture on 'Liquid Air,' delivered at the beginning of this year, I made the following observation during one of the lecture experiments. A small solid copper cylinder was immersed in liquid air contained in an unsilvered glass Dewar vessel in order to cool it down prior to its immersion in water to demonstrate the formation of ice. During the cooling of the cylinder in the liquid air, the usual rapid evolution of gas occurred on immersion, which lasted for some time, after which the liquid air became quiescent and it appeared that temperature equilibrium had been reached. However, instead of remaining quiescent, as one would expect, after a few seconds a sudden re-evolution of gas took place, which was of short duration, and then a state of equilibrium was apparently attained.

I have recently confirmed this observation, and some experiments have been carried out to see whether this phenomenon is of general occurrence with metals, or whether it is specific for copper. It has only been possible, so far, to examine the following metals: lead, iron, tin, platinum and aluminium, and in these cases no such action was observed under similar conditions.

It appears from these experiments that either:

(1) Copper undergoes an allotropic change with heat evolution at a temperature slightly above that of liquid air. One is reminded of the phenomenon of recalescence in the case of iron at higher temperatures.

Or (2) a surface action peculiar to copper comes into play.

Such an effect must cause a considerable loss in filling copper Dewar vessels with liquid air.

I have so far been unable to trace any record of this peculiar behaviour of copper in the literature.

GEORGE JAMES ALEXANDER.

Rock Ferry, Cheshire.

The Reaction to Flea Bites.

IT does not seem to be generally appreciated that the irritating wheals which may follow the bites of various insects are anaphylactic in origin. The first time that a person is bitten by a species of insect which has never bitten him before, nothing or next to nothing may happen, but when he has become sensitive to the proteid in the liquid which the insect injects in the process of biting, he develops the local irritable swelling which is familiar to most people.

Some years ago (*J. Path. Bact.*, 17 (1912), 110) I showed that my wife, who gave a violent reaction to the bite of the human flea (*Pulex irritans*), did not respond at all to bites of the rat flea (*Xenopsylla cheopis*) until they had been fed on her five times during six weeks, when she developed extensive wheals. We have recently got the same results with the rabbit flea (*Spilopsyllus cuniculi*). Single fleas were fed on June 6 and June 18, and four fleas on July 11, without any result; after feeding two on August 13 red papules developed seven days later; single fleas were fed on August 22 and September 1, and in each case a moderate reaction developed about 36 hours later. It is rather remarkable that the minute quantity of foreign proteid injected by the fleas in four bites should be enough to make a person sensitive. Lack of sensitisation is not, of course, the only reason why people do not react. Some persons who are extensively flea bitten seem to become immune. Others are naturally immune: however often I am bitten by them, I give no response to fleas of any kind, though midges and some mosquitoes irritate me extremely. At least that is so in Hertfordshire; from my only experience of Scotch midges, in which I was bitten very freely, I had no trouble; they were probably a different species.

The rabbit flea does not in my experience bite man very readily; in some trials I have quite failed to get them to do so even after several days' starvation. When they do, they take a long time to get their feed, and if undisturbed may remain attached for so long as an hour. Brumpt ("Précis de parasitologie," 3rd ed., 1922, p. 829) notices this peculiarity, which seems to apply to their feeding on rabbits as well as man.

A. E. BOYCOTT.

October 2.

Zoological Nomenclature: Hübner's (1806) 'Tentamen.'

THE secretary of the International Commission on Zoological Nomenclature has the honour to invite attention of the zoological profession to the fact that application has been made for the suspension of the International Rules, in the case of Hübner's (1806) 'Tentamen' in order to establish its nomenclatorial availability.

Briefly summarised: The formal nomenclatorial status of this document, involving about 100 names admitted by some authors as of generic rank, has been under controversy for many years, and opinion of specialists in Lepidoptera is still divided.

The arguments, as submitted, in favour of suspension of rules, maintain that: (1) there are sound reasons both for admitting and for denying recognition to the 'Tentamen' from the viewpoint of interpreting the Rules; (2) the evidence *pro* and *con* is not sufficiently conclusive to remove the question from debate; (3) the rejection of the 'Tentamen' will produce greater confusion than uniformity, will necessitate a vast amount of undesirable labour and economic loss of time and work; (4) if, on the ground of expediency, the rules can be suspended in this case, the nomenclature of the Lepidoptera, as used for the past thirty years, can be largely maintained.

The 'Tentamen' is one of the most important and most controversial cases ever submitted to the Commission. A discussion, with essential bibliographic references, will be found in *Smithsonian Misc. Coll.*, v. 73 (4) (now in press).

The Commission will delay announcement of vote, on the requested suspension, at least until September 1, 1927, in order to give interested authors, and especially entomological societies, opportunity to study the premises and to present to the Commission their views and arguments, *pro* or *con*, regarding the action requested.

In order to protect groups other than Lepidoptera, a prerequisite to suspension of rules would be that representative specialists in Lepidoptera agree upon and furnish to the Commission definite bibliographic references to the 107 names which they view as genotypes.

C. W. STILES,
Secretary to Commission.

U.S. Hygienic Laboratory,
Washington, D.C.,
August 21.

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

I HAVE discovered two errors in my recent paper which appeared under this title in NATURE of August 21, 1926. These errors were due to the hurried assemblage of facts and citations under the heading "Geographic Isolation and Speciation"; they will be carefully corrected in a sequel to this paper which is now in preparation for the *American Naturalist*, to be published under the title "The Origin of Species, V.: Speciation and Mutation." Meanwhile, I desire to point out as inaccurate the following statement in my paper:

"As an example of wide isolation without speciation, the house wren of Florida, *T. ædon ædon*, exhibits the same characters as those of Tierra del Fuego, but in the intermediate regions another species, *T. musculus*, exhibits a large amount of subspeciation and several complete intergradations."

On the contrary, the house wren is not known to breed in Florida and does not occur in Tierra del

Fuego. The species occurs in Patagonia and in the southern United States, but the birds from these two areas are specifically distinct.

The second erroneous statement is in the final paragraph of the same section, where (2) and (4) contradict each other:

"(2) . . . a desert subspecies, *P. m. sonoriensis*, reared for eight years in a humid environment, is entirely unmodified in the direction of the humid subspecies *P. m. gambeli*.

(4) Similar results from transplantation of *P. m. rubidus* and *P. m. sonoriensis* are obtained: reared in an entirely new environment, they do not converge toward each other but toward local humid subspecies *P. m. gambeli*."

Here (4) should read:

"Similar results from transplantation of *P. m. rubidus* and *P. m. sonoriensis* are obtained: reared in an entirely new environment, they do not converge toward each other or toward the local humid subspecies *P. m. gambeli*."

I regret having made these erroneous statements in a zoological field outside my own, and I trust that this correction will prevent their wider circulation.

HENRY FAIRFIELD OSBORN.

American Museum of Natural History,
September 21.

The Spectrum of Zinc.

IN the course of an investigation for the British Non-Ferrous Metals Research Association, which it is hoped will prove successful in applying the spectroscope to the quantitative assay of the impurities in zinc, the following observations of more special scientific interest were noted.

A zinc line, which does not appear to have been measured, occurs at λ2147·36 I. Å. (±0·02) near the cadmium line at λ2144·39 Å. Close to the 'raie ultime' of cadmium λ2265·04 Å. is a zinc line the wavelength of which is λ2265·35 I. Å. (±0·02). This should be taken into account when searching the zinc spectrum for lines due to impurities, as with spectrographs of comparatively low dispersion, such as the Hilger quartz spectrograph size E. 31., the zinc and cadmium lines are indistinguishable. Hagenbach and Schumacher (*Z. wiss. Phot.*, **19**, p. 129, 1919) give the following as zinc lines: λλ2265·08 (8) and 2265·40 (2), and it is highly probable that the former line is a cadmium line.

Spectrograms were taken on a Hilger quartz spectrograph size E. 1. and the zinc lines measured on a photo-measuring micrometer size L. 1. using various samples of zinc.

The samples of zinc supplied by the British Non-Ferrous Metals Research Association included one sample from the New Jersey Zinc Co., prepared by fractional distillation after electrolytic refining, and was considered to be spectroscopically pure.

D. M. SMITH.

Research Department, Adam Hilger, Ltd.,
September 15.

Observed Relative Intensities of Stark Components in Hydrogen.

ATTRACTED by the singularly large observed variations (*Astrophys. Jour.*, **62**, 229, 1925) from estimated intensities of certain strong Stark components of H_β (H. A. Kramers, Copenhagen, 1919) we have recently made quantitative measurements from a suitable source by means of a neutral wedge. It is interesting to compare the results with the new theoretical calculations by Schrödinger (*Ann. d. Phys.*, **80**, 437, 1926). Following are the observed, calculated, and estimated ratios of intensities of components having polarisations and displacements as indicated. The displacement Δ is expressed in the unit which appears in the quantum theory of the Stark-effect.

Components Compared.	Ratio of Intensities. Obs.	Calc.	Est.
p components of H_β, $\frac{\Delta=\pm 8}{\Delta=\pm 10}$	1·00	1·06	0·40
s components of H_β, $\frac{\Delta=\pm 4}{\Delta=\pm 6}$	1·59	1·55	0·54

The much weaker components, p, $\Delta=\pm 6$ and s, $\Delta=\pm 2$ appear somewhat stronger than the theory indicates. This is possibly due in part to superimposed secondary spectrum lines, which could not be detected by the present method. Owing to the increased interest in this research, the measurements are now being extended to the weaker components and to H_γ and H_δ with such modification in method as to permit the detection of any seconday spectrum lines.

J. STUART FOSTER.
M. LAURA CHALK.
(National Research Student.)

McGill University, Montreal,
September 6.

Absorption Spectrum of the Hydrogen Molecule.

WITH the continuous spectrum described by Lyman (*Astrophysical Jour.*, **60**, 1) as a background, and with hydrogen flowing through the receiver of the spectrograph, it was found possible to photograph the absorption spectrum of molecular hydrogen in the extreme ultra-violet. More than twenty absorption bands were observed between λλ1245 and 840. Most of the bands were clearly resolved and show the characteristic structure of the emission bands in the ultra-violet. The most striking feature of the spectrum is a progression of strong absorption bands beginning with λ1105. At least twelve bands of this progression were easily recognised. This adds a new electronic level to the three already obtained (Dieke and Hopfield, Oakland Meeting of the American Physical Society, June 1926) from the hydrogen emission spectrum. A continuous absorption spectrum begins sharply at λ840. This continuous absorption corresponds to the dissociation of the molecule into a normal and an excited atom. The long wave-length limit of the continuous absorption compares well with the theoretical value 14·4 volts. Complete details will be published later.

J. J. HOPFIELD.
G. H. DIEKE.

University of California,
Berkeley, August 17.

Sterility in the Vegetable Marrow.

THE vegetable marrow appears to have been affected by a form of sterility this season. I have been told of cases both in Gloucestershire and Surrey where the plants have produced an enormous number of male flowers and only one, or possibly two, female flowers. In the case of one marrow to a plant the resulting fruit has been a large one. Every plant was affected in the same way. No disbudding had been practised. In my own case I have had, as usual, an abundant crop, including about three dozen well-ripened fruits for winter use. The season has been favourable for half-hardy plants. Can any reader suggest a reason for this occurrence in a monœcious plant?

ELEONORA ARMITAGE.

Dadnor, Herefordshire,
September 25.

The Analysis of Line Spectra.[1]

By Prof. A. FOWLER, F.R.S.

RATHER more than sixty years ago, when the spectroscope became an effective instrument of scientific research through the work of Kirchhoff and Bunsen, it was regarded essentially as providing a new and powerful method of chemical analysis. It soon had brilliant results to show in the discovery of a number of new elements, but this kind of discovery could not go on indefinitely, and the interest of chemists as a body in spectrum analysis would appear to have declined rather rapidly. Spectrum analysis, as was soon realised, was not so simple a matter as it first appeared, and called for so much study that its pursuit was mainly left in the hands of a small band of specialists.

Some of the most important developments of spectroscopy have been closely associated with attempts to interpret the spectra of celestial bodies. The introduction of photographic methods by Huggins led almost at once to the discovery of new lines apparently belonging to hydrogen in the spectra of Sirius and other white stars, which were afterwards of great value in the establishment of Balmer's law of the hydrogen spectrum. Perhaps the greatest contribution of early astrophysics to our stock of knowledge, however, was that which so clearly pointed to the essential identity of matter throughout the universe.

With the discovery that the spectra of certain elements were modified by varying the character of the exciting source, chemical analysis of the sun and stars was supplemented and eventually overshadowed by investigations of the physical conditions which prevail in those bodies. The sun and stars thus came to be regarded as natural experiments on generally similar masses of matter at various high temperatures—experiments ready prepared for observation and always in operation. Thus many laboratory researches were directly instigated by astrophysical observations. To take one example, the fragmentary observations by Lockyer and by Liveing and Dewar of what were afterwards called *enhanced lines* were extended and systematised through an attempt by Lockyer, in which I myself took part, to interpret the spectrum of the solar chromosphere as photographed during the total eclipses of the sun in 1893 and 1896. The immediate result was an important correlation of the changes in the laboratory spectra of the elements with the succession of types in stellar spectra,[2] from which it appeared that enhanced lines were especially characteristic of stars which, on other grounds, were believed to be hotter than the sun. These investigations laid the foundations for a true interpretation of the spectra of the hotter stars, and led to the more extended studies of enhanced lines which have proved of such great importance in the development of the theory of the origin of spectra and the structure of atoms.

The remarkable developments of spectroscopy in the direction of atomic physics have resulted from discoveries relating to regularities in spectra. In the representation of series spectra the wave-number of a line always appears as the difference of two *terms*, and a series of lines appears as a regular succession of differences between a limiting term and a sequence of terms, the limit itself being a term of another sequence.

Much of the early work on series regularities in spectra is summarised in the now well-known symbolic representation of a series system, namely:

Principal series	$1\,S—mP_i$
Sharp series	$1\,P_i—mS$
Diffuse series	$1\,P_i—mD_i$
Fundamental series . . .	$2\,D_i—mF_i$

where 1 S, for example, represents an individual term, and mS a sequence of terms of S type. The S terms are always single, but the others are complex in all but singlet systems; so that $i=1$ for singlets; 1, 2 for doublets; and 1, 2, 3 for triplets (in the older numeration). A sequence of terms may be represented by an approximate formula such as that of Hicks, in the form $R/[m+\mu+\alpha/m]^2$, where R is the Rydberg constant, m a serial number, and μ and α constants (usually proper fractions) to be determined from the observed lines. The possible combinations of terms in the production of lines are restricted in accordance with selection rules which have since been extended to more complex spectra, as will appear later.

It should be understood that these studies of the structure of spectra were pursued with the clear conviction that they would ultimately reveal the secrets of atomic structure, and the analysis of spectra, as distinct from spectrum analysis, gradually became one of the principal objects of spectroscopic research.

With the advent of Bohr's theory of spectra in 1913, spectroscopy entered on a new phase of activity. The theory and its immediate explanation of the spectra of hydrogen and ionised helium are now so well known as to call for little more than mention. Adopting the Rutherford conception of a neutral atom, spectroscopic terms were translated by the theory into 'energy levels' of the atom, so that a spectrum line is considered to represent the energy emitted by an excited atom when it passes from a non-radiating state of a certain energy to another of lesser energy. The terms are, in fact, proportional to the energies of the corresponding 'stationary' states.

The theory in its first form also gave a definite significance to the enhanced lines occurring in the spectra of other elements besides helium, and predicted that such lines would form series systems for which the series constant would be 4 R, 9 R, 16 R, and so on for atoms at successive stages of ionisation.

Bohr's theory proved a great stimulus to experimental spectroscopy as well as to theoretical investigations. Among the first fruits was the experimental verification of the predicted 4 R value for the series constant in the spectra of ionised magnesium, calcium, and strontium.[3] Next, Sommerfeld's well-known extension of the theory of the hydrogen spectrum by taking account of the relativistic variation of the mass

[1] From the presidential address delivered to Section A (Mathematical and Physical Science) of the British Association at Oxford, on August 9.

