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Scientific Worthies

XLVI.—The Right Hon. Lord Rutherford of Nelson, O.M., F.R.S.

IT is often a matter of surprise to note the profound differences between the methods the human mind adopts towards the problems it is seeking to solve, and any narrow classification would necessarily be inexact because of the variety of possible temperaments. Among the scientific investigators who have devoted their lives to the study of physics, two main tendencies can, however, be noted. On one hand, there are those who are dominated by the abstract aspect. They are interested not so much in the facts as in the theories to which these facts lead. There is no lack of illustrious men to whom the intellectual aspect has appeared the more important, and quite recently striking successes have resulted from just such methods of investigation. Other scientific men, while not denying that the object of science is to correlate and to predict phenomena, and without confining themselves merely to the compilation of facts, yet feel that we are so far from being able to form a logical and clear idea of reality that we are scarcely beyond the point of realising the danger of too abstract generalisations. Such generalisations run the risk of describing more the mind of the man who puts them forward than Nature itself—which is the object of research and of experimental physics. As has often been remarked, facts serve to produce theories, leading in their turn to the discovery of new facts, which may in their turn destroy the theories by which they were discovered.

The scientific career of Lord Rutherford is a splendid example of this second method of physical investigation, and it will be sufficient to show that this point of view is not in any way inferior either in importance or in fertility to the other.

Lord Rutherford's earliest work was in a sphere quite apart from that to which he has since devoted his life, but it showed clearly enough his remarkable qualities as a physicist. He investigated the change in the magnetisation of a steel wire due to the passage of oscillatory currents, and he was able to show that Hertzian waves could, by producing oscillatory currents, cause a sudden diminution in the magnetisation of such a wire. This discovery was utilised later by other workers and developed to form a detector for wireless telegraphy.

The three years, 1895–98, which Lord Rutherford passed at Cambridge working under Sir J. J. Thomson determined the orientation of his future

interests by permitting him to study the newly discovered properties of ionised gases and the causes of this ionisation. He went to McGill University in Montreal imbued with the ideas and inspiration which had enabled Sir J. J. Thomson to make the Cavendish Laboratory a birthplace of famous physicists. It was not long before the young professor found in radioactivity the subject for which his peculiar genius was most suited. It was then 1898, two years after the discovery by Becquerel of the radioactivity of uranium ; Pierre Curie and Mme. Curie had just added greatly to the range of the new phenomenon by discovering polonium and radium, and the list of the radioactive bodies already included thorium and the two alkali metals.

While, however, the far-reaching importance of these new discoveries was obvious to everyone, the interpretation of the facts in this new domain presented fundamental problems which remained unanswered. A most important research from this point of view was published in 1900 by Rutherford, from Montreal, when he was able to show that the thorium bodies gave out a type of radioactive emanation. He maintained the view that this was in effect a material gas constituting a new chemical species which should find a place in the family of inactive gases to which helium and argon belonged, and this was ultimately, in collaboration with Soddy, shown to be true. This bold hypothesis received a most striking confirmation when the more marked and more permanent phenomena shown by radium emanation were discovered in their turn.

Following up his researches on thorium, Rutherford was able to detect the presence of an induced radioactivity which he attributed to an active deposit, invisible and yet material, carried in the form of electric particles which could be concentrated on an electrode by means of an electrostatic field. This active deposit was an attribute of the emanation and was thus an example of the affinity which exists between the radioactive bodies. Later, while studying the radium emanation discovered by Dorn, Rutherford found many properties which emphasised its material properties, as, for example, that it could be condensed in suitably cooled tubes. He was also able to obtain a complete spectrum of this new chemical element, which Ramsay and Soddy had shown beyond doubt was a gas. It is very remarkable that Rutherford and Soddy suggested in 1902 that helium might be one of the products of disintegration of the radioactive bodies.

The year 1903 was one of the most decisive for the new science which was then growing up, for it saw in effect the discovery of the production of helium from radium emanation, the fundamental discovery by Curie and Laborde that preparations of radium gave out a continual supply of heat, and it also saw the birth of the theory of radioactive transformations put forward by Rutherford and Soddy to explain the facts shown by the thorium family. At first sight many of the phenomena shown by the radioactive bodies were very strange ; the activity did not always seem to depend upon the bodies which constituted the source ; it could be carried to a certain distance and could there produce the phenomenon called induced activity, all of which was very obscure. Neighbouring surfaces, without apparently suffering any modification, acquired a power of emitting radiations for which the rate of decrease with time appeared to be connected in a mysterious way with the growth of activity of the primary substance. To-day, when we have a theory of the atom, admittedly rough, but which yet explains in an admirable way a great number of diverse facts, the interpretation of these phenomena, so inexplicable in the early days, now seems simple enough. But if one looks back to the year 1900, when the ideas of the nuclear atom, and of Bohr orbits, were as yet unformulated, it will readily be appreciated what imagination and what sureness of intuition were necessary in order to disentangle so rapidly such a complication of strange and new facts.

Rutherford and Soddy put forward in 1903 a complete theory of these phenomena which permitted the prediction, both qualitatively and quantitatively, of the whole complicated consequence of events. This theory was based on a conception of the utmost simplicity which has since served, without any modification, to classify all the facts discovered in this new domain.

The fundamental idea of this theory is that among the great number of atoms of a body which possess the property of radioactivity, there is a definite probability that in a given time a certain number of these atoms will have changed into a new type by the ejection of a material particle owing to a type of instability. In other words, the number of atoms which change in unit time is always proportional to the total quantity of matter which is then present.

A detailed calculation then showed that such a substance will disappear according to an exponential law ; if the new atoms are also unstable and are transformed much more rapidly than the first kind

(which is the case for uranium, radium, and thorium), there will result a type of equilibrium between the successive descendants of the same radioactive family, so that their relative proportions are perfectly defined in the minerals and in the preparations which contain them. The radiations which are emitted are a direct result of the transformations of the atoms and therefore provide an exact measure of its rate of disintegration.

Schweidler and later Kohlrausch showed that Rutherford's theory, which was at first presented as a kind of analogy with irreversible monomolecular reactions, could be viewed entirely from the point of view of chance and was therefore subject to the laws of the calculus of probability. This was perhaps one of the first examples of the intervention of statistical laws in fundamental atomic phenomena, an idea of which the more recent discoveries of physics have shown both the generality and the profound philosophic importance. In the light of present knowledge, one may well ask to-day whether such a law was not imposed *a priori* to the exclusion of all others.

The laws of radioactive disintegration thus stated formed a framework for the classification of all the new substances produced by the successive transformations of each family. Thus a new chapter in physics and in chemistry was begun, that of matter in a state of evolution, which has led in time to all that we know to-day about radioactivity.

But besides this, the study of the radiations, the investigation of their nature, of their properties, and of their effects, form a peculiarly interesting branch of this new science, and it is only necessary to compare the early works of Mme. Curie and of Rutherford with the latest volumes published by Kohlrausch and by Rutherford to understand the double aspect of the facts grouped under the name of radioactivity.

After 1905, Lord Rutherford directed his efforts mainly to the study of the radiations, and the success which he achieved in this field was not less than that which had greeted his earlier efforts. There are three kinds of rays, α, β, and γ, and Lord Rutherford's earliest work was concerned with distinguishing between them. Afterwards, commencing with the α-particles, he has contributed more than anyone else to establishing the fact that they consist of helium atoms carrying a double positive charge and projected with a velocity corresponding to an energy of several millions of volts. It has been possible not only to study the properties of a beam of α-rays, but also to detect the effect of single particles and to count them by direct methods, which in course of time have been developed to a high degree of perfection. The detection of single particles has now rendered possible the detailed verification of the predictions of the law of probability about the distribution of the particles both in space and in time.

The expulsion of helium nuclei and of β-particles, that is, high speed electrons, from the radioactive nucleus, threw a new light on the whole problem of the constitution of atoms. This question had previously seemed so remote that no one had dared thus to think of it before the first ten years of the twentieth century. In fact, it remained so obscure that, at the first Solvay Conference, when it was asked what picture one could form of the emission of spectral rays, the eminent specialists there present were caused merely to reveal their own ignorance on the subject. No one was better placed than Lord Rutherford to make a decisive attack on this problem, by bringing to it a definite atomic model founded on experimental facts.

Various experiments carried out under his direction on the scattering of rapid particles in their passage through matter led to the formulation of an approximate law describing the deviations, and this Lord Rutherford saw could only arise if there was some kind of condensed nucleus forming the central part of the atom. This theory, put forward in 1911, was greatly expanded and developed in 1914, after the splendid theoretical work of Bohr and the notable experiments of Moseley, which were both carried out in Lord Rutherford's laboratory. From this resulted the atomic model universally accepted to-day and known under the name of the Rutherford-Bohr atom. In this model, as is so well known, the atom is supposed to be formed by a central nucleus carrying a positive charge and surrounded by a cloud of satellite electrons, the number of which is equal to the number of the net positive charges on the nucleus. This whole number, called the atomic number, plays an essential rôle in the theory of spectra, in the classification of elements, and in all problems connected with atomic physics. It shows the position of an element in the natural order of the elements, characterises the chemical type, and, in conjunction with the number of protons in the nucleus, constitutes even to-day the data of which we are most sure in relation to the ultimate particles of matter.

The β-rays and the γ-rays also occupied the attention of Lord Rutherford and his school, and in 1914 he was able to obtain for the first time a spectrum of the γ-rays by diffraction from a crystal of rock

salt. The experimental method was extremely ingenious and was specially adapted to work with the necessarily small angles of reflection. In this way he was able to show that the γ-rays were analogous to the X-rays, but of shorter wave-length.

The electrons of different speeds which constitute the β-radiation can be separated out by a magnetic field, and a detailed analysis of this emission, and also the study of the high speed secondary electrons which are produced, formed an important chapter in the researches undertaken at about this time. The γ-rays emitted by radioactive bodies form a line spectrum, and while the greater portion of the β-rays form a type of continuous spectrum the origin of which is yet obscure, there is also a series of groups of electrons of definite speed which, when analysed by a magnetic field, form a type of corpuscular spectrum. The question as to whether there should be a connexion between these two spectra by means of the photoelectric effect was considered by Lord Rutherford, and later, in the hands of his co-workers, experiments on this subject threw great light on the complexity of the emission of the β-rays. In this way it was possible to study the spectrum of the γ-rays, although their wave-lengths were so short as to render the normal method of crystalline diffraction inapplicable.

Finally, there is a third phase of Lord Rutherford's work, marked by discoveries no less important than those preceding, and concerned with the artificial disintegration of the lighter elements by bombardment with the α-particles emitted by radioactive bodies. According to present ideas, which are in great part due to the researches which have just been referred to, the chemical properties of an element depend entirely on the value of the nuclear charge. Some of the electrons which surround the nucleus can be removed, or even the nucleus may be stripped bare, when the atom would in the first case be partly, and in the latter case completely, ionised; yet still, from the point of view of the chemical nature of the element, it would be the same as at the commencement of the process, and the atom would regain all its former properties as soon as it had recaptured its full number of electrons. In order to effect a change in the atomic species, it is essential to change the positive nucleus. It may be said, indeed, that the nucleus determines the structure of that portion of space which constitutes the atom. This central fort is guarded by strong defences. There is an intense electric field which opposes the progress of a projectile which approaches it, and will in fact prevent its arrival unless it be endowed with very great energy. It occurred to Lord Rutherford that the α-particles did in fact constitute precisely the most powerful type of projectile at our disposal for attacking the nucleus, and he proceeded to use this weapon.

It was therefore in 1919 that for the first time an actual case of chemical transmutation of an element was proved scientifically. It was found that the hydrogen nuclei, which are to-day called protons, could be detached from the nuclei of nitrogen and other bodies by bombardment with α-particles. In the case of aluminium, the explosion sets free a certain quantity of intra-atomic energy, which gives the proton greater energy than that of the incident projectile.

This was the beginning of a new branch of physics and chemistry, that of artificial radioactivity. At first progress was somewhat slow, due to inherent difficulties in the early experimental methods, but now the science is making great strides. There is little doubt that it will quickly lead to important results and throw light on the intimate details of this new world of nuclei which the work of Lord Rutherford has opened up for the physicists of the future.

As professor of physics at Manchester—where he obtained in a few years so many striking results that it has been possible to form a museum of historic apparatus—and then at Cambridge, a successor to the great line of illustrious physicists of which the last, Sir J. J. Thomson, had just retired after influencing the whole subject of physics in a way which becomes more apparent every day, Lord Rutherford has continuously affected all those who surround him by his personal influence. He has maintained and even increased the great traditions of the Cavendish Laboratory, from which have come so many admirable researches and so many notable men of science. The list of the physicists who have worked under his direction is a long sequence of names of which the greater number have attained fame, and in no small measure is the brilliance and certainty of the results due to the continual co-ordination of a series of researches directed towards one end. The number of distinguished physicists who have co-operated in this advance is so large that it would be impossible to mention all and invidious to choose a few, but reference to any work on radioactivity will show how many have worked under Lord Rutherford and collaborated in his researches.

Taking Lord Rutherford's work as a whole, one finds that underlying it there is always a concrete

picture of the problems based on direct experiments, and then, avoiding all mathematical complications, these experimental facts are connected up by means of a theory which gives a direct visual picture of the phenomena. Recent theoretical views suggest that such a mechanistic view of Nature cannot be pushed beyond a certain point, and that the fundamental laws can only be expressed in abstract terms, defying all attempt at an intelligible description. The philosophy of science has always swung between these two points of view. The work of the great physicist to whom these lines are dedicated shows, however, to what brilliant discoveries the method followed by Lord Rutherford can lead.

M. DE BROGLIE.

New Guinea Sorcerers

Sorcerers of Dobu: the Social Anthropology of the Dobu Islanders of the Western Pacific. By Dr. R. F. Fortune. Pp. xxviii + 318 + 8 plates. (London: George Routledge and Sons, Ltd., 1932.) 15*s.* net.

DR. FORTUNE has given us a remarkably interesting and valuable account of the natives of the islands of Tewara, Dobu, and of the village of Basema, all in the D'Entrecasteaux group, which lies off the south-east end of New Guinea. Previously we had only the general observations of government officials in the Annual Reports of Papua, the useful little book "The Northern D'Entrecasteaux", by Jenness and Ballantyne (Oxford, 1920), and a few notes by various travellers. The great merit of this book is that it describes the functioning of society and of social activities: it is thus a dynamic survey and not merely an account of social structure, as has usually been the case in previous ethnological studies—and, indeed, it is a good illustration of the modern method of field-work.

The social unit of the Dobuans is the *susu*, or matrilineal group, of which a variable number constitute a village. Every husband must come from another village, and he has but a precarious position in his wife's village, as there is a strong solidarity between the wife, her brothers, and all other members of that *susu*, and, in addition, divorces are frequent. Every alternate year the family lives in the wife's and in the husband's village. When a man dies, he is buried in the domicile of his own *susu*, and thereafter his children may never enter that village. The marital group, or simple family, is necessarily weak as compared with the *susu*, and each village contains a heterogeneous collection of men from different villages, who distrust one another. A man cannot alienate from his sister's children, in favour of his own, his village land, his personal name, his skull, his status, or his fruit trees; but he can, and often does, teach his son his magical formulæ, and he is obliged to teach these to his sister's son. Teaching both parties is really a subversive action, as magic gives power, status, and a small income, and when put in the hands of individuals who are very apt to be antagonistic they may use it one against the other. A father will never give his magic to more than one son; the others are left magicless, with the result that blood brothers are usually very jealous of one another. Practically all property descends in the *susu*, but a father may give some garden land that lies away from the village to his son, as well as to his sister's son; but no child can eat of any fruit or crop grown on land that was his or her father's, though such food can be exchanged for food from someone else's dead father's land.

All activities such as gardening, the lashing of canoes, the love between man and woman, and even disease, death, wind, and rain, are supernaturally created by the ritual of incantation with the help of the appropriate technological processes, gifts, and the like. Technology and mundane measures are not to be despised, but the incantation is the really important factor. Incantations are directed to supernatural beings, many of whom originally were human beings but are now immortal; their names are never pronounced except in inaudible undertone in actual ritual. It was they who originated the formulæ and gave them to the first ancestors of man, but nothing happens if the possessor of the formulæ does not use it. For example, in the ritual addressed to seed yams, the man is not muttering a form of words to yams merely, he is addressing a Personal Being, for yams are such in a metamorphosed form. The section on social organisation in gardening and the ritual of the garden are of particular interest.

Sorcery permeates the whole life of the Dobuans and is an integral part of their supernatural system; it "is practised by everyone, and believed in firmly by everyone. Like most supernatural systems it enlists its believers, not by tricks, deceits, and stratagems, but by a more dignified faith in the reality of Unseen Forces, and in the reality of the power of human speech to affect these Unseen Forces, that were 'born with the sun and the moon and the earth'." In an appendix, Dr. Fortune criticises the action of the administration towards sorcery.

The system of periodical ceremonial exchanges of valuables between a circle of islands, known as *kula*, which was first described in a masterly manner by Malinowski, is here dealt with from a somewhat different angle. One group of a particular kind of valuables passes in one direction and another kind in the opposite direction, but the retention of them is purely temporary and they circulate indefinitely. Dr. Fortune makes the illuminating remark that the *kula* is like an annually repeated peacemaking ceremony, hence "the *kula* exchange of ornamental valuables, useless enough in itself, helps to maintain annual exchanges of other" and useful objects. The peoples of the islands are great traders, as has been shown by Seligman, but we are told that it is all done without direct barter. There is no haggling; it is a matter of giving and receiving presents. The great prestige of the *kula* undoubtedly makes strongly for peaceful relations between potentially hostile internationals, and at the same time is a strong protection to ordinary trade in an area rent by the fear of the black art, suspicion, and hostility.

In his introduction, Prof. Malinowski makes some comparisons between the Dobuans and the Trobrianders, and the present writer agrees with him in his appreciation of the importance of Dr. Fortune's investigations and the manner in which he has presented them. A. C. HADDON.

The Assembly of the Sages

Turba Philosophorum: ein Beitrag zur Geschichte der Alchemie. Von Julius Ruska. (*Quellen und Studien zur Geschichte der Naturwissenschaften und der Medizin: Fortsetzung des Archivs für Geschichte der Mathematik, der Naturwissenschaften und der Technik. Herausgegeben vom Institut für Geschichte der Medizin und der Naturwissenschaften.* Redigiert von P. Diepgen und J. Ruska, Band 1.) Pp. x+368. (Berlin: Julius Springer, 1931.) 58 gold marks.

ANY man of science who wishes to see scientific method applied to solve literary and historical problems will savour intense intellectual delight in Prof. Ruska's book on the "Turba Philosophorum". A major enigma in itself, the Turba comprises a multitude of lesser riddles, and though the author with characteristic modesty describes his work as a mere preliminary study, he will be found to have left but comparatively little for future research to unravel. Like the Emerald Table of Hermes, upon which also Ruska has published a valuable investigation, the Turba enjoyed an authoritative reputation among medieval alchemists, and was confidently quoted whenever it was desired to clinch an argument or conclusively to refute an opponent. An English version of this alchemical classic was made so long ago as 1896, by the learned historian of occultism, Mr. A. E. Waite, but a critical study of the problem as a whole remained unattempted until Prof. Ruska began his systematic work upon it in 1927.

Briefly put, the problem is as follows. In the form of *dicta* and of question and answer, the Turba purports to convey the alchemical tenets of an assembly of sages, some of whom have Greek names, while the names of others appear to have no parallel in any known tongue. Though the early manuscripts are in Latin, the queer phraseology and reprehensible syntax indicate that Latin was not the original language of the work, while numerous Arabic constructions and idioms, together with a large admixture of Greek alchemical ideas, seem to suggest that the Turba was written in Greek, translated into Arabic, and thence rendered into Latin. The principal part of the problem is thus to settle the origin of the treatise; the lesser, but by no means insignificant part, is to interpret the bizarre names and words that it contains, and to discover its affiliation to other early alchemical writings. Prof. Ruska's conclusion upon the chief point will be found irrefutable; his ingenuity in grappling with the others must excite our admiration as his faultless logic compels our assent.

The first fact that emerges from a close examination of the Turba is that the extraordinary proper names are to be regarded as Latin attempts to transcribe Arabic versions of Greek names. Proceeding from this basis, Prof. Ruska considers (*a*) the Arabic system of transcribing Greek words, and (*b*) the Latin system of transcribing Arabic words. Application of this method to the names in the Turba has led him to make a large number of unexpected but quite convincing identifications. Thus Iximidrus proves to be Anaximandros, Pandolfus is none other than Empedokles, Lucas is not Lucas but Leukippos, and Bonellus is the curious corruption of Apollonius as Horfolcos is of Herakleios! We may follow the steps of one of these remarkable equations. In medieval Arabic, Empedokles is rendered ANBADUQLIS. By the mere omission of an *alif* and a slight displacement of diacritical points this becomes BANDAFILUS, whence the Latin transcriptions Pandolfus and Pandophilus are seen to be not merely intelligible but almost inevitable.

The abundance of Greek personal names in the

Turba might seem to lend support to the thesis of a Greek origin of the work, but other facts definitely negative it. In the first place, it cannot be doubted that the Latin version is a direct translation from the Arabic, for in addition to the evidence just described, Prof. Ruska shows that many phrases and sentences are literal renderings of common Arabic formulæ. Most striking, perhaps, is the occurrence in one passage of a sentence from Sura 112 of the Koran: *Dico tamen, quod Deus unus est, nunquam genuit nec genitus est.* In a manuscript of the Turba at Erfurt, the copyist has added "secundum Sarracenos" to this heretical statement, while in other examples the offending words have been altered to *unumque genuit neque tamen genitus est.*

Yet the fact that the Latin Turba is a translation from the Arabic does not, in itself, exclude the possibility that the Arabic Turba may also have been a translation—a translation from the Greek. It would be easier to settle this question if Arabic manuscripts of the work were available, but although one at least was in existence in Cairo in 1537, none is known to be extant at the present day. Excerpts from the Turba are, however, to be found in certain other Muslim alchemical treatises, and it is not too much to hope that the whole book may be discovered sooner or later in some Cairene or Indian library. In spite of the lack of a complete Arabic text, Prof. Ruska is able to show—conclusively, as we think—that the Turba is not a translation from the Greek, but the original composition of some unknown Islamic chemist, probably of the ninth or tenth century. To summarise his arguments within the present limits is impracticable, but the attentive reader—especially if he be familiar with Muslim alchemy—will find that they carry conviction.

Prof. Ruska has completed his investigation into the sources of the Turba by the establishment of a critical Latin text, and by a careful and fully annotated translation into German. The fourth and concluding part of his book is a consideration of the literary problems involved, in which such points as the theological, cosmographical, and alchemical ideas of the Turba are discussed and elucidated. There are excellent indexes, and the typography is of a very high standard. Every scholar for whom the history of science holds interest will congratulate Prof. Ruska upon his brilliant achievement, and will congratulate himself upon the opportunity to add to his shelves a work as full of fascination as of sound learning.

E. J. HOLMYARD.

Rock Structures and their Interpretation

Principles of Structural Geology. By Prof. C. M. Nevin. Pp. xi + 303. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1931.) 17*s.* 6*d.* net.

THIS admirable book is one of the most competent and stimulating of the contributions to geological literature that have appeared in recent years. Structural geology is defined as the study of the framework of the earth's crust—and in its broader phases of the entire earth—and the causes responsible for its deformations.

After a preliminary chapter on the physical properties of rocks, the principles of the subject are developed, with special attention to the conception and application of the strain ellipsoid. Thus from the outset, ability to reason in three dimensions is made possible to the careful student. The author is, indeed, to be gratefully congratulated on the ingenious use he makes of this powerful instrument for structural analysis. Special care is taken to show that more than one interpretation may be possible of the evidence seen in the field, and "matters now in dispute among geologists are not avoided simply because they are unsettled". Successive chapters deal carefully and lucidly with flexures, faults, joints, cleavage, and structures in unconsolidated sediments. The illustrations and diagrams are excellent throughout. Each chapter affords the author an opportunity of discussing some of the larger problems of geology, with the result that the book is not only an unsurpassed guide to students but also a storehouse of valuable hints and clues which merit consideration by structural geologists in general.

