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The Worth of Knowledge.

O fret not after knowledge !—I have none,
And yet my song comes native with the warmth.
O fret not after knowledge !—I have none,
And yet the Evening listens.
KEATS.

IN the course of his presidential address to the Education Section of the British Association at the recent Southampton meeting, Mr. W. W. Vaughan, headmaster of Rugby School, remarked that an agricultural labourer who had left school at thirteen years of age is often a better-educated man, in the best sense of knowledge, than a city clerk or other black-coated worker who had passed through a secondary school course before entering office life. Those who are familiar with the countryside and farm labourers know that much truth is contained in Mr. Vaughan's observation, but they know also that it is a dangerous doctrine to preach because of the excuse it gives to farmers and parents to secure the release of children from school at the earliest possible age in order to put them at work in the field. It is easy to suggest that a child who leaves school for outdoor work at ten or twelve years of age may be learning more than he would in a village classroom, but this is the kind of reasoning that leads to the exploitation of child-labour; and, in Great Britain at any rate, the State has rightly decided that every child without exception, whether in country or town, must now remain at school until at least the age of fourteen years has been reached.

There are, of course, many social reasons for this necessary condition, and among them is the value of discipline. Knowledge itself, especially that often contemptuously called "book-learning," may, as Keats expressed in the lines from his sonnet on "The Thrush," quoted above, be of little actual worth as a means of gaining or giving delight to life, yet, like the gift of mercy, it can be twice blessed if rightly used. There is one joy in seeking after knowledge and another in arousing interest in others in the beauty and promise of the new world revealed. What is worth having is worth sharing, and it is because of this conviction that we continually urge support and encouragement to effort made to create and foster wide interest in scientific achievement.

This is one of the objects of the British Association, and we believe that the annual meetings do much to fulfil their purpose in this respect through the publication in the newspapers of summaries of the presidential addresses, lectures and selected papers. It is, however, in no captious spirit that we suggest that much more remains to be done if the service of science in modern life is to be understood through the meetings of the Association. In the first place, there should be no misapprehension as to the constitutions of the audiences for which the president's address and the addresses of the sectional presidents are intended. Members of the lay public are invited to join the Association, but the presidential addresses are almost invariably unintelligible to them; and so are most of the papers. There are no doubt people like the lady who said she did not understand a scientific lecture she had attended, yet she liked the sound of it, but it is scarcely the function of the Association to titillate the ears of passive listeners.

We are of the opinion, however, that the addresses of the president and of the sectional presidents are better read than heard, and on this account we are glad that they are again available in volume form.[1] The first part of Prof. Lamb's presidential address deals with the absorbing topic of the nature and purpose of science in general, and we hope that it will be widely read and discussed, for such remarks, so admirable in form and substance, not only provide scientific workers with justification for the faith which is in them, but also tend to "clear the air" of any lingering feeling of hostility between them and those whose labours are purely humanistic. The addresses of the sectional presidents cover a very wide field, almost the whole gamut of the sciences. Many of them deal mainly or exclusively with recent advances in specialised departments; others, like those on engineering and anthropology, are throughout historical; and again others, like the addresses to the educational and economic sections, discuss problems which are of perennial