[2] Lockyer, *Roy. Soc. Proc.*, vol. 60, p. 475 (1897).

[3] A. Fowler, *Phil. Trans.*, A, vol. 214, p. 225 (1914).
The verification of 9 R for doubly-ionised aluminium by Paschen (*Ann. d. Phys.*, vol. 71, p. 142, 1923), and of 16 R for trebly-ionised silicon by A. Fowler (*Roy. Soc. Proc.*, A, vol. 103, p. 413, 1923), followed in due course.

of the electron with its orbital velocity predicted a fine structure of the lines of hydrogen and of ionised helium which was almost immediately verified by Paschen's remarkable observations of the structure of ionised helium lines under very high resolving power.

A general explanation of the existence of several types of series S, P, D . . . in the spectra of more complex atoms immediately followed, namely, that such types of series are to be attributed to the action on the series electron of a perturbing field due to the presence of other electrons in the atom, producing a precessional motion similar to that associated with the relativity effect, but of very much greater value.

Apart from the first two groups and the aluminium sub-group of the periodic table, the spectra of the elements, with few exceptions, are extremely complex and long defied analysis. It was not until 1922 that a key to the structure of complex spectra was furnished by the investigations of Catalán, who was then working at the Imperial College of Science. The essential feature of Catalán's work was the discovery that in the arc and spark spectra of manganese, and in the arc spectrum of chromium, there were terms of greater complexity than the triple terms which had previously been recognised. It was this discovery that opened a way to the analysis of complex spectra in general. It has been pursued with amazing success by Catalán himself, Walters, Laporte, Meggers, Sommer, and others, and the main features of the structure of many spectra as complicated as that of iron have been revealed.

It is not necessary to go into all the intricate details of the spectra, because the general results can now be very simply summarised in consequence of the theoretical developments which have gone hand in hand with the experimental investigations. Bohr and Sommerfeld had already established certain 'selection rules' for the combination of the terms of the simpler spectra on a quantum number basis, and immediately following the work of Catalán, Sommerfeld showed that the scheme of 'inner quantum numbers' which he had devised for the simpler spectra could be extended so as to fit the observations empirically. As other spectra came to be disentangled, an assignment of quantum numbers which appears to be adapted to all spectra was completed by Landé.

In accordance with the work of Bohr, Sommerfeld and Landé, a spectral term may be represented by four quantum numbers, written in the form n^r_{kj}. Here n is the *principal* quantum number, increasing by unity for successive terms of the same sequence; k is the *azimuthal* quantum number and has the values 1, 2, 3, 4, 5 . . . . . . for the term types S, P, D, F, G . . . . ; j is the *inner* quantum number, having one or more values according as the term is single or multiple; r represents the *maximum multiplicity* of terms in the system to which the term belongs, so that $r=1$ for singlets, 2 for doublets, 3 for triplets, and so on.

The selection rules regulating the term combinations of most general occurrence are:

For different types of terms: $\Delta k = \pm 1$.

For individual component terms: $\Delta j = \pm 1$ or 0, with $j=0$ to $j=0$ forbidden.

For systems of terms: $\Delta r = \pm 2$ or 0.

Apparent exceptions to the first selection rule, $\Delta k = \pm 1$, are of very frequent occurrence. In the spectra of the alkaline earths there are several groups of lines—some of them of great intensity—which do not belong to the regular series, but are related to them through the characteristic separations of the respective triplet systems, as was first recognised by Rydberg more than thirty years ago. Groups of this type were further investigated by Popow and by Götze, and their real structure was deduced from observations of Zeeman effects. It then appeared that such a group was derived from combinations of P terms of the regular series with another set of P terms, or of ordinary D terms with a second set of D terms. The additional types of terms, which are usually distinguished as 'anomalous terms' and designated by P′, D′ . . ., have the same inner quantum numbers and show the same Zeeman effects as ordinary terms of corresponding types; but in their combinations with the regular terms they mostly follow the rule $\Delta k = 0$, giving the combinations PP′, DD′ . . . . Among themselves, however, the anomalous terms combine in accordance with the ordinary selection rule, $\Delta k = \pm 1$, giving such combinations as P′D′, D′F′ . . . . Such terms are not restricted to the spectra of the alkaline earths, but have been found to be of very general occurrence in all but the simplest spectra.

In the actual analysis of a spectrum, the selection rules which have been indicated for the combination of terms are supplemented in a very practical way by Sommerfeld's 'intensity rule' and to a less degree by Landé's 'interval rule.'

The whole question of intensities in related groups of lines has recently been placed on a quantitative basis through photometric measurements initiated by Ornstein, Burger, and Dorgelo at Utrecht. It results that the intensities in such groups are in the ratio of integers, and it may accordingly be concluded that intensities, like frequencies, are determined by quantum considerations.

Unfortunately, the analysis of a spectrum does not always lead to a knowledge of the actual values of the terms, or energy levels. These can be determined for any of the relatively simple spectra, in which comparatively extended series can be traced and their limits calculated. In most of the complex spectra, only the relative values of the terms have been deduced, since extended sequences in these spectra are apparently of rare occurrence. Even for these, however, the term of highest numerical value, representing the lowest energy level, can often be identified, and this is of special value in view of its association with the normal state of the atom.

This completes the story of spectroscopic terms and their possible combinations on what might be called a purely numerical basis; that is, in so far as the analysis of a spectrum can at present be based merely on a table of wave-lengths and intensities. Especially as regards the more complex spectra, however, advantage has to be taken of every possible experimental aid to the classification of the lines—particularly, in the first instance, as a means of sorting out the lines characteristic of an element at different stages of ionisation.

Thanks to the industry of numerous workers, many of the complex spectra have now been partially analysed, and two of the principal generalisations foreshadowed some years ago have been greatly strengthened. The first of these is expressed by the so-called 'alternation law,' according to which the arc spectra of the elements are alternately of even and odd multiplicities in passing from the first to the higher groups of the periodic table. No exceptions to the rule have yet been found.

The second generalisation is expressed by the spectroscopic 'displacement law,' which states that the first spark (enhanced) spectrum of an element has a structure similar to that of the arc spectrum of the element which precedes it in the periodic table. To make this generally applicable, however, it is necessary to qualify the rule by restricting the meaning of similarity to a common odd or even multiplicity.

These rules have by no means been proved for all elements, but they are true for all spectra which have been disentangled up to the present time, and may safely be adopted as a starting-point in the analysis of further spectra. They have been almost completely verified for the elements of the two short periods Li (3) to Cl (17), but may be more effectively illustrated by the arc spectra of the elements K (19) to Ni (28) by the use of data collected by Catalán, which are given in Table I. The table includes references to the 'ground term,' *i.e.* the highest term or deepest energy level:

TABLE I.

TERM SYSTEMS IN ARC SPECTRA, K-NI.

Group.	I	II	III	IV	V	VI	VII	VIII		
Element.	19.K	20.Ca	21.Sc	22.Ti	23.V	24.Cr	25.Mn	26.Fe	27.Co	28.Ni
Multiplicities		1		1						1
	2		2		2				2	
		3		3		3		3		3
			4		4		4		4	
				5		5		5		5
					6		6		6	
						7		7		
							8			
Ground term	^2S	^1S	^2D	^3F	^4F	^7S	^6S	^5D	^4F	^3F

A very striking relation, to which attention appears to have first been directed by Hund, is that, as regards the ground term, the spark spectrum of each of the elements Ca to Ni is more closely related to its own arc spectrum than to the arc spectrum of the preceding element. This may be shown as follows:

	20.Ca	21.Sc	22.Ti	23.V	24.Cr	25.Mn	26.Fe	27.Co	28.Ni
Arc . .	^1S	^2D	^3F	^4F	^7S	^6S	^5D	^4F	^3F
Spark . .	^2S	^3D	^4F	^5F	^6S	^7S	^6D	(^5F)	(^4F)

It is not improbable that such systematic relations will be of considerable assistance in the unravelling of the numerous complicated spectra which remain to be investigated.

The more recent results of the analysis of complex spectra have provided an ordered knowledge of a multitude of facts which have an important bearing upon the development of the theory of spectra and the arrangement of electrons in the outer parts of normal atoms. Theoretical workers have not been slow to utilise the new data, and have, indeed, frequently been able to forge ahead of experimental results.

The principal problems immediately resulting from the analysis of the more complex spectra resolve themselves into two—first, the distribution of the electrons among the various possible types of orbit; and, second, the deduction of spectroscopic terms from a given distribution of electrons.

In the consideration of the first problem we are not confined to the evidence afforded by optical spectra. Other data towards this end are furnished by X-ray spectra and by the variations of the chemical and physical properties of the elements according to their positions in the periodic classification. Bohr's well-known table of electron orbits (1922) was built up by taking account of these properties and considering the formation of atoms by the successive capture and binding of electrons. The orbits themselves were distinguished by the quantum numbers n_k $(k \leq n)$, and it was assumed that the orbits of the earlier bound electrons were essentially unchanged when another electron was introduced into the system.

These ideas of Bohr have been remarkably developed in recent years, especially through the work of Main Smith[4] and Stoner,[5] who independently arrived at similar conclusions, chiefly from the consideration of chemical and physical properties respectively. In the new scheme the inner sub-levels are completed at an earlier stage than in Bohr's arrangement, and there is a greater concentration of electrons in the outer sub-levels of each group. The nature of the modification will be sufficiently indicated by comparing the electron distribution among the sub-levels in helium, neon, argon, and krypton, according to the old and new arrangements (Table II.).

TABLE II.

ARRANGEMENT OF ELECTRONS IN RARE GASES.

Bohr.

	Atomic Number.	K	L		M			N			
		1_1	2_1	2_2	3_1	3_2	3_3	4_1	4_2	4_3	4_4
He	2	2									
Ne	10	2	4	4							
A	18	2	4	4	4	4					
Kr	36	2	4	4	6	6	6	4	4		

Main Smith and Stoner.

	Atomic Number.	K	L			M					N		
		1_{11}	2_{11}	2_{21}	2_{22}	3_{11}	3_{21}	3_{22}	3_{32}	3_{33}	4_{11}	4_{21}	4_{22} ···
He	2	2											
Ne	10	2	2	2	4								
A	18	2	2	2	4	2	2	4					
Kr	36	2	2	2	4	2	2	4	4	6	2	2	4
	$n_k=$	1_1	2_1	2_2		3_1	3_2		3_3		4_1	4_2	

The new scheme of electron distribution was shown by Stoner to be supported by a consideration of the intensities of X-ray lines, the absorption of X-rays, chemical and magnetic properties, and optical spectra. It retains all the essential features of Bohr's picture of the building up of atoms, and is equally in accord with chemical considerations, as is especially shown by the work of Main Smith. The electronic arrangements of all the elements from 1 to 92, in their normal states, may now be specified with considerable confidence.

[4] "Chemistry and Atomic Structure," London, 1924; *Review of Chemistry and Industry*, March 28, 1924.
[5] *Phil. Mag.*, vol. 47, p. 719 (1924); vol. 49, p. 1289 (1925).

With the attainment of a definite conception of the electronic structure of the various atoms it becomes possible to approach the second of the two problems referred to above, namely, the determination of the spectroscopic terms associated with a given distribution of electron orbits. The first steps were taken by Russell and Saunders, and independently in part by Wentzel, who, in a discussion of the so-called 'anomalous' terms, which have already been mentioned, made one of the most illuminating contributions to spectroscopy of recent years. To the three $^3PP'$ groups of calcium already known two more were added by Russell and Saunders, who were thus able to show that the five groups formed a series which could be approximately represented by a Ritz formula. The surprising result then appeared that, as referred to the regular triplet limits, the later P' terms were numerically negative. The earlier P' terms, having positive values, certainly originated in the neutral atom, and it could scarcely be doubted that the later terms also had the same origin.

The existence of these negative terms implies a greater equivalent energy than that required for ionisation of the atom, and it follows that it is possible for the atom to remain neutral while absorbing more energy than that necessary to remove the series electron. Hence, in accordance with a previous suggestion made by Bohr, but unknown to them, Russell and Saunders concluded that the energy must be divided between two (or more) electrons, each of which is displaced to a higher energy level, without the removal of either of them. The detailed numerical evidence led inevitably to the conclusion that both valence electrons might jump at the same time from outer to inner orbits, and that the net loss of energy would then be radiated as a single quantum, *i.e.* as monochromatic emission.

Arising out of the work of Russell and Saunders, together with further contributions by Pauli, Goudsmit, and Heisenberg, a general theory of complex spectra has been developed in a practical form by Hund.[6] The theory enables the deeper spectrum terms corresponding to any specified configuration of electrons to be determined with considerable certainty.

It is a fundamental feature of the new theory that, in a complex spectrum, the quantum numbers which specify an electron orbit are quite distinct from those which specify a spectroscopic term. The former are five in number, namely, n, k_1, k_2, m_1, m_2. The latter, which number three, are represented by r, l, j. The theory consists of semi-empirical rules for deducing r, l, and j for the deeper-lying terms from the quantum numbers of the electrons in uncompleted groups.

The assignment of five quantum numbers to each electron orbit is due to Pauli, who supplemented it by a hypothesis—generally known as Pauli's principle—which asserts that no two electrons in an atom can occupy orbits having the same values for these five quantities. This principle can be shown to lead immediately to the scheme of electron distribution suggested by Main Smith and Stoner.

The extraordinary theoretical developments in recent years, leading to the prediction of certain features of the spectra of elements and the structure of atoms, have possibly overshadowed the progress in experimental spectroscopy. Nevertheless, much experimental work of immediate importance to theory has been carried on, and much more is urgently called for.

The present resources of experimental spectroscopy would appear to be adequate for the elucidation of the majority of the outstanding problems. For most elements the conditions of excitation can be so modified that the spectrum is well under control, so that all the lines, or only a selection of them, can be produced at will.

The old, well-tried methods of exciting substances to luminosity—the flame, arc, spark, and vacuum tubes—have by no means been superseded. They have, however, been supplemented by numerous other experimental arrangements. Some of these, like the electric furnace so effectively employed at Mount Wilson by A. S. King, have brought the spectrum of an element under more gradual control, so that a valuable aid in the classification of the lines of a complicated spectrum is provided by the order of their appearance as the temperature is raised. Other methods have definitely brought additional spectra within the range of laboratory experience.

One class of 'experiments,' as I have previously mentioned, is provided by the heavenly bodies. Saha's theory of high-temperature ionisation, further developed by Fowler and Milne and by Miss C. H. Payne, has already been utilised in the prediction of the ionisation potentials of certain multiply-ionised atoms for which the structures of the corresponding laboratory spectra have not yet been sufficiently determined to indicate the energies of the normal states. In this way it is conceivable that we may obtain approximate values of the actual energy levels in some of the complex atoms for which only relative values can at present be directly determined from the spectra.

Enough has been said, I hope, to give some idea of the main lines of development and present trend of spectroscopy. The analysis of spectra with which I have been chiefly concerned is a fascinating pursuit, and the establishment of a beautiful order out of an apparent chaos of spectrum lines brings great satisfaction to the investigator. I have endeavoured to show, however, that the analysis of spectra is not an end in itself, but that under the guidance of quantum theory it has fundamental contributions to make to our understanding of atomic structure and of the periodic classification of the chemical elements. It appears not at all improbable that some of the mysteries of chemical valency may also find a solution in the classification of spectrum lines, and there are indications that the conceptions of spectroscopy may ultimately extend our knowledge of the structure of matter in the liquid and solid states.

It may be that in the future the theory of spectra will be so far developed that it will become possible to calculate the positions and intensities of the lines composing the spectrum of an element with greater accuracy than they can be observed. We are, however, still very far from this ideal, and meanwhile experiment and theory must go hand in hand towards a better understanding of the problems that lie immediately before us.

[6] *Zeit. f. Phys.*, vol. 33, p. 345; vol. 34, p. 296 (1925).