The remaining chapters are devoted to rock structures and topography, and to more speculative matters regarding the earth as a whole, and such questions as isostasy, continental drift, and mountain building. Here, as throughout the book, Prof. Nevin follows so far as practicable the spirit of Voltaire: "Let us make an exact analysis of the matter and then we shall try to see, with much diffidence, if it fits any principle". The general working hypothesis is advanced, though in no dogmatic manner, that the earth is continually being deformed; that "separated periods of quiet and intense stress are true for localised areas such as the seats of future mountain ranges, and even for continental masses, but are mythical when applied to the earth as a whole". It is concluded that the contraction hypothesis rests on a very insecure foundation; that the possibility of

continental drift can no longer be safely ignored; and that the forces which cause mountain deformation and major vertical uplifts still remain complete mysteries.

The book is so good that it presents an adequate excuse for asking for more. In a future edition, which should be called for at no distant date, chapters might well be added on igneous bodies and on rock-flowage. The index is not so full as it might be. Very few misprints or errors of fact have been noticed. On page 6 the term *amorphous* is used as if it did not include certain materials having strength. On page 229 *uranium* is twice printed where *radium* is intended, and determinations of radioactive elements in rocks are wrongly attributed to Kolhörster. Elsewhere the name of Jeffreys is given without the final letter. These slips, however, are negligible compared with the indisputable fact that Prof. Nevin has enriched geological literature with a treatise that is at once a textbook of outstanding importance and a discussion of earth problems that no geologist can afford to overlook.

Short Reviews

Vorlesungen über theoretische Physik an der Universität Leiden. Von Prof. Dr. H. A. Lorentz. Band 5: *Die Maxwellsche Theorie (1900–1902).* Bearbeitet von Dr. K. Bremekamp. Übersetzt von Dr. H. Stücklen. Pp. vii + 199. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1931.) 16·20 gold marks.

THE influence of the teacher, as exhibited in his lectures, may be powerful and lasting, but if his lectures remain unpublished, that influence is confined to the comparatively narrow circle of his direct hearers, and it becomes as difficult for one who has not sat at the feet of the teacher to appreciate his gifts as it is to judge at second hand the art of Garrick or of Kemble. Happily, the pious care of the pupils of Prof. Lorentz has rescued from oblivion much of value in his routine teaching, and we are fortunate not only in the worth of the subject matter thus permanently placed on record, but also in the picture it provides of another aspect of a great personality, a great advancer of knowledge, who is now seen as an inspiring teacher.

Whatever Lorentz touched, however commonplace or well worn the theme, he made his own. The lectures earlier printed showed us his clarity of thought, his systematic manner of building up his subject, and his rare capacity for wide and philosophic generalisation combined with attention to minute detail.

These qualities are again apparent in this compact volume, which opens with a section containing a brief but luminous discussion of the elements of vector algebra, of Stokes's and Green's theorems, of the equations of Laplace and of Poisson. Maxwell's equations are then developed, and chapters follow which deal with electrostatics, steady and induced currents, the energy in the electromagnetic field, and the electromagnetic theory of light. It would be difficult to find a clearer development of the subject confined within the moderate compass of less than two hundred pages.

ALLAN FERGUSON.

Minds in Arrear: some Practical Aspects of Mental Deficiency. By Dr. E. B. Sherlock. Pp. ix + 181. (London: Baillière, Tindall and Cox, 1932.) 5*s*.

DR. SHERLOCK was, until recently, medical superintendent of the Darenth Training Colony in Kent, so is particularly fitted to deal in an authoritative manner with any questions of mental defect. He wisely points out that his small book, "Minds in Arrear", is meant primarily for the general reader and not for the specialist. His attitude towards the generic term for mental defect is very broad-minded and in keeping with the most recent opinion. There is a growing tendency to get rid of, if possible, the term amentia, which means 'absence of mind' and is also used in Norway, Holland, and Italy to connotate what is understood as confusional insanity. The word oligophrenia, invented by Bleuler, is a clumsy word, but will probably be finally adopted for international use.

Dr. Sherlock contrasts the normal mind with the abnormal mind, differentiating inadequacy of stimulus from inadequacy of response. The inadequacy of response is made up of paucity of ideas, defective apprehension, an inability to concentrate, poorly developed general intelligence, and abnormal affects.

The remarks on sterilisation are very guarded, and we only wish that other writers on this vexed subject would weigh their evidence as carefully as he does. It is wisely pointed out that sterilisation, to have any value, would have to be compulsory. The majority of defectives are not the offspring of people themselves defective, so that compulsion would be a difficult matter. Segregation, although it may be an expensive matter, is of considerably greater value as a matter of practical politics.

The author's plea that mental defectives should be brought within the provisions of the Mental Treatment Act, 1930, has a great deal to commend it, and is a move in the right direction.

Difficulties of the Evolution Theory. By Douglas Dewar. Pp. viii + 192. (London: Edward Arnold and Co., 1931.) 12*s*. 6*d*. net.

A LABORIOUS anthology of facts which have not been completely elucidated by evolutionists, leading up to the conclusion that new forms of life arise by creation and may be afterwards modified, in minor respects, by gradual evolution. The following is a novel contribution to the anti-evolutionist case: "Another feature not easily reconciled with the evolutionary theory is the great disparity in the span of life of various animals. If every organism be descended from a common

ancestor, would such enormous differences exist? Why should a parrot live to over 100 years . . . while the pheasant apparently does not live longer than 15 years; why should an elephant live for as much as 120 years, while no rhinoceros is known to have lived more than 37, and no hippopotamus more than 33 years; why should the cat live three times as long as the guinea-pig? As the vast majority of individuals in a state of nature are killed long before they have reached their full span of life, and as species the members of which are long-lived do not seem to be more flourishing than those of which the members are short-lived, it does not seem possible that the disparity in longevity has arisen as a result of natural selection. . . . If, however, the various types have been created independently, we should expect this disparity in the span of life, because the *raison d'être* of these types is the stocking of the earth with a great variety of forms, and length of life is a characteristic that offers ample scope for variety." In an appendix, the author discusses at length "The alleged origin of mammals from reptiles", without once mentioning the ear-ossicles. G. P. W.

Industrial Microbiology: the Utilization of Bacteria, Yeasts and Molds in Industrial Processes. By Prof. H. F. Smyth and Prof. W. L. Obold. Pp. x+313+3 plates. London: (Baillière, Tindall and Cox, 1930.) 27*s.* net.

THIS book is devoted to an account of the ways by which industry has utilised the chemical activities of bacteria, yeasts, and moulds. It is divided into twelve sections, beginning with accounts of the production of carbocylic acids, alcohols, and ketones; and followed by a discussion of the way in which carbohydrates, such as cotton, hemp, jute, cellulose, etc., are by microbiological activities dealt with in industry. Further sections on the production of foods and other commercial products complete the volume. The general purpose of the book is to bring before manufacturers, and students thinking of entering this field of work, the information already available but scattered through a wide field of scientific journals and technical publications. On the whole, the authors have done their work fairly well, though their spelling and structure of sentences leave much to be desired. Their decision to make the bibliography a selected one and not complete is wise, since the uninitiated student with a long list of references before him is apt to waste a good deal of time reading unnecessary papers before reaching the ones that are of real importance to his subject.

(1) *The Children we Teach: Seven to Eleven Years.* By Dr. Susan Isaacs. Pp. 176. (London: University of London Press, Ltd., 1932.) 3*s.* 6*d.* net.
(2) *Education of the Backward Child.* By David Kennedy-Fraser. Pp. 254+4 plates. (London: University of London Press, Ltd., 1932.) 6*s.* net.

THE reason why we mention these two books together is that they both bear upon the problems of education, and the reason why we mention them at all is that they are both examples of scientific method in the field of educational inquiry. The older philosophic method of approach to psychological questions is well known to have been to a great extent replaced by a scientific method of approach. The same may be said of the serious study of education. This used to be the business of the philosopher and of the psychologist who drew his inspiration from philosophy. Now the serious study of education is also undertaken by modern psychologists like Dr. Susan Isaacs and Dr. Kennedy-Fraser, both of them well equipped for the respective tasks undertaken in these two books. (1) Dr. Isaacs writes simply, but with the simplicity of one who knows the complexities also, about normal children of the junior school age. The subject is a timely one, and for most parents and teachers there is a message on nearly every page of her book. (2) Dr. Kennedy-Fraser has made a study of the backward child, who may be backward in a temporary or in a permanent sense, and is not to be confused with the mentally defective child. The backward child, as here defined, has not received the attention that he deserves, whether from administrators or from psychologists. This book helps to fill a gap in our educational literature.

Handbuch der Pflanzenanatomie. Herausgegeben von Prof. K. Linsbauer. Lieferung 28. Abteilung 2, Teil 2: *Bryophyten.* Band 7/1: *Anatomie der Laubmoose.* Von Wilhelm Lorch. Pp. viii+358. (Berlin: Gebrüder Borntraeger, 1931.) 37·50 gold marks.

THE new volume in Linsbauer's "Handbuch der Pflanzenanatomie" on the anatomy of mosses, by Wilhelm Lorch, gives a useful survey of the literature on the subject, but the striking feature of the volume is the amount of original work contributed by the author. Results of previous workers have been reinvestigated, new facts added, and the majority of the very numerous text figures are original.

The text reveals that development has been followed in considerable detail; from this, points of interest emerge with regard to the behaviour of the adult tissues. For example, it is stated that the rupture of the calyptra from the vaginula takes place in the region of the last division in the intercalary growth of the archegonium, which follows fertilisation of the ovum. The interesting section on peristome development also is suggestive that the order of divisions in the meristem is most important, and one regrets that the figures of the developmental stages do not give a rather clearer picture of the condition of the cells in the various regions at different times.

The section on the chemistry shows that cellulose is the usual basal substance of the walls, though this is often masked by impregnation with tannins or other substances. In relation to the ease with which water is taken up by almost any part of a moss, it is also of interest to find that the presence of an appreciable cuticle has been confirmed for a considerable number of species.

Structure of Atomic Nuclei

TO give a report of a discussion on a subject so complicated as the physics of the nucleus would be an arduous task at any time, but when it is an occasion for dealing with two new discoveries, it is a task the difficulty of which is sufficient excuse for any shortcomings. Not only did Dr. J. Chadwick describe his experiments leading to the identification of the neutron at the discussion on the subject at the Royal Society on April 28, but also Lord Rutherford reported that Dr. Cockcroft and Dr. Walton, working in the Cavendish Laboratory, had succeeded in effecting the artificial disintegration of several elements with protons from a high potential discharge tube.

The discussion was opened by Lord Rutherford in a characteristic address. Referring briefly to a number of different subjects, he showed convincingly how rapidly the subject of nuclear physics has extended in recent years. There is now a variety of lines of attack upon what he has appropriately termed the central problem of physics. Optical methods have been shown to lead to information about the masses of isotopes and the type of statistics they obey, while the details of the hyperfine structure give a direct measurement of the nuclear spin. Radioactivity has shown itself capable of revealing new details about the heaviest nuclei, and a close investigation of the α-rays has thrown new light on the origin of the γ-rays. Quite apart from the information they yield about the nuclei from which they originate, the γ-rays and α-rays have proved as useful in recent years as in the past for investigating the fundamental laws governing high frequency radiation and high speed particles. A new type of absorption of electromagnetic radiation by the nucleus has been brought out by the work of Meitner, Hupfild, Tarrant, and Gray, which the last two workers believe to involve a true excitation of the nucleus.

In the more colloquial sense, however, it is in the field of artificial disintegration that the most exciting results have been obtained. A great deal of work has been carried out in different laboratories recently on the production and control of high voltages, and Cockcroft and Walton, working in the Cavendish Laboratory, have developed the technique of producing and using steady high potentials so high as 600,000 volts. They investigated the effect of bombarding lithium with protons of a few hundred thousand volts, and found the striking result that the lithium nucleus can absorb the proton and break up into two α-particles, each of which recoils with an energy corresponding to more than eight million volts (NATURE, April 30, p. 649).

The experiments are simple in principle even if the technique is difficult. By means of a specially built discharge tube, protons are accelerated up to energies of several thousand volts. They are allowed to fall on a screen covered with lithium, to the side of which, and just outside the tube, is placed a zinc sulphide screen. A window covered with thin mica is arranged in the side of the tube, so that particles coming from the lithium can, if they have sufficient energy, reach the zinc sulphide screen. It was known from previous measurement that the protons themselves had not sufficient energy to penetrate the mica and reach the zinc sulphide screen, even if they were reflected from the lithium oxide without loss of energy. Bright scintillations were observed in the zinc sulphide as soon as the energy of the proton beam exceeded 120 thousand volts, and the numbers of these scintillations increased very rapidly as the voltage was raised. The particles causing these scintillations had a range in air of about 8 cm., whereas the protons responsible for their emission could only penetrate about 1 cm. This simple fact alone is a definite proof that disintegration involving a large emission of energy had occurred. The general character of the scintillations, coupled with the range of 8 cm., suggested that these particles were α-particles, and this was borne out by the nature of the tracks obtained in an expansion apparatus. The process is therefore imagined to be

$$Li^7 + H^1 \longrightarrow 2\,He^4.$$

From Aston's accurate measurements of the masses of these atoms, it follows that there would be a liberation of from 15 to 17 million electron-volts of energy in this process, in excellent agreement with the energy of 8×10^6 electron-volts which helium nuclei need in order to have a range of 8 cm. While it therefore seems almost certain that this is a correct description of what is happening, Cockcroft and Walton were careful to emphasise that the nature of the high speed particle liberated in the disintegration had not yet been definitely established. Additional evidence will be provided if it is possible to show, as would follow from this hypothesis, that the particles always occur in pairs travelling in opposite directions.

The magnitude of the effect may be illustrated by the following figures. The effect becomes appreciable once the proton beam is accelerated with more than 120 thousand volts, and at 250 thousand volts one disintegration particle was obtained for about every 10^9 protons hitting the lithium. The tube could be run at several microamperes, and since one microampere corresponds to about 10^{13} protons per second, it is clear that even with small solid angles there are plenty of particles to detect. Herein lies one of the important advantages of this new method. The yield of disintegration particles obtained even with the eight million volt particles from radioactive bodies is only of the order of one millionth, and it is a very powerful radioactive source which emits 2×10^9 α-particles per second, and those in all directions. It is easily seen that, despite the inefficiency of these low velocity protons, the actual number of disintegrations that can be effected is very much greater than with particles of radioactive origin, due to the large number of protons that can be used.

In still another direction this discovery is of importance, since it gives a different type of nuclear disintegration. Using α-particles, it has been found that a proton is ejected and the α-particle is captured, forming an atom of greater mass. If protons cause a disintegration, they must form an atom of smaller mass and lower in the periodic system.

Similar experiments have been tried with other elements, and it has been found that beryllium, boron, carbon, possibly nitrogen, fluorine and aluminium all give particles of characteristic range and of greater energy than the incident protons; oxygen and copper gave no effect. While disintegration occurred with both boron and aluminium with protons of energy so low as 150 thousand volts, with the other elements it was necessary to go to more than 300 thousand volts before noticeable effects were produced. It would therefore seem that the greater majority of the lighter elements can be disintegrated by bombardment with protons. While it is easy to speculate that processes such as

$$Fl^{19} + H = He + O^{16}$$
$$\text{or } Al^{27} + H = He + Mg^{24}$$

may occur, there is as yet no evidence about the nature of the particles except that which has been described in the case of lithium, and conclusions of any kind are mere guess-work until more information has been obtained.

Dr. Chadwick began by describing the results that have been obtained from investigating the collisions of α-particles with the nuclei of the lighter elements. Scattering experiments on one hand, and artificial disintegration experiments on the other, have combined to yield a wealth of information that could scarcely have been anticipated a few years ago. If these experiments of Chadwick and others are not discussed here, it is not because of any lack of recognition of their fundamental importance and interest, but merely to come more quickly to Chadwick's discovery of the neutron.

Bothe and Becker first noticed that a very penetrating radiation was emitted when beryllium was bombarded with α-particles. Working with this beryllium 'radiation' and using an ionisation method, Joliot-Curie and Joliot found the surprising result that protons were ejected when it passed through materials containing hydrogen. If, as had always previously been supposed, this beryllium 'radiation' was of electromagnetic nature, the quantum would have to have an energy of 50×10^6 volts to account for the observed range, 30-40 cm. in air, of the protons. In addition, it was particularly difficult to understand how the absorption process could occur so frequently.

Chadwick investigated this phenomenon, using the powerful valve counter methods which had been developed in the Cavendish Laboratory, and found some most surprising results. It appeared that this beryllium 'radiation' liberated particles from all light elements through which it passed, but if these processes were held to be due to interaction with some electromagnetic radiation, the quantum had to be 100×10^6 volts from the results with nitrogen, 150×10^6 volts from argon, whereas the value 50×10^6 volts was obtained from experiments with hydrogen. Chadwick realised that these difficulties disappeared if the beryllium 'radiation' were assumed to be of corpuscular nature, and then the particles detected by the valve counter would be atoms of the material radiated set in motion by collision with these corpuscles.

Now the beryllium 'radiation' is extremely penetrating; it loses less than one-half of its intensity in passing through one inch of lead, so that if it is corpuscular, then the corpuscles must be only very slightly affected by the atoms through which they pass. This can only mean that the field of influence of these corpuscles is limited to a minute space around them, and that they can pass close to an electron or nucleus without disturbing it or giving energy to it. A neutron, that is a proton and electron in close combination, would have just such properties, and, moreover, if its mass were about unity, and its velocity sufficiently high, it could set other atoms in motion on the rare occasions of direct collisions with the nuclei.

Important confirmation of the correctness of these general ideas was furnished by experiments in which the beryllium 'radiation' was passed through nitrogen contained in an expansion chamber. While no tracks were found corresponding to the neutron itself, clear photographs were obtained of nitrogen recoil atoms set in motion by the process already described. Chadwick has produced convincing evidence of the accuracy of this hypothesis by the following arguments based on his experiments. From measurements of the ranges, he determined the maximum velocities u_H and u_N which hydrogen and nitrogen nuclei could acquire by collision with a neutron. This evidently occurs in a head-on collision, so that if m and v denote the mass and velocity of the neutron, it follows from the conservation of energy and momentum that

$$u_H = \frac{2m}{m+1} \cdot v$$
$$u_N = \frac{2m}{m+14} \cdot v$$

Inserting the experimental values, he obtained a value for m slightly greater than unity, and a velocity about 3×10^9 cm. per second. He obtained a far more accurate estimate of the mass of the neutron from a consideration of its origin. Chadwick and also Joliot-Curie and Joliot had discovered that neutrons are liberated from boron as well as from beryllium. In the former case the process is presumably

$$B^{11} + He^4 \longrightarrow N^{14} + n^1$$

where n^1 denotes the neutron of mass about unity. Aston has made accurate measurements of the masses of boron, helium, and nitrogen, so that utilising the connexion between mass and energy given by the relativity theory, the energy balance of the process can be examined. It is found, taking into account the kinetic energy of the α-particle, that the velocity of the neutron, obtained by the method already mentioned, can only be accounted for if the mass of the neutron lies between 1·005 and 1·007. Since the mass of a free hydrogen atom is 1·0078, it follows that the energy of binding of

the proton and electron is about one million volts. The combination of all this evidence can leave little doubt that the neutron really does exist and has been detected.

This discovery of a new kind of matter, a new element, is an outstanding event in the history of physics, and it is to be anticipated that important advances in our knowledge of the laws governing protons and electrons will be reached from investigation of its properties. Entirely new fields of speculation about the structure of atomic nuclei are opened up by the discovery that in at least two cases neutrons form part of the structure, but it is far too early to discuss matters of this kind.

Quite apart from the interest attached to the discovery of the neutron itself, it appears that it offers new possibilities of investigation in the field of artificial disintegration. Chadwick, in collaboration with Feather and Dee, has found that neutrons can also effect the disintegration of the nuclei with which they collide. This will constitute again another type of nuclear reaction, different from that produced either by α-particles or protons. For example, if it involved capture of the neutron and ejection of the proton, the resulting nucleus would have the same mass as before, but the atomic number would be lower by one.

There are important experimental advantages connected with the use of neutrons. The neutron is almost selective; it produces no effect unless it makes an almost direct collision, and when this happens the probability is quite considerable that a disintegration will occur. For example, Feather has obtained 180 tracks in nitrogen, of which 30 were due to disintegration. Observation in the expansion chamber of disintegration by neutrons is much easier than the corresponding effect with α-particles, for since the neutron produces very little ionisation, a very large number of neutrons may be passed into the chamber per expansion without confusing the photographs. On the other hand, the interpretation of the disintegrations is more difficult, for neither the direction of the neutron nor its velocity at the moment of collision can be deduced from the photographs.

Important contributions to the discussion were made by many others, but they will not be referred to now. It is excusable on this occasion if the well-established branches of the subject are asked to give way to two such promising newcomers. It is not intended to prejudge their ultimate importance, but only to conform to the interest which everyone will feel in these new discoveries.

C. D. ELLIS.

Oil and Petrol from Coal*

By Prof. C. H. LANDER, C.B.E.

BY 1927 the technical aspect of the hydrogenation of coal had reached so promising a stage that Imperial Chemical Industries, Ltd., thought it worth while to explore independently the possibility of its commercial exploitation, and for this purpose a large research section was set up at its Billingham factory, where a full-scale plant capable of dealing with ten or fifteen tons of coal per day has since been developed. Fig. 2 shows the modified process as it is carried out at Billingham. The converters are now vertical, and are heated internally; thus the serious difficulties caused in the earlier plant, by the action of hydrogen upon metals at high temperatures, have been obviated. The material passes into the converters at a fairly high temperature, and the heat of the reaction, which is exothermic, is more than sufficient to maintain the process. A relatively thin paste is used, which can be injected into the converter at a pressure of 200-250 atmospheres, where it is treated with hydrogen at a temperature of 450° C.

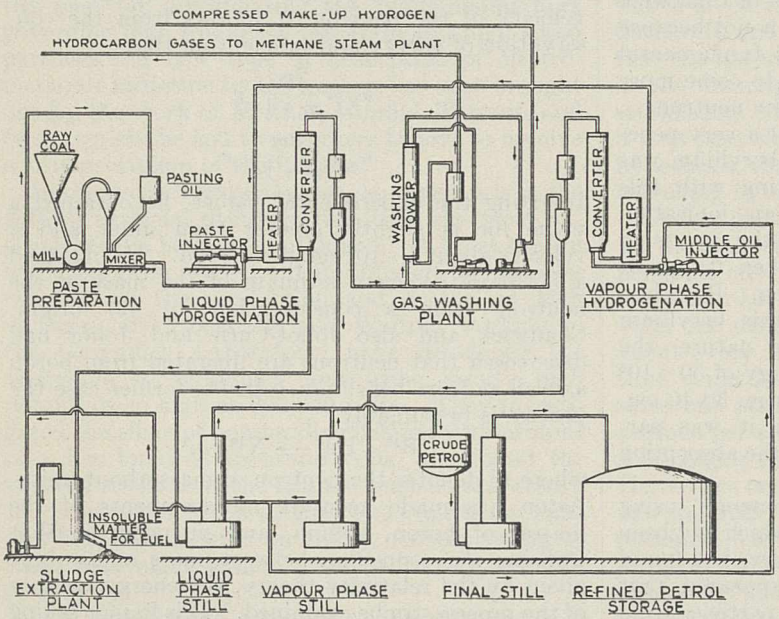


FIG. 2.—Flow diagram of hydrogenation plant and refinery.