Scientific and Industrial Research in Australia and New Zealand.

AT the Imperial Conference now in session, among other important problems for discussion is that of Imperial co-operation in scientific research. By far the most promising schemes for advancement in that direction, in Australia and New Zealand respectively, are those recently evolved by Sir Frank Heath, Secretary to the Department of Scientific and Industrial Research, London, as the result of his recent visit to those countries, at the invitation of their Governments, which have now unanimously adopted the proposals he has laid before them.

In addition to internal development, the importance of the protection of new countries against the accidental introduction of insect pests alone, not to mention plant pests, has lately been emphasised by Dr. Edward M. Ehrhorn, the well-known entomologist of Honolulu. He has stated that the losses caused by insect attack on the principal crops of the United States amount to upwards of 1,000,000,000 dollars a year, "a sum more than sufficient to meet the entire cost of the Federal Government's annual expenditures." Most of these pests were accidentally introduced, and many could have been excluded by a scientifically controlled quarantine.

Already in Australia rust and other fungoid diseases have attacked the wheat, but their ravages have been greatly lessened by the breeding of rust-resisting varieties, as initiated by Farrer of New South Wales, and by the disinfecting of the seed wheat with copper compounds. Formerly the seed wheat was dipped, before being sown, in a weak solution of copper sulphate. This poisoned the fungoid spores and so saved much loss from rust, but it somewhat damaged the seed wheat. Now, in lieu of this the seed wheat is dusted with finely powdered copper carbonate, and this process alone, as compared with the earlier one, is increasing the value of the Commonwealth wheat yield by about 2,200,000*l.* per annum.

This discovery, of vast value to Australia, the United States, and other wheat-growing countries, has been the result of 'team work,' partly by native-born Australian workers, partly by men trained in the best schools of the homeland, and the whole improved by American investigators. If the increased value of the American and other wheat crops throughout the world, accruing from this discovery, be added to the 2,200,000*l.* a year gained by Australia, the total sum realised would repay, many times over, all cost of agricultural research. A far greater gain will follow when, as the result of scientific breeding of wheat, both rust-resisting and drought-resisting types are evolved. In view of such research, particularly in Australia, Prof. J. D. Watt, of the University of Sydney, considers the desired end is already in sight. What is true of scientific team-work applied to wheat, is true also of all the primary and secondary industries.

The key-note of the Australian and New Zealand research schemes is 'team-work': team-work within Australia and New Zealand themselves, and team-work within the Empire, but such team-work, to attain the best, must not be spasmodic. In Sir Frank Heath's words: "What the industries want is a steady long-sighted policy of help and advice from the State in a national movement for the co-operative attack on scientific problems similar to that successfully initiated here [New Zealand] in the marketing of products overseas." Again, the report on the Australian proposals refers to the distribution of the Commonwealth's activities among the States according to their suitability for different sections of the work as "a means of convincing them that the national effort in scientific things is a pervasive instead of a centralised and bureaucratic influence."

In order to give effect to the proposals of the Commonwealth Government for the reorganisation of the Institute of Science and Industry, an Act was passed by the Commonwealth Legislature in June last which provides as follows:

A Commonwealth Council of Scientific and Industrial Research to be constituted, consisting of not less than nine members, three nominated by the Prime Minister, and appointed by the Governor-General, and including the official chairman of the council. This body is to be the executive during the six-monthly interval between the meetings of the full council. The remaining six members of the council come from the six States of the Commonwealth, each of these members being the chairman, for the time being, of the State Committee (advisory to the Council of Scientific and Industrial Research) in the particular State to which he belongs. In addition, the council may co-opt such other members as may be approved by the Minister on account of their special scientific knowledge. In order to give continuity to the policy of the council, the scheme provides that each of the three executive officers shall hold office for several years.

The Act provides for the State Committees to be constituted "as prescribed." Under the Government scheme, the chairmen are to be selected by the Commonwealth Government after consultation with the State authorities: three members appointed by the State Governments from the staffs of their scientific departments; three members representative of pure science, of which at least two must be from the local universities —such men to be selected by the National Research Council; these six members and the chairmen to co-opt three (or, exceptionally, more) other members representative of primary and secondary industries within the State.

The Commonwealth Council has already held several meetings, and consists of the following:

Executive:
- G. A. Julius, *Chairman*, President last year of the Institute of Engineers in Australia.
- Prof. A. C. D. Rivett, Professor of Chemistry, University of Melbourne.
- W. J. Newbigin, Managing Director of the firm of W. J. Adams & Co., Ltd., an engineer and member of the Chamber of Commerce.

The remaining members are:

Queensland. Prof. H. C. Richards (Geology).
New South Wales. Prof. J. D. Watt (Agriculture).
Victoria. Sir David Orme Masson (Chemistry).
Tasmania. Mr. Keam (Pastoralist).
S. Australia. Prof. T. Brailsford Robertson (Physiology).
W. Australia. Mr. Perry (Industrialist).

In addition, the following two members have been co-opted:

Queensland. Prof. E. J. Goddard (Biology).
Melbourne. Prof. H. A. Woodruff (Veterinary Science).

Thus, both the Commonwealth Council and the State Committees are widely representative. Great freedom of action is given to the council by placing it immediately under the Prime Minister, not as one of his departments, but as an advisory council to him.

Annual estimates for the special work of the year have to receive the sanction of the Commonwealth Parliament in the usual manner, but the financial provision, of far-reaching importance, adopted by the Parliament is as follows: The appropriation from the consolidated revenue fund of the sum of 250,000*l.* to form a trust account, the capital and interest to be used for the purpose of scientific and industrial investigations. A further sum of 100,000*l.* has been appropriated out of the consolidated revenue fund as an endowment fund (of which the executive of the council are trustees), the interest on which is to be used: (1) to assist persons in their scientific research; and (2) to train students for scientific research. The Commonwealth Parliament also voted 29,000*l.* to clear off all debts left by the old Institute of Science and Industry. In addition, the sum of 50,000*l.* was asked for by the council for the particular work to be undertaken within the present financial year.

At the instance of the Prime Minister, the Right Hon. S. M. Bruce, the Cabinet gave immediate effect to Sir Frank Heath's recommendations for facilitating the further training in the homeland of the most promising young Australian scientific workers by sending four such, at once, to be trained for two years in research institutions, chiefly those attached to the Department of Scientific and Industrial Research, London. Four additional students are about to be nominated for training abroad. An allowance of 150*l.* is made to these students for their passages to and from Australia, and the salary is 300*l.* a year with an additional provision of a sum up to 100*l.* for each student for travelling while abroad. Reciprocal arrangements have now been made for the reception of students from the homeland at centres of research in Australia and New Zealand. This excellent provision is not the least important of the plans for securing good team-work within the Empire.

The field work of the council this year will be as follows: Cold-storage problems in co-operation with the British Food Investigation Board, with special reference to beef; liquid fuels, treatment of fuels for saving oil and other products by low-temperature distillation, Bergius process, etc.; forest products, continuation of researches on making paper pulp out of timber, utilisation of gums, resins, tannins, etc.; animal diseases and pests, blow-fly and buffalo-fly pests, diseases of cattle, sheep, and horses; plant diseases and pests, researches for checking the spread of prickly pear (29,000,000 acres in Australia now overrun by this pest).

The chairman of the council, Mr. Julius, is expected to arrive in England next year to discuss scientific and industrial problems of mutual interest to the homeland and to Australia. Thus, so far as Australia is concerned, the new council is already going strong.

In regard to New Zealand, on the recommendation of the Prime Minister, the Right Hon. J. G. Coates, the Parliament has adopted practically all of Sir Frank Heath's scheme as follows: An Advisory Council of Scientific and Industrial Research is to be formed, under the Prime Minister, for the general utilisation of science for the advancement of New Zealand's industries. It is also to co-ordinate and see to the proper maintenance of the Geological Survey, Magnetic Survey, Meteorological Office, the Hector Observatory, the Samoan Scientific Service, and a State Laboratory for Standards and Tests to include the present Dominion Laboratory. An agricultural college is to be built and an institute of dairying to be established to collaborate with it. Expensive buildings are not suggested, but much of the initial research work is to be done at the college laboratories. It is suggested that the Dairy Products Control Board share with the Government the cost of maintaining such a research institute.

In regard to forestry problems, of great importance to the Dominions and the Empire, in view of the alarming decrease in the supply of soft woods (Great Britain now imports 40,000,000*l.* of timber annually) it is recommended that a forestry institute be created, later, by the Government, assisted by the timber milling companies, and that meanwhile a general report on the whole question of the New Zealand forests be obtained from the ablest forester available. With regard to fuel resources, and how best to utilise the somewhat friable coals of New Zealand, a research student is to be sent at once to the Fuel Research Station of the Department of Scientific and Industrial Research at Greenwich. Then there is the hydro-electric problem: it is estimated that New Zealand has a potential supply of no less than five million continuous horse-power.

So much for the primary industries. For the secondary industries, two technical field officers are to be appointed to assist co-operative research associations, and particularly to advise the smaller industries. Arrangements are to be made for a scientific library to comprise the chief public and university libraries as well as some private libraries. New Zealand is advised to link itself up with the International Research Council by establishing a local National Research Council; and to found National Research Scholarships and grants to professors and others for research work.

The total grants for the last-named services are not to exceed 2000*l.* a year, while the initial cost of the council, apart from office charges, etc., is estimated to be about 7000*l.* a year. A scientific officer is to be attached to the Office of the High Commissioner of

New Zealand in London to act as a liaison between the Department of Scientific and Industrial Research and the new department in the Dominion.

The universities, the New Zealand Institute, and the Cawthron Research Institute all find places in the scheme, as well as the Department of Industry and Commerce. The Advisory Council is to be constituted much as in the Commonwealth, with this important exception, namely, that in view of the smaller distances to be travelled in New Zealand as compared with Australia, the meetings of the council are to be held monthly, the executive being left in the hands of the secretary of the council, a well-trained man of science, Dr. E. Marsden, until recently assistant director of education, formerly a fellow of the University of Manchester and professor of physics at Victoria College, University of New Zealand. A bill to give statutory effect to the above recommendation has recently been carried by the New Zealand House of Representatives.

Thus, in New Zealand, as in Australia, in the future application of science to the development of industry, the watchword is 'team-work,' as for the nations around the Pacific who meet triennially in the Pan-Pacific Science Congress, no less than for the League of Nations. For any work worth the doing the first essential is to find the man, and surely in the selected teams of Australia, and in the leader of the New Zealand Councils for Scientific and Industrial Research, the men have been found.

News and Views.

THE preliminary programme of the third Pan-Pacific Science Congress, which is to be held at Tokyo from Saturday, October 30, until Thursday, November 11, contains a provisional scheme and time-table of the work of the congress, a list of the excursions which have been arranged, lists of sailings, and other matter useful to those who propose to attend the meeting or to contribute to its proceedings. His Imperial Highness Prince Kotohito of Kan-in has consented to act as patron, and H.E. the Prime Minister of Japan will be president of the congress. There is a long and distinguished list of honorary vice-presidents, which includes the diplomatic representatives of the chief Powers, a number of the Japanese Ministers of State, and heads of universities. The arrangements for the meetings have been in the hands of an organising committee appointed by the Japanese National Research Council, under the auspices of which the congress is held. A change has been made in the organisation of the meeting itself to promote solidarity of feeling and action. There is no doubt that the change will also greatly facilitate the conduct of business in a congress covering so wide a field. The different branches of science have been classified into two broad divisions, the physical sciences and the biological sciences, instead of into sections and sub-sections for each branch of science as in previous congresses. Divisional meetings and joint divisional meetings will take the place of the sectional meetings. At these, discussions will take place between allied branches of science on subjects of more or less common interest, in other words on border-line problems. Sectional meetings will continue to be held, but taking quite a subordinate place—for the contributions of a special nature which from their scope are unsuitable for discussion at a divisional meeting.

THE character of the discussions at the congress must, to a great extent, depend upon the number and nature of the communications offered, but the organising committee has drawn up a provisional list of subjects. In the joint divisional meetings it is proposed to hold a symposium on certain plans for international co-operation in the study of the more important scientific problems of the Pacific, and, secondly, to survey the present state of knowledge of the physical and biological oceanography of the Pacific. The subjects suggested for divisional or sectional discussion cover a wide range in all branches of science, from astronomy to economic geography, agriculture, and medicine, in all cases with special reference to the Pacific. It is noticeable that there is a considerable bias in favour of topics which have a practical application. In the physical section meteorology, earthquakes, and the study of volcanoes take a prominent place. In the biological sciences the fauna and flora of the Pacific are to be discussed in relation to distribution, as well as from the practical point of view of protection, and, where appropriate, in relation to economic development. Anthropology is well represented in the discussion of the antiquity of man in the Pacific, the anthropometry of races of the Pacific, the study of Ainu, Papuans, and pygmies, the culture of the East Indies in relation to the question of 'diffusion,' and the relation of food, clothing, and houses to climate. A series of excursions has been arranged to suit the special interests of members of the congress extending from October 18 until November 19, which will include visits to Ainu villages, the famous shrine and temple at Nikko, Hakone volcano, Fuji, coal and copper mines, hot springs, cretaceous, tertiary, pliocene, and other geological formations in various localities, the old Imperial Palace and the University at Kyoto, as well as other places of importance for the study of the fauna and flora or the commercial and industrial activities of Japan. After the official excursions are over, facilities will be afforded for a longer stay if desired.

PROF. R. RUGGLES GATES, who has just returned to London after a visit to Russia, gives us some interesting information as to the position of some scientific work and institutions there. In the course of his letter he says that much valuable work is being done in the various plant-breeding stations which he visited. These included Tammisto, near Helsingfors, Finland, as well as Khibiny in Russian Lappland, north of the Arctic circle, which is devoted chiefly to the production of northern vegetables and oats for fodder; Peterhof and Desto Selo, near

Leningrad, where extensive genetical, biometric, cytological, and physiological investigations are being carried on, especially with cereals, under the direction of Profs. Philiptschenko, Vavilov, and Levitsky, and Drs. Pissarev and Karpetschenko; Petrovsky-Razoumovsky, where extensive experiments, particularly with oat-breeding, are being made by Dr. Schegalov; and Saratov, where the greatest interest attaches to a series of unique wheat-rye hybrids of Prof. Meister, and where Dr. Plachek is improving the varieties of sunflowers, which are extensively grown as a crop in Southern Russia.

IN Moscow, the Institute of Experimental Biology is one of several laboratories under the direction of Prof. Koltzoff, in which a great range of genetical and cytological as well as other experimental work in animal biology is being done. The genetical section is in charge of Prof. Tschetverikoff. Much eugenical work is also being done in Moscow and Leningrad, especially in the collection of pedigrees, and a *Russian Journal of Eugenics* is edited by Profs. Koltzoff, Liublinsky and Philiptschenko. The Timiriazev Institute in Moscow, under the direction of Prof. Navashin, is chiefly devoted to research in plant cytology and genetics. Prof. Gates also visited the Botanical Gardens in Leningrad, Tiflis, and Batoum, the chief interest of the Tiflis garden being its large collection of Caucasus plants. A study was made of the tundra vegetation in the far north and the steppe region in Southern Russia and the Caucasus. While in Moscow Prof. Gates was present at the opening of a small museum of Metchnikoff relics in the Institute of Experimental Pathology. Madame Metchnikoff came from Paris for the occasion.

CONSIDERABLE interest has been aroused among archæologists by discoveries at Glozel, on the right bank of a rivulet called Le Vareille, about twenty miles south-east of Vichy, of which little had been heard in England until attention was directed to them by Prof. S. Reinach in a letter to the *Times* of September 27, in which he referred to their bearing upon the date of the Magdalenian culture. The excavations, which began in 1924 and were carried out by Dr. Morlet, assisted by a young peasant Émile Fradin, yielded last summer a curious combination of objects in association which is at least puzzling. The objects were of stone, bone, and more or less baked clay, without a particle of metal or Celtic or Roman pottery. They consisted of (1) a few polished axes and small flints (there is no flint in the neighbourhood): (2) very thick hand-made vases, one of them decorated with a human head (eyes and nose but no mouth), a fiddle-shaped figurine representing a woman, without a mouth and recalling the so-called owl-vases of Troy; (3) pebbles engraved with outlines of animals or inscriptions or both, in the most degraded Magdalenian style; (4) a large number of clay tablets covered with inscriptions, some long and well engraved. Of these inscriptions some are described as being like the Phœnician, but the greater number are quite different.

INSCRIPTIONS from so remote a period are not known if we except some of Piette's earlier painted pebbles from the Mas d'Azil and a few (apparent) graffiti on reindeer horn. The only similar inscriptions of anything like so early a date were found in Portugal in 1894; but these aroused some suspicion and have not been universally accepted. Prof. Reinach, to whom we are indebted for these details of the find, is of the opinion that we have here a religious deposit of early neolithic age associated with a degenerate Magdalenian culture which is thus brought down so late as 4000–3000 B.C., he holds that it points to the western origin of writing. Prof. Elliot Smith, in his presidential address to the Anthropological Society of University College, London, on October 15, referred to this curious association in one deposit of neolithic objects with Cretan affinities, Magdalenian objects, and a linear script. He suggested that if the neolithic phase did not begin in western Europe until the second millenium B.C., there was nothing inherently improbable in the association; but it necessitated cutting off one millenium from the dating on Prof. Reinach's view, that the close of the Magdalenian period might have been so late as 3000 B.C. Further, if the Ægean origin of the pottery was admitted, the claim for the western origin of writing was unjustifiable.

AT the Imperial College, South Kensington, on October 13, Dr. W. H. Keesom, professor of physics and director of the Cryogenic Laboratory in the University of Leyden, described the experiments by which he succeeded in solidifying helium in June and July last. The methods of refrigeration employed by the late Dr. Kamerlingh Onnes made it possible to attain a temperature of less than one degree above the absolute zero, and by applying great pressure at this temperature, Dr. Keesom found it possible to reduce helium to the solid state. Under the most favourable conditions a pressure of the order of 100 atmospheres was sufficient for the purpose. In the earliest experiments, in which the use of much higher pressures was contemplated, the solidification took place in a German silver tube, and was demonstrated by the indications of a differential manometer showing that the tubes had become blocked. In later experiments a glass vessel was employed, so that the solid helium could be seen. It was not distinguishable from the liquid to the eye, having apparently the same refractive index and density, but the existence of the solid was proved by the fact that a metal stirrer immersed in the substance became fixed. By means of a simple device for melting the helium in immediate contact with the stirrer, the latter was released, and could be hammered against the unmelted solid a short distance away. A curve of melting-point against pressure was drawn, and it was found that, unlike the corresponding curve for other substances, it did not meet the vapour pressure curve, and there was therefore no triple point. By extrapolation the melting-point curve was shown to become parallel to the axis of temperature at the absolute zero, in accordance with Nernst's heat theorem.

RECENTLY the International Education Board, founded by Mr. John D. Rockefeller in 1923, made an offer of 30,000*l*. towards the cost of erection, equipment, and endowment of new premises for the Department of Animal Breeding in the University of Edinburgh, on condition that a similar sum was obtained in Britain. It was announced by the Principal of the University, Sir Alfred Ewing, on Thursday last that Lord Woolavington had given a sum of 10,000*l*. towards the endowment of a chair of animal breeding in the University, and that the Development Commission would make a substantial grant, so that the condition laid down by the International Education Board might now be regarded as fulfilled.

THE Board of Agriculture first suggested in 1913 that research in animal breeding should be undertaken in Edinburgh, and a joint committee, representative of the University and the College of Agriculture, was appointed to consider the matter in conjunction with the Board and the Development Commission. The organisation of the work was interrupted by the outbreak of the War, but was resumed in 1919, and towards the end of 1920 the Department of Animal Breeding was established with Dr. F. A. E. Crew as director. It was first housed in the immediate neighbourhood of the Old College, but for the last two years has occupied laboratories in the new Department of Chemistry at West Mains, adjacent to which ten acres of pasture belonging to the University have been made available. The financial arrangements now announced will enable the Department to be provided with premises specially equipped for work on animal breeding, and as a site at West Mains is available, it is anticipated that the building of the new Department will soon be undertaken.

AT a meeting of the Society for the Study of Inebriety on October 12, Dr. J. D. Rolleston read a paper on alcoholism in classical antiquity in which he stated that, in view of the fact that the scientific study of inebriety dates only from the middle of the nineteenth century, very little is to be gleaned from contemporary medical writers as to the prevalence and effects of alcoholism in ancient Greece and Rome. The main sources of information are the poets, especially the gnomic writers and satirists, philosophers, moralists, and encyclopædists such as Pliny the elder and Athenæus. Though there is some indication of the existence of chronic alcoholism, as is shown by passages in Pliny and Seneca, alcoholism in classical antiquity was mainly of a convivial character, and industrial alcoholism, apart from that associated with prostitution, was unknown. Dr. Rolleston quoted numerous passages from the classical writers dealing with the dysgenic influence of alcohol and other evil effects of drink on the community and the individual, especially the relation of inebriety to insanity, crime and poverty, and the measures, often of a fanciful character, recommended by the ancients for the prevention and treatment of drunkenness. In conclusion, Dr. Rolleston pointed out that the alcoholism of classical antiquity differed from that of to-day by its predominance among the upper classes, the lack of legislative control, the absence of distilled liquors and the non-existence of syphilis, which is now often contracted as the result of alcoholic indulgence and runs a severe course in alcoholic subjects.

THE Innwerk Aluminium Co. has built an electric power station at Töging in Germany in order to utilise the various falls on the river Inn. It is the largest hydro-electric power station in Germany. It is estimated that the annual average output will be 465 million kilowatt-hours. A description of the equipment of this station appears in the July number of *A E G Progress*. A peculiarity of the scheme is that no provision is made for storage. The hydraulic energy is immediately converted into electrical energy. There is never waste due to water flowing uselessly over the weir. The amount of power available is so large that it cannot always be utilised for power and lighting. At the time the station was built it was doubtful whether it would be more economical to manufacture aluminium or nitrogen. Hence the electrical equipment was designed so that either direct current or alternating current could be obtained. At the Töging station there are 15 nine-thousand horse-power turbines. The first eight of these machines drive three-phase generators, whilst the other seven drive direct current dynamos, the output of which is used for the manufacture of aluminium, the furnace rooms for which are near the station. The alternating current is carried on overhead wires at 100 kilovolts pressure to the Hart carbide factory, which is ten miles away. Special precautions have been taken to prevent the pole wheel from bursting should a turbine 'run away.' They are made of steel cast in one piece, and two rings of Siemens Martin steel are shrunk on to them. The strength of this steel is 78,000 lb. per square inch.

THE fiftieth annual meeting of the Conchological Society of Great Britain and Ireland was held at the City Museum at Leeds on October 16 under the presidency of Mr. J. W. Taylor, the doyen of the Society. There was a large gathering of members, and a number of delegates from related societies attended with messages of congratulation and good wishes. The president in his address dealt with the evolution of the Mollusca, and there were various exhibits of interest, including the Stubbs Collection which has been recently acquired by the Museum. The Society was founded in Leeds fifty years ago within a few days by Messrs. W. Nelson, W. D. Roebuck, H. Crowther, and J. W. Taylor, and the last two were happily present at the jubilee, which was appropriately celebrated at Leeds, though the Society has had its headquarters at the Manchester Museum for some years past. Mr. Hugh Watson, of Cambridge, was elected president for the ensuing year.

THE newly-created Society of British Foresters held its inaugural meeting during the recent meeting of the British Association at Oxford. The object of this Society is to help in the technical development of forestry in Great Britain. Forestry is coming more and more into prominence, and it is felt that the time has now arrived for the establishment of an association of those engaged in it and in allied sciences. A journal will be published, and this will provide a place for the publication of the results of forestry investigation and practice in Great Britain, and for the dissemination of results obtained elsewhere. The officers of the Society are: *President*, Mr. R. L. Robinson; *Vice-President*, Prof. R. S. Troup; *Members of Council*, Mr. C. O. Hanson, Major F. M. Oliphant, Mr. R. S. Pearson, Mr. Frank Scott, Mr. J. D. Sutherland, Dr. Malcolm Wilson; *Editor of Journal*, Dr. H. M. Steven; *Business Editor*, Mr. J. Lyford Pike; *Secretary and Treasurer*, Mr. R. Angus Galloway, 8 Rutland Square, Edinburgh.

THE following courses of lectures have been arranged at the Royal Institution during November and December. The Tyndall Lectures will be delivered by Dr. G. W. C. Kaye, who will commence a course of three lectures on the acoustics of public buildings on Tuesday, November 2, at 5.15; and on Tuesday, November 23, Sir William Bragg begins a course of four lectures on the imperfect crystallisation of common things. On Thursday afternoons, beginning on November 4, there will be two lectures by Sir Edgeworth David on Antarctic exploration of the past and future; three by Dr. R. R. Marett on the archæology of the Channel Islands; and two by Sir Squire Sprigge on (1) early medical literature and (2) medical literature in relation to journalism. On Saturday afternoons, November 27 and December 4, at three o'clock, Dr. G. C. Simpson will give two lectures on atmospheric electricity. The Juvenile Lectures this year, the hundred and first course, will be delivered by Prof. A. V. Hill on nerves and muscles, how we move and feel: (1) Nerves and the messages they carry (Dec. 28); (2) muscles and how they move (Dec. 30); (3) the heart and some other muscles (Jan. 1); (4) the lungs and blood (Jan. 4); (5) nerves and muscles working together (Jan. 6); (6) speed, strength, and endurance (Jan. 8).

THE ninth annual Streatfeild Memorial Lecture will be delivered by Mr. F. C. Robinson at the Institute of Chemistry on Friday, November 19, at 8 P.M. His subject will be "The Chemist in the Non-Ferrous Metallurgical Refinery," and Prof. G. G. Henderson, president of the Institute of Chemistry, will take the chair. Tickets of admission are obtainable on application to the Registrar, Institute of Chemistry, 30 Russell Square, London, W.C.1. Frederick William Streatfeild was on the staff of the City and Guilds Technical College, Finsbury, from its foundation until his death in March 1918, as a teacher of applied chemistry. He won the esteem and affection of several generations of Finsbury students, who established a fund for the provision of an annual memorial lecture to mark their appreciation of his work and worth. Previous Streatfeild Memorial lecturers have been: Sir William Pope (1918), Prof. G. T. Morgan (1919), J. H. Coste (1920), W. P. Dreaper (1921), Prof. C. H. Desch (1922), E. M. Hawkins (1923), Julian L. Baker (1924), and Francis H. Carr (1925). On the closing of Finsbury Technical College, the administration of the Fund and the arrangements of the lecture were entrusted to the Institute of Chemistry.

FARADAY House Testing Laboratories, Southampton Row, London, W.C.1, have issued a scale of fees for testing mechanical, electrical, and chemical materials, instruments, and machinery. Arrangements are also made for the loan of instruments, workshops, for investigations and reports, and for advice and assistance to inventors.

Two of the best signs of activity and vigour of the optical industry in Great Britain are the number and importance of the scientific papers which are published by optical firms. We have before us a list of fifteen or sixteen publications which have appeared in scientific and technical journals during the last two years from Messrs. Hilger's workshop. Of these, nine were papers read at the recent Optical Convention, two deal with the lens interferometer and its use, two with spectrum analysis and spectrographs, and one with a new measuring micrometer.

WE much regret the appearance of a misprint in Dr. K. R. Ramanathan's letter in NATURE of September 4, p. 337. Observations at Simla referred to near the end show that polarisation for the red reaches values so high as 87 per cent., and not 30 per cent. as printed.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A lecturer in organic chemistry and an assistant lecturer in geography in the University of Birmingham—The Secretary (October 30). A lecturer in electrical engineering at the Chesterfield Technical College—The Director of Education, S. Mary's Gate, Derby (October 30). A lecturer in agricultural botany at Armstrong College, Newcastle-upon-Tyne — The Registrar (November 6). An assistant lecturer in botany in the University of Birmingham—The Secretary (November 6). A scientific officer for, primarily, research in connexion with electrical ignition appliances at the Royal Aircraft Establishment, South Farnborough—The Chief Superintendent, R.A.E., South Farnborough, Hants (November 10, quoting No. A. 81). A professor of zoology in the University of Birmingham—The Secretary (November 22). An engineer to take charge of the section of wood preservation of the Forest Products Research Laboratory at Princes Risborough—The Secretary, Dept. of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (December 1). A reader in wireless telegraphy and high-frequency technology at the Indian Institute of Science, Bangalore—Dr. W. H. Eccles, Institution of Electrical Engineers, Savoy Place, W.C.2. A woman B.Sc., biology, physiology, and biochemistry, and preferably physics or mathematics, for work at the Wellcome Physiological Research Laboratories, Beckenham—The Director. An assistant agricultural botanist under the Linen Industry Research Association — The Secretary, Research Institute, Lambeg, Co. Antrim. A head of the physics department of Huddersfield Technical College — The Director of Education, Education Offices, Huddersfield.

Our Astronomical Column.

RECENT SUNSPOTS AND MAGNETIC STORM.—Although no unusually large spot has appeared as yet this month, the sun's disc has presented a striking feature, consisting of a procession of four large groups of spots in the northern hemisphere. Some of the spots were occasionally naked-eye objects to keen vision, but as they kept just on the limit of visibility they have not been included in the list of the largest spots given from time to time in these columns. Their approximate positions will be of interest to observers, however, and are tabulated as follows:

Group.	Central Meridian Passage.	Longitude.	Latitude.	Area.
a	Oct. 9·2	232°	15° N	700
b	11·2	205	18 N	900
c	13·7	173	16 N	600
d	16·7	133	24 N	650

(The areas, corrected for foreshortening and expressed in millionths of sun's visible hemisphere, were measured on Oct. 13.)

Group *d*, comprising a roughly circular spot with small companions, represents the return of the large September spot No. 10.

On Oct. 14, at 20^h, the commencement of a magnetic disturbance was recorded at Greenwich, which continued for about 12 hours, the greatest deflexion of the declination needle being about 0·5°. At 19^h on Oct. 15 a recrudescence of the disturbance took place which rapidly developed into one of great magnitude, the declination traces showing extreme deflexions of more than 1°. Serious difficulties in telegraphic transmission were experienced at the same time, and a display of the aurora was reported from America. At the time of the commencement of the preliminary disturbance, the longitude of the sun's central meridian was 157°, and at the commencement of the great disturbance it was 145°. As will be seen from the above table, the present instance is an example of the considerable uncertainty in ascribing a relation between a particular sunspot and a magnetic storm, judging merely from the position and appearance of the spot. Spectroscopic observations may, of course, come to hand which will throw some light on the matter.

It may be added that the general activity of the sun is still increasing. Apart from the occurrence of spots and faculæ, this fact is shown by the prominences during the last three months. Mr. Newbegin reports that, for the past three weeks, the average number per day he has observed spectroscopically at the sun's limb is 20.

UNUSUAL DISPLAY OF LARGE METEORS.—Mr. W. F. Denning writes that during the three nights Oct. 9 to 11 four brilliant meteors were observed by himself or friends at Bristol, and that three recorded paths indicated a well-defined radiant in Corona at 230° + 33°.

On the evening of Oct. 9 at 20^h 30^m G.M.T. a bright meteor, equal to twice the apparent magnitude of Jupiter, was seen in Draco moving from 244° + 47° to 261° + 59°; motion rather swift. On the same evening at 22^h 20^m a fireball, three or four times the brightness of Venus, appeared in Auriga, falling approximately from Auriga to low in the N.W. It left a long vaporous trail which remained visible for ten minutes or more. Near the end of its flight it gave a great outburst of light which illuminated the sky and land. This brilliant object had a radiant at about 262° + 55° and was probably a fragment of Giacobini's comet of 1900. The comet has a radiant at 253° + 56° as computed by Rev. M. Davidson, and its orbit is nearest to the earth (distance 5½ millions of miles) on Oct. 9.