The hydrocarbon vapours, the volatile fractions of oil, the water, ammonia, etc., are carried away at the top of the converter in the stream of excess hydrogen. The liquid products are condensed under pressure, and the permanent gases are passed on for oil scrubbing, after which they are recirculated through the plant. The hydrocarbons scrubbed out of the gas are passed to a 'methane-steam' plant for the production of

* Continued from p. 641.

hydrogen. The oils are distilled, and the heavier fractions used for pasting the coal. The petrol obtained requires only a slight purification treatment prior to use.

The intermediate oils are passed to a vapour-phase converter, where further hydrogen is added, and the mixture of hydrogen and oil vapours is passed over a catalyst; a petrol is obtained from this vapour-phase hydrogenation product by distillation after reduction of pressure. The residual oil obtained in this phase may be re-cycled, or may be sold as diesel oil. The heavy oil residue from the first converter can be blown out, and the liquid product recovered, the residue from which is a solid

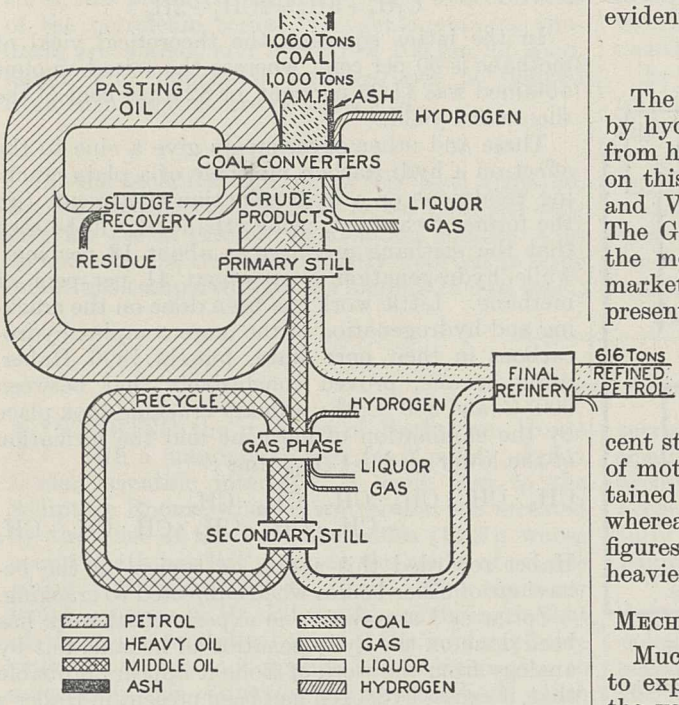


FIG. 3.—Diagram showing ingoing and outgoing products in a hydrogenation plant of 1000 tons a day.

material containing ash, together with some 5 per cent of the original coal; it could be used only under the boilers. A diagram showing the ingoing and outgoing products in a plant designed for the hydrogenation of 1000 tons of coal a day is shown in Fig. 3.

By re-cycling, etc., in the plant at the Fuel Research Station, some 140 gal. of motor spirit per ton of coal as charged could be obtained, but this has been appreciably exceeded in the large-scale Billingham plant. In this, 100 tons of coal (reckoned on the dry, ash-free basis) is capable of yielding 62 tons of petrol and 28 tons of gas, leaving a residue of about 6 tons of partially converted material. The gas can be used for hydrogen manufacture, and the residue for firing boilers.

For each ton of coal hydrogenated, a further ton is required for raising steam for hydrogen manufacture and power generation, and for making the producer gas required for the process. The overall coal consumption is therefore 3·15 tons (reckoned dry and ash-free), or 3·65 tons of actual coal, per ton of petrol produced. The overall thermal efficiency is 43 per cent, as will be seen in Fig. 4.

The figures for cost given by Imperial Chemical Industries, Ltd., now work out at about 7*d.* a gal., of which 2*d.* is the cost of the coal. It will be seen that this petrol cost is actually less than the present duty, so that at the moment, in a plant of sufficient size, petrol from coal could compete very easily with petrol from foreign sources. Some time ago I was given an opportunity of examining both the technical and financial sides of the Billingham plant, and although at that time so low a figure as 7*d.* a gal. had not been reached, it was already evident that 8*d.* or 9*d.* a gal. would not be exceeded.

HYDROGENATION OF TAR

The treatment of high and low temperature tar by hydrogenation is another method of producing from home sources a supply of motor spirit. Work on this subject has been carried out by Ormandy and Varga, and at the Fuel Research Station. The Gas Light and Coke Co. is also investigating the method in order to find a more favourable market for certain of its tar fractions which are at present almost a drug on the market. A small continuous plant for the hydrogenation of tar has been erected at the Fuel Research Station. The low temperature tar obtained by carbonising coal at 700° C. with 10 per cent steam has been treated in this plant; 150 gal. of motor spirit and 65 gal. of diesel oil were obtained per ton of low temperature tar treated, whereas by straight distillation the corresponding figures would be 15 gal. of motor spirit, 117 gal. of heavier oils, and 884 lb. of pitch.

MECHANISM OF THE HYDROGENATION REACTION

Much further experimental work will be needed to explain the precise effect of hydrogenation on the various constituents of coal, crude oil, or tar, which are all very complex substances, but we already know that the hydrogenation action is a progressive one. When coal is subjected to hydrogenation, the first action is that it becomes plastic, and if hydrogenation is stopped at this stage a pitch-like material is obtained. If a non-coking coal is mildly hydrogenated, it is converted into a material possessing marked coking properties, and so we have for the first time the possibility of converting non-coking coal into coking coal, which, it must be admitted, is not at present an attractive commercial proposition.

An interesting paper describing investigations into the "Thermal Decomposition of Hydrocarbons", namely, methane, ethane, ethylene, and acetylene, was given by Bone and Coward to the Chemical Society in 1908. The character of the products formed when these gases were heated, either alone or in the presence of hydrogen, was examined, and it was concluded that "in the cases of ethane and ethylene, it may be supposed that the *primary* effect of high temperature is to cause an elimination of hydrogen with a simultaneous loosen-

ing or dissolution of the bond between the carbon atoms, giving rise (in the event of dissolution) to residues such as $:CH_2$ and $\dot{:}CH$. These residues, which can only have a very fugitive separate existence, may subsequently either (*a*) form $H_2C:CH_2$ and $HC\dot{:}CH$, as the result of encounters with other similar residues; or (*b*) break down directly into carbon and hydrogen; or (*c*) be directly 'hydrogenised' to methane in an atmosphere already rich in hydrogen. These three possibilities may all be realised simultaneously in the same decomposing gas in proportions dependent

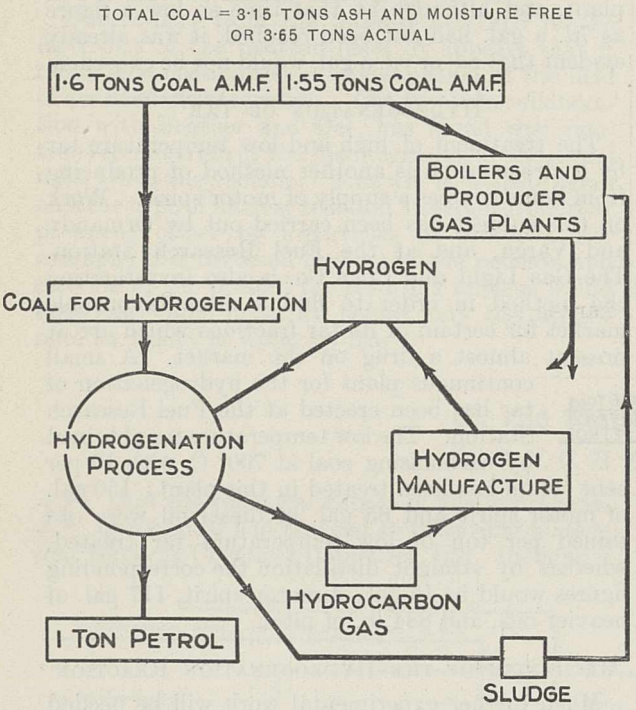
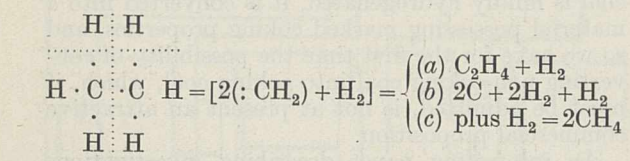
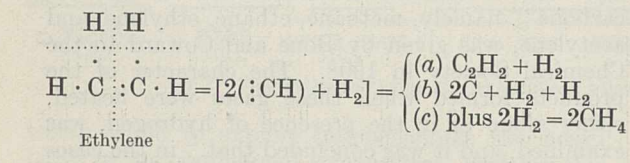


FIG. 4.—Diagram showing heat value of materials used in producing 1 ton of petrol. Areas are proportional to heat values.

on the temperature, pressure, and amount of hydrogen present. The whole process may be represented by the following scheme, the dotted line indicating the tendency to dissolve the bond between the carbon atoms: "





In one of his experiments Bone heated mixtures of ethane and nitrogen and ethane and hydrogen in a hot tube and maintained them at 800° C. for one hour, with the following result:

Original mixture.	Percentage methane obtained.				Mean.
$C_2H_6 + 3N_2$	18·5	17·15	18·3	18·7	18·15
$C_2H_6 + 3H_2$	42·9	38·0	43·9	40·15	41·25

$$\text{Ratio } \frac{41{\cdot}25}{18{\cdot}15} = 2{\cdot}27$$

From this it appears that with an inert gas the result corresponded very nearly with the equation

$$C_2H_6 + 3N_2 = C + CH_4 + H_2 + 3N_2$$

whereas with active hydrogen the change appears to be principally

$$C_2H_6 + 3H_2 = 2CH_4 + 2H_2$$

In the latter equation the theoretical yield of methane is 50 per cent, whereas the actual amount obtained was 41·25 per cent, or 82·5 per cent of the theoretical yield.

These and other experiments give a clue to the effect on a hydrocarbon molecule of a plain cracking treatment or a hydrogenation treatment. In the former treatment, using ethane, it will be seen that the methane produced is about 18 per cent, while hydrogenation gives about 41 per cent of methane. Little work has been done on the cracking and hydrogenation of the more complex hydrocarbons in their pure state, but, in 1896, Haber, using hexane, proved conclusively that between 600° C. and 800° C. the primary cracking took place by the elimination of methane and the formation of the lower olefine C_5H_{10} thus:

$$CH_3 \cdot CH_2 \cdot CH_2 \cdot CH_2 \cdot CH_2 \cdot CH_3 = CH_3 \cdot CH_2 \cdot CH_2 \cdot CH : CH_2 + CH_4$$

Haber regarded this action as typical of the behaviour of other bodies when subjected to cracking.

So far as I am aware, no experimental work has been done on the hydrogenation of hexane, but by analogy from the work of Bone it appears probable that, if excess hydrogen had been present in Haber's experiments, some of the olefines would have been hydrogenated to pentane. This assumption is confirmed to some extent by the fact that in hydrogenating low temperature tar and other heavy oils the separation of carbon can be practically eliminated and the production of permanent gases lessened.

The above considerations, while admittedly incomplete, provide a useful picture of the reactions taking place during the hydrogenation of such substances as coal, oil, or tar.

SYNTHETIC ALCOHOLS AND HYDROCARBONS

It would be undesirable to conclude without touching shortly on the third possible method of producing motor spirit from coal, namely, the synthetic production of alcohols and hydrocarbons. Only in exceptional circumstances could this process compete with carbonisation or hydrogenation for the production of liquid fuels, but for the production of alcohol for solvents it has already become the basis of a large industry. The raw coal is first carbonised to produce coke, the liquid and

gaseous products finding their normal markets; the coke is then subjected to the water-gas process so as to produce a mixture of carbon monoxide and hydrogen. By the use of various catalysts, together with, if necessary, additional hydrogen, liquids of various types are obtainable. Such catalytic conversion has been investigated in Germany by Fischer and the Badische Anilin und Soda Fabrik, in France by Patart and his co-workers, and in England by Prof. G. T. Morgan at the Chemical Research Laboratory, by Prof. W. A. Bone at the Imperial College of Science and Technology, and by Imperial Chemical Industries, Ltd. Dr. Franz Fischer, of Mulheim, working at atmospheric pressures, has produced liquid and solid hydrocarbons of the petroleum series. Oxygen-containing products are absent, and a yield of 100 gm. of solid, liquid, and liquefiable hydrocarbons is claimed from each cubic metre of water-gas.

Conclusion

On the technical side much has been achieved. By the carbonisation of coal, liquid products suitable for use in internal combustion engines or in furnaces can be obtained directly, but not in large quantities compared with the amount of coal used; in such processes the greatest stress must be laid upon the markets for the solid and gaseous products, oil and petrol being merely by-products. By the hydrogenation of petroleum, or of low temperature tar and certain fractions of high temperature tar, large percentage yields of motor spirits can be obtained.

By the direct hydrogenation of a suitable coal some 160 gal. of motor spirit per ton of coal treated can be made, and even when the additional coal for the process is taken into account the yield is 80 gal. and the thermal efficiency is 43 per cent. Alternatively, motor spirit can be obtained synthetically either in the form of alcohols or of hydrocarbons, by first converting the coal into carbon monoxide and hydrogen, but not, under present conditions, so cheaply as by hydrogenation.

In view of the mechanical difficulties of working, on a large scale, a process involving simultaneously high pressures and high temperatures, the technical progress of coal hydrogenation has been surprisingly rapid. It is now undoubtedly possible to manufacture petrol from coal. The commercial prospects of the process are, nevertheless, uncertain, for it is always difficult to forecast the future of a synthetic, in competition with a natural, product.

The Royal Academy

ENTERING the galleries of Burlington House with a mandate to seek for "points of particular scientific interest", I went first to the Sculpture Rooms, where my attention was arrested by the bust of Sir Patrick Geddes (1427), whose recent death has left a gap in the ranks of science which will not easily be filled. The character which emerges in Mr. Pibworth's rendering is that of the acute analytical mind; the contemplative philosopher does not appear. It is interesting to consider in this connexion the appreciations which have appeared in the Press from a number of Geddes's friends, each reflecting a different facet of his many-sided mind. His influence in the world was undoubtedly due in large measure to the great variety of persons with whom he was able to make sympathetic contact.

The full-size model of the Native War Memorial, Lagos (1382), by Mr. James A. Stevenson, admirably illustrates the statuesque character which is so marked in many of the African peoples. I suggest that such successful generalisation of the attributes of existing races is of "more particular scientific interest" than the emphasis of simian characters, now so popular, which inevitably suggests the 'missing link' as the true ideal of the human form.

Among the oil paintings, well placed at the end of Gallery II., "Spoleto, Italy" (103), by Mr. Osmund Pittman, is a fine composition, showing the hill town above a river spanned by an arched bridge (the water reflecting the colour of the sky), the architectural forms pleasing in the simplicity common to Mediterranean building, with plain plastered wall, small windows, low roofs, and absence of chimneys. In "Old Mill House, Avila, Spain" (150), by Mr. Oliver Hall, R.A., severity of architecture and a stern landscape are in fine accord, and the scheme of tone and colour is skilfully continued in the design of frame which this painter habitually employs.

"Last Rays: Northern Ireland" (194), by Mr. Julius Olsson, R.A., is one of those studies of sunset colour upon the sea which cannot be too often repeated, for the effect is as fleeting as it is beautiful. Mr. S. J. Lamorna Birch has a study of the columnar granite cliffs of the Land's End (225) rising from smooth, flat sands, across which the long, low waves come gliding in. "Harbour" (262), by Mr. George Graham, recalls for our pleasure the perfection with which the forms of hull and sail, of spars and rigging, are outlined by the plain background of water and sky in the estuaries of a low-lying shore.

Mr. Joseph Farquharson, R.A., has a most poetic study of the stately columns of a fir forest among the mountains (339), with solemnity of deep, rich colour.

Mr. Guy Kortright's "Springtime in Dalmatia" (557) and "August Heat: Corsica" (623) are remarkable studies in the essential forms of the land, although not, I think, equally successful in conveying the transitory qualities of the seasons. "Twilight in the Downs" (604), by Mr. William Clarkson, renders in a harmony of tones the mystery of the dying day.

Among the water-colours, Mr. Frank Baker's "Widecombe-in-the-Moor" (781) gives us the ever-welcome scene of church and hamlet backed by swelling hills, seen in the soft sunshine of the

English summer. In Gallery No. VI., Mr. Samuel Smith's dry point of "Richmond Castle, Yorkshire" (1165), is a fine study of architecture set between the water and the sky.

The Architectural Room provides much food for thought. Looking at the dignified and harmonious designs of residential and business blocks in framework of steel, we wonder why the appearance of our great cities is not more pleasing, and are impelled towards the hopeful conclusion that the source of our present discontent is the mixture of the cubical with the older, gabled forms; and that all may once more be well when the new pattern has complete possession. VAUGHAN CORNISH.

News and Views

Georges Cuvier

ON May 13 occurs the centenary of the death of the distinguished French naturalist and statesman, Baron Cuvier, often referred to as the founder of comparative anatomy. "It was", says von Zittel, "the creative genius of Cuvier that erected Comparative Anatomy into an independent science, and defined principles upon which the investigation of fossil Vertebrates could be carried out with accuracy. . . . His greatness rests upon the magnificent work that he accomplished in the domain of Vertebrates, upon the scientific method which he founded for the identification of fossil bones, and upon his successful demonstration that the primeval mammals were not mere varieties of living forms, but belonged to extinct species and genera." Moreover, Cuvier, by his skill as a lecturer and writer and by his commanding personality, attracted many to the study of geology and palæontology, while, as one of the inspectors appointed by Napoleon to reorganise the schools and colleges of France and other countries, he did much to introduce and extend the teaching of natural history and other sciences.

CUVIER, who was made a baron in 1819, was born on Aug. 23, 1769, at Montbéliard, then belonging to the Duchy of Württemberg, his full name being Georges Léopold Chrétien Frédéric Dagobert Cuvier. A child of unusual gifts, he received his earliest education from his mother, but at the age of fifteen years became a student at the Academy of Stuttgart, and at nineteen was a tutor in a nobleman's family in Normandy. Here he passed the years of the Revolution, little affected by the events of the time, but meanwhile extending his knowledge of natural history. The turning point in his career came with his friendship with the Abbé Tessier, through whom he went to Paris, where he quickly attained to a distinguished position. In 1795 he was given a post in the Museum, in 1796 was made a member of the Institut de France, in 1800 he succeeded Daubenton at the Collège de France, and in 1803 he was made permanent secretary to the Academy of Sciences. His works included his "Leçons d'anatomie comparée" (1801–5), "L'Anatomie des mollusques" (1816), "Le Règne animal" (1817), "Les Ossements fossiles de quadrupèdes" (1821–24), and his uncompleted "Histoire naturelle des poissons". His *éloges*, published in three volumes, included those on Priestley, Banks, Delambre, Berthold, Lacépède, and Davy. For some years he was Chancellor of the University of Paris, and both under Napoleon and his successors he held high State appointments. His death was regarded as a national calamity, and his burial in the Père la Chaise cemetery was attended by a large concourse of people.

Portraits at the Royal Academy

IN addition to the paintings and other studies at the Royal Academy mentioned by Dr. Vaughan Cornish in his article published elsewhere in this issue, the exhibits include portraits of the following: Dr. Alfred Cox, medical secretary to the British Medical Association, 1912–32 (190), by Sir Arthur Cope; Dr. Thomas Sinclair, M.P. for the Queen's University of Belfast (210), by Mr. George Harcourt; Prof. Blair Bell, of the University of Liverpool (261), by Mr. John A. A. Berrie; Prof. R. S. Troup, director of the Imperial Forestry Institute, Oxford (332), by Mr. Peter A. Hay; Sir Robert Witt, vice-chairman of the Institute of Industrial Psychology (377), by Mr. Oswald Birley; Dr. W. W. Vaughan, headmaster of Rugby School, 1921–31 (398), by Mr. Glyn Philpot; Mr. F. Howard Livens, vice-president of the Institution of Mechanical Engineers (447), by Mr. Arthur G. Walker; Dr. Bevan Lean, headmaster of Sidcot, Somerset, 1902–30 (542), by Mr. Bertram Priestman; Lieut.-Gen. the Right Hon. J. C. Smuts, president in 1931 of the British Association (594), by Mr. John Wheatley. Among the statuary we notice: Sir Ernest Shackleton (1390), statue, and Lord Melchett (1392), relief, both by Mr. Sargeant Jagger; Sir Ambrose Fleming, emeritus professor of electrical engineering in the University of London (1492), bronze bust, by Mr. George H. Paulin; Sir Jagadis Chandra Bose, director of the Bose Research Institute, Calcutta (1564), bronze head, by Marguerite Milward.

Science in Drama

THE need for men of science to appreciate the sociological consequences of their work, alongside the equally vital necessity for politicians to realise what science opens up in the field of social and industrial reconstruction, have often been stressed in these columns. It is, therefore, with much interest that we note the production at the Globe Theatre, London, of "Wings over Europe", by Robert Nichols and Maurice Brown. The authors avail themselves of a legitimate poetic licence. A young and brilliant scientific worker with a rather simple sociological outlook discovers how to release the energy of the atom, and offers to present his discovery to the British cabinet, provided the cabinet will at once take such steps as should now be possible to eliminate poverty and reduce all work to the barest minimum. The confusion and despair of a cabinet of men ignorant

of the elements of science and wedded to traditions that are now doomed is well portrayed, if rather exaggerated. That such a theme can find its place successfully on a London stage is significant of the fact that the importance of science as an unconscious revolutionary factor in society is beginning to be appreciated.

Scientific Precision and Popularisation

WHY is it that, in a certain class of publication aiming at popularity, vagueness seems to be considered essential in attracting the interest of the general public? It appears particularly in relation to geographical and ethnographical details. We have before us two small volumes from a series with many pleasing features, "Things Seen by the Camera" (London: George Routledge and Sons, Ltd., price 2*s.* 6*d.* net each). Of these, each contains sixty-four photographic reproductions. One deals with China and the Chinese, and another with the natives of Africa. The latter is concerned exclusively with physical types and covers a fairly representative range, some evidently chosen to demonstrate peculiarities of dress or physical deformation, such as the distension produced by the woman's lip-ornament. The volume dealing with China, in addition to characteristic or peculiar types, includes scenes from Chinese life and examples of Chinese buildings and architecture. It often happens that material of this kind is collected by those who have lived in out-of-the-way parts of the world and are not in touch with scientific bodies. They put their material in the hands of agencies, which distribute it to the popular Press, but through inadequate description, material which might be of value to the scientific worker not infrequently loses its utility. In fairness to the two publications before us, it must be said that in most instances they give an approximate or precise attribution. But if in one case, why not in all? "Witch-doctor from Central Africa", "Native Girl from Rhodesia", says little. The popular attraction of the picture could not possibly be affected by the addition or omission of the name of the tribe in brackets.

Britain's Contributions to World Progress

IN a thoughtful essay entitled "The Projection of England" (London: Faber and Faber, Ltd., 1*s.*), Sir Stephen Tallents reminds us of our heritage of greatness in most fields of thought and activity, and points out that in the modern interdependence of nations, England can no longer afford to pursue a policy of standing aloof from the rest of the world. He indicates some of the attainments of the British in the fields of science and industry, and reflects that these are too little known to other nations. England neglects many opportunities of making herself known abroad, and of communicating her knowledge and discoveries to a wider world. In short, while he deprecates any form of national boasting, Sir Stephen Tallents argues that we need to develop "a continuous and sustained presentation of our industrial ability and our industrial ambitions through every available channel of communication open to us". For this purpose, well-executed films are indispensable, but Sir Stephen presses for the art of national projection in a metaphorical as well as a literal sense. His proposal is that we should have a school of national projection—not as a government department, but rather as the result of private munificence—that must study national characteristics and achievements and lose no opportunity of suitably presenting these as records of fact to the wider world, through the medium of Press and poster, films and wireless, exhibitions and conferences. In these forms of enterprise, he complains that Britain has fallen behind some of the other great States of the world.