On Oct. 10 at 20^h 20^m a slowish meteor equal in brightness to Venus traversed part of Cygnus, crossing the stars ϵ and ξ Cygni, the path being from 318° + 30° to 333° + 32°. It left a bright streak for several seconds and burst with a strong flash when between the two stars mentioned.

On Oct. 11 at 21^h 17^m a meteor as luminous as Jupiter appeared in Perseus, and shot from 53° + 43° to 53° + 23°.

It is an unusual circumstance to get a radiant from brilliant meteors alone. A singular abundance of fireballs has, however, diversified the present season since September 6. They have been directed from a number of different showers, though several have apparently had their origin in radiants near the N.E. and N.N.E. region of the horizon. Corona, as a radiant of meteors in October, is quite unknown, for that constellation is low in the N.W. in the evening hours and sets before 23^h at this time of the year.

COMETS.—The comet Giacobini-Zinner, discovered in 1900, and seen again on its second return in 1913, has been detected by Dr. Schwassmann at Bergedorf on Oct. 16, 17^h 50^m U.T., in R.A. 17^h 24^m 52^s, N. Decl. 2° 32′, magnitude 14·0. The indicated value of T, the perihelion passage, is Dec. 11·77, 1926, about four days later than Mr. Cripps's predicted date. His other elements are: ω 171° 44′ 8″, Ω 195° 56′ 35″, i 30° 43′ 14″, ϕ 45° 47′ 29″, log q 9·99726, equinox 1926·0.

EPHEMERIS FOR 0^h U.T., CORRECTED BY ABOVE OBSERVATION.

	R.A.	Decl.	log *r*.	log Δ.
Oct. 24	17^h $45{\cdot}1^m$	0° 35·1′ N	0·0836	0·1358
Nov. 1	18 9·9	1 38·5 S	0·0618	0·1212
„ 9	18 37·9	3 55·9	0·0415	0·1061
„ 17	19 8·6	6 15·3 S	0·0239	0·0908

This makes the sixth comet to pass perihelion in 1926, four being periodic and two parabolic.

Neujmin's Comet is expected to pass perihelion on January 2 next; however, if a doubtful object observed by Mr. Neujmin in 1920 was really his comet, the date will be 22 days later. The following ephemeris for 0^h is by Mr. B. F. Bawtree, on the earlier assumption:

	R.A.	N. Decl.
Oct. 23	9^h $59{\cdot}3^m$	18° 34′
„ 31	10 23·3	15 48
Nov. 8	10 47·3	12 45

As two revolutions have taken place since discovery, there is considerable uncertainty in the positions. The comet is likely to be faint.

Mr. J. Polak, of Saratov, had investigated the perturbations of Holmes's comet, discovered in 1892, and seen again in 1899 and 1906, but not since then. Dr. Zwiers calculated its perturbations up to 1906, but after his death no one continued the work. Mr. Polak shows that the Jupiter perturbations in 1908 were very large, increasing the period by 6 months, and diminishing the eccentricity from 0·412 to 0·379. This explains the failure to find the comet in 1913 and 1919. The return in the former year was a very favourable one, and an ephemeris is given in *Astr. Nach.* 5465. The general region is Aug. 4, R.A. 1^h 0^m; N. Decl. 20°; Oct. 3, R.A. 0^h 34^m; N. Decl. 30°. Plates of that region taken in 1913 should be examined for images of the comet.

The perturbations since 1908 have been small and the next perihelion passage will be near March 12, 1928. The comet may be seen (especially by southern observers) in the autumn of 1927. As this is one of the few comets discovered in England it is satisfactory to find that work on it is resumed.

Astr. Nach. 5466 contains an interesting study of the brightness of comet Tempel II in 1925. During the month of July it brightened up four magnitudes, from 10·5 to 6·5; log *r* changed from 0·14 to 0·12, and log Δ from 9·58 to 9·51. These changes are so small that it is clear that the brightening was mainly due to physical change in the comet. One may conjecture that at greater distances the sun's physical effect on the cometic envelopes is insignificant, but that it becomes important at a certain point (not apparently the same for all comets), and henceforth develops rapidly with approach to the sun. It is, however, difficult to frame laws that will cover all cases.

Research Items.

Eskimo Engravings on Walrus Ivory.—Three examples of Eskimo art from Alaska of a type rarely seen in Europe are described by M. L. Giraux in the *Journal de la Société des Américanistes de Paris*, N. Sér. T. 18. The objects in question are made of walrus ivory, measuring 31 cm., 33 cm., and 36 cm. in length respectively, and are engraved and painted or stained in colour with human and animal figures. Among the human figures is that of a male in European clothing. All the figures are realistic, but the animals in particular exhibit an intimate acquaintance on the part of the artist with their characteristic attitudes and habits. Although all the Eskimo of Alaska show considerable dexterity in carving wood, bone, ivory, and reindeer horn, the inhabitants of the coast from the Yukon delta to the lower Kuskokwin river are particularly noted for their artistic skill. The technical methods employed in dealing with the ivory of a walrus tooth in the days before the introduction of iron and steel implements, are of considerable interest, especially in view of the marked resemblance of the objects under consideration to palæolithic engravings. Four grooves were made in the tooth with a piece of quartz or other siliceous stone. When these had been made as deep as the form of the cutting edge of the stone implement allowed, the two pieces were flaked off either by simple pressure of the hand or by means of a wooden knife-blade-like implement, which was inserted in the groove. The central piece of ivory thus obtained was rubbed down to the required shape by a freshly broken stone. The perforation found in some of the objects was then made by a stone drill and sand, working in a slight depression previously made, and actuated by a cord or strap. The polishing was done either with a very fine-grained stone (soapstone) or by the hand used with very fine-grained sand. Lastly, another piece of ivory was employed to produce a high polish. The gravers were sharp pieces of stone, flint, quartz, schist, or soapstone, usually fixed in pieces of wood, each material requiring a special method in manufacturing the graving tool. The colours employed were black (plumbago and charcoal or gunpowder mixed with blood), red (oxide of iron or ochreous earth), yellow (ochreous earth), white (argillaceous clay), and green (oxide of copper). A dark reddish brown used for staining seal skin was obtained by macerating the inner bark of alder in urine for twenty-four hours.

An Endemic Flora.—An unusual analysis of an endemic flora will be found by F. Lewis in the *Annals of the Royal Botanic Gardens, Peradeniya*, vol. 10, part 1. With the data given in Trimen's "Flora of Ceylon," and from his own observations as to altitude, the author has analysed the distribution of the large endemic flora in relation to its distribution at different altitudes. The result is that the greater number of endemics are to be found at the foot of the hills instead of at the highest altitudes, a conclusion which the author briefly discusses, assuming that in the more densely populated lower levels the struggle for existence is greater, and natural selection has thus operated more vigorously.

Japanese Botany.—The botanical output of Japan proceeds apace, and fortunately abstracts will be found of practically all publications in the *Japanese Journal of Botany*. A brief notice of some of the interesting papers is all that can be attempted here. Yoshiji Yoshii has published a very extensive study of the maturation of the seed of *Pharbitis Nil*. The process of maturation can be divided into a series of stages; the chemical changes, water content, etc., of the seeds were studied and also their capacity to germinate when tested at these different stages. (*Journ. of Faculty of Science, Tokyo*, Section III. vol. 1, Part i.). Isaburo Nagai publishes four papers upon mutations in *Oryza sativa* L. in the *Japanese Journal of Botany*, Vol. 3, No. 2; in the same journal Kametaro Oharo has a paper upon Japanese fossil conifer woods, which he has been studying at the palæobotanical institute at Berlin, and there are two cytological papers upon pollen development, that by Tetsu Sakamura and Isamu Stow, dealing with the experimental production of pollen grains with abnormal chromosome numbers in *Gagea lutea*. In the previous issue of the same journal, Ichiro Ohga has an interesting paper upon the structure of ancient but still viable fruits of the Indian Lotus. The author began these studies in Manchuria, and continued them at Tokyo and then at the Johns Hopkins University at Baltimore. These old lotus fruits occurred in a peat bed in the Pulantien Basin, in South Manchuria, and are probably at least three or four hundred years old. The retention of viability for such a long time is probably due in large part to the approximate maintenance of the water and gas content in the tissues of the embryo, due to the structure of the fruit coats and their maintenance in the undisturbed condition of the peat bed. A very full account of the life history, fertilisation and cytology of the fungus *Plasmopara Halstedii*, is given by Prof. Makoto Nishimura in the *Journal of the College of Agriculture*, Hokkaido Imperial University, Sapporo, Vol. 17, Part I, with five plates of drawings which are well reproduced. Koki Masui has a paper upon the mycorhizal relation of the fungus *Cantharellus floccosus*, Schw. with the roots of *Abies firma* in the *Memoirs of the College of Science, Kyoto Imperial University*, vol. 2, No. 1, 1926. It seems clear that this fungus is definitely parasitic on the tree, in many cases killing branches of the root.

Corals and Sediments.—Problems of sedimentation and rock formation in tropical, coral-bearing regions constitute the subject-matter for research in vol. 23 of the papers from the Department of Marine Biology of the Carnegie Institution of Washington. M. N. Bramlette, in dealing with some marine bottom samples from Pago-Pago harbour, Samoa, describes the nature of present sedimentation processes in and around the harbour. Chemical and mechanical analyses of the samples are given and discussed and, in some cases, a detailed analysis of the organic constituents has been made. Borings from the reef were also examined and, on comparison with the bottom samples, shown to be relatively richer in magnesium carbonate. A study of reef-sand from the Bahamas by M. I. Goldman is concerned chiefly with the problem of dolomitisation. The chemical composition of the sand was determined directly and also by calculation from a count of the different constituents of known composition, mainly calcareous skeletons. The difference found is taken to represent a change in chemical composition, the results in the present case indicating a relative decrease in the amount of magnesium carbonate. The results are not considered conclusive, however, and suggestions are put forward for other methods of investigation. N. R. Smith, reporting on a bacteriological examination of 'Chalky Mud' and sea water from the Bahama Banks, classifies the bacteria found and describes an experiment to show that calcite is precipitated from sea water as a result of bacterial growth when food is supplied and when the supply of calcium in solution is maintained by the addition of calcium sulphate. He states also that calcite is formed from natural sea water by the strong ammonifying vibrios found in the mud, the only addition required being organic nutritive matter. J. A. Cushman supplies a list of some recent Foraminifera from Porto Rico with notes on their distribution. An account of some late Miocene or early Pliocene mollusca and sharks' teeth from the Fiji and Tonga Islands by W. C. Mansfield, is accompanied by a useful annotated bibliography of the geology of the Fiji Island. T. W. Vaughan and J. E. Hoffmeister describe some Miocene corals from Trinidad, mostly new species.

VORTEX DISTRIBUTION BEHIND AN AEROFOIL.—Lanchester, in his "Aerodynamics," vol. 1, indicated from general theoretical considerations that the flow in the wake of an advancing aerofoil of finite span should comprise a layer of vorticity immediately behind the trailing edge and two general circulatory motions of opposite directions of rotation, one at each tip. Broadly speaking, this prediction has stimulated investigations at Göttingen, in America, and at the National Physical Laboratory at Teddington, receiving ample verification. In Aeronautical Research Committee Report, R. and M. No. 951 (H.M. Stationery Office, 1*s*. net), Messrs. Fage and Simmons have subjected this theory to an accurate quantitative test and mapped out the changes which occur in the vortex distribution in the wake of an aerofoil. The result provides an experimental verification of the theoretical relation given by Lanchester, that the total strength of the vorticity leaving a semi-span of an aerofoil, as obtained by integration over the transverse plane close behind the aerofoil, is equal to the circulation around the median section, and that the distribution of vorticity is in close association with the distribution of lift along this span. At 13 chords behind the aerofoil the rolling up of the vortex band is practically complete and, within the limits of experimental error, at a distance of 0·57 chords in front of the aerofoil the flow is irrotational. The theory thus verified has undoubtedly given a new impetus to aeronautical developments.

CATHODE SPUTTERING.—In the *Ann. der. Phys.*, No. 15, p. 672, 1926, A. von Hippel describes a new method for the investigation of cathode sputtering, and he shows that sputtered metal particles consist, at any rate to a very large extent, of uncharged atoms. In his experiments a cadmium cathode was usually employed, but experiments were also carried out with silver and zinc cathodes. The particles emitted from the cathode collide with ions and electrons, and if they were atoms they would emit their resonance lines. Thus, if the resonance lines of the cathode material are observed close to the plate, which lies outside the dark space, on which the sputtered particles are deposited, then we have evidence of the atomic nature of the particles. Clear proof of this was obtained, however, by comparing the intensity of the cadmium 3261 line with the intensity of the mercury 2537 line, when the vapour pressure of the mercury inside the sputtering chamber was known. From these observations the vapour pressure of the sputtered particles was calculated, and the value thus obtained agreed, within the limits of experimental error, with the value obtained from calculations based on a knowledge of the thickness of the sputtered film and on the assumption that the particles were atoms. Incidentally it was found that sputtered cadmium absorbed mercury vapour very rapidly.

AGE-HARDENING OF ALUMINIUM ALLOYS.—It has been shown that the alloys of aluminium with manganese and silicon possess the property of age-hardening after quenching from a high temperature, and also that alloys of aluminium with copper show age-hardening to a lesser degree. In the first part of a paper by Kathleen E. Bingham read at the Liège meeting of the Institute of Metals on September 3, and entitled "The Constitution and Age-hardening of some Tenary and Quaternary Alloys of Aluminium containing Nickel," it is shown that the tenary alloys of aluminium with copper and nickel do not possess this property of age-hardening in any appreciable degree. This suggests that the addition of nickel to the alloys of aluminium with copper suppresses the phenomenon of age-hardening. This is explained by the constitution of the alloys, since the property of hardening depends on the precipitation of one or more of the constituents, and it has been shown that with 2 per cent. of nickel and about 6 per cent. of copper there is no $CuAl_2$ present, either at 500° C. or on cooling slowly to 200° C.; *i.e.* 2 per cent. of nickel increases the solubility of $CuAl_2$ in these alloys at both high and low temperatures. Finally, it is shown that the addition of 1 per cent. manganese to the alloys of aluminium with copper and nickel causes the precipitation of a large amount of magnesium silicide on cooling from 500° C. to 200° C., and also affects slightly the solubility of $CuAl_2$ and $NiAl_3$. In the series containing 4 per cent. copper, 2 per cent. nickel, and 1·5 per cent. magnesium, marked age-hardening takes place, and it is suggested that it is due chiefly to the precipitation of magnesium silicide, since it has been seen that any due to the $CuAl_2$ is very slight. One per cent. magnesium is already in excess of the amount required for the formation of the compound Mg_2Si, as there is only about 0·13 per cent. silicon in the aluminium used.

TESTING ON HARDENED STEEL.—The testing of high carbon tool steel has hitherto been carried out almost entirely in the form of actual machine tests on tools made from the steel. Axel Lundgren, in a paper read at the Stockholm meeting of the Iron and Steel Institute describes a simpler test. The type of test adopted was a bend test, carried out in a machine specially designed for this work. Steels with more than 1 per cent. of carbon annealed in such a manner that the cementite was in a fine-grained form, show, after subsequent hardening and tempering, a higher bend strength and a higher resistance to impact than specimens which, before hardening, have been so annealed that coarse-grained cementite has developed. An annealing which yields a cementite in a spheroidised condition will, after hardening, yield a steel consistently tougher than will a treatment which resulted in the cementite appearing in the form of a network, and this despite the fact that the cementite has afterwards disappeared. Steel with the highest percentage of carbon, 1·3 per cent., shows, after hardening and tempering, a higher bend strength than do lower carbon steels. Annealing so as to produce a fine-grained cementite results, when the steel is hardened and tempered, in the production of a higher bend strength than is obtained from an unannealed steel. The steels quenched at too high a temperature and then tempered at a temperature of 150° to 200° C. show a reduced bending strength, particularly when the tempering temperature is lower. So far as hardness is concerned, the steel with 1·3 per cent. of carbon is slightly harder after heat treatment than the 0·9 per cent. carbon steel. The difference is not great, but with lower carbon contents a rapid decrease in hardness is recorded. Similarly, a slightly greater hardness has been observed in the specimens which were not annealed before hardening, than from those which had been annealed. The influence of the rate of cooling upon the ultimate bending stress, after tempering, has been tested with a tempering temperature of 300° C. In this connexion it has been found that in the case of very rapid cooling in benzene, a much lower bending strength was obtained, than in the case of a less rapid cooling in air.