Trevithick's First Rail Locomotive

ON April 27, simultaneous meetings of the members of the Newcomen Society were held in London and New York. At both places, two papers were read, the first being by Mr. W. W. Mason on Trevithick's first rail locomotive, and the second by Mr. C. L. Chandler on early shipbuilding in Philadelphia. As the centenary of the death of Richard Trevithick would be commemorated next year, it seemed desirable, said Mr. Mason, to determine, so far as possible, the truth about the locomotive Trevithick built in 1803 and with which he experimented in South Wales in the early part of 1804. Neither the account of the experiment in Francis Trevithick's "Life" of his father nor those contained in other works agree as to the design of the engine, while there are discrepancies in the drawings in existence. One account, for example, says the cylinder was placed vertically within the boiler, while Llewellyn's drawing, preserved in the Science Museum, shows the cylinder horizontal. But this is only one point which calls for further investigation. Whatever doubt may exist as to the arrangement of the engine, however, there is little question that on Feb. 21, 1804, it took a load of 10 tons of bar iron and about 70 passengers from the Penydarran works, where it was constructed, down the old tram-road to its junction with the Glamorganshire Canal at Abercynon, a distance of about 10 miles, and in March repeated the journey, but with a net load of 25 tons. One of the most versatile inventors of his age, Trevithick was a pioneer in the use of high pressure steam, and by his experiment in 1804 he became the father of the steam locomotive.

Broadcast Reception in the United States

IN *World Radio* for April 15 there is an interesting account of a motor tour by R. M. Bell in the United States with a portable receiving set. As good highways connect all parts of the country, the 3000-mile trip from the Atlantic seaboard to Los Angeles can be made quite easily. The tour brought within daylight range most of the American stations. In Chicago the 25 local stations made it difficult to hear outside stations. Doubtless the same difficulty arises in New York, which has 43 local stations. Near Chicago, a relay from Poznań came through in excellent volume. There are nine television stations at present 'on the air'. Chicago uses 45 lines per picture and 15 pictures per second, New York uses

60 lines and 20 pictures per second. In Los Angeles, the 17 local broadcast stations, several of which are 'on the air' for 24 hours daily, made reception from other cities practically impossible, but a number of international relays from abroad were heard from them. The B.B.C. orchestra was heard as distinctly as it is in London. When passing through the Japanese and Mexican portion of the city, the street resounded with a speech from Berlin. In Tennessee, near Nashville, Los Angeles, 1775 miles to the west, and New York, 775 miles to the east, could be heard easily on the portable receiver. The writer mentions that Los Angeles (KFI), Dallas (WFAA), and Cincinnati (WLW) transmitted splendidly. In daytime they could be heard at a distance of 300 miles in good volume, and at night at distances of more than 1000 miles. When he got back to Pennsylvania, he heard at 7 A.M. the toasts given at the Lindbergh banquet at Tokyo (9 P.M. in Japan) being relayed from the local networks.

Ultra-short Wave Television

A SUCCESSFUL public demonstration of ultra-short wave television was given on Friday, April 29, at Messrs. Selfridges' stores in Oxford Street, London. The transmitter was situated on the roof of the laboratories of Baird Television, Ltd., in Long Acre, W.C.2, the wave-length used being 6·1 metres. The ultra-short waves have the advantage over medium wave-lengths that they allow television pictures of much finer detail to be transmitted, and provide a reliable local service free from fading and atmospheric disturbances. An interesting feature of the transmission was that although sent out on ultra-short waves, the images could still be received easily by possessors of the ordinary Baird 'Televisor' and wireless sets of normal type designed for the present B.B.C. television transmissions. To do this, the only extra apparatus required was an ultra-short wave adaptor, which virtually converts any normal receiver into a super-heterodyne. The demonstration given on April 29 is the first public demonstration of the possibilities of ultra-short wave television to be given anywhere in the world, and marks a further stage in the development of the art.

Developments in Methods of Communication

A PAPER on modern communication systems, by Dr. F. Lüschen, was read to the Institution of Electrical Engineers on April 7. Dr. Lüschen pointed out that the rapid progress of invention has made modern communication systems very complicated to design. Few realise how difficult it was to solve the problem of the interconnexion of wired and wireless systems. This was first carried out in the telephone link between Great Britain and the United States. Further problems that have been solved are the multiple utilisation of lines for telegraphy and telephony, the control of electrical apparatus at a distance, and the electro-acoustic transmission problems involved in broadcasting and sound-films. These methods have widely extended the field of use of communication systems. The information contained in the spoken word is an extremely complicated function of the time. The transmission system is composed of widely different elements. At first, therefore, it appears to be a hopelessly difficult problem. Yet, with the help of a few simple mathematical principles, engineers have succeeded in visualising the transmission of signals. As an illustration of the pitch of perfection to which carrier-current telephony has reached in the United States, Dr. Lüschen described a pole line carrying twenty pairs of conductors, sixteen of which carry three high frequency channels each, in addition to their low frequency communication circuits, while the other four pairs are equipped with ten telegraph channels each. Twenty pairs of wires thus result in 150 communication circuits, 80 of them being telegraph circuits and 70 of them telephone circuits. Dr. Lüschen also gave interesting particulars of tests made on a system of telephony and telegraphy linking Berlin with Buenos Aires. It is designed to transmit speech and two telegraphic messages simultaneously.

Rival Theories of Hearing

IN his Royal Institution discourse on Friday, April 29, on theories of hearing, Prof. H. Hartridge reminded his listeners that rivalry still exists between the theories of hearing, because the small size, the delicacy, and the inaccessibility of the internal ear make direct observation and experimentation well-nigh impossible. Some of the rival theories are the telephone theory, the modified telephone theory of Boring, the modified telephone theory of Watt, the volley theory of Wever and Bray, the pattern theory of Ewald, the stationary wave theory, and the resonance theory. At the present day, controversy principally centres round the resonance theory and some form of telephone theory. The production of deafness over a narrow range of frequencies, by surgical interference with a part of the internal ear, is accounted for more readily on the resonance theory than on the rival theory. The same may be said of boilermakers' deafness and its experimentally produced counterpart. When physical tests are applied to hearing, evidence is obtained in each case in favour of resonance and contrary to telephony. The universal acceptance of the resonance theory is delayed by various criticisms, which arise in most cases from unfamiliarity with the behaviour of resonators and sense organs. The resonance theory accounts satisfactorily for all the phenomena, and no other theory does this.

Purpose in Evolution

IN the Riddell Memorial Lectures for 1931, delivered before the University of Durham at Armstrong College, Newcastle-on-Tyne, Sir J. Arthur Thomson discussed the general subject of "Purpose in Evolution" (Oxford University Press, 1932, pp. 59, 2*s*. 6*d*. net). The opening lecture examined various aspects of Nature in view of the question: Is there a purpose in evolution? It grants that often the development and ways of acting of living units are purposive, and comes to the conclusion that the scientific facts do

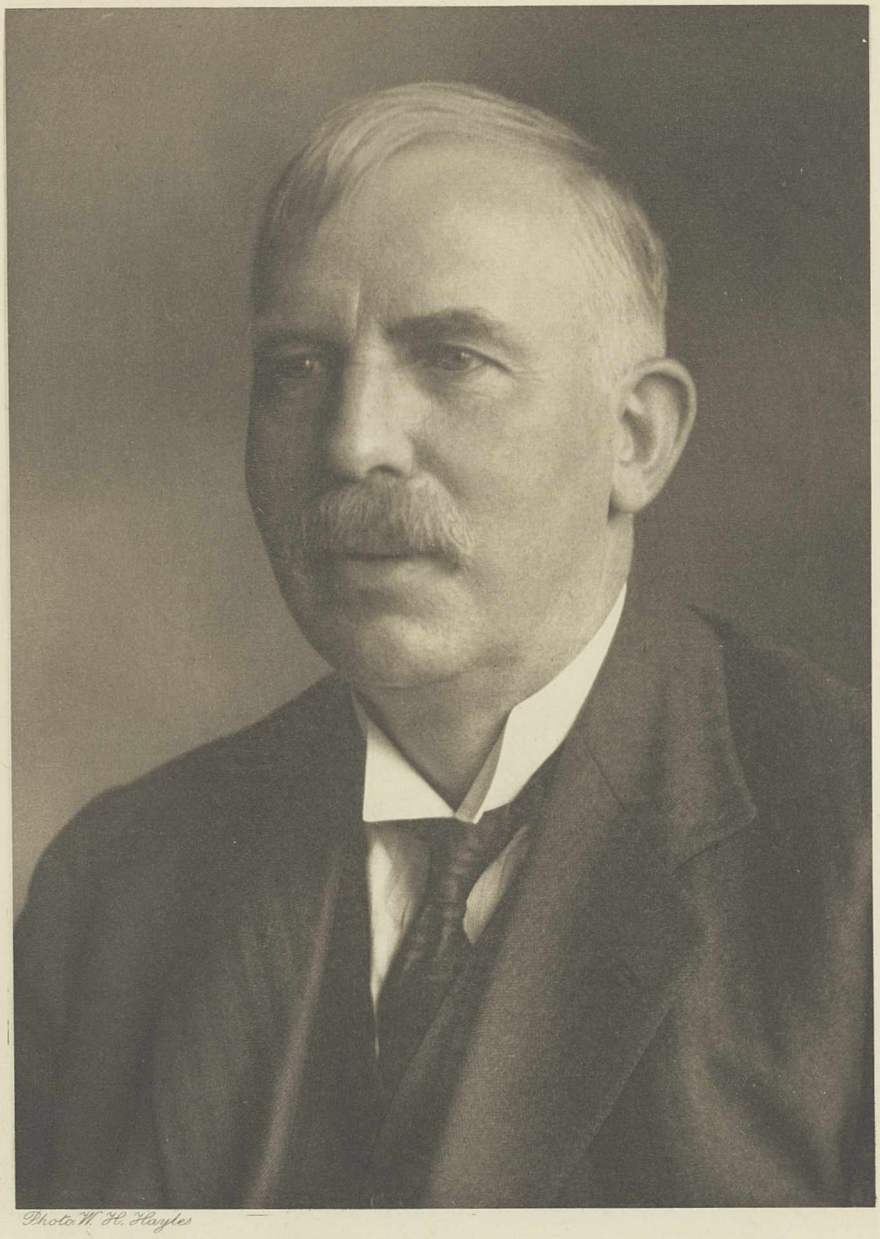


Photo W. H. Hayles

Rutherford

suggest the interpretation that Nature expresses a purpose, and that since the scientifically known system of Nature, being largely unconscious, cannot be credited with a purpose, we are led to think of a Creator's purpose. The fact that the scientific ideal is limited to a naturalistic description does not in the least imply that we need refrain from idealistic, transcendental, mystical, or religious interpretation—the only kind of interpretation there is. The second lecture dealt with the disharmonies in Nature and the difficulties to which they give rise in the teleological interpretation of a Creator's world, but such disharmonies, often exaggerated, need not obscure the greater fact of an overriding harmony. The final lecture, on "Lessons from Evolution", based on the fact of a real progress in organic evolution, is a plea for a ranging of human endeavour in line with the trends which have been conspicuously progressive in the re-human ascent of life.

Control of Canadian Insect Pests

THE Canadian Government and the Empire Marketing Board are jointly financing a search in Europe for the parasites of certain Canadian insect pests. The Canadian Department of Agriculture has asked the help of the Parasite Breeding Laboratory at Farnham Royal, Bucks, which is maintained by the Empire Marketing Board, in combating the present severe outbreak of a forest insect, *Diprion polytomum*, and also in fighting the plague of balsam woolly aphis, which is causing serious injury to balsam fir in the Maritime Provinces. If the balsam woolly aphis infection spreads throughout the eastern forests, as it threatens to do, enormous losses in pulpwood will result. The only hope seems to lie in the introduction of a parasite to check the advance of the aphis. The pest came originally from Europe, but it is not common, and an intensive search will have to be made in Central Europe to find its insect parasites. These insects will then be brought to England and bred up at the Farnham Royal laboratories. Nearly one million insect parasites have been bred and dispatched from time to time from Farnham Royal to all parts of the Empire. The wheat-stem sawfly, one of the Western farmers' major problems, is now being investigated. Officers of the Imperial Institute of Entomology have collected parasites in France and bred them up in England. Last season several large consignments of broken wheat straw, containing sawflies plus parasites, were packed in special boxes and shipped to Canada. These parasites have been released in the wheatfields, and up to date are doing well.

Blanching of a Bay Horse

IN the *Field* for April 16, p. 582, Miss J. McAlpine gives an account of a bay horse the mane of which, black as usual in this colour, turned nearly white owing to a severe fright it received at six years of age when out at grass in a very long field. An aviator, in trying to land here, drove the horse the whole length of the field, and nearly alighted on it. No one saw the horse for three days afterwards, but it was then found to have lost the colour of its mane, as described, while the tail had also become quite grey. A photograph of the animal, now nine years old, accompanies the note, and shows the pale mane very plainly, so that the effect of the shock seems to have been permanent. The writer of this note once casually saw in a London street a bay pony with a grey mane and also an angular grey patch let in, as it were, on the brown short hair of the neck, but put it down to a freak of variation. The horse is more liable to variation in pelage than any other domestic mammal, and another bay, an aged van-horse, also seen casually in London, was spotted with white over the brown parts as clearly as any deer, but with smaller, more angular spots.

Frequency of Insects in the Air

AMONG a recent series of "Why the Weather" articles by C. F. Talman, issued by Science Service, there is one article commenting on some experiments made in France by A. Bonnet to determine what that meteorologist called the 'entomological density' of the air, a few feet above the ground. This quantity, defined as the number of insects in a cubic metre, was obtained by means of a muslin net attached to the front of a motor car. The car was driven for a kilometre in unfrequented regions far from places where insects collect in exceptional numbers, and the insects in a 1000 cubic metre sample of air were collected and counted. The density was found generally to vary from one or two at sunrise to about seventy in the early afternoon, with a subsequent decline to one or two again at sunset. Those species normally found only very early and late tended to appear in the middle of the day when the air was nearly saturated. This is a line of research that might appeal to motoring meteorologists. It would be interesting to trace the effect of the insect density upon visibility, and see to what extent some of our midsummer hazes are due to large values of this quantity.

Orthographical Relief

A NEW method of showing surface relief on a topographical map is described by Prof. T. Kitirô in the *Geographical Journal* for March. The inventor claims this to be a natural, in contrast to a conventional, method, since it is based on the principle of shading, and gives the reader the appearance of the land rather than detached information of heights. The method makes use of what Prof. Kitirô calls the 'inclined contour'. This is defined as the projection upon a datum plane of the outline of the intersection of the ground surface with an inclined plane. By contrast, the ordinary contour, which is distinguished as the horizontal contour, is the projection upon a datum plane of the intersection line of the ground surface with a horizontal plane. The inclination of the inclined plane is assumed to be 45°. The effect of these inclined contours is to give a shaded map of relief features with a southern illumination on the specimen of a Japanese map which is reproduced. The thickness of the inclined contours is constant, and after experiment it was found most useful to have between thirty and seventy lines to the centimetre.

The method of drawing these contours from the ordinary contoured map is fully described. One obvious disadvantage is that they give a dark map, but this might be overcome by drawing the contours in grey or buff. The finished map certainly gives a striking picture of relief where the slopes are steep.

Sugar Cane Research

THE Report of the proceedings of the Imperial Sugar Cane Research Conference, held in London in July 1931, has recently been issued by H.M. Stationery Office (price 2*s*. 6*d*. net). The conference, to which reference has already been made in NATURE (July 25, p. 160) was convened by the Empire Marketing Board to discuss the future of scientific research in sugar cane production, but it was decided that the world economic position should be considered in drawing up a research programme. As a result, some seventy pages of the report give a review of the economic position of the industry, which contains many valuable facts and figures. The present organisation of research within the British Empire is considered in some detail in reference to the various cane sugar growing areas, after a brief general introduction by Dr. P. S. Hudson that deals mainly with the genetical side of the problem. Dr. Hudson concludes that whilst some early advances have been made, and still may be expected, the full utilisation of scientific methods in breeding, which involves a cytological study of the genetical material, can alone lead to continued progress and development in this line of work, which is of so much importance in developing Empire resources. Dr. W. R. Thompson points out that, owing to the wide range of habitat in which sugar cane can be successfully grown, it suffers from an unusually large list of insect parasites. With some of these, such as the leaf froghopper in Hawaii, a very great measure of success in combating them has been obtained by using the method of biological control. Dr. Thompson states that the method of biological control has this great advantage that, when it can be successfully applied, it provides what is practically permanent relief at a relatively small initial cost.

Evaluating Periodicities by Machinery

THE application of Fourier's harmonic analysis to weather phenomena has revealed many outstanding periodicities. To those who feel that the next step should be directed towards understanding the cause of these periodicities, rather than the evaluation of yet more, the invention of mechanical aids to 'periodicity hunting', such as Abbot's periodometer, will naturally make little appeal (Smithsonian Miscell. Coll., vol. 87, No. 4 (Pub. 3138): "The Periodometer, an Instrument for Finding and Evaluating Periodicities in Long Series of Observations". By Dr. C. G. Abbot). The device is one for avoiding numerical computation in studies of this kind. It does not detect periodicities; that has to be done by inspection of the statistical material. This step involves a personal factor. Given any suspected periodicity, the machine shows to what extent this appears consistently throughout the material, and determines the shape of the curve of variation of the element over this period. The reality of the periodicity is judged from the shape of this curve. Having decided that it is real, the operator is then able, with the aid of the machine, to eliminate this periodic variation, and so gets a residual curve that is scrutinised afresh for other periodicities. The curve of variation may depart widely from a simple sine curve, and this method of analysis therefore differs from the classical Fourier process, and on account of the presence of the personal factor will give different results when different workers use the same material. The ultimate test of merit is, of course, whether the method will lead to greater knowledge of underlying physical causes, and it remains to be seen whether this will be the case. The cost of production of the first periodometer was apparently a thousand dollars, the money being provided by the Research Corporation of New York.

Chemistry and Action of Drugs

IN his Lane Lectures on pharmacology, Prof. W. Straub, of Munich, discusses certain problems of general interest in the chemistry, synthesis, and action of drugs (Stanford University Publications: University Series: Medical Sciences, vol. 3, No. 1, 1931; London: Humphrey Milford). Two are devoted to digitalis, the chemistry of the glucosides of the leaf and their physiological action being reviewed. Prof. Straub points out that the differences in action of the glucosides of the cardiac tonics, digitalis, strophanthus, and squill, can be explained to a great extent by a knowledge of the speed with which they are taken up by the tissues of the body as well as by the heart, and of the ease or difficulty with which they can be afterwards destroyed. The greater response of the pathological, as compared with the normal, heart to digitalis can be similarly explained, since the slowing of the circulation permits of a greater absorption of the drug by the tissues. These lectures were primarily addressed to pharmacologists. Three subjects were chosen as of interest to students and physicians; anæsthesia, the pharmacology of the heavy metals, and the camphor problem. In the latter lecture Prof. Straub discusses the attempts made to prepare a synthetic compound having similar stimulant effects to camphor on a failing heart and respiration without its disadvantage of slow absorption after injection. Cardiazole (pentamethylene tetrazole) appears to fulfil the requirements best at the present time; it is more soluble in water than in oil, so that it will be rapidly absorbed, but its oil insolubility will ensure that it exerts a stimulant rather than a narcotic action on the central nervous system. The sixth lecture, addressed to a scientific audience without medical interests, dealt with certain general problems of the use of intoxicating drugs.

Reconstruction of Tokyo and Yokohama

DURING the seven years that followed the great earthquake of Sept. 1, 1923, the rebuilding of Tokyo and Yokohama was practically completed, at a cost of nearly eighty-five million pounds. M. Jean Gracy has written a full account of the renovated cities, of

which a summary is given in the last number of the *Matériaux pour l'Étude des Calamités* (pp. 156-165; 1931). The total area appropriated for new streets and parks is 914 acres in Tokyo and 89 acres in Yokohama, and of this, one-tenth was taken from the previous owners without compensation. In Tokyo, three classes of streets have been laid down. In those with much traffic, the total length is 73 miles; no street is less than 80 ft. wide, and some for short distances are as much as 108 ft. and 144 ft., and one even 252 ft. wide. Those with a moderate amount of traffic have a total length of 86 miles and a width varying from 36 ft. to 72 ft. Four hundred bridges have been restored so as to resist both fire and earthquakes. The value of open spaces was well shown in 1923. Accordingly, three large parks have been made with a total area of nearly 50 acres, and 51 small ones with an area of 37 acres, the latter being usually near primary schools, for which they serve as playgrounds.

Absorption Spectrophotometry

MESSRS. Adam Hilger, Ltd., 98 King's Road, London, N.W.1, have issued a bound book of eighty pages dealing with the theory and practice of absorption spectroscopy (price 5*s.* net, postage 3*d.*). It contains a brief theoretical introduction, then thirty-two pages of description of Hilger apparatus and description of technique, including work in the ultra-violet, visible, and infra-red regions, with a note on photoelectric methods, and the rest of the book deals with applications, particular attention being directed to biological aspects and analysis. This contains references to original literature. A companion volume, entitled "Recent Applications of Absorption Spectroscopy" (price, bound, 3*s.* 6*d.*, postage 2*d.*), published by Messrs. Hilger, provides a very complete and carefully classified account of the literature from 1922 to 1931, with useful notes. The two publications form a handy yet compendious guide to the practice and literature of spectrophotometry in all parts of the optical spectrum, and may be recommended to all interested in this branch of science.

Health of the Navy in 1930

THE health of the Navy during 1930 appears to have been remarkably good, judging by the details contained in the "Statistical Report" for the year, recently issued by the Admiralty (London: H.M. Stationery Office. 2*s.* 6*d.* net). The total number of cases of disease and injury in a force of 88,840 men was 38,031, a marked decrease on the previous year and in comparison with the five years' average. Venereal diseases head the list of admissions with 5154 cases, respiratory catarrhs (4378 cases) and tonsillitis (2429 cases) coming next, apart from local injuries and wounds, which numbered 7238 cases. There were only 36 cases of alcoholism, 11 cases of typhoid and paratyphoid fevers, and 5 cases of Mediterranean fever.

Announcements

THE Masters' Memorial Lectures of the Royal Horticultural Society will be delivered in the lecture room of the Society's new hall in Greycoat Street, Westminster, on May 10 and 11, at 3.30 P.M., by Sir Frederick Keeble, on "Garden Fertility: its Origin and Maintenance".

THE Royal Society of Edinburgh announces that the Keith Prize for the period 1929–31 has been awarded by the Council to Dr. A. W. Greenwood, lecturer in the Institute of Animal Genetics, University of Edinburgh, for papers on the biology of the fowl; and the Neill Prize for the period 1929–31 to Dr. C. H. O'Donoghue, reader in zoology in the University of Edinburgh, for papers on the blood vascular system, and for earlier work on the morphology of the *corpus luteum*.

LIEUT.-COL. F. C. SHELMERDINE, Director of Civil Aviation, opened an exhibition of aerial photographs by Aerofilms, Ltd., on Tuesday, May 3, at the Camera Club, 17 John Street, Adelphi, W.C.2. The exhibition will remain open to the public until May 31 daily from noon until 6 P.M. Examples are shown of the application of aerial photography to archæological and geological research, general survey work, town planning, and many other problems.