International Congress of Psychology.

THE eighth International Congress of Psychology was held at Groningen on September 6-11. Nearly 250 psychologists attended. All appreciated the arrangements made by the national committee, consisting of Profs. Heymans (president), Wiersma, Roels (secretary), Brugmans (2nd secretary), Bouman, Buytendijk, Zwaardemaker, and the late Prof. van Wayenburg, and especially by the local reception committee. On the social side, concerts and other entertainments and excursions were arranged, and the reception by the Municipality of Groningen in the Stadspark was a brilliant function.

More than eighty papers were read. Mention may be made of a symposium on intensity differences of sensation, which was opened by Dr. C. S. Myers (London), and Prof. Werner (Hamburg).

Dr. Myers showed how the study of spinal reflexes contributed to our knowledge of intensity differences. As the strength of a stimulus increases, not only does each muscle contract with greater vigour, but *additional* muscles are also brought into play. Moreover, when the stimulus becomes strong enough, the original reflex may be suddenly transformed into another. Thus if the skin between the pads and cushion of the dog's hind foot be pressed or stretched in the spinal animal, the leg is reflexly *extended*. But if the stimulus becomes sufficiently powerful, this reflex changes into one totally different, and the leg is reflexly *flexed*. Instead of inducing contact with the stimulus-object, the stimulus now evokes escape from it. Instead of being, as before, related to the act of walking, the reaction now has reference to that of flight. The sensation passes from one of touch to one of pain. Corresponding to such an abrupt change in type of reaction, the whole pattern of events in the spinal cord must be supposed to undergo an equally abrupt change. The evidence thus points to sensational intensity being in actual experience inevitably an impure variable. Just as with increase of a reflex stimulus the latter spreads to other reflexes, so, as we increase the strength of a tonal stimulus, new sensations inevitably arise; it alters not merely in intensity but also in timbre. It is indeed seldom, if ever, possible that a stimulus is so weak (or so pure) as not to affect mixed sensory elements.

Yet another feature of reflex action is that, when a stimulus provokes reflex flexion of a limb, it simultaneously inhibits antagonistic reflex extension of that limb. If proven applicable to the sensory field, this means that increase of one sensation is accompanied by decrease of an opposite sensation, *e.g.* warmth and coolness, red and green, blue and yellow, white and black. In the white-black pairs there is even a gradual transition from one pure pattern to the other pure pattern through every degree of admixture. It is therefore not surprising that so much discussion has been evoked as to whether changes in the white-black series of sensation are to be regarded as changes in quality or in intensity of sensation. The true answer is that both are inevitably simultaneously changed; or, as Dr. Myers long ago pointed out (*Brit. Journ. of Psychology*, Oct. 1913), intensity differences may be regarded as neither qualitative nor quantitative, but strictly *sui generis, i.e.* intensive.

Prof. Spearman (London) communicated some results obtained from his well-known doctrine of noegenesis, according to which all cognitive operations can be analysed into a system of ultimate laws and processes. These processes were sharply divided into two kinds, the insightful and especially the *eductive* processes, and those which are merely *reproductive*. Thus in the study of individual differences of ability, all current tests of intelligence may be analysed into their eductive and reproductive constituents. The former has shown itself to involve one single general factor, and if anything is to be given the title of 'general intelligence,' it can be nothing else than this. As for the other or reproductive kind of process, this has proved to be wholly independent of the general factor. Thus eduction and not reproduction is the only trustworthy basis of a successful mental test. In the same way the operations involved in the so-called learning by trial and error admit of analysis into the two kinds of constituents, eductive and reproductive, and are far from being 'mechanical,' as generally supposed. The topic of error is another field illuminated by this doctrine. An exhaustive examination of every sort of belief that can unquestionably be regarded as erroneous—from the highest chains of reasoning down to the merest tricks of illusion—every one of them prove to rest primarily upon the law of retentivity and the process of reproduction. All purely noegenetic processes are incapable of error in the slightest degree.

The doctrine of noegenesis also enables the whole range of cognition to be surveyed, and such ancient 'faculties' as 'memory,' 'imagination,' 'attention,' and so forth, as well as such modern ones as 'the power of censorship' or 'keenness in breaking up a complex'—always resolve themselves without the smallest remainder in terms of ultimate psychological laws.

Demonstrations were given by Dr. Godefroy (Amsterdam) on the principles of electrotachography. His method of investigating the psychogalvanic reflex is essentially the transformation of the galvanogram obtained by the Veraguth-Waller method into its first differential or speed curve. Into the circuit which is led through the person tested, the primary coil of an alternating current transformer has been introduced, while the secondary is connected directly with the galvanometer. Thus whenever a change of intensity of the primary current takes place the galvanometer shows a deflexion, and the ordinates of the curve obtained are proportional to the rapidity of the changes in intensity of the primary current. There is also the advantage that the galvanometer returns to zero after each tachographic deflexion. There is, however, at present considerable difference of opinion as to the cause of the psychogalvanic reflex. Dr. Godefroy's experiments lead him to support the hypothesis of the emotional genesis of the phenomenon. Dr. Aveling (London), however, after elaborate experimentation, concludes that the psychogalvanic phenomenon is characteristically the consequent of conation.

Several interesting exhibits and demonstrations were given of various apparatus, designed by Prof. Zwaardemaker of Utrecht, which are well-known to psychologists and to nose and ear specialists, namely, various kinds of olfactometers, an apparatus for demonstrating the presence of odorous molecules in the air, etc.

Prof. Zwaardemaker has recently designed an apparatus for the reinforcement of speech on behalf of the deaf by audions and thermotelephones. The choice of the microphone, the valves and the transformers is a matter of knowledge of modern radio telephony, but Zwaardemaker, not content with subjective listening at the thermotelephone, secured objective measurements by employing the Rayleigh principle of the acoustic mirror.

In conclusion, the records of the Congress point to activity along lines already initiated, and there was little evidence of the breaking of new ground. Thus the researches of the 'configurationists,' useful as they are, as a contrast to the work of some 'atomists,' could yet be assimilated by many outside their camp without sacrificing any psychological principles. LL. W. J.

Coal Blending.

THE gradual exhaustion of the more easily mined seams of coal in Great Britain, and other factors which are resulting in increasing costs of mining and transport, are combining to focus attention on the necessity of employing more scientific methods in the preparation and utilisation of coal. In coal carbonisation, the main object of the coke oven is to produce coke possessing the special properties required by the metallurgical industries; whereas the chief aim of the gas industry has been to manufacture gas of the quality required for domestic and industrial purposes, and coke as a secondary product has not received the attention it deserves. The possibility of producing coke with the qualities desirable in a solid smokeless fuel for domestic use is now being realised, and coke quality and structure are consequently being given much more consideration.

Many attempts have been made to manufacture a solid smokeless fuel, containing a comparatively high percentage of volatile matter, by the carbonisation of coal at low temperatures; and satisfactory products have been obtained, but the costs of the processes have been so great that it has not yet been possible to establish them on a sound commercial basis.

In high temperature carbonisation processes, largely on account of the low thermal conductivity of coal, the charge adjacent to the retort walls is fully carbonised before any marked decomposition of the coal in the centre of the charge has commenced. The exposure of the coke to high temperatures for long periods, and the small amount of volatile matter, both operate in the direction of rendering the product difficult to ignite. The work of numerous investigators, however, has led definitely to the conclusion that these are not the only factors which influence the quality of coke as regards relative ignitability, combustibility, and reactivity. Other factors of importance include the character of the coal carbonised, the state of division of the coal, the method, speed, and duration of heating and the temperature of carbonisation.

The character of the coal to be carbonised may be controlled by grinding and mixing coals of different coking properties with one another or with coke breeze or other substances, in predetermined proportions. The main effects of efficient blending are more rapid heat penetration of the charge and the production of a harder and more easily combustible coke. The method, speed, and duration of heating are largely determined by the design of carbonisation plant.

In a recent paper to the Iron and Steel Institute,[1] Mr. David Brownlie presents a useful survey of the subject of coal blending; that is, the mixing of coals with one another and with other carbonaceous materials, such as low temperature fuels, coke, pitch, etc., especially in connexion with carbonisation. A summary of the paper is not attempted in this article, since the paper, although extending to forty-two pages, is in itself a summary, and the titles of the sections alone occupy more than one page.

Some coking coals are so constituted that they do not require blending for the production of good high temperature coke, but the amount of coal of this type is limited. Scientific blending would render many more coals available for use in the carbonisation industries. It must be emphasised, however, that the blending of coals on a commercial scale requires close attention, as the correct blend for a particular process and temperature of carbonisation would not necessarily be suitable for other processes or temperatures. Other factors, in addition to the amounts of resinous material in the coals constituting a blend, must also be taken into account. For example, the investigations of the Joint Research Committee of the University of Leeds and the Institution of Gas Engineers have shown that the degree of fineness of the coal carbonised exerts important influences. Further, the work of C. B. Marson and J. W. Cobb has demonstrated that the character of the coke may be influenced considerably by the nature of the ash constituents. Iron oxide, calcium oxide, and sodium carbonate have marked beneficial effects, but certain other substances examined were apparently inert.

The application, on a commercial scale, of the results obtained in laboratory investigations of coal blending presents certain difficulties. In addition to the installation of grinding and mixing machinery, increased bunker capacity would be required. It would also be necessary to ensure that only small variations in the quality of coal from a particular colliery occurred in different consignments. The advantages obtained by blending must also compensate for the additional cost of the preparation of the blends; and in this connexion it must be pointed out that the depreciation of grinding machinery, when coke is one of the constituents of the blend, may be considerable. A. PARKER.

[1] Coal Blending. A General Review of Principles as Applied both to High and Low-Temperature Carbonisation, by D. Brownlie. Iron and Steel Institute, June 1926.

Physical Phenomena and Molecular Orientation at Interfaces.

THE behaviour and properties of interfaces were discussed at a conference arranged by the Faraday Society on October 1. The subject is of fundamental importance in the science of colloids, and it is only by a better appreciation of the former that we can hope to unravel the peculiarities of such complex systems as are to be found in natural colloidal materials. The liquid-gas and liquid-liquid interfaces are more simple than those containing a solid surface, since liquids present equipotential surfaces. There is little doubt that the concept of a unimolecular layer of orientated molecules as constituting the surface layer of an insoluble oil on the surface of water is correct, and many investigations are being made on the conditions of formation and stability of these orientated, two-dimensional systems in their solid, liquid, vapour, and gaseous states of aggregation. All the usual three-dimensional phase phenomena, such as allotropy or the process of vaporisation, have been shown to have their two-dimensional prototypes. For soluble substances the surface composition can only be calculated by means of the Gibbs' equation, a thermodynamic process which gives no information as to the dimensions or orientations of the surface phase. That within certain ranges of bulk concentrations, however, the Gibbs' layer is unimolecular, is made probable by experiments on sparingly soluble fatty acids and the analogy between the properties of the surfaces of solution and three-dimensional gases.

This simple idea, however, does not appear to be applicable to all types of binary mixtures; it is possible that in some solutions the Gibbs' layer is thicker than one molecule, but reasons for and against are founded as yet on but slender arguments. The kinetic interpretation of the lowering of the surface tension by two-dimensional liquids, vapours and gases does not, however, meet with universal acceptance, and we find the concept of a negative surface tension developed on the assumption of a molecular halo or wide zone of molecular attraction. This idea is based upon the view that a material spread upon the surface of water will cover but a definite area, and not expand indefinitely, as is assumed on the kinetic hypothesis, a problem clearly susceptible of experimental solution.

As is the case in solutions, the adsorption of ions at liquid interfaces is attended with the operation of electric forces resulting in an ordered distribution of the ions in the interfacial phase. The nature of this distribution is of great importance in an interpretation of the phenomena of electric endosmose and electric cataphoresis. Freundlich has shown quite definitely that the potential difference or electro-kinetic potential of which those phenomena are manifestations is in no way related to the total potential difference across the interface, the one considered by Nernst in his development of a mechanism of operation of electric cells. It is thus necessary to conceive an ionic distribution the total amount of which can be calculated by Gibbs' method, such as will give rise to those two well-defined potential differences. Whilst this problem still awaits a detailed solution, it appears clear that the old and well-known conception of Helmholtz of a condensed double layer, as well as the idea of a diffuse double layer developed by Gouy, must both be rejected in favour of some composite type combining the advantages of both.

Attempts have not been lacking to show that the free surface of a liquid presents an ordered arrangement. Whilst consideration of the mean life of a molecule on the surface of a liquid, as well as the dependence of the surface energy and the Eötvös constant on the molecular structure, show that some orientation does in fact exist, it is clear that the total surface energy of a liquid is not defined entirely by the nature and orientation of the surface layer of molecules.

The nature of the free surface of a solid and the phenomena attending adsorption are more complicated. Whilst unimolecular films are the rule rather than the exception on liquid surfaces, the building up of secondary films, *i.e.* multi-molecular in thickness, is quite frequent on solid surfaces, although the loss in free energy attending the formation of each molecular layer is greatest for the first layer. It is not, however, a simple matter to calculate the film thickness from the amount of material adsorbed, since the surface of a solid is by no means uniform in character, and breaks in the adsorption isotherm may indicate merely the covering up of a fresh portion of the surface possessing a different surface energy. The variation in surface texture, dependent upon the presence of different crystal facets and edges, as well as the presence of broken crystals, is accompanied by a variation in surface energy, the interrelationship for heteropolar materials having been investigated by Born and Lennard Jones. For metals, however, we are not yet in a position to make the necessary calculations. Whilst both catalytic activity and adsorptive powers are dependent on the nature of the surface, the almost specific nature of many of these processes shows that both surface energy and surface structure are necessary factors to be taken into consideration in dealing with these problems.

The Faraday Society is again to be congratulated in promoting a highly successful meeting, at which it was possible not only to listen to a number of distinguished foreign visitors, but also to obtain the point of view which has led different investigators in certain fields to diametrically opposed conclusions.

E. K. R.

The Wellcome Historical Medical Museum.

AFTER closure for nearly a year for reorganisation and enlargement, the Wellcome Historical Medical Museum, Wigmore Street, London, W.1, was reopened on October 14 by Sir Humphry Rolleston, in the unavoidable absence abroad of the founder, Mr. H. S. Wellcome. Sir Arthur Keith delivered a short address, and Sir Frederic Kenyon and Sir D'Arcy Power also spoke in proposing and seconding a vote of thanks to the previous speakers. A brief tour of the Museum discloses the great variety and interest of the collection, but does little more than whet the appetite for return visits on future occasions, when selected objects could be more fully studied.

The visitor first enters the Hall of Primitive Medicine, in which are displayed the paraphernalia of the medicine-man, including his masks and costumes; a reconstructed skull-hunter's hut from south-east New Guinea is here a prominent feature. In the same section are also arranged a large number of charms, amulets, and talismans used by both primitive and modern man. In the Anatomy Room the history of anatomy is illustrated by means of drawings, paintings, and sculpture: there is a fine collection of bone and ivory mannikins used in the teaching of anatomy in the sixteenth and seventeenth centuries. Proceeding through a short picture gallery, the visitor enters the Hall of Statuary, containing statues and casts of the deities associated with medicine in ancient times. In addition, the hall and its gallery contain collections of surgical, scientific, and dental instruments, arranged to illustrate the evolution of each particular instrument. Special mention may be made of the collection of microscopes and that illustrating the development of the modern spectacles.