Australian Science Abstracts, a quarterly publication issued by the Australian National Research Council, Sydney, is a useful guide to investigations dealing with many aspects of Australian scientific activity—anthropology, zoology, botany, and physiology; veterinary science, agriculture, and economics; geology, geography, chemistry, and engineering. The subscription price is 4*s.* a year, including postage.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant physicist in the Radiological Department of the Cancer Hospital, Fulham Road—The Secretary, Cancer Hospital (Free), Fulham Road, S.W. (May 12). A full-time teacher, mainly for science or mathematics in the Junior Technical School, Horwich, and for engineering subjects in the Technical College—The Secretary, Railway Mechanics' Institute, Horwich (May 13). A pathologist for certain of the Liverpool Corporation Hospitals—The Town Clerk, Municipal Offices, Liverpool (May 14). A director of education of the Polytechnic, Regent Street—The Clerk to the Governors, The Polytechnic, 309 Regent Street, W.1 (May 21). A principal of the Cordwainers' Technical College—The Clerk to the Board of Management, Cordwainers' Hall, 7 Cannon Street, E.C.4 (May 24). An assistant keeper on the higher staff of the Victoria and Albert Museum—The Director and Secretary, Victoria and Albert Museum, South Kensington, S.W.7 (May 31). Assistant lecturers in, respectively, philosophy and physics at the University College of Swansea—The Registrar, University College, Singleton Park, Swansea (June 4). A student probationer (zoologist or physiologist) at the Marine Biological Laboratory, Plymouth—The Director, Marine Biological Laboratory, Plymouth (June 10). A borough electrical engineer to the Durban (South Africa) Corporation—The Town Clerk's Office, Durban, Natal, South Africa (July 15).

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.*]

Action of the Alkaloids and Carbon Monoxide on the Enzymatic Activity of Plants

In a series of investigations which I began during 1929 [1] I was able to demonstrate, with the help of my collaborators, that the debatable question of the function of alkaloids in plants could be profitably examined by investigating the various enzymatic activities, beginning with those of germinating seeds.

The first case that I examined was that of barley in which exists, as is well known, an increasing activity of amylase with increase of germination. Beside, I noticed a net augmentation of activity due to the addition of dilute solutions of strychnine nitrate. In turn [2] the activities of lipase, amylase, protease, and oxidase were measured in castor oil seeds germinating in pure water and in strychnine nitrate solutions of different concentrations. In every case the addition of strychnine at the concentration optimum of 1 per thousand causes an increase of activity. It should be noted that this increase is not due to action of the alkaloid on the enzymes already formed, because the effect is not observed with the enzymatic extracts of seeds.

The amount of increase of the activity is different, the most sensible effects being in lipase and oxidase. The effect of alkaloids being consequently selective for different enzymatic activities explains, in my opinion, why they do not always help the growth of plants; in effect, they can determine a want of equilibrium in the various biochemical activities, which for full growth of the plant we suppose must be properly proportioned. Investigations showed that the *Ricinus* seedlings, that were followed for a month during their germination, showed constant improvement, by the addition of solutions of strychnine nitrate. The alkaloid contained in the bark of the *Ricinus* seeds, ricinine, has shown itself necessary for the germination, but strychnine can be substituted for it. Caffeine has also been found to be advantageous up to an advanced age; but this is an isolated fact, because this alkaloid is toxic for barley, flax, and other plants. From the observed facts, the opinion that alkaloids must be considered as hormones of the plants is strengthened.

My researches show that carbon monoxide itself alters in a sensible way the enzymatic activities of plants. This gas, also in small quantities, stops the assimilatory activity of green plants in light, but not the respiration (oxidase): so it was supposed that it also had selective action on the enzymatic secretions.[3] It was effectively shown that carbon monoxide depresses amylase activity of barley and of *Ricinus* powerfully; while in the same *Ricinus* it increases slightly the lipase activity. In consequence, the behaviour of the gas during the germination of seeds was to be expected to be irregular; thus it was found that while wheat is able to germinate in an atmosphere rich in carbon monoxide, the field cabbage and hemp only germinate with great difficulty, while flax and tomato do not germinate at all. Leguminous plants, such as lupin and pea, showed special behaviour: they are able to germinate in an atmosphere rich in carbon monoxide, and also if the operation is accomplished under a cover with seeds made sterile: a considerable absorption of nitrogen which causes much depression is observed.[4]

The determination of the contained combined nitrogen denoted an increase from 20 to 40 per cent in a few days. This fact combined with the selective action of carbon monoxide and of alkaloids on the enzymatic activity of germinating seeds makes one believe that the nitrogen assimilation in leguminous plants, as other authors have supposed, is due to the stimulating action of nitrogen bacteria, but not exclusively to these bacteria. The nitrogen assimilation is related to enzymatic activities which are latent in leguminous plants. In further confirmation of this are the new investigations that we are making now; from which it appears that the alkaloids also are able to promote nitrogen assimilation by lupins and peas.

The other effects, observed up to now in different seeds, in relation to different enzymatic activities, are summarised in the accompanying table:

Seed.	Exciting Substance.	Percentage Variation of the Enzymatic Activity.			
		Lipase.	Per-oxidase.	Amylase.	Protease.
Ricinus	Carbon monoxide (50 per cent air)	+5	..	−70	..
,,	Strych. 1 °/₀₀ *p*H = 4·6	+20	+150	+4	+10
,,	Strych. 1 °/₀₀ *p*H = 6·8	from +50 to +250	..	..	..
,,	Ricinine 1 °/₀₀	+30	..	..	..
Barley	Caffeine 0·5 °/₀₀	..	..	−20	..
,,	Strych. 0·5 °/₀₀	..	..	+80	..
,,	Carbon monoxide	..	..	−70	..

Investigations on these lines are being continued in this Institute, and will be extended to other kinds of plants and alkaloids.

MAURIZIO PADOA.

R. Scuola Superiore di Chimica Industriale,
Bologna, March 12.

[1] M. Padoa, *Giorn. Chim. Ind. Appl.*, **11**, 504; 1929: **12**, 247, 495; 1930.
[2] M. Padoa e A. Spada, *Giorn. Biologia Appl. all' Ind. Chim.*, **1**, Nos. 1, 3, 5, 6; 1931.
[3] M. Padoa e Nerina Vita, *Ann. Chim. Appl.*, **19**, No. 4; 1929. *Biochem. Z.*, **244**, Nos. 4-6; 1932.
[4] Nerina Vita, *Biochem. Z.*, **245**, Nos. 1-3; 1932.

Colour Response in a Leech

Colour change in response to environmental conditions has been described in the following groups: vertebrates, crustaceans, and certain molluscs. There are two types of mechanism by which rapid redistribution of the pigment in the skin is brought about. In molluscs, the pigment is contained in minute elastic bags, which can be expanded by means of a specially arranged musculature, and contract because of their own elasticity. In crustaceans and vertebrates, the pigment is present as granules inside stellate cells, and can migrate through the protoplasm, being either localised in the centre of the cell or distributed more or less evenly through its processes.

The common fresh-water leech *Glossosiphonia complanata* has conspicuous stellate cells in its skin, containing brown or black pigment. I have observed that the pigment in these cells undergoes changes in configuration, contracting together if the animal is kept in total darkness, and spreading out into the stellate shape if it is kept in light. They are therefore chromatophores of the vertebrate-crustacean type. Curiously enough, they are so few and so widely spaced that their activity has little or no effect on the general coloration of the leech.

The accompanying photographs (Fig. 1) were obtained as follows. A number of leeches were kept in darkness for several days, and then pairs were selected, the two members of each pair having chromatophores in the same state of expansion. One member of each pair was kept in daylight for a day, while the other was put back into darkness. They were then fixed, mounted whole in balsam, and photographed. The upper photograph shows a group of chromatophores from the illuminated member of such a pair, and the

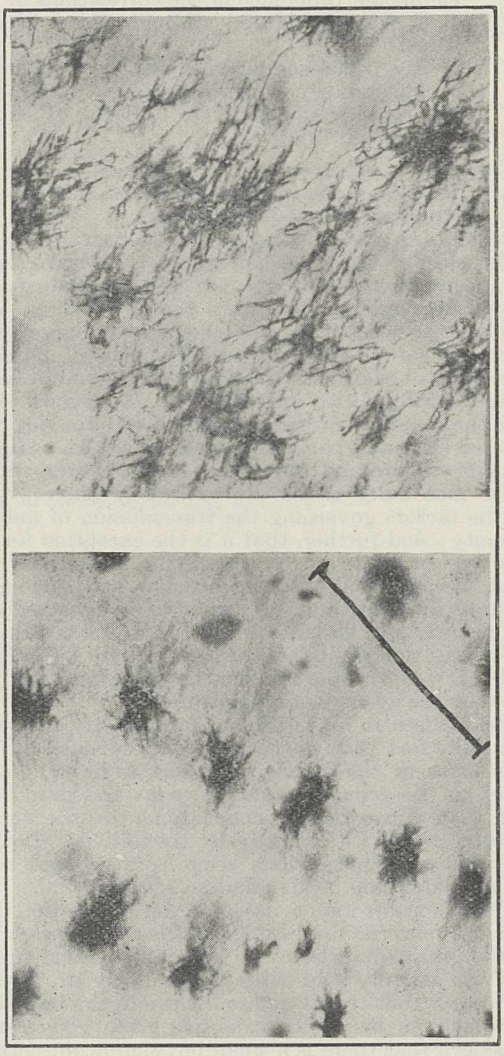


FIG. 1.

lower is a group from its fellow kept in darkness. The scale line on the lower picture represents 0·3 mm.

Hogben and Slome [1] have shown that there are two distinct modes of response to light in vertebrate chromatophores:

(1) 'Primary Reactivity': expansion in light, and contraction in darkness. This response is seen in blinded animals, and is probably a direct effect of the light on the chromatophores themselves.

(2) 'Secondary Reactivity': expansion when the animal is illuminated on a dark background, and contraction when it is illuminated on a pale background. This is a complex response, involving the eyes and a co-ordinating mechanism, and is superposed on the first.

Preliminary experiments have revealed no response to background in *Glossosiphonia*, which apparently presents the primary mode of response alone and uncomplicated by the secondary. G. H. Parker [2] has recently pointed out that in vertebrates, crustaceans, and cephalopods the visual organs are highly developed, and suggests that colour change has only evolved in groups in which the eye is capable of distinguishing the details of the luminous environment. It is therefore interesting to note that a chromatophoral mechanism exists in an animal with eyes of extremely simple construction, and that it is of the mode which, in vertebrates, does not depend upon the visual organs. Prof. Parker's generalisation remains valid if it is restricted to secondary reactivity, that is, to colour change in response to background.

The physiology of the response and its possible occurrence in other leeches are being investigated.

G. P. WELLS.

Department of Zoology,
University College, London,
April 2.

[1] Hogben and Slome, *Proc. Roy. Soc.*, B, **108**, 10; 1931.
[2] G. H. Parker, *Proc. Nat. Acad. Sci.*, **17**, 594; 1931.

Is Preformed Cystine Essential to Sheep for Wool Production?

IN a recent paper [1] attention has again been directed to the fact that the proteins of pasture grass contain only exceedingly small quantities of the sulphur-containing amino-acid cystine.[2] As Evans points out, sheep's wool is relatively rich in sulphur, and this, it has been shown, is almost exclusively present as cystine [3] (13 per cent by weight of cystine may be taken as an average figure for wool keratin).

Since cystine has always been regarded as an 'essential' amino-acid which the animal body is unable to synthesise, it becomes of interest to calculate the amount of food necessary to produce a year's growth of wool. A 12 lb. fleece may be assumed to yield 6 lb. of clean wool, containing 0·78 lb. of cystine. Putting the cystine content of pasture herbage, which comprises the main part of a sheep's daily ration in many parts of the world, at 0·01 per cent on weight of dry matter, and, for the sake of argument, assuming that none of this cystine is katabolised and excreted, it follows that an animal must eat 21·4 lb. of dry grass per day, or about 60 lb. of fresh pasture—an impossible amount, since a normal, fully grown sheep under optimal conditions will consume only about 4 lb. per day.

The wool research workers in Australia under the late Prof. Brailsford Robertson assumed that the quantity of cystine available in the diet of sheep must be a factor limiting the quantity of wool they can produce.[4] The sulphur content of wool is not fixed, however, but variable,[3, 5] and it appears that the sulphur content (cystine content) of wool grown during periods of adequate nutrition, for example, after rains when the pasture is lush, is higher than that grown during periods of scarcity.[6]

In Bonsma's experiments, controlled feeding on maize meal (poor in cystine) over a whole year failed, however, to bring about either marked decrease in fleece weight or in sulphur content of the wool grown. It would appear that more cystine is used in producing wool than can be accounted for in the food eaten.

Evans concludes, as have others, that there must be present in the diet some substance closely related to cystine from which the latter can be synthesised. Neither cysteic acid,[7] taurine,[8, 9] sulphates, elementary sulphur,[10] dithio-glycollic acid, or dithio-dipropionic acid, in spite of their close chemical resemblance to cystine,[11] nor any other compound (with the exception

of cystine peptides) has ever been reported in the literature as capable of replacing cystine in the diet.

It would appear, however, that no strict feeding experiment, keeping a cystine and sulphur balance-sheet, has ever been performed upon a sheep—the assumption that cystine cannot be synthesised being borrowed from experience with laboratory animals.[12, 13, 14] It is the purpose of this note to point out that the two cases are entirely dissimilar, and to suggest a very plausible manner in which the cystine requirements of sheep can be met whilst on a cystine-deficient diet which contains, however, sufficient other sulphur-containing compounds.

The mouse, rat, and guinea-pig are omnivora, characterised by quick metabolism, whilst the sheep is a herbivorous animal, in the gut of which bacterial activity plays a very important rôle.

It is customary in nutritional work upon sheep to allow 6-8 days for the complete passage of the ingesta through the alimentary canal. The intestinal flora and fauna (bacteria, yeasts, etc.) are almost certainly able to synthesise cystine from inorganic sulphur and it is conceivable that the population of the sheep's intestine, by continual increase, is transforming sulphates into cystine, built into their own protoplasm, with a high grade of efficiency. As bacteria die, their cell protoplasm autolyses, again setting free the sulphur, now in the form of cystine, which is readily available to the sheep.

That the metabolism of an ingested product does actually follow a different course in carnivora and in herbivora has been demonstrated in the case of taurine by the experiments of Schmidt and Clark [15] and of Salkowski.[16] It is computed that in man about 8 gm. of bacteria are excreted in the fæces daily, and this number will almost certainly be much higher in the case of the sheep, so that from the quantitative point of view the above argument is satisfactory. Some experiments are being planned at the Onderstepoort Laboratory to put our hypothesis to the test.

It seems to us of the utmost importance that this question should be thoroughly investigated, and the availability or otherwise of simple sulphur compounds for wool production by the sheep settled beyond all doubt. Otherwise, there is a danger that whole schemata of nutritional research and of advice to the pastoralists in two continents may rest upon no surer foundation than an unjustifiable assumption.

CLAUDE RIMINGTON.
J. G. BEKKER.
Onderstepoort Veterinary Research Laboratory,
Pretoria, South Africa, Feb. 1.

[1] Evans, *J. Agric. Sci.*, **21**, 806; 1931.
[2] Aitken, *Biochem. J.*, **24**, 250; 1930.
[3] Rimington, *Biochem. J.*, **23**, 41; 1929.
[4] Marston and Brailsford Robertson, Commonwealth of Australia Coun. Sci. and Ind. Res., *Bulletin* **39**, 1928.
[5] Barritt and King, *J. Text. Inst.*, **17**, T. 386; 1926.
[6] Bonsma, *J. Text. Inst.*, **22**, T. 305; 1931.
[7] Lewis and Lewis, *Proc. Soc. Exp. Biol. Med.*, **23**, 359; 1926. *J. Biol. Chem.*, **69**, 589; 1926.
[8] Rose and Huddleston, *J. Biol. Chem.*, **69**, 599; 1926.
[9] Beard, *Amer. J. Physiol.*, **75**, 658; 1925–26.
[10] Daniels and Rich, *J. Biol. Chem.*, **36**, 27; 1918.
[11] Westerman and Rose, *J. Biol. Chem.*, **75**, 533; 1927.
[12] Osborne and Mendel, *J. Biol. Chem.*, **20**, 351; 1915.
[13] Jones and Finks, *J. Biol. Chem.*, **41**, 379; 1920.
[14] Geiling, *J. Biol. Chem.*, **31**, 173; 1917.
[15] Schmidt and Clark, *J. Biol. Chem.*, **53**, 193; 1922.
[16] Salkowski, *Virchows Archiv*, **58**, 460; 1877.

Inheritance of Milking Capacity

I SUBMIT that on the evidence available Mr. Madsen[1] was justified in reaching the tentative conclusion, that some of the genetic factors governing milking capacity are transmitted in a sex-linked manner, and that the points mentioned by Mr. Edwards[2] in his letter are based upon a misapprehension of the subject. Mr. Edwards states two objections, but if his first one be analysed it will be seen to contain three different points, so that all Mr. Edwards's objections to the conclusion reached by Mr. Madsen may be summarised as follows:

1. That the sires are selected by genotype, rather than phenotype.
2. That the record of a single cow is insufficient in foretelling the production of her progeny.
3. "... it is doubtful if one should expect to find a significant difference in the correlations of two such records diluted through three generations."
4. That the difference between the two correlation coefficients is not significant, and that such a difference would be likely to occur by chance once in ten times.

The logic on which the first objection is based is not clear. How does the method employed in the selection of the sires affect the grandams? Would Mr. Edwards argue that those cows which are mated to bulls selected by genotype are of a different order from cows mated to bulls selected on phenotype? Or would he argue that since the sires of the bulls involved are selected on their genotypes, therefore their dams are of a different order from the maternal grandams of the bulls in question? In any event, when the full paper is published, Mr. Madsen will show that the majority of the sires involved have not been selected on genotype, but on appearance plus pedigree.

As to the second objection, Mr. Edwards should know that dairy cattle are extremely heterozygous for the factors governing the transmission of milking capacity; and further, that it is the exception for the genotype of a cow to be assessed in respect of milk yield, because her offspring are few and seldom all sired by the same bull. It is not to be expected that the records of a single cow will be of great value in foretelling the production of her progeny by another bull. I would point out that a statistical study is based on the average of a large number.

Mr. Madsen in his letter was particularly careful to stress the fact that the *genotypes* of the male, but the *phenotypes* of the female, ancestors were being compared to the genotypes of their sons and grandsons, and that consequently correlations to the female ancestry were in a category by themselves. Both of Mr. Edwards's objections seem to be based on a misunderstanding of Mr. Madsen's statements.

The third objection is based on the speculation that, with the material used by Mr. Madsen, no correlation to the grandams was to be expected. Incidentally, this was also my own expectation. But Mr. Madsen has shown that this is not so. Despite the inevitable drawbacks of his method, he has given good reason to believe that there is a small but significant correlation to the maternal grandam, while the slight positive correlation to the paternal grandam is insignificant. Mr. Edwards is scarcely justified in upholding speculation against ascertained fact.

The last objection refers to the value of the standard error. If the study were to be contained within reasonable limits, an error of such value was unavoidable. Actually more than 100,000 lactations had been analysed and classified. Mr. Madsen's conclusions are based not merely on his own work, but also on the material contained in the paper by myself, Scott and Fowler,[3] which he quotes, and, by implication, on the work of Gowen, to which reference is made in our paper. Mr. Madsen was also acquainted with other papers dealing with this subject, including the most recent one from this Institute,[4] which presents a case for the possibility that certain of the genetic factors controlling milk production are inherited in a sex-

linked manner. Any one of these several investigations alone might be insufficient for drawing such a deduction, but when what Mr. Edwards calls one chance in ten recurs repeatedly, it is surely not illogical to presume that it has some significance, and to try to interpret the facts. Of all possible explanations, sex-linkage is not only the simplest, but also the most reasonable.

I should like also to correct an error on the part of Mr. Edwards. If he will re-calculate the figures carefully, remembering that he is dealing with a *standard* error of $\pm 0{\cdot}03$, he will find that the results would be likely to occur by chance, not once in ten times, as he states, but once in twenty. I leave it to others to determine whether this difference is significant.

Finally, I may take this opportunity of congratulating Mr. Madsen on his study, which is in some respects the most comprehensive of this nature that has as yet been made. His material is unique and his results give considerable food for thought. It is to be regretted that funds for such research, both in Britain and in Denmark, have been recently curtailed, so that the publication of the full paper has been considerably delayed.

A. D. BUCHANAN SMITH.

Institute of Animal Genetics,
University of Edinburgh,
April 16.

[1] NATURE, Jan. 30, p. 165.
[2] NATURE, March 19, p. 437.
[3] *J. Dairy Research*, **1**, pp. 174-179; 1930.
[4] Smith, A. D. Buchanan, and Robison, O. J., "The Inheritance of Milk Yield", Conference Papers, International Dairy Congress, Copenhagen, 1st Section, pp. 127-140; 1931.

Vocal Powers and Eyes of Kangaroos

MR. FINLAYSON [1] quite rightly corrects the statement that kangaroos are never known to utter any sound normally. I have in Melbourne, four miles from the Melbourne Post Office, at my home, two large grey kangaroos and eight wallabies. I have kept such animals for years, by reason of an investigation undertaken long since into the refractive condition of the eyes of the monotremes and marsupials and of mammalia generally.

Of the three sounds Mr. Finlayson refers to, I have heard two frequently. These ten animals are fed in the morning, and when they are hungry they have minor differences amongst themselves, and the kangaroos frequently make a sort of grunt or growl if they think that their food is being interfered with. The bark or cough is quite distinct. It may be a warning signal to kangaroos, but it is certainly a danger signal as regards human beings. Whether from gout or old age or something of the sort, the old male kangaroo occasionally becomes disagreeable, and the bark or cough, or what appears to be a bark or cough, is a warning to a human being—a warning which, if he is wise, he will heed—to keep away. The greatest danger comes from tame kangaroos, because they have no fear of man. I bred a very fine specimen of *Macropus Giganteus*, which later on became so dangerous, as we gathered from the continual barking, that I had to have him transferred to the Zoo. I have never known a female kangaroo to show any desire to attack, but on one occasion when some children were petting a baby kangaroo, just out of the pouch, the mother gave a soft growl, or what sounded like it.

Whilst writing, I may direct attention to the fact that I have not been able to obtain a good estimate of the refractive character or of the accommodation of the eyes of kangaroos or wallabies. In the case of some of the monotremes and the smaller marsupials the work has been done, and a note appears in the *Medical Journal of Australia* for Feb. 6, 1932, summarising the result.

Subject to an investigation of the kangaroos, which is very difficult owing to their size and the difficulty of handling them, the result is that the eyes of the animals referred to are imperfect as optical instruments, and there is no evidence that they accommodate at all. Throughout the mammals, until the primates are reached, accommodation is rudimentary or absent, and the ciliary muscle is variable or rudimentary in amount. This capricious development, or want of development, of accommodation in these creatures opens up the fundamental riddle from the point of view of evolution. Why these animals should have rudimentary accommodation and a variable ciliary muscle, which can be of no real service—especially in some cases owing to the gross error of refraction in their eyes—so far appears to be an insolvable puzzle.

Those who have read Prof. W. A. Osborne's recent article on accommodation in the animal kingdom and Prof. Wood Jones's Bancroft lecture, both published in the *Medical Journal of Australia*, 1931, will realise the extraordinary complexity of the problem which accommodation in animals presents. I hope it will be possible to investigate accommodation in kangaroos, but this involves the capture of the animal, the maintenance of his life, and the frequent use of anæsthetics.

JAMES W. BARRETT.

103-105 Collins Street,
Melbourne, C.1,
March 1.

[1] NATURE, Jan. 23, p. 131.

Types of Iridescent Clouds

THE remarkable clouds at high altitude which have been the subject of two interesting articles by Prof. Carl Størmer [1] and Prof. S. Chapman [2] in NATURE are referred to as iridescent or mother-of-pearl clouds. In order to prevent misunderstanding, I should like to point out that the high clouds in question should not be confused with the much more common 'iridescent clouds' which are described in most textbooks of meteorology.[3] The latter are cirro-stratus or cirro-cumulus clouds and are certainly well within the troposphere, at a height of approximately 10,000 metres, while the clouds described by Størmer are two or three times as high and are well within the stratosphere.

While the high clouds in the stratosphere can be confused with much lower clouds on account of the use of the adjective 'iridescent', they can also be confused with another type of cloud because of the use of the adjective 'high'. Occasionally, generally after violent volcanic eruptions, bright clouds can be seen long after sunset, showing that they are at a great altitude. Prof. O. Jesse has determined the height of these 'luminous night clouds' to be between 70 and 80 kilometres, and they are, therefore, much higher than the high iridescent clouds described by Størmer and Chapman, both of whom are careful to warn their readers against confusing the two types of high cloud.

There are then three types of clouds which have to be carefully distinguished: (1) iridescent clouds in the troposphere at 10 kilometres, (2) high iridescent clouds in the stratosphere at 20-30 kilometres, and (3) high luminous night clouds at 70-80 kilometres. The physical composition of these three types of clouds is an interesting problem. In order to explain the brilliant colours on the iridescent clouds of the troposphere, it is necessary to assume that in spite of the low temperature at which they occur (about $-40°$ C.), these clouds are composed of super-cooled water

drops, or at least of small spheres, and not of crystals.[4] The same reasoning would indicate that the iridescent clouds of the stratosphere are also composed of drops; but there is so little water vapour in the stratosphere that it is difficult to see how clouds of the density described by Størmer can be formed.

The high luminous night clouds are supposed to derive their water from the volcanic eruptions with which they appear to be associated—they were particularly bright from 1883 to 1889 after the Krakatoa eruption—but the close association of the iridescent stratosphere clouds with a particular type of weather appears to make this explanation unsuitable for them.

It is quite clear that there is still a great deal to learn about the physical state of the upper atmosphere.

G. C. SIMPSON.

Meteorological Office, London,
April 19.

[1] NATURE, Feb. 16, 1929, p. 260.
[2] NATURE, April 2, 1932, p. 497.
[3] See "Meteorologische Optik", by Pertner-Exner, second edition, p. 460.
[4] Simpson, *Quar. J. Roy. Met. Soc.*, **38**, 291; 1912.

IN NATURE of April 2, Prof. Chapman has an interesting article on the iridescent (mother-of-pearl) clouds observed by Prof. Størmer of Oslo. These clouds, which are unmistakable in appearance, are reported to have been at the great height of 26 to 30 km. I once discussed these clouds with the late Prof. Mohn, but there was then no suggestion that they floated so high. Their appearance at the altitude now recorded opens up some interesting problems.

The clouds are to be seen from time to time at sea: it was my custom to call them 'fish-scale colour clouds' and to associate them with bad weather.

The reports of luminous 'night clouds' have always puzzled me, and although I spent a great deal of time in the open air, I have never seen them, nor have I ever met any seaman who has. Is it possible, however, that there may be some connexion between this great altitude and luminosity?

DAVID WILSON-BARKER.

Royal United Service
Institution, S.W.1.

Hexuronic Acid as the Antiscorbutic Factor

WE have reported in a previous note,[1] that with a daily dosage of 1 mgm. hexuronic acid guinea-pigs were kept free from symptoms of scurvy for fifty-five days. This experiment was continued to the ninetieth day. During this time all animals receiving hexuronic acid showed normal growth. On the ninetieth day all animals were chloroformed, and on autopsy were found entirely free from scurvy. The animals receiving 1 c.c. of lemon juice showed mild scurvy. The experiment was completed with all the necessary controls.

Since the hexuronic acid used was prepared from animal sources (adrenal glands), no objection can arise that the observed antiscorbutic activity was due to a contamination by a more potent antiscorbutic substance. The daily dose of hexuronic acid employed was of the same magnitude as the hexuronic acid content of the protective dose of lemon juice (1·5 c.c.). It is generally accepted that animals surviving ninety days with no symptoms of scurvy on autopsy and showing normal growth could be kept indefinitely free from scurvy under identical conditions. This allows us to conclude that vitamin C is a single substance and identical with hexuronic acid.

Simultaneously with our previous note, C. G. King and W. A. Waugh [2] reported that they have obtained, from lemon juice, crystals which showed antiscorbutic activity and were apparently similar in chemical and physical properties to hexuronic acid. The duration of the test period was not stated, and apparently no chemical analysis was made. Until this is done, the nature of their product remains in doubt.

This research was sponsored by the Ella Sachs Plotz Foundation.

J. L. SVIRBELY.*
A. SZENT-GYÖRGYI.

Institute of Medical Chemistry,
University Szeged, Hungary, April 22.

* Holder of an American-Hungarian Exchange Fellowship, 1931–32, from the Institute of International Education, New York.

[1] NATURE, April 16, p. 576.
[2] *Science*, vol. 75, No. 1944, April 1, 1932.

EVER since Prof. A. Szent-Györgyi suggested the possible identity of hexuronic acid [1] with the 'reducing principle' present in all active antiscorbutic solutions, I have been experimenting at various periods in this connexion. These experiments led me to the conclusion that the likelihood of 'hexuronic acid' being identical with the antiscorbutic factor was small, but I much regret that owing to illness I am at the moment precluded from supplying from my experimental notes the relevant data which seem to me to justify this provisional conclusion. Moreover, in view of J. L. Svirbely and Prof. A. Szent-Györgyi's claims referred to in NATURE of April 16, my previous experimental work on the subject will have to be further amplified, and therefore I cannot now enter into a detailed discussion of the matter. It is my intention, however, to make in this note only one or two comments on Svirbely and Szent-Györgyi's results.

According to Svirbely and Szent-Györgyi, 1 milligram of hexuronic acid was found to offer a marked protection against scurvy in guinea-pigs, and they justly assert that the activity of this compound is most probably higher, but that, owing to its long exposure to air, a loss of the vitamin has occurred and consequently the minimum dose would be lower than 1 mgm. They further state that 1·5 c.c. of lemon juice, the minimum protective dose for guinea-pigs against scurvy, is equivalent to 0·5 mgm. of hexuronic acid, thus implying that the minimum dose of the antiscorbutic factor is about 0·5 mgm. of hexuronic acid. In this connexion it must be pointed out that such minimum doses have been obtained by other workers and myself with fractions from lemon juice which were evidently grossly contaminated. This fact militates rather against the contention that hexuronic acid and the antiscorbutic factor are identical. The interesting point that emerges, in my opinion, from Svirbely and Szent-Györgyi's data is that it is possible to prepare active fractions of the antiscorbutic factor from a definite animal tissue.

S. S. ZILVA.

Division of Nutrition,
Lister Institute, London.

[1] A. Szent-Györgyi, *Biochem. J.*, **22**, 1387; 1928.

Occurrence of 'Cleistogenes' in certain Grasses

BEDDOWS [1] has raised some interesting points regarding *Triodia decumbens*, particularly as regards the occurrence of 'cleistogenes' at the base of the fertile tillers in the cleistogamous form. Subsequent investigation of their structure has shown that these 'cleistogenes' may contain as many as three florets. Structures are present within their enveloping prophyll which possibly represent empty glumes; these, however, are by no means consistent either as to form or presence. The fertile florets, on the other hand, have well-developed flowering glume and palea. The three

minute bi-sporangiate anthers are intrastigmatic. 'Cleistogenes' may ripen as many as two healthy caryopses, which have been found germinating *in situ*.

It is interesting to note that these 'cleistogenes' are apparently somewhat similar to the 'axillary spikelets' described by Weatherwax [2] for *Danthonia sericea*. 'Cleistogenes' have also been found in herbarium material of *Danthonia calycina* and *D. breviaristata* very kindly supplied by Prof. Friedrich Vierhapper of Vienna.

I have found the rare open flowering or chasmogamous type of *T. decumbens* in Wales. This also produces 'cleistogenes'. Examination of the aerial inflorescences of this form shows a gradation between the characters usually associated with chasmogamy and those usually associated with cleistogamy. Weatherwax [2] describes a rather similar phenomenon in *Danthonia sericea*. ANNIE A. POULTER.

Agricultural Botany Department,
University College of Wales,
Aberystwyth, March 31.

[1] Beddows, A. R., "*Triodia decumbens*, Beauv. (*Sieglingia decumbens*, Bernh.)", *Ann. Bot.*, **15**; 1931.
[2] Weatherwax, P., "Cleistogamy in Two Species of *Danthonia*", *Bot. Gaz.*, **85**; 1928.

Bacterial Disintegration of the Wool Fibre

WITH reference to the note by R. Waters on the retting of wool,[1] workers in the field of wool research have long been acquainted with the bacterial disintegration of the wool fibre, as mentioned by him.

The phenomenon, as produced by micro-organisms, was described by Schimke in 1892, and, in 1898, Löbner associated such a condition with the activities of bacteria. So far back as 1866, however, Nathusius-Königsborn directed attention to the spindle-shaped nature of the individual cortical cells. In 1902, Kalmann published illustrations of wool fibres which he had retted by inoculating cloth with a pure culture of a spore-forming bacillus.

Confirmatory evidence has since been brought forward by MacInnes (1923), Hirst (1923), Trotman and Sutton (1924), Burgess (1924), Bartsch (1931), and others, most of whom have associated the retting process chiefly, but not exclusively, with members of the aerobic group of the Bacillaceæ (Bergey).

As Mr. Waters suggests, the process, or perhaps the enzyme-containing extract, may be used to facilitate the study of the cellular structure of wool. Moreover, provided the cells themselves are not attacked, such a study may *prima facie* help to elucidate the nature of the different constituents of the fibre.

R. BURGESS.

Microbiological Department,
Wool Industries Research Association,
Leeds, April 1, 1932.

[1] NATURE, March 26, p. 467.

Biological Effect of Associated Water Molecules

IN a recent book,[1] one of us (H. T. B.) has pointed out that water deprived of trihydrol would be quite useless to living organisms. This suggestion has been supported by experimental results,[2] which demonstrate that water rich in trihydrol obtained from melted ice will sustain filaments of the alga *Spirogyra* in a normal condition for several days, in contrast to filaments maintained under the same external conditions in water from the same source containing a lower proportion of polymerised molecules; in this dihydrol water the protoplasts soon shrink and the filaments become quite limp, due to loss of turgor.

Since the publication of the first report,[2] which described the macroscopical appearance of masses of *Spirogyra* in the solutions, cytological observations have been made, with the help of Prof. F. E. Lloyd, showing that the water from recently condensed steam, containing less of the active polymer trihydrol, causes the *Spirogyra* filaments to assume a colourless mass which occupies a more compact volume than the same number of filaments in trihydrol water, which maintains the rigidity and turgor of the cells, and in this way the trihydrol filaments occupy a greater volume in the solutions. The collapsed protoplasts in water poor in trihydrol resemble plasmolysis forms with the chloroplasts badly twisted. Similar experiments are now being performed on *Euglena* and *Amœba*.

HOWARD T. BARNES.
T. CUNLIFFE BARNES.

McGill University, Montreal.

[1] Barnes, Howard T., "Ice Engineering". Renouf. Pub. Co., Montreal, 1928.
[2] Barnes, T. Cunliffe, *Proc. U.S. Nat. Acad.*, **18**, 136; 1932.

Absolute Energies of the Lines in ß-Ray Spectra

I HAVE been engaged for some time in investigating the β-ray spectra of thorium-B and the thorium-C bodies, and my measurements suggest that the published values of the energies of the groups may not be so accurately known as is generally supposed. This is a point of considerable importance, since it is now realised that there is a close connexion between the frequencies of the γ-rays which are deduced from β-ray spectra and the energies of the different groups of α-particles emitted in the actual or neighbouring disintegrations. In investigating this connexion, it is necessary to compare the energies of γ-rays and α-particles, and since there is no direct method of comparison, it is essential to know the absolute energies of both.

The published values for the energies of the lines in the β-ray spectra of the thorium bodies are nearly all based on a determination of Black's, but this in its turn was based on some experiments I made on the radium-B spectrum nine years ago. So far as my present experiments go, I think it is possible that many of the published values of the energies of the lines in the thorium (B + C) spectrum may be a half per cent or more too high, and quite likely also the values in the radium (B + C) spectrum. I am publishing shortly an account of my measurements, when this point will be fully discussed.

The object of this letter is, first, to direct attention to the need for some other independent measurement of the absolute energies, and, secondly, to prevent the too drastic use of the existing values either in support or criticism of any theory until this matter has been definitely settled. C. D. ELLIS.

Cavendish Laboratory,
Cambridge, April 25.

Passage of Neutrons through Matter: a Correction

IN the note on the above subject published in NATURE of March 26, p. 469, the quantity k occurring in the formula for the loss of energy per centimetre path of a neutron due to electron collisions, is defined incorrectly as $2\pi Mv/h$ where M is the mass of the neutron. This mass M is not the mass of the neutron, but the reduced mass of the electron and neutron or, effectively, the mass m of the electron. With this alteration it is believed that the formula is correct.

The field used in the calculation was $\frac{e^2}{r}e^{-\lambda r}$; not $e^2.e^{-\lambda r}$ as there stated, which is of course dimensionally wrong. H. S. W. MASSEY.

Cavendish Laboratory,
Cambridge, April 22.

Research Items

Jewish Folklore in Palestine.—Miscellaneous notes on the folklore of the Jews in Palestine recorded by the late Mrs. H. Spoer (A. Goodrich-Freer) and published in *Folklore*, vol. 42, pt. 1, include references to beliefs connected with sin, disease, and the powers of evil. Many of the Jews of Jerusalem travel down to Jaffa at the coming of the New Year in order to be able to shake their skirts into the waters of the little stream of el-Auja, praying and confessing their sins. It is necessary that there should be fish in the water, in order that they may devour the sins as they are shaken out. A variant of former days, possibly owing to the fact that there was then no railway, was to plant palm-leaf baskets with beans, one for each adult in the family. On the eve of New Year, each would swing the basket over his head, saying, "This basket instead of me", and then drop it in the water, At the present time, the father of the family has to lay his hand on a white cock, confessing his own sins and those of his family, unless they are old enough to perform the ceremony for themselves. During the cholera scare of 1909–10, recently immigrated Russian Jews, who cared nothing for local tradition, averted the danger in their own way by assembling in their own burial-ground on the Mount of Olives and making merry for a day and a night, even celebrating a mock-marriage, to the consternation of the orthodox. In this they were following Russian custom. Russian peasants distract the attention of the spirits of evil by celebrating the marriage of deformed or orphaned persons over the grave of someone who has died of cholera, thus diverting the danger in a direction in which it can do no harm.

Society Islands' Canoes.—Dr. E. S. Craighill Handy, in the course of a study of houses, canoes, and fishing in the Society Islands (*Bull.* 90, Bernice P. Bishop Museum, Honolulu), distinguishes three types of craft which have been described indiscriminately as canoes —dug-outs, built-up canoes with round bottom, and composite vessels with sharp keel. All these types depended on the outrigger for stability unless they were double. The dug-out, made for fishing in or near the reefs, sometimes had one or more strips fastened to the upper margin of the hull, thus forming a gunwale, which, giving more freeboard, enabled the canoe-polers to stand on the sides as they propelled the craft. The old built-up canoe consisted of a hollow log, or, in the larger vessels, of several logs fastened together. To these were added side-boards and bow and stern pieces. Their depth seldom exceeded 3 ft. and their beam 21 inches. The after-part was generally one-third wider than the fore-part. The bow-piece had fastened to it a board projecting out for four or five feet parallel to the surface of the water. The modern sailing boats of the Leeward Islands are distinctly built-up boats ; but they differ from the old model in the shape of the hull, which has a round instead of a V-shaped bottom and perpendicular sides. Both types of craft were made into the great pontoon or double canoes, two being lashed about 4 ft. apart by spars and the interval bridged with poles to form a rough deck, sometimes surmounted by a thatched hut. The builders were a guild with rites and places of worship. Men and work were taboo while the canoe was being made ; and on its completion a man was sacrificed and eaten by the priest of the chief's temple.

Twins Reared Apart.—Another pair of identical twins reared apart has been studied by Prof. H. H. Newman (*J. Heredity*, vol. 23, No. 1). These girls, now twenty-nine years of age, were separated at five months, but both were brought up in the State of Ohio, less than 100 miles apart. Mary, however, has resided in a small town from the age of six years, while Mabel has lived on a farm and engaged in farm work. Mary attended high school, then acted as clerk in a store, and afterwards gave pianoforte lessons. This occupational difference has made Mabel 28 pounds heavier, 1½ in. taller, with greater muscular and bone development, although the extreme similarity in finger and sole patterns, eye and hair colour, and features prove them to be identical twins. Several series of psychological and intelligence tests show, however, striking differences in mentality and temperament. Mary ranks much higher in the intelligence tests, which throws some doubt on them as tests of innate ability. This pair of separated identical twins thus differ from each other physically, intellectually, and temperamentally. Of the four similar pairs previously studied, two differed intellectually but not temperamentally, while the other two were intellectually similar but very different temperamentally. In two cases there was also marked physical difference. Averaging these results and comparing them with 50 pairs of identical twins reared together, the difference in intelligence quotient (I.Q.) of separated identical twins is more than three times as great as that of those reared together. Another conclusion reached is that fraternal twins reared together are, on the average, one and a half times more similar in mental rating than are identical twins reared apart. Dr. Newman concludes, nevertheless, that heredity is probably more potent than environment in determining mental status. The study of further pairs of separated twins should throw further light on this problem.

Further Spread of the Land-Snail *Achatina fulica*.—This large East African snail, three inches long, promises to become a menace throughout the tropical and sub-tropical world, half of which it already infests. Y. H. C. Jarrett has prepared an account of its latest naturalisation, in Amoy, a centre from which it may well become a serious pest of Chinese agriculture (*Hong Kong Nat.*, vol. 2, p. 262, 1931). The snail was transported from East Africa to Mauritius nearly a century ago ; thirty years later it was carried thence to Calcutta, and in 1910 it had become common in northern Bengal. About 1900 it obtained a footing in Ceylon, and within little more than ten years had become a disgusting pest. From Ceylon or India to Malaya and to Singapore and so to China mark the stages of a progress which is certainly not at an end. The snail is voracious and prolific ; it lays about a hundred eggs in its first year, two to three hundred at the end of the second year, and close on a thousand in all. In 1928 it was introduced to Sarawak from Singapore as food for poultry, and by 1930 had become so great a pest that in 1931 a small reward was offered for its destruction—between Oct. 1 and Oct. 15, 1931, approximately half a million snails and twenty million eggs were destroyed. Hand-picking, dumping in the ocean, burying the animals in sacks deep in the ground have all been tried, without much effect, as methods of control. The last hope appears to be that the snail may find a favoured place in the dietary of the Chinese populace.

Spotted Wilt of Tomatoes.—One of the most striking results of the work on spotted wilt in tomatoes by Bald and Geoffrey (*Bull.* 54, Commonwealth of Australia Coun. Sci. Ind. Res., pp. 24, 1931) is the

varied host range of the virus causing the disease. *Nasturtium*, *Zinnia*, and Iceland poppy certainly show wide differences for a disease-producing agent which seems to direct its main activities against tomatoes. The tobacco thrip has been confirmed as an insect vector of the disease. *Frankliniella insularis* is shown to be another transmitting insect and to have an intimate relation to the virus. It is necessary that the larva feed on the diseased plant in order that the mature insect produced from it may be viriferous. The virus has been transmitted by mechanical methods, but an extract from a diseased plant loses its disease-producing capacity after standing a few hours. The extract is also rendered inactive by heating to 42° C. for ten minutes—a low temperature in comparison with other viruses.

Oil Origin and Accumulation.—Data of petroleum origin, migration, and accumulation for the oil-pools of the Nemaha granite ridge of Kansas and Oklahoma have been described by Mr. J. L. Rich (*Bull. Amer. Assoc. Pet. Geol.* for December 1931). These pools are mainly located at a widespread unconformity at the base of the Pennsylvanian shales, where these rest on the edges of Ordovician and Mississippian rocks. The evidence, coupled with that from an analysis of some later structures in the region, indicates that the hitherto assumed contemporaneity of the oil with those shales is suspect; in fact, it was clearly not generated until long after they were laid down, and its source cannot be sought in rocks in the immediate vicinity of the pools as they now occur. It appears possible that much of the oil was generated at a distant source from the present pools as a result of regional metamorphism, during the Appalachian revolution (Pennsylvanian-Permian), of older Palæozoic rocks; any types capable of yielding petroleum by the mechanism of geodynamic and geothermal 'cracking' of organic mother-substances through the normal agencies of metamorphism would serve. The conclusion that the oil has thus migrated from a great distance is inevitable, possibly from the metamorphosed area in south-east Oklahoma; and if the Appalachian revolution was responsible, then we may fix generation, migration, and accumulation at this epoch with reasonable certainty: a sharply contrasted theory with those previously held, and a decided hint in other cases where contemporary deposition of oil from indigenous organic matter subject to biochemical change—a common postulate—is invoked.

Forecasting of Indian Monsoon Rainfall.—In vol. 4, No. 37, of the *Scientific Notes of the India Meteorological Department*, S. R. Savur discusses the various formulæ used in seasonal forecasting in the India Meteorological Department since Sir Gilbert Walker placed the subject on its present mathematical basis in 1924. These formulæ connect future Indian rainfall with various meteorological data relating to different parts of the world that are available at the time that the forecast is made. A good deal of work has been done, especially by Fisher, since these formulæ were worked out, with the object of deciding with what degree of confidence multiple correlation coefficients of the kind used by Walker can be regarded as 'significant'. Use is made of this recent work in deciding which, if any, of Walker's factors are likely in the long run to be found insignificant, and which may therefore be discarded. The 1924 formulæ stand this critical examination on the whole very well, but certain factors have been found to be less important than was formerly supposed to be the case, and it is evidently the intention of the writer of this paper to try to find other factors that could replace those rejected. This, it appears, is likely to be a difficult task; until it has been accomplished, the accuracy of the forecasting will remain at its present level, seeing that a mere reduction in the number of factors used cannot bring about any improvement. Such is the economic importance of the monsoon rains that the moderate measure of success already attained cannot be dismissed as of no practical value.

Vibrations of a Lofty Building.—Mr. T. Fukutomi made some useful observations on April 25–May 25, 1931, on the vibrations of the Takeda Building in Tokyo (*Earthq. Res. Inst. Bull.*, vol. 9, 1931, pp. 485-507). This consists of an underground floor and nine other floors, and its total height is 99 ft. Tromometers of the same type were placed on the underground, fourth, and ninth floors, the intermediate one being removed to the sixth floor on May 16. As a rule, the building vibrated with a period of 0·4 sec., the amplitudes of the vibrations on the ninth, sixth, fourth, and underground floors being in the ratios 1·00 : 0·84 : 0·67 : 0·06. There is a diurnal period in the amplitude with its maximum epoch at 3 or 4 P.M., possibly due to the passage of tram-cars. During the month of observation, four sensible earthquakes were recorded, the mean maximum accelerations on the floors being as 1·00 : 0·42 : 0·26 : 0·24. On the underground floor, the direction of motion was nearly perpendicular to the line joining the origin and the building; on the ninth floor, it coincided very nearly with the direction of free vibration.

Ultra-sonic Waves in Liquid Columns.—Vol. 6 of the *Canadian Journal of Research* contains two papers from the National Research Laboratory, Ottawa, contributed by Drs. R. W. Boyle, G. S. Field, and D. K. Froman, on dispersion and selective absorption in the propagation of ultra-sonic waves in liquids contained in tubes. The liquids were water, naphtha, castor oil, transformer oil, and chloroform, the tubes of glass, celluloid and cellophane of various thicknesses, and the oscillations were produced by the action of a high frequency electric circuit on a quartz or tourmaline piezo-electric oscillator. The frequencies were from 20 to 100 kilocycles per second and were measured by means of a Hertzian wave meter, and the velocity of phase propagation along the column by the distances apart of the nodes, which are indicated by the small bubbles which collect there. The authors find that the velocity varies with the frequency in the same way as the velocity of light varies on the two sides of an absorption band, and that the absorption is due to the conversion of the energy of longitudinal into that of transverse oscillations, the frequency of which is determined by the diameter of the liquid column, and for thin tubes is independent of the material and thickness of the walls of the tube.