One of the most interesting collections in the Museum is found at the end of the Portrait Gallery, where the Jenner relics are arranged: there one can see the original manuscripts in which Jenner's views on vaccination are set forth, and also the instruments used by him in his work; a homely touch is provided by the presence of his favourite arm-chair. Passing from the Alchemy Room, a flight of stairs is descended to the ground floor; the main hall contains a varied collection of pictures and material illustrating the War in both its naval and military aspects. At the far end is found the Lister Collection, including a portion of the actual Lister Ward from the Old Infirmary in Glasgow, in which he developed the practice of antisepsis in surgery. Passing sections illustrating methods of torture, the plague, and a lying-in room of the sixteenth century, the visitor enters a large hall devoted to the history of pharmacy. Here will be found a sixteenth-century alchemist's laboratory, a London chemist's shop of the eighteenth century, a barber-surgeon's shop, and Chinese and Turkish drug stores.

Two impressions remained with us when we left: the great boon to mankind the discovery of anæsthetics has been, after inspection of the pictures illustrating surgical operations in pre-anæsthetic days, and the persistence of a belief in charms through many centuries up to the present day, in spite of the increase in scientific knowledge.

In the course of his address at the reopening of the Museum, Sir Arthur Keith said that a museum should fulfil two functions: it should serve the needs of students, fostering research, and at the same time it has a duty to the public, that of direct education. One way to write a history is by the study of the writings of others which have been preserved to us; the other is by the examination of the objects of man's handiwork, many of which have been retrieved through excavations, when their situation throws light on the periods at which they were in use: thus the existence of stone, bronze, and iron ages was discovered by this means. History, then, can be written on the shelves of a museum. But a history of medicine is the most difficult of all to write, since the use of a primitive medicine-man's emblems of his art is only really understood when we have a knowledge of his beliefs. On these he bases a theory of medicine, which guides him in the practice thereof; in general, the spirit is the real person and illness is due to the attack of baneful spirits, so that his practice is directed to the driving out of these immaterial beings.

A museum can only fulfil its main function of encouraging research if it is itself a centre of research. It can be seen when a museum is successfully fulfilling this function, by the appearance of members of its staff at scientific meetings, by the publications issuing from it, and by the number of students who make use of it.

In the education of the public the curator of a museum should be an able 'case-dresser.' The average man has little time or inclination for a detailed study of the exhibits, so that he requires his history to be put before him in a few well-chosen and salient objects. Since the best elementary treatises are usually written by the most learned men, it is probable also that the educational function of a museum will be directed equally well with research by the most learned of our curators.

Money is an essential item in the work of a museum, so that the thanks of all are due to those who contribute service to mankind by founding and maintaining it as a centre of research and education.

University and Educational Intelligence.

CAMBRIDGE.—Mr. L. H. Thomas, Isaac Newton student and Smith's prizeman, has been elected to a fellowship at Trinity College. Mr. H. M. Robertson (Leeds) has been elected to a research studentship in economics at Emmanuel College, and Mr. A. H. Wilson to an honorary research studentship in mathematics. The Hon. Bertrand Russell, Trinity College, will lecture on "The Analysis of Matter" at Trinity College, giving the Tarner lectures on the philosophy of the sciences.

Dr. A. C. Haddon, Christ's College, has been appointed honorary keeper of the New Guinea collections in the Museum of Archæology and Ethnology. J. A. Ratcliffe, Sidney Sussex College, has been elected to the Stokes Studentship for research in physics at Pembroke College.

The Commissioners have offered to the University for discussion new statutes modifying the statutes with regard to various trust emoluments to bring them into line with the new statutes. They propose a new statute, throwing open scholarships and prizes to women on the same terms as to men, leaving the University power to exclude women from any one or more of the emoluments for which they have not hitherto been eligible.

EDINBURGH.—Prof. E. Shearer, in his inaugural address as professor of agriculture, spoke on "Agricultural Education and the Community." He stated that our system of agricultural education is based on lines which are sound and well adapted to the general circumstances of the country. Useful work has been accomplished in the past, but present efficiency and future progress are unduly handicapped by meagre financial provision. Nothing is more certain than that the agricultural future, amidst ever-increasing competition, will lie with those nations that take the fullest advantage of scientific knowledge.

ST. ANDREWS.—The Court has appointed Dr. J. D. McBeath Ross to the lectureship in physical chemistry in University College, Dundee, vacant by the resignation of Dr. O. R. Howell, appointed to a post in Manchester Muncipal Technical College. Mr. J. M. Hay has been appointed to the lectureship in mechanical engineering and machine design in University College, Dundee, vacant by the resignation of Dr. W. J. Walker, appointed to the chair of mechanical engineering in the University of Witwatersrand, Johannesburg, South Africa.

ON Wednesday, October 20, H.R.H. the Prince of Wales opened a new women's hostel, a teaching dairy, and farm buildings at the Cheshire School of Agriculture, Reaseheath. These buildings complete the equipment of the institution, and render possible centralisation of a comprehensive scheme of agricultural education, hitherto somewhat scattered. The school lies in the centre of a small estate, the mansion on which serves as a residential hostel for forty men students and as the headquarters of a scientific staff. There are two farms, the larger, 210 acres in area, being used for teaching and commercial ends, and the smaller, which extends to 50 acres, being devoted to experimental work. A 6-acre holding within the estate has been equipped as a poultry department, and the original gardens have been extended and stocked to illustrate various phases of horticultural work. An extensive range of stabling has been adapted as chemical, botanical, and bacteriological laboratories. The dairy, now added to the buildings, has been built primarily for teaching purposes; it has been equipped with the ordinary apparatus of a good cheese-making farm, and also with sufficient examples of dairy machinery to demonstrate the possibilities of mechanical devices. The Women's Hostel is a pleasing structure which perpetuates the half-timbered style so characteristic of the county. There is accommodation for thirty students. A county institution, the school aims primarily at instruction suited to the needs of farmers' sons and daughters, and others taking up rural pursuits for a livelihood. Separate courses, all of three to six months' duration, are provided in agriculture, dairying, horticulture, and poultry-keeping. Though the end in view is severely practical, instruction is largely on the traditional lines of scientific institutions; for it is characteristic of the Cheshire farmer that he wants his son to be taught "something he cannot learn at home," rather than to be trained in manual operations. The school also maintains an extensive advisory service throughout the county.

Contemporary Birthdays.

October, 24, 1854. Right Hon. Sir Horace C. Plunkett, K.C.V.O., F.R.S.

October 26, 1874. Prof. T. M. Lowry, C.B.E., F.R.S.

October 27, 1856. Prof. Ernest William Hobson, F.R.S.

October 28, 1868. Mr. Frederick William Lanchester, F.R.S.

October 29, 1868. Mr. Charles P. Eugène Schneider.

Sir HORACE PLUNKETT, sometime an Irish administrator, was born in Gloucestershire. He was educated at Eton and University College, Oxford. Soon after attaining his majority he worked at the development of a ranch in Montana, acquainting himself with all the details of American agricultural methods. Afterwards, Irish agriculture and industry engaged his whole-hearted energies for many years, with much practical issue. Chairman of the (then) Sub-Section of Agriculture at the British Association's Dublin meeting in 1908, Sir Horace gave a highly informative address, worthy of reference to-day, on "Science and the Problem of Rural Life."

Prof. LOWRY was born at Low Moor, Yorkshire. Educated at Kingswood School, Bath, he entered later the Central Technical College of the City and Guilds Institute, South Kensington. Here for seventeen years, from 1896, he held an assistantship to Prof. H. E. Armstrong, F.R.S. From 1912 until 1916 he was lecturer in chemistry at Guy's Hospital Medical School. In 1920 Prof. Lowry was appointed to the chair of physical chemistry in the University of Cambridge. Bakerian lecturer of the Royal Society in 1921 (in collaboration with Dr. P. C. Austin), he dealt with "Optical Rotatory Dispersion." On the same subject he discoursed in December 1925, before the Société de Chémie Physique, Paris, in exemplification of Biot's researches. Prof. Lowry is the author of two useful works, "Historical Introduction to Chemistry" (1915) and "Inorganic Chemistry" (1922).

Prof. HOBSON, Sadleiran professor of pure mathematics in the University of Cambridge, was born at Derby. Entering Christ's College, Cambridge, he graduated senior wrangler. The Royal Society awarded him a Royal medal in 1907 in respect of the fundamental character of his contributions to mathematics and mathematical physics, particularly with reference to the history and development of mathematics.

Mr. F. W. LANCHESTER, whose pioneer work and researches in aeronautics were recognised last year by the Royal Aeronautical Society in the award of its gold medal, and by his election as an honorary fellow, was educated privately and at the Royal College of Science, South Kensington. Early in his career he was technical adviser to the Birmingham Small Arms Company, and to the Daimler Company. From 1909 until 1920 he was a valued member of the Advisory Committee for Aeronautics.

Mr. C. P. EUGÈNE SCHNEIDER, ironmaster and metallurgist, owner, in family succession, of the famous Creusot Works in France, was nominated in 1917 president of the Iron and Steel Institute, and he held office for a year. It was a departure in procedure cordially and unanimously received. Distinguished specially in metallurgical research and practice, Mr. Schneider is also prominent as a scientific industrialist. In 1920–21 the Iron and Steel Institute published papers of his in its *Journal* on "An Investigation of various Forging Operations carried out under Hydraulic Presses."

Societies and Academies.

LONDON.

Society of Public Analysts, October 6.—A. Chaston **Chapman**: On the presence of compounds of arsenic in marine crustaceans and shellfish. Marine crusteans and shellfish have been found to contain from 10 to 174 parts of arsenic (as As_2O_3) per million of the wet edible portions. Native oysters contained from 5 to 10 parts, and Portuguese oysters from 33 to 70 parts per million. In fresh-water fish, shellfish and crustaceans, the amounts of arsenic ranged from only about 0·4 to 1·5 parts per million. The arsenic in the marine animals is therefore derived from the sea water. Potted and canned crustacea and shellfish contained from 0·5 to 85 parts of arsenic per million. The arsenic in the urine of two experimental subjects was raised from the normal figure of about 1/200 grain per gallon to ½ grain in one case, and ⅓ grain in the other, after a meal of lobster.—A. Chaston **Chapman** and H. **Linden**: On the presence of lead and other metallic impurities in marine crustaceans and shellfish. The following amounts of copper (parts per million of the dried edible portion) were found: lobster, 167; crab, 130; and whelks, 115. The amounts of lead ranged from 5 (whelk) to 25·6 (lobster). Native oysters contained from 12 to 400 parts and Portuguese oysters 10 to 307 parts of lead per million. Like the arsenic, these metallic impurities are probably derived from the sea water.—A. R. **Tankard** and D. J. T. **Bagnall**: The examination of fish for formaldehyde. Various kinds of fish gave a positive reaction in Schryvor's phenylhydrazine test, indicating the presence of 1 to 2 parts per million of formaldehyde. Since, however, trimethylamine (a common constituent of fish) can be readily oxidised to formaldehyde, a positive reaction does not necessarily indicate the presence of added formaldehyde. The reaction tends to be less marked when putrefaction of the fish has set in.—Karl **Sandved**: The potentiometric titration of tin with potassium bromate. The best results (error 0·5 per cent.) were obtained by oxidation of the stannous tin with antimony chloride or ferric chloride, and potentiometric titration of the reduction compound with potassium bromate. A method of determining tin in the presence of antimony has been devised, and the potentiometric titration of ferrous iron has been closely studied.—R. R. T. **Young**: The determination of nicotine in tobacco. Kellor's, Kissling's, and other methods have been critically examined. Accurate results are obtained by extracting the tobacco with a mixture of petroleum spirit, ether, and aqueous potash, shaking the ethereal extract with dilute (1 : 1) alcohol containing cochineal, adding excess of hydrochloric acid to the separated aqueous layer, and titrating with standard sodium hydroxide. Ammonia is best determined by distillation after precipitation of the nicotine with iodine, but little ammonia, if any, was present in the tobaccos examined.

PARIS.

Academy of Sciences, September 6.—Alfred **Rosenblatt**: The plane irrotational movements of incompressible viscous fluids.—H. **Pélabon**: Rectifying contacts. A detector consists essentially of the system metal-dielectric-metal. The thickness of the dielectric must be as small as possible and remain constant. Various practical means of satisfying these conditions are suggested.

September 13.—H. **Deslandres**: Remarks on the law of distribution in time of magnetic storms. The theory of corpuscular radiation appears to be able to explain the greater part of solar phenomena.—Valère **Glivenko**: Surfaces of finite area.—Julius **Wolff**: A generalisation of a theorem of Schwartz.—**Gossot** and **Liouville**: The principles of interior ballistics.—V. N. **Ipatief** and B. A. **Mouromtsef**: The reduction of chromic combinations by hydrogen under pressure and at high temperatures.—F. **Taradoire**: The rapid oxidation of drying oils and antioxygens. With the exception of the nitroso derivatives of diphenylamine, none of the other organic antioxygen substances employed were sufficiently active to prevent the spontaneous inflammation caused by the oxidation of drying oils on cotton wool.—**Raymond-Hamet**: A supposed sympathicotropism of Uzara.—Methodi **Popoff**, Minco **Dobreff**, and George **Paspaleff**: The development of the eggs of the sea-urchin (*Strongylocentrotus lividus*) under the action of extracts of the pollen of the oak and of calla.

September 20.—Th. **Got**: A remarkable class of ruled surfaces.—A. **Myller**: Normal curvature and geodesic torsion.—George D. **Birkhoff**: The signification of the canonical equations of dynamics.—André **Meyer**: The catalytic rôle of mercury in the sulphonation of anthraquinone. To explain the catalytic influence of mercury on this sulphonation, Martinet and Roux have formulated an ingenious hypothesis. One deduction from this is that α-anthraquinone sulphonic acid should be transposed into the β-acid by simple heating with concentrated sulphuric acid. This the author is unable to confirm, the α-acid remaining unchanged under these conditions.—E. **Kohn-Abrest** and S. **Kawakibi**: Nitrates in animal and vegetable tissues. Details of a modification of Lunge's method of determining nitrates suitable for organic material.

SYDNEY.

Royal Society of New South Wales, September 1.—F. W. **Booker**: The internal structures of the Pentamendae of N.S. Wales. Brachiopod material was examined by means of serial thin sections, from 1 to 1.5 mm. apart. A new sub-genus, Barrandina (Synonym *Pentamerus linguifera*, var. *Wilkinsoni*, Eth. Fils 1892), containing two new species, *B. Wilkinsoni* and *B. Minor*, is described. A structure new to science is noted in the cruralium of these two species. It is also present in *Sieberella galeata*, Dalman, and *Sieberella glabra*, Mitchell, but not in *Pentamerella* (*Barrandella*) *Molongensis*, Mitchell.—M. B. **Welch**: The wood structure of certain eucalypts belonging chiefly to the ash group. The woods of seven species of eucalyptus are described in detail. In common with other members of the genus, the woods are practically diffuse-porous, though growth rings are more prominent in certain of these species than in most. The vessels possess simple end perforation. Transition forms occur between the fibre-tracheids, making up the bulk of the woody tissue, and the typical tracheids. Wood parenchyma is usually not abundant and is chiefly vasicentric.

Official Publications Received.

BRITISH AND COLONIAL.

Journal of the Indian Institute of Science. Vol. 9A, Part 2: Vegetable Oils containing Glycerides of Erucic Acid. By J. J. Sudborough, H. E. Watson and P. Ramaswami Ayyar. Pp. 25-70+2 plates. 2.8 rupees. Vol. 9A, Part 3: The Production of Ether by Solid Catalysts. By S. K. Kulkarni Jatkar and H. E. Watson. Pp. 71-109+4 plates. 3 rupees. Vol. 9A, Part 4: The Constituents of some Indian Essential Oils. Part 18: Derivatives of Abietic Acids. By Madyar Gopal Rau and John Lionel Simonsen. Pp. 111-116+3 plates. 8 annas. (Bangalore.)