***e/m* from the Zeeman Effect.**—The accepted spectroscopic value for the ratio of the charge of an electron to its mass has been substantially confirmed in an investigation of the Zeeman effect of zinc λ6362 and cadmium λ6439 by J. S. Campbell and W. V. Houston (*Phys. Rev.*, Feb. 15). This is of special interest, since recent values for the ratio obtained from cathode rays agree with those found from optical experiments, and the present measurements are made by a method very different from the earlier in detail. The splitting of the lines was produced by the field in an air-core solenoid consuming about 50 kilowatts, and was determined with a Fabry-Perot interferometer, yielding the result that e/m is $1{\cdot}7579 \pm 0{\cdot}0025 \times 10^7$ e.m.u. per gram.

Rates of Solution of Gas in a Liquid.—The commonly accepted theory of the rate of solution of a gas in a

liquid, due to Noyes and Whitney, assumes that a stationary film exists on the surface of the liquid and instantaneous saturation of the upper layer of this by the gas. The rate of solution then depends on the rate of diffusion of dissolved gas. Miyamoto (*Bull. Chem. Soc. Japan*, Jan.) points out that the thickness of the stationary film resulting from this theory, 10^{-3}–10^{-2} cm., is improbable, and he has examined the result of an assumption that among the molecules of colliding gas only those with component velocities normal to the surface greater than a threshold value can enter, and a similar relation holds for molecules escaping from the liquid. No assumption of a stationary film is made, which seems the correct procedure in the case of well-stirred liquids. It is shown that the new theory leads to an equation of the same form as the old one and in addition explains the results of experiments on the rate of oxidation of sodium sulphite solutions, stannous hydroxide, and ferrous hydroxide, previously made by the author, in a more satisfactory manner. The maximum rates of oxidation in all these cases are identical under the same conditions, and are governed by the maximum rate of solution of oxygen in water. The value of the threshold velocity of the entering oxygen molecules is calculated as 3·4 times the root mean square value at 15°-35°.

Facsimile Radio Transmission.—Science advances with the ability to make measurements. During the last few years, mainly owing to the advent of short-wave transmissions with wave-lengths ranging between 14 metres and 50 metres, greatly improved methods of measurement have been introduced, and a new technique of echo and facsimile measurement has been developed. In 'facsimile' measurements, the object is to record at the receiving end a pulse emitted at the transmitting end. In practice, the message is placed on a drum and a spot of light from a rotating optical system is caused to scan the message. The reflected light from the picture is led to a photo-cell. The output of the photo-cell modulates the transmitter. A similar optical system revolving in synchronism at the receiving end records the signals. In a paper on radio transmission, read to the Institution of Electrical Engineers on March 23, T. L. Eckersley utilises some of the phenomena observed in facsimile transmission to obtain information about the Kennelly-Heaviside layer. Facsimile records usually show a series of one, two, three, or more separated marks corresponding to the arrival by different paths of a single transmitted impulse. The differences in the times of arrival can be measured with high accuracy. It is from these measured time differences that the author finds the ray angles, heights of the effective layers, and the maximum electronic density in the Kennelly-Heaviside layer. For high angle transmission, for example, those recorded between Writtle, near Chelmsford, and Somerton, in Somerset, the marks (echoes) are so regular that they can be definitely fitted into a multiple-reflection scheme. For shallow angle transmission the echo times are more irregular, and difficulty is experienced in fitting them into an optical scheme. Mr. Eckersley calls a ray which has been reflected n times from the K.H. layer the nth order ray. A study of facsimile transmissions from South Africa to Montreal shows that the high angle rays have greater attenuation than the lower ones. This suggests that at sufficient distances, only the lowest angle ray will survive, and perfect facsimile reproduction will result.

Astronomical Topics

New Comet.—Mr. Carrasco, of the Madrid Observatory, discovered a comet of the twelfth magnitude on April 22. Several observations have been obtained, from which Miss Vinter Hansen and Mr. Möller, both of the Copenhagen Observatory, have deduced the following elements :

T	1931 Dec. 14·594 U.T.	
ω	117° 25·07′	1932·0
Ω	17 43·53	
i	58 11·09	
log q	0·394164	

Thus the comet passed perihelion 4 months before discovery, and is now 3 units from the sun and 2 units from the earth. Dr. W. H. Steavenson obtained the following observation at Norwood :

May 1^d 0^h 33·0^m, R.A. 12^h 6^m 40·98^s, N. Dec. 22° 1′ 34·8″ (1932·0)

This is very close to the ephemeris from the above orbit, which is continued below (for 0^h) :

	R.A.	N. Decl.
May 5	12^h 3·0^m	20° 41′
9	11 59·9	19 21
13	11 57·3	18 1
17	11 55·2	16 42

Dr. Steavenson also obtained an observation of the comet Houghton-Ensor (so named because Mr. G. E. Ensor discovered it independently at Pretoria on April 2) :

April 30^d 0^h 17·2^m, R.A. 12^h 42^m 50·38^s, S. Decl 17° 18′ 43″ (1932·0).

Dr. Waterfield observed it at Headley on the same night, and considered that its magnitude was eighth or ninth ; it was a fairly large object, with some central condensation. It is keeping very close to the ephemeris of Cunningham and Whipple, which is as follows (for 0^h) :

	R.A.	Decl.
May 5	12^h 42^m 19^s	S. 8° 3′
9	12 42 30	S. 2 2
13	12 43 13	N. 2 51
17	12 44 25	N. 6 47

U.A.I. Circ. 370 reports another remarkable object discovered by Dr. Reinmuth at Königstuhl :

April 27^d 22^h 13·5^m U.T., R.A. 13^h 42^m 7·8^s, S. Decl. 10° 41′ 52″ (1932·0) ; mag. 12·5 ; Daily motion, −4^m 56^s, S. 4′ ; the retrograde motion in R.A. is greater than that of any of the known asteroids, so either it is a comet or an asteroid with a very abnormal orbit.

Astronomical Photographs at Harvard.—The immense value of the great collection of astronomical photographs taken at Harvard Observatory is known to all astronomers. On many occasions it has enabled the history of novæ or variables to be traced for years before their discovery. Early images of Eros were also found upon them. Science Service announces, in a bulletin dated March 23, that this valuable collection has now been placed in a new fireproof building at Harvard, where the plates are both safer and more easily accessible. It will be news to many that some plates of the collection go back to the year 1850, when the first photograph of a star ever taken was made at Harvard with the 15-inch equatorial. But it is only from the introduction of the dry plate in the early 'eighties that the series becomes continuous. The inauguration of the new building comes at an appropriate time, as Harvard is the appointed meeting place of the International Astronomical Union at the beginning of September.

Research in Rubber Manufacture

THE twelfth annual report of the Research Association of the British Rubber Manufacturers, presented at the annual meeting of the Association on Feb. 2, gives not only a succinct account of its varied activities but also a striking picture of the extent to which scientific research is serving the intellectual, technical, and material development of the rubber industry. Since the commencement of its career, the Association has contributed more than sixty papers to the scientific and technical Press, while nearly 25 per cent of the published matter in the *Transactions* of the Institution of the Rubber Industry from manufacturing sources originates from the Croydon laboratories. Apart from this, many confidential reports and circulars have been issued to members, and the scientific investigations carried out range from plasticity measurements on raw rubber, the comparison of Para, smoked sheet, and crepe, the properties of synthetic rubber or compounding ingredients such as litharge, accelerators and antioxidants, on the properties and testing of vulcanised rubber, to the numerous applications of vulcanised and hard rubber in tyres, cables and insulation materials, footwear, flooring, and proofings.

Joint investigations on cable insulation rubber have been carried out with the Admiralty, and on hard rubber and on a series of butadiene polymerisation products made by the I.G. Farbenindustrie A.-G. intended for use as insulation materials, with the British Electrical and Allied Industries Research Association. Testing apparatus has been devised which has simplified works' laboratory technique; and the cumulative value of the Association to the public, apart from the industry, is illustrated by the increased mileage of motor tyres, which as a result of research has increased from 2000 miles service in 1900 to 12,000, with an estimated car-mile saving of at least 4*d*., or an approximate saving to the public of £100,000,000 on tyres of 1900 quality. An increase of 1-2 per cent in the life of boots, shoes, hot-water-bottles, etc., due to the use of antioxidants would represent a saving to the public far greater than the amount payable to the Research Association under the levy scheme.

In view of these results, it is somewhat disappointing to find that finance is still causing the Association a good deal of anxiety. In part this is due to the increased responsibilities thrown on the Association by the advance of scientific knowledge, and to the growing use of its services by members and subscribers, but the adverse and uncertain general economic conditions of trade have been a further factor. In addition, the reduction of the grant from the Department of Scientific and Industrial Research from £2500 to £2000 for 1932 as a measure of national economy has placed on the industry itself the onus of finding resources for any expansion in the scientific services provided by the Association. It is accordingly the more unfortunate that, although passing its second reading, the Rubber Industry Bill made no further progress, owing to the congestion of Parliamentary business, and the expansion which the institution of the levy would make possible is still deferred.

Apart from its strictly scientific work, the Association participated in the successful negotiations between a committee representative of chemical interests generally and the British Engineering Standards Association which resulted in the formation of the British Standards Institution, covering the whole industrial field. The negotiations issued in a scheme providing for an organisation divided into four main divisions dealing with building, engineering, chemical, and textile interests, the proposals thus representing the fulfilment of one of the recommendations of the Imperial Conference dealing with co-ordination of standardisation within the Empire. On the Chemical Division Council the interests of the rubber industry are represented by the India-Rubber Manufacturers' Association, but the matter of standardisation is one of prime importance to the Research Association and, during the year, preliminary consideration has been given to the internal organisation of the rubber industry for the formulation of specifications for manufactured rubber goods, and the Association has co-operated during 1931 in the preparation or revision of British standard specifications for moulded insulating material for general electrical purposes, rubber tubing for use with petrol, benzol, and paraffin ; oil-resisting rubber tubing, rubber-jointing material, benzol and rubber belting.

Since there are no rubber organisations in the Dominions in any way analogous to the Research Association, apart from those in Ceylon and Malaya, the question of Imperial co-ordination in research scarcely arises in the rubber industry, but visits from representatives of the National Research Council of Canada and the Australian Council for Scientific and Industrial Research already afford a basis for some effective liaison when the systematic study of the problems of rubber manufacture is taken up in the Dominion or the Commonwealth. Close relations have been maintained between the Research Association and the Rubber Institute of Malaya, and a number of technical questions, such as the suitability of air-dried sheet for manufacturing purposes, the concentration and extraction of latex serum in bulk, latex emulsification problems, have been discussed between the two organisations. In addition, although with the imposition of a small cess upon rubber exports for the maintenance of the Ceylon rubber scheme, financial responsibility passed from London to Ceylon, by joint arrangement between the organisations in Ceylon and Malaya a scheme has been evolved for transfer of control to a Joint Advisory Council, thus securing continuance of the scientific investigations of the properties of the raw material and close co-operation between the producer and the manufacturer.

Co-operation with the Rubber Growers' Association has also been established, not only in publicity work on behalf of the industry, but also in the investigation of difficulties holding up the utilisation of rubber for various purposes, and the study of promising potential applications. Among such problems may be mentioned the utilisation of latex–oil emulsions as lubricants, the acoustic properties of rubber flooring for cinemas, the increasing of the resistance of rubber to oils, while such questions as the destruction of rubber by white ants, rubber goods for tropical railways, resistance of coloured rubber paving to light and weather, have been the subject of joint discussion. Co-operation in the study of problems confronting the utilisation of rubber has, however, by no means been confined to the Rubber Growers' Association. Investigations on ebonite have been carried on jointly with the British Electrical and Allied Industries Research Association, in which the Ceylon rubber research scheme and representatives of Government departments have participated. The War Office, India Office, Air Ministry, and Post Office are all represented on the Association's Tyre Research Committee, and co-operation with the motor industry and the British

Boot and Shoe and Allied Trades Research Association on problems relating to the manufacture and utilisation of rubber will undoubtedly develop.

An important feature of the work of the Association is its library and information bureau, which serve the growing needs of all connected with the industry for a source of information and advice over a wide range of subjects. Without the regular issue of the monthly summary of current literature it would be difficult for the industry to keep itself abreast of all the latest developments; and when to this invaluable intelligence service there is added the issue of periodical circulars summarising the available knowledge on many scientific, technical, and economic subjects and the satisfying of an ever-growing number of inquiries (amounting to 690 in 1931 alone) covering all phases of the rubber industry, it can safely be asserted that the Research Association is rendering to the British industry services that are unsurpassed by the similar associations in Germany and Holland. In addition, a centralised organisation is able to carry out work of this kind much more thoroughly and efficiently than any one firm alone could hope to do, and avoids all the overlapping and duplication of effort which would occur if individual firms maintained their own organisations.

Already the number of cards in the index maintained by the Association amounts to well over 125,000, and the subject cards alone are increasing by about 14,000 a year. These statistics, however, give little idea of the magnitude of the work involved in cross indexing, and in the course of the work the library and information bureau has evolved its own system of classifying scientific, technical, and commercial information on rubber, based on a generalised decimal notation, although the International Brussels system was rejected on account of serious difficulties it offers in use for rubber information. The value of the work of this section of the Association is further attested by the recognition of the library in 1930 by the Carnegie Trust as an outlier of the National Central Library. The generous grant made in accordance with that recognition has made it possible to expand considerably the library collection, and thus to improve further the utility of what is already a fully representative collection of all modern publications and particularly in regard to trade literature.

The above brief outline of the activities of the Association taken from the annual report gives some indication of the many services which the Research Association is rendering to the rubber industry, and illustrates the way in which that research reacts to the direct benefit of the public, as well as the tendency towards co-operative research between different branches of industry. One of the most surprising things in the report is the smallness of the staff with which this extensive and important work is being carried out. When we consider that as yet relatively little is known regarding the nature of rubber or the changes which occur during vulcanisation, apart altogether from the many problems presented by the utilisation of rubber, it is clear that the expansion in the work of the Association, and particularly the extension of systematic fundamental research which is anticipated as a result of the Rubber Industry Bill passing into law, should be of the utmost value and importance to the industry. Its practice cannot but be imperfect when the mechanism of the essential process is incompletely understood. The future of the rubber industry depends upon the wise, continuous, and adequate prosecution and application of scientific research, and the praiseworthy work already carried out by the Research Association indicates the possibilities when the industry as a whole devotes to the support of co-operative research the energy and financial support which it imperatively demands.

Uses of Empire Timbers*

UNDER the auspices of the Forest Products Research Board of the Department of Scientific and Industrial Research, inquiries are being carried out into the possible uses of Empire timbers. The results of the first year's investigations are given in the annual Report of the Board before us. Under the auspices of the Empire Timber Committee the work was started late in 1929, further facilities for the contemplated research becoming available by the end of last year.

Tests have been undertaken with East African camphor wood from Kenya for cabinet making; walnut and sapeli woods from Nigeria, both for cabinet making; and *Meranti tombaga* and Keruing timbers from the Federated Malay States, which might displace some of the Philippine timbers on the London market, provided they can be imported at competitive prices. New Zealand silver beech is to be tested for furniture wood at High Wycombe and in the making of rifle stocks at the Small Arms Factory at Enfield. Another subject reported upon is the investigations into the creosoting of British Columbian Douglas fir, since this timber might prove a considerable asset for railway sleepers. So far, Douglas fir timber has proved less easy to creosote than Baltic fir. By adopting the Canadian and American method of what is known as 'incising' over the sleepers, it was found possible to inject as much creosote into them as the Baltic species will absorb.

The writers of the report comment upon the increased interest of the public in Empire timbers, for use in both Government and private buildings. But the opinion is stressed that the joint work of the Department and the Empire Marketing Board is not by itself sufficient to cover the necessities of achieving a general development and national use of Empire timbers. Unless production and marketing are closely co-ordinated with research, the work of the Board will be impaired. Apart from measures to be taken by the timber trade, it is stated that there is a lack of adequate official machinery for dealing with difficulties in the producing areas; more especially in certain of the tropical regions.

The difficulties, it is urged, could be largely overcome by comprehensive botanical and economic surveys of our forest resources, involving some enlargement of the facilities at the disposal of the Imperial Forestry Institute and the forest services, and by closer liaison and personal touch with the interests concerned in the country of origin. The suggestion of the enlargement of the facilities at the disposal of the forest services is timely at a moment when most of these services are being cut down owing to financial stringency.

The efforts of the departments responsible for the admirable work described in the report here dealt with require the careful consideration of the authorities responsible for forest administration in the various Colonies.

* Department of Scientific and Industrial Research. Report of the Forest Products Research Board; with the Report of the Director of Forest Products Research for the Year 1930. Pp. vii+52+10 plates. (London: H.M. Stationery Office, 1932.) 4s. net.

University and Educational Intelligence

CAMBRIDGE.—It is proposed to confer the degree of Sc.D. *honoris causa* upon Sir William Bragg, director of the Royal Institution of Great Britain.

A lecture on the Liversidge Foundation will be delivered by Prof. A. V. Hill, Foulerton Research Professor of the Royal Society, on Friday, May 13, at 5 P.M., on "Chemical Wave Transmission in Nerve".

EDINBURGH.—Sir Thomas Hudson Beare, professor of engineering, has been granted leave of absence, having been appointed leader of the official delegation from Great Britain to the Congress of the International Association for Bridge and Structural Engineering, to be held in Paris on May 19–25.

The Scottish Universities' Committee of the Privy Council has approved of a scheme for the affiliation to the University of the Heriot-Watt College. An ordinance is to be prepared in conformity with the provisions of the Universities (Scotland) Act, 1889, giving effect to the scheme.

Dr. George W. M'Crea, assistant in the Department of Chemistry, is exchanging for one year from Oct. 1, 1932, with Prof. Warren C. Vosburgh, of Duke University, Durham, North Carolina, U.S.A.

MANCHESTER.—Applications are invited for the Grisedale biological scholarship (botany or zoology, preferably the latter), value £200. The scholarship is offered to graduates who have already had some training in research. The latest date for the receipt of applications is June 1. They should be sent to the Registrar of the University.

THE London County Council is again offering two Robert Blair fellowships in applied science and technology, each of the value of £450 and each tenable for a year. The scholarships are for advanced study, and will be tenable in the dominions, the U.S.A., or abroad. Particulars and application forms are obtainable from the Education Officer (T.3), County Hall, S.E.1. Completed forms must be returned by June 1.

THE twenty-third Conference of the Association of Teachers in Technical Institutions is to be held at Cardiff on May 14–17. The first public meeting will be on Whit Monday, when the Conference will be officially welcomed by the Lord Mayor of Cardiff, and the retiring president, Mr. H. Ade Clark, will induct the president for 1932–33, Mr. S. H. Moorfield, Wigan and District Mining and Technical College. Among the topics to be discussed by the Conference are the relation of education and industry, junior instruction centres, junior technical schools, and recruitment for industry. An exhibition of books and apparatus will be held in the Technical College during the Conference.

Calendar of Geographical Exploration

May 8, 1922.—The Alps of Chinese Tibet

Prof. J. W. Gregory, accompanied by C. J. Gregory, left Bhamo on the Upper Irrawaddy and went to Tengueh, covering 145 miles in 8 days. Thence they crossed the Salween and went to Yungchang, afterwards exploring a region completely unknown from the geological point of view, and very little known geographically. They reached the valley of the Yangtse Kiang after ascending the Loma Ho and discovering a series of hot springs. In 1893, Prof. Gregory examined the East African Rift valley northward from Lake Naivasha to Lake Baringo; he is now on an expedition in the Andes.

May 9, 1926.—To the Poles by Aeroplane

Commander R. E. Byrd, with F. Bennett, made the pioneer aeroplane flight to the north pole and back, from Spitsbergen. In 1928–29, from a base near the Bay of Whales, Byrd examined Marie Byrd Land, and also flew to the south pole and back.

May 10, 1553.—Willoughby and Chancellor

Sir Hugh Willoughby, in the *Bona Esperanza*, accompanied by two other vessels, left Ratcliffe on a voyage which was intended to open a northern route to India. The equipment of the vessels was carried out under the direction of Sebastian Cabot, then an old man. On July 14 they landed on the Norwegian coast, in that region from which Othere had begun his voyage to the White Sea in the time of Alfred the Great. Two of the vessels reached the coast of Russian Lapland and found a good harbour at the mouth of the Arzina River, probably the modern Varzina, but during the winter Willoughby and all his men died, probably of scurvy. Russian fishermen found the two vessels and the corpses in the following year. Willoughby's will showed that he was alive in January 1554. The third vessel, the *Edward Bonaventura*, commanded by Chancellor, was separated from its two companions by a storm in August 1553, and reached the mouth of the Northern Dwina in the White Sea, where a small monastery existed and where the port of Archangel later developed as a result of Chancellor's voyage. Chancellor and his companions were invited to Moscow, and the route from England to Russia via Archangel was established shortly afterwards. The expedition thus had very different results from those expected by its promoters. Chancellor was wrecked near Aberdeen in November 1556, when conveying a Russian embassy and a cargo of goods from the Dwina River. He and his wife and seven Russians were drowned.

May 12, 1539.—Discovery of the Mississippi

Hernando de Soto started from Havana, and landed in Espiritu Santo Bay, on the west coast of the present State of Florida, in search of the gold reported by Gabez de Vaca. He probably passed into Georgia as far as 35° N., then south to the region where Mobile now stands, and finally north-west to the Mississippi, which he reached in 1541. He wintered on the Ouachita, in what is now Arkansas and Louisiana, west of the Mississippi. On the return journey along the Mississippi, de Soto died in 1542, but his men, under Luis Moscoso de Alvarado, descended the river to the sea from a point near its junction with the Arkansas, the voyage occupying 19 days. Thence they coasted along the Gulf of Mexico to Panuco. This important journey was the first extensive exploration of the southern United States; it resulted in the discovery of the Mississippi, and gave to the world the first account of the social customs of the Indians of the southern States.

May 12, 1721.—Greenland

A Norwegian missionary, Hans Egede, with his wife and family, sailed from Denmark, and landed on the west coast of Greenland near Godthaab. He lived there until 1736, and collected much information about the south-western districts and the Eskimo tribes. Greenland had been known to the Norse, Eric the Red having sailed there in 982 and spent three years in its south-western regions. The Norse colonies there flourished at first but died out in the fifteenth century, J. Davis finding no trace of them in 1585. Egede's settlement led to renewed exploration and colonisation of the interior.

Societies and Academies

LONDON

Royal Meteorological Society, April 20.—**J. N. L. Baker**: The climate of England in the seventeenth century. Descriptive writings provide evidence of a somewhat inconclusive character, and this can be supplemented by the reports of the Venetian Ambassadors, published in the Calendars of Domestic State Papers (Venetian) and elsewhere. The Calendars of Domestic State Papers furnish many scattered references, both to short periods and to long spells of weather, and from these a continuous account can sometimes be constructed. They also include important tables of winds covering the periods 1667–72 and 1675–78. The MS. diaries preserved in the Bodleian Library are also of value. That of Dr. Napier covers the period 1598–1635 but is very fragmentary: that of Elias Ashmole only extends from 1677 to 1685 but is unusually full. Most of this evidence has not previously been used, and an attempt has been made to correlate it with the accepted rainfall figures of Townley and Derham and other records, such as the diaries of Evelyn and Pepys. In a number of cases the older evidence is unreliable; at the same time, all the evidence is of an unscientific nature, and strict comparison with reliable evidence of modern times is apt to lead to erroneous conclusions.—**C. W. G. Daking**: The meteorology of Kamaran Island (Red Sea). The upper winds of this region would have played a big part in the journeys of the air-ship *R 101* to India and back, and it was probably because this information would have been so valuable that observations were commenced at Kamaran Island. In most respects, the climate experienced is typically tropical, but it is noteworthy that, for so small an island, the conditions are as trying as those experienced inland on the continents of Africa and Asia.—**David Brunt**: Notes on radiation in the atmosphere (1). The absorption spectra of water vapour and liquid water are applied to consider the justification for regarding cloud sheets and fog as black body radiators. Long wave radiation from the atmosphere fits very closely a formula only involving the absolute temperature and the vapour pressure. The fall of temperature after sunset on clear nights is closely proportional to the square root of the time from sunset. The tendency to instability is greatest for clouds of medium height.