Transactions of the Royal Society of Edinburgh. Vol. 54, Part 3, No. 17: Some new Ordovician and Silurian Fossils from Girvan. By Dr. F. R. Cowper Reed. Pp. 735-739+1 plate. 1s. Vol. 54, Part 3, No. 18: The Geology of Jan Mayen. By J. M. Wordie. Pp. 741-745+2 plates. 1s. 6d. Vol. 54, Part 3, No. 20: Calamoichthys calabaricus J. A. Smith. Part i: The Alimentary and Respiratory Systems. By G. Leslie Purser. Pp. 767-784+1 plate. 2s. 6d. Vol. 54, Part 3, No. 21: Contributions to the Study of the Old Red Sandstone Flora of Scotland. iii: On Hostimella (Ptilophyton) Thomsoni, and its Inclusion in a new Genus, Milleria; iv: On a Specimen of Protolepidodendron from the Middle Old Red Sandstone of Caithness; v: On the Identification of the large 'Stems' in the Carmyllie Beds of the Lower Old Red Sandstone as Nematophyton. By Dr. W. H. Lang. Pp. 785-799+2 plates. 5s. 6d. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, L d.)

Department of Agriculture, Ceylon. Bulletin No. 76: Supplement No. 1 to the Guide to the Central Experiment Station, Peradeniya, issued as Bulletin No. 70. Pp. 24. (Peradeniya.) 40 cents.

Botanical Survey of South Africa. Memoir No. 7: The Native Timber Trees of the Springbok Flats. By Ernest E. Galpin. Pp. 26+26 plates. (Pretoria: Government Printing and Stationery Office.)

Department of Science and Agriculture, Jamaica. Microbiological Circular No. 5: Panama Disease in Jamaica. By C. G. Hansford. Pp. ii+35. (Kingston, Jamaica: Government Printing Office.)

University of London: University College. Calendar, Session 1926–1927 (Centenary Year). Pp. clxxx+10+475+44. (London: Taylor and Francis.)

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 64, No. 358, October. Pp. 989-1092+xxx. (London: E. and F. N. Spon, Ltd.) 10s. 6d.

Engineering Abstracts from the Current Periodical Literature of Engineering and Applied Science, published outside the United Kingdom. Published by the Institution of Civil Engineers with the Co-operation of other Engineering Societies in Great Britain and the Dominions. New Series, No. 29, October. Pp. 221. (London: The Institution of Civil Engineers.)

FOREIGN.

Transactions of the Astronomical Observatory of Yale University. Vol. 3, Part 4: Catalogue of 1275 Stars; Re-observation by Means of Photography of Astronomische Gesellschaft Stars between Declinations +1° and +2°, reduced to 1875·0 without applying Proper Motions. By Frank Schlesinger, with the collaboration of C. J. Hudson, Louise Jenkins and Ida Barney. Pp. 135-151. Vol. 3, Part 5: Complement to the Tables of the Motion of the Moon, containing the Remainder Terms for the Century 1800–1900, and Errata in the Tables. By Ernest W. Brown, with the assistance of H. B. Hedrick. Pp. 155-204. Vol 3, Part 6: The Evidence for Changes in the Rate of Rotation of the Earth and their Geophysical Consequences, with a Summary and Discussion of the Deviations of the Moon and Sun from their Gravitational Orbits. By Ernest W. Brown. Pp. 205-235+3 plates. (New Haven, Conn.)

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 530: Establishment of Radio Standards of Frequency by the Use of a Harmonic Amplifier. By C. B. Jolliffe and Grace Hazen. Pp. 177-189. (Washington, D.C.: Government Printing Office.) 10 cents.

Rapport annuel sur l'état de l'Observatoire de Paris pour l'année 1925, présenté au conseil dans sa séance du 6 mars 1926. Pp. 26. (Paris.)

Cornell University Agricultural Experiment Station. Bulletin 449: Biology and Control of the White-Pine Weevil, *Pissodes strobi* Peck. By Samuel A. Graham. Pp. 32. Memoir 97: Calcium Sulfate as a Soil Amendment. By M. H. Cubbon. Pp. 51. (Ithaca, N.Y.)

Jahresbericht der Hamburger Sternwarte in Bergedorf für das Jahr 1925. Nebst einer Übersicht über die meteorologischen Beobachtungen 1919–1925. Pp. 34. (Bergedorf.)

Astronomische Abhandlungen der Hamburger Sternwarte in Bergedorf. Band 2, Nr. 7: Beiträge zur physischen Untersuchung der grossen Planeten. 3: Beobachtungen und Zeichnungen des Planeten Mars während der Perihelopposition 1924 ausgeführt am 60 cm-Refraktor der Hamburger Sternwarte in Bergedorf. Von K. Graff. Pp. 30+12 Tafeln. (Bergedorf.)

Mitsuru Kuhara's On the Beckmann Rearrangement. Edited by Prof. Shigeru Komatsu. Pp. v+83. (Kyoto: Kyoto Imperial University.)

Festschrift der Zentralanstalt für Meteorologie und Geodynamik zur Feier ihres 75jährigen Bestandes im Jahre 1926. Herausgegeben von der Akademie der Wissenschaften in Wien unter Mitwirkung der Zentralanstalt für Meteorologie und Geodynamik. Pp. v+195. (Wien.)

Report of the National Research Council for the Year July 1, 1923–June 30, 1924. Pp. iv+59-95+129-205. Report of the National Research Council for the Year July 1, 1924–June 30, 1925. Pp. iv+106. (Washington, D.C.: Government Printing Office.)

American Museum of Natural History. Guide Leaflet Series No. 64: Meteorites, Meteors and Shooting Stars. By Frederic A. Lucas. Pp. 24. (New York City.)

Year Book of the Michigan College of Mines, 1925–1926, Houghton, Michigan. Announcement of Courses, 1926-1927. Pp. 11. (Houghton, Mich.).

The American Journal of Hygiene. Monographic Series, No. 6, September: The School of Hygiene and Public Health of the Johns Hopkins University. Pp. iii+55. (Baltimore, Md.) Free.

Sveriges Geologiska Undersökning. Årsbok, 18, 1924. Motsvarande No. 329–333 av Ser. C. (Avhandlingar och Uppsatser.) Pp. ii+96+129+130+34+20+11. (Stockholm.) 8.50 kr.

Publication No. 587: A Decade of Progress in the Design and Manufacture of Scientific Optical Instruments and Apparatus. Pp. 20. (York and London: Cooke, Troughton and Simms, Ltd.)

Price List for 1926–7. Pp. 28. (London: Dubilier Condenser Co., (1925) Ltd.)

Microscopical Illuminating Apparatus. Pp. 32. (London: Ogilvy and Co.)

Diary of Societies.

SATURDAY, October 23.

North of England Institute of Mining and Mechanical Engineers (Newcastle-upon-Tyne), at 2.30.—T. S. Durham: Thin Seam Mining.—J. J. Stout: Description of an Old Windmill.

MONDAY, October 25.

Cambridge Philosophical Society (Annual General Meeting) (in Cavendish Laboratory), at 4.30.—Dr. H. Jeffreys: On Compressional Waves in Two Superposed Layers.—S. Pollard: (*a*) On the Descriptive Form of Taylor's Theorem; (*b*) The Summation of a Fourier Integral of Finite Type.—G. C. Steward: Note on the Petzval Optical Condition.—Prof. E. A. Milne: Maxwell's Law, and the Absorption and Emission of Radiation.—*Communicated by title only*:—T. L. Wren: The Correspondence between Lines in Threefold Space and Points of a Quadric Fourfold in Fivefold Space, established by a Geometrical Construction.—Dr. Roughton and Dr. Hartridge: Improvements in the Apparatus for Measuring the Velocity of Very Rapid Chemical Reactions. II.—Dr. Constable: On the Stability of Copper Catalysts Produced by Thermal Decomposition.—J. A. Christiansen: Note on the Velocity of Gas-reactions.—W. T. Richards: Note on the Effect of Alpha Particles on Paraffin.
Institute of Actuaries, at 5.—Sir Joseph Burn: Presidential Inaugural Address.
Royal College of Surgeons of England, at 5.—C. E. Shattock: Demonstration of Surgical Conditions of Blood-Vessels.
Institution of Electrical Engineers (Informal Meeting), at 6.
Institution of Electrical Engineers (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—P. J. Robinson: Chairman's Address.
Institution of Electrical Engineers (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—J. Rosen: Chairman's Address.
Institution of Mechanical Engineers (Graduates' Section, London), at 7.—E. L. Diamond: An Investigation into the Cylinder Losses of Locomotive Engines.
Medical Society of London, at 8.—Clinical Evening.
Royal Society of Medicine (Odontology Section), at 8.—J. B. Parfitt: Presidential Address.—C. A. Wakeford: Some Observations on the Tooth Band and on the Enamel Organs of the Human Deciduous Teeth.
Ethological Society (at Royal Sanitary Institute), at 8.30.—Dr. B. Hollander: Life and Mind (Presidential Address).
Institute of Chemistry (Manchester and District Section) (Annual General Meeting) (at Manchester).—Prof. G. G. Henderson: The Chemist and the Community.

TUESDAY, October 26.

Royal Society of Medicine (Medicine Section), at Guy's Hospital, at 5.—Clinical Meeting.
Institution of Civil Engineers, at 6.—Senator G. Marconi: Radio Communications (James Forrest Lecture).
Illuminating Engineering Society (at E.L.M.A. Lighting Service Bureau, 15 Savoy Street), at 6.30.—Reports on Progress during the Vacation and Developments in Electric Lamps and Lighting Appliances.
Institution of Electrical Engineers (East Midland Sub-Centre) (at Loughborough College), at 6.45.—R. B. Matthews: Electro Farming.
Royal Photographic Society (Kinematograph Group), at 7.—Capt. C. W. R. Knight: Filming the Golden Eagle.
Institute of Chemistry (Edinburgh and East of Scotland Section, jointly with Society of Chemical Industry, Edinburgh and East of Scotland Section) (at 36 York Place, Edinburgh), at 7.30.—W. A. Williams: Costs in Industry.

WEDNESDAY, October 27.

Institution of Automobile Engineers (North of England Centre) (at Engineers' Club, Manchester), at 7.—H. Kerr Thomas: The Debt of the Community to the Automobile (Presidential Address).
Institution of Engineers-in-Charge (at Magnet House, Kingsway), at 7.30.—N. E. Barber: Small Refrigeration Plants and their Application.
Faraday Society (at Chemical Society), at 8.—A. C. Vivian: Beryllium.—F. I. G. Rawlins: The Chemical Constants of the Halogen Hydrides.—J. Colvin: The Decomposition of Nitrosotriacetonamine in Presence of Hydroxyl Ion. Part I. The Region of Small Concentration of Alkali.—Freda M. Hunter: Latent Heat of Dilution of Sugar Cane Solutions.—J. J. Hedges: The Adsorption of Water by Colloidal Fibres.—A. N. Campbell: The Anodic Behaviour of Ferro-Manganese.—T. C. Sutton: Abnormal Absorption of Gases by Steel.—R. H. Humphry and R. S. Jane: The Observation of Cataphoresis in Colourless Sols. I. Rubber in Benzene.—J. S. Dunn: A Simple Kinetic Theory of Viscosity.—A. C. Chatterji and N. R. Dhar: Condition of Silver Chromate in Gelatin from Electric Conductivity and Diffusive Experiments.
Royal Society of Arts, at 8.—Dr. R. J. Tillyard: Progress of Economic Entomology, with special reference to Australia and New Zealand (Trueman Wood Lecture).

THURSDAY, October 28.

Institution of Locomotive Engineers (at Engineers' Club, Coventry Street), at 7.—R. C. Bond: Braking of Trains on Electrically-operated Railways.
Institute of Metals (Birmingham Local Section jointly with Birmingham Metallurgical Society, Staffordshire Iron and Steel Institute) (at Engineers' Club, Birmingham), at 7.—Prof. D. Hanson: Fatigue.
Institution of Automobile Engineers (London Graduates' Meeting) (at Watergate House, Adelphi), at 7.30.
Institution of Automobile Engineers (Luton Graduates' Meeting) (at Luton), at 7.30.—W. S. Bull: Hydraulic Transmission as applied to Automobiles.
Chemical Society (at Institution of Mechanical Engineers), at 8.—Prof. S. P. L. Sörensen: The Composition and the Characterisation of Proteins (Hugo Müller Lecture).

FRIDAY, October 29.

Royal College of Surgeons of England, at 5.—Sir Arthur Keith: Demonstration of Specimens illustrating Disorders in the Growth of Bone.
North-East Coast Institution of Engineers and Shipbuilders (Annual General Meeting) (Newcastle-upon-Tyne), at 6.—Sir Theodore Morison: How should an Engineer be trained?
Institution of Mechanical Engineers (Informal Meeting), at 7.—R. Lowe: Steel Castings in Mechanical Engineering.
Junior Institution of Engineers, at 7.30.—A. V. Ballhatchet: Distortion in Wireless Reception.
Society of Technical Engineers (at Queen's Hotel, Birmingham), at 7.30.—R. Hazleton: The Engineers' Bill.
Society of Chemical Industry (Liverpool Section) (at Liverpool University), at 8.—Dr. E. F. Armstrong: Research and Enterprise in Chemical Industry: New Routes to Old Chemicals (Hurter Memorial Lecture).
Institute of Chemistry (Glasgow and West of Scotland Section) (at Glasgow).—Annual General Meeting.

SATURDAY, October 30.

Institute of Metals (North-East Coast Local Section, jointly with Institute of British Foundrymen) (at Neville Hall, Newcastle-upon-Tyne), at 6.15.
Royal Society of Medicine (Study of Disease in Children Section) (at Children's Hospital, Birmingham).

PUBLIC LECTURES.

SATURDAY, October 23.

Horniman Museum (Forest Hill), at 3.30.—V. Gordon Childe: The Dawn of Civilisation in Europe.

SUNDAY, October 24.

Guildhouse (Eccleston Square), at 3.30.—Prof. W. A. Bone: The Economic Aspects of Coal.

MONDAY, October 25.

University of Leeds, at 5.15.—Sir Frank Dyson: Eclipses.
King's College, at 5.30.—C. J. Gadd: Evil Spirits in Babylonian Religion.
Southampton University College.—Dr. H. T. Calvert: The Activated Sludge Process of Sewage Treatment (Chadwick Lecture).

TUESDAY, October 26.

Gresham College, at 6.—A. R. Hinks: The Landscape of the Moon. (Succeeding Lectures on October 27, 28, and 29.)

WEDNESDAY, October 27.

Royal Institute of Public Health, at 4.—Prof. L. P. Abercrombie: Town Planning in Relation to Health.
London School of Economics and Political Science, at 6.—F. W. Roberts: The Adrema Machine and its Uses.
Fulham Central Public Library, at 8.—C. G. Parsloe: Roman and Saxon London.

THURSDAY, October 28.

King's College, at 5.30.—J. E. Barnard: The Design and Construction of Modern Microscopes.
Fulham Central Public Library, at 8.—R. Sudell: Bulb Culture.

SATURDAY, October 30.

Horniman Museum (Forest Hill), at 3.30.—Miss M. A. Murray: Seed-Time and Harvest in Ancient Egypt.

SUNDAY, October 31.

Guildhall (Eccleston Square), at 3.30.—Prof. H. H. Turner: The Fight against Fear.

CONGRESSES.

October 24 and 25.

Rumanian Congress of Oto-rhino-laryngology (at Bucarest).

October 25 to 27.

British Commercial Gas Association (at Newcastle-upon-Tyne).

October 25 to 28.

Italian Congress of Surgery (at Padua).

November 4 to 7.

Journées médicales de Montpellier (at Montpellier).