Geological Society, March 9.—**W. G. Tidmarsh**: The Permian lavas of Devon. With the exception of certain members in the south of the area, these are intermediate rocks, ranging from types resembling basalts to normal and olivine minettes. Details of various lavas and analyses of fourteen rocks and three minerals are presented.—**B. Jones**: The geology of the Fairbourne-Llwyngwril district, Merioneth. The area is occupied by a westward extension of the Upper Cambrian and of the Ordovician rocks of the Arthog-Dolgelley and Cader Idris districts, and the sequence is, in general, similar to that in those districts, with, however, certain noteworthy differences. An unexpected discovery was that of a wide expanse of Bala beds extending along the Dysynni valley and north of the Talyllyn (Bala) fault.

PARIS

Academy of Sciences, March 21.—**H. Deslandres**: Simple relations between the molecular spectrum and the structure of the molecule. From a study of the infra-red spectra of binary molecules the author has deduced the formula $\nu = 1062 \cdot 5\ q'/r's'$, where ν is the frequency, s' the number of external electrons excited in one of the atoms, q' and r' being integers. The possible meaning of this formula is discussed and some further applications given.—**M. de Broglie, F. Dupré la Tour, L. Leprince-Ringuet, and J. Thibaud**: The effects of ionisation observed in the presence of the beryllium rays under the excitation of the α-rays from a bulb containing radium emanation.—**C. Matignon, Kling, and Florentin**: The transformation of saturated acyclic hydrocarbons into ethylenic hydrocarbons. Details of the products obtained by the action of catalysts upon ethane, propane, and butane at temperatures ranging from 500° to 650° C. The catalysts used were copper and nickel, both on pumice.—**André Blondel**: The cyclic impedances of an earthed polyphase cable.—**C. Camichel, L. Escande, and G. Sabathe**: The similitude of vortices.—**Émile Guyénot, Mlles. K. Ponse and J. Wietrzykowska**: The luteinisation of the ovary and masculinisation in the guinea-pig.—**Jean J. Placinteanu**: The deduction of Maxwell's equations with the aid of Eddington's wave tensor.—**C. E. Winn**: The oscillation of the means of Hölder and of Cesàro.—**Georges Bouligand**: Some points of the theory of ensembles.—**Louis de Broglie**: The densities of mean values in Dirac's theory.—**Nicolas Kryloff and Nicolas Bogoliuboff**: The phenomenon of the establishment of the silent zone (*entraînement*) in radio technique.—**J. F. Cellerier**: The phonic test for the measurement of the mechanical intensities of sounds.—**François Boissier**: A new iodine accumulator. This battery is based on the reversible reaction $ZnI_2 = Zn + 2I$. Its e.m.f. is 1·2 volts and efficiency about 80 per cent.—**Pierre Jolibois and Georges Fouretier**: The photographic registration of pH during reactions in solution. The apparatus described in a previous note for recording the electrical conductivity of an electrolyte as a function of the quantity of reagent added has been modified to give a record of the pH of a solution. A reproduction of the curve obtained by the neutralisation of orthophosphoric acid by soda is given.—**H. Colin and Mlle. A. Chaudun**: The action of neutral salts on the inversion of sugar by acids.—**René Dubrisay**: A phenomenon of capillary chemistry. A solution containing a mixture of sodium laurate and oleate is made to foam by passing a current of air or nitrogen. Analysis of the froth and residual liquid confirmed the theoretical view that the ratio oleic acid to lauric acid was higher in the froth than in the residual solution.—**Ed. Chauvenet and J. Tonnet**: The anhydrous combinations of thoryl chloride with the alkaline chlorides.—**L. Bert and E. Andor**: The bromination of $C_6H_5 \cdot O \cdot CH_2 \cdot CH : CHCl$.—**R. Cornubert and P. Robinet**: The phenomena of isomerism in the tetrahydropyrones.—**M. Grunfeld**: The relation between the ultra-violet absorption spectra and the reaction velocities for certain classes of amines.—**Marius Badoche**: Researches on the coloured hydrocarbons: a blue hydrocarbon.—**L. Royer**: The orientation of crystals of the epsomite series by mica.—**Mlle. Lucienne George**: The origin of the Gnetaleæ.—**D. Montet**: The effect of radioactivity on the germination of bulbs.—**H. Hérissey and J. Laforest**: A heteroside extracted from the Portuguese laurel, *Cerasus lusitanica*.—**Philippe Fabre**: The utilisation of electromotive forces of induction for the registration of the variations of velocity of conducting liquids: a new hæmodromograph without a paddle in the blood. The apparatus is based on the e.m.f. due to induction developed in any moving conductor in rapid motion in an intense magnetic field.—**H. Simonnet and G. Tanret**: Some physiological properties of neriine and other proximate principles of the oleander. The glucosides of the oleander are cardiac glucosides.—**A. Machebœuf and G. Sandor**: Study of the extraction of the lipides of blood serum by ether in presence of

alcohol. The ratio of ether to alcohol for maximum extraction must fall between narrow limits: the time of contact is also important.—**Jean Roche**: The action of oxygenation on certain physico-chemical properties of the hæmocyanine of the snail.—**C. Mathis** and **C. Durieux**: The identity, at Dakar, of *Spirochæta Duttoni* var. *crocidurœ* and the spirochæte naturally infecting *Ornithodorus erraticus*.

VIENNA

Academy of Sciences, Jan. 14.—**Leopold Schmid** and **Walther Rumpel**: Constitution of the colouring matter in toad-flax flowers (*Linaria vulgaris*). It was found earlier that this colouring matter contains a molecule $C_{17}H_{14}O_6$ united to form a glucoside with one molecule of a hexose and one of a methylpentose. It is now shown that the coloured constituent is the 4 : 6-dimethyl ether of scutellarein. The flowers contain also entricontane and mannitol.—**Julius Donau**: A new micro-gravimetric analytical process. A combined precipitating and filtering dish with a platinum-foil cover and with platinum black as filtering layer, is described. Dissolution, precipitation, washing, and drying are carried out in the same vessel and losses of precipitate thus entirely avoided. Accurate results have been obtained in the determination of chlorine, iron, sulphate, and potassium chloride.—**Robert Janoschek**: Geology of the Brennberg Hills.—**Karl Linsbauer**: Nuclei, nucleoli, and movements of the plasma in the vesicular cells of *Mesembryanthemum cristallinum*.—**Gustav Jantsch** and **Ernst Wiesenberger**: Higher valency compounds of the rare earths. (1) Lanthanum oxide.—**Martin Gusinde** and **Viktor Lebzelter**: Somatology of the Indians of Tierra del Fuego. Sixty years ago the three different aboriginal races of Tierra del Fuego numbered together about 12,000 members, but it is estimated that less than 300 of pure descent now remain. The region peopled by each of these races is sharply defined and little mixing occurs. Their modes of life vary, the Yamana and Halakwalup being water-nomads and the Selk'nam hunter-nomads. The results of anthropological measurements of a number of individuals of each tribe are given.—**Otto Sickenberg**: A new antelope, *Parurmiatherium rugosifrons*, nov. gen. nov. spec., from the Lower Pliocene of Samos.

Jan. 21.—Contributions to the knowledge of the climate of towns: (1) **Hanns Tollner**: Distribution of temperature in Vienna in the summer of 1931.—(2) **Friedrich Lauscher** and **Ferdinand Steinhauser**: Radiation in Vienna and its neighbourhood.—**Fritz Wessely** and **Editha Nadler**: Substances contained in the root of *Pimpinella saxifraga* (2). In addition to pimpinellin and isopimpinellin, previously described, this root contains also a third compound of the same class, namely, isobergaptene, to the molecule of which a three-ringed structure is ascribed.—**Fritz Wessely** and **Ferdinand Kallab**: A re-arrangement in the flavone series.—**Leopold Schmid** and **Anton Seebald**: The colouring matter of the yellow dahlia. This colouring matter comprises, besides apigenin, also a deep yellow compound, $C_{15}H_{10}O_5$, which melts at 324° and contains three hydroxyl groups and a *p*-hydroxybenzoic acid residue in its molecule.—**Karl Morsch**: Action of ammonia and amines on esters of unsaturated acids. (1) Action of ammonia, methylamine, and diethylamine on ethyl crotonate.—**Franz Fuhrmann**: Biochemistry of the luminous bacteria. (1) Influence of sodium and potassium chlorides and bromides.—**Karl Strubecker**: Rhombic nets of straight lines and circles.—**Alfred Tarski**: Concept of truth in the language of the deductive sciences.

Forthcoming Events

FRIDAY, MAY 6

IRON AND STEEL INSTITUTE (at Institution of Civil Engineers), at 10 A.M.—Annual Meeting.

ROYAL SOCIETY OF MEDICINE (Otology Section) (Annual General Meeting), at 10.30 A.M.—Discussion on Labyrinthitis.

CAMBRIDGE UNIVERSITY (in Senate House), at noon.—Prof. A. Einstein: Die Theorie der Elektrizität im Rahmen der allgemeinen Relativitäts-theorie (Rouse Ball Lecture).

INSTITUTION OF MECHANICAL ENGINEERS (London Spring Meeting), at 2.30.—A. Binns: Recent Developments in the Mechanical Equipment of the Port of London Authority.—At 7.30.—J. H. Boyd: The Building of a Modern Motor-car Manufacturing Plant.

ROYAL SOCIETY OF ARTS (Indian Meeting), at 4.30.—Miss B. M. le P. Power: Indian Labour Conditions.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 5.—Annual General Meeting.

PHYSICAL SOCIETY (in Physiological Laboratory, University College), at 5.—Prof. A. V. Hill: The Measurement and Analysis of the Heat Production of Nerve (Lecture).

UNIVERSITY COLLEGE, at 5.30.—Sir Bernard Pares: Russia and the West (Lecture).

GOLDSMITHS' COLLEGE (New Cross), at 5.45.—Prof. J. F. Unstead: Recent Developments of the Regional Method—as applied to Teaching.

ROYAL INSTITUTION OF GREAT BRITAIN, at 8.30.—Conversazione.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—Annual General Meeting.

CAMBRIDGE UNIVERSITY (in Anatomy Lecture Room, New Museum).—Prof. J. J. R. Macleod: Linacre Lecture.

SATURDAY, MAY 7

GOLDSMITHS' COLLEGE (New Cross), at 3.30.—Prof. H. J. Fleure: Social and National Ideals in their Geographical Settings—A Study of Some European Problems.

MONDAY, MAY 9

UNIVERSITY COLLEGE, at 2.—Dr. W. W. Greg: The Descent of Manuscripts (Lecture).

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

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 6.15.—Annual General Meeting.

BRITISH ASSOCIATION OF CHEMISTS (Notts and Derby Section) (Annual Meeting) (at King's Café, Derby), at 7.15.—A. W. Knapp and others: Discussion on the Organisation of the Profession.

MEDICAL SOCIETY OF LONDON (Annual General Meeting) (at 11 Chandos Street, W.1), at 8.—At 8.30.—Sir James Berry: Fallen Idols (Annual Oration).

TUESDAY, MAY 10

ROYAL HORTICULTURAL SOCIETY (Greycoat Street, S.W.1), at 3.30.—Sir Frederick Keeble: Garden Fertility (Masters Memorial Lectures) (1).

ROYAL SOCIETY OF MEDICINE (Therapeutics and Pharmacology Section) (Annual General Meeting), at 5.—Discussion on Some Problems concerning the Prevention and Treatment of Acute Rheumatic Infection.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Annual General Meeting.

BRITISH ASSOCIATION OF CHEMISTS (Birmingham Section) (at Chamber of Commerce, Birmingham), at 7.30.—Annual Meeting.

(NEW) INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS (British Branch) (at Institution of Mechanical Engineers), at 7.30.—Dr. W. Rosenhain: The Work and Objects of the Association.

ROYAL SOCIETY OF MEDICINE (Psychiatry Section), at 8.30.—Annual General Meeting.

ROYAL INSTITUTE OF PUBLIC HEALTH (at Belfast) (*continued on May* 11 *to* 15).

WEDNESDAY, MAY 11

ROYAL HORTICULTURAL SOCIETY (Greycoat Street, S.W.1), at 3.30.—Sir Frederick Keeble: Garden Fertility: its Origin and Maintenance (Masters Memorial Lectures) (2).

ROYAL SOCIETY OF MEDICINE (Surgery: Sub-Section of Proctology), at 5.—Annual General Meeting.

NATIONAL INSTITUTE OF INDUSTRIAL PSYCHOLOGY (at London School of Economics), at 5.30.—Dr. C. S. Myers: Psychological and Social Factors in Business Rationalisation (2): The Dangers of Rationalisation.

SCHOOL OF ORIENTAL STUDIES, at 5.30.—Dr. Pran Nath: Indus Inscriptions.

INSTITUTION OF ELECTRICAL ENGINEERS (Tees-Side Sub-Centre) (Annual General Meeting) (at Cleveland Technical Institute, Middlesbrough), at 7.—E. H. E. Woodward and W. A. Carne: An Analysis of the Costs of Electricity Supply and its Application in Relation to Various Types of Consumers.

INSTITUTE OF METALS (at Institution of Mechanical Engineers), at 8.—Prof. F. Körber: The Plastic Deformation of Metals (Annual May Lecture).

THURSDAY, MAY 12

UNIVERSITY COLLEGE, at 5.30.—Prof. W. R. Hess: The Autonomic Nervous System (1). (*Succeeding Lecture on May* 13.)

IRON AND STEEL INSTITUTE (Additional Meeting) (jointly with Staffordshire Iron and Steel Institute) (at Chamber of Commerce, Birmingham), at 6.30.—Presentation of Papers.

OIL AND COLOUR CHEMISTS' ASSOCIATION (London Section) (Annual General Meeting) (at 30 Russell Square, W.C.1), at 7.30.—S. K. Thornley: Development of Government Intervention and its Effect on our Industry.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—Annual General Meeting, followed by Ordinary Meeting.

FRIDAY, MAY 13

ROYAL ANTHROPOLOGICAL INSTITUTE (Sociological Research Committee), at 5.30.—J. H. Driberg: Economic Stages of Development in Africa.

BRITISH ASSOCIATION OF CHEMISTS (London Section) (at Broad Street Station Restaurant, E.C.), at 7.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at Cowdry Hall, Aberdeen), at 7.30.—Prof. J. K. Catterson-Smith: Everyday Uses of Electricity (Faraday Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir John C. W. Reith: Broadcasting.

INTERNATIONAL COMMITTEE ON THE HISTORY OF SCIENCE (at Paris) (*continued on May* 14 *to* 16).

SATURDAY, MAY 14

ASSOCIATION OF TEACHERS IN TECHNICAL INSTITUTIONS (Annual Conference) (at Technical College, Cardiff) (*continued on May* 15 *to* 17).

Official Publications Received

BRITISH

Transactions and Proceedings of the Perthshire Society of Natural Science. Vol. 9, Part 2, 1930-31. Pp. 35-68+xv-xxx+plates 12-17. (Perth.) 3*s*. 6*d*.

The Hastings and East Sussex Naturalist: the Journal of the Hastings and St. Leonards Natural History Society. Edited by Anthony Belt. Vol. 4, No. 5, 31st March. Pp. 93-120. (St. Leonards.) 2*s*.

The University of Sheffield. Report on Research Work carried out in the Departments of Mining and Fuel Technology during the Session 1930-31. Pp. 18. (Sheffield.)

Royal Botanic Gardens, Kew. Bulletin of Miscellaneous Information. Appendix 1, 1932: Review of the Work of the Royal Botanic Gardens, Kew, during 1931. Pp. 54. (London: H.M. Stationery Office.) 1*s*. 4*d*. net.

The Ninety-eighth Annual Report of the Royal Cornwall Polytechnic Society. New Series, Vol. 7, Part 1, 1931. Pp. xii+106+16+5 plates. (Camborne.) 5*s*.

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1413 (Ae. 534—T. 2986): Wind Tunnel Experiments on the Cowling of Air Cooled Engines. By W. G. A. Perring. Pp. 49+21 plates. 2*s*. 6*d*. net. No. 1438 (T. 3146): Wind Tunnel Experiments on High Tip Speed Airscrews. By A. S. Hartshorn and Dr. G. P. Douglas. Pp. 12+8 plates. 9*d*. net. (London: H.M. Stationery Office.)

Oxford Bibliographical Society. Proceedings and Papers, Vol. 3, Part 1, 1931: A Bibliography of the Honourable Robert Boyle, Fellow of the Royal Society. By J. F. Fulton. Pp. 172. (Oxford.) 10*s*.

Department of Scientific and Industrial Research: Forest Products Research. Leaflet No. 5: Empire Timbers from Home and Overseas for Building and Structural Purposes—Timbers and the Uses for which they are considered as generally Suitable. By Major J. R. Cosgrove. Pp. ii+24. (London: H.M. Stationery Office.) 1*s*. 3*d*. net.

Transactions of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 70, No. 424, April. Pp. 393-476+xx. (London: E. and F. N. Spon, Ltd.) 10*s*. 6*d*.

Abstracts of Dissertations approved for the Ph.D., M.Sc. and M.Litt. Degrees in the University of Cambridge for the Academical Year 1930-1931. Pp. 101. (Cambridge: Printed at the University Press.)

Publications of the Dominion Observatory, Ottawa. Vol. 10: Bibliography of Seismology. No. 12: October, November, December 1931. By Ernest A. Hodgson. Pp. 193-210. (Ottawa: F. A. Acland.) 25 cents.

Union of South Africa: Department of Agriculture. Science Bulletin No. 102: Oils from South African Eucalypts. By Dr. F. J. de Villers and C. P. Naude. (Division of Chemistry Series No. 117.) Pp. 20. (Pretoria: Government Printing Office.) 6*d*.

Transactions of the Geological Society of South Africa. Vol. 34: January to December 1931. Pp. iv+167+7 plates. 42*s*. Proceedings of the Geological Society of South Africa: containing the Minutes of Meetings and the Discussions on Papers read during 1931. To accompany Vol. 34 of the Transactions, January-December 1931. Pp. iii+lii. (Johannesburg.)

The Ross Institute and Hospital for Tropical Diseases, Putney Heath, London, S.W.15. Annual Report and Accounts for 1931. Pp. 72. (London.)

N.Z. Department of Scientific and Industrial Research. Bulletin No. 32: Bush Sickness; Investigations concerning the Occurrence and Cause of Bush Sickness in New Zealand. Pp. 62. (Wellington, N.Z.: W. A. G. Skinner.) 2*s*. 9*d*.

Proceedings of the Society for Psychical Research. Part 123, Vol. 40 April. Pp. 165-362. (London.) 10*s*.

The Hannah Dairy Research Institute. Report for the Two Years ending 31st March 1932. Pp. 16+4 plates. (Auchincruive.)

Imperial Bureau of Plant Genetics: Herbage Plants. Bulletin No. 6: Research on Forage Crops in Soviet Central Asia, with special reference to Turkestan Lucerne. Pp. 32. (Aberystwyth.) 1*s*. 6*d*.

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1418 (T. 3137): Addition of Rolling Moments due to Roll and Sideslip. By H. B. Irving. Pp. 3+3 plates. (London: H.M. Stationery Office.) 4*d*. net.

FOREIGN

Geological Survey of China. Palæontologia Sinica. Series C, Vol. 7, Fascicle 2: Mammalian Remains from Locality 5 at Chouk'outien. By W. C. Pei. Pp. 20+1 plate. Series C, Vol. 9, Fascicle 1: Fossil Mammals from the late Cenozoic of Northern China. By P. Teilhard de Chardin and C. C. Young. Pp. v+93+10 plates. (Peiping: French Bookstore; London: Edward Goldston.)

Ministry of Agriculture: Technical and Scientific Service. Bulletin No. 116: On the Principal Types of Piroplasm observed in Bovines in Egypt. By Prof. Dr. M. Carpano. Translated from the Italian by E. Talarewitch. Pp. 30+7 plates. (Cairo: Government Press.) 10 P.T.

Journal of Science of the Hiroshima University. Series A (Mathematics, Physics, Chemistry). Vol. 1, No. 3, October 1931. Pp. 159-228. 83 sen. Vol. 2, No. 1, February. Pp. 102. 1.20 yen. (Tokyo: Maruzen Co., Ltd.)

U.S. Department of Agriculture: Bureau of Biological Survey. North American Fauna, No. 50: Mammals of New Mexico. By Vernon Bailey. Pp. 412+22 plates. (Washington, D.C.: Government Printing Office.) 1 dollar.

Jahresbericht der Hamburger Sternwarte in Bergedorf für das Jahr 1931. Erstattet von dem Direktor Dr. R. Schorr. Pp. 22. (Bergedorf.)

Proceedings of the American Academy of Arts and Sciences. Vol. 67, No. 3: Sources of American Discontent. By H. Addington Bruce. Pp. 43+60. 45 cents. Vol. 67, No. 4: Postulates for Separation of Point-Pairs (Reversible Order on a Closed Line.) By Edward V. Huntington and Kurt E. Rosinger. Pp. 61-146. 1.45 dollars. (Boston, Mass.)

Agricultural Experiment Station: Michigan State College of Agriculture and Applied Science. Circular Bulletin No. 140: Home Production of the Family's Food Supply. Pp. 32. Special Bulletin No. 215: Successful Farm Practices in the Upper Peninsula. By G. W. Putnam. Pp. 69. Special Bulletin No. 217: Marketing Michigan Beans. By Wilbur O. Hedrick. Pp. 85. Special Bulletin No. 218: Spray Injury Studies. 1: Injuries from Summer Applications on Apples. By W. C. Dutton. Pp. 68+16 plates. Special Bulletin No. 219: Spray Injury Studies. 2: Secondary Effects of Spray Injury to Apple Foliage. By W. C. Dutton. Pp. 38. Technical Bulletin No. 118: Investigations in the Mosaic Disease of Bean (*Phaseolus vulgaris* L.). By Ray Nelson. Pp. 71+11 plates. (East Lansing, Mich.)

U.S. Department of Commerce: Bureau of Standards. Bureau of Standards Journal of Research. Vol. 8, No. 2, February, Research Papers Nos. 407-415. Pp. 159-320. (Washington, D.C.: Government Printing Office.) 40 cents.

U.S. Department of the Interior: Geological Survey. Bulletin 831-A: The Jackson Gas Field, Hinds and Rankin Counties, Mississippi. By Watson H. Monroe. Pp. 11+17+2 plates. 10 cents. Water-Supply Paper 694. Surface Water Supply of the United States, 1929. Part 12: North Pacific Slope Drainage Basins. C: Pacific Slope Basins in Oregon and Lower Columbia River Basin. Pp. vi+154. 25 cents. Water-Supply Paper 704: Surface Water Supply of the United States, 1930. Part 9: Colorado River Basin. Pp. v+117. 20 cents. (Washington, D.C.: Government Printing Office.)

U.S. Department of Agriculture. Circular No. 50: Proximate Composition of Fresh Fruits. By Charlotte Chatfield and Laura I. McLaughlin. Revised edition. Pp. 20. 5 cents. Circular No. 146: Proximate Composition of Fresh Vegetables. By Charlotte Chatfield and Georgian Adams. Pp. 24. 5 cents. Circular No. 205: The Iron Content of Vegetables and Fruits. By Hazel K. Stiebeling. Pp. 20. 5 cents. (Washington, D.C.: Government Printing Office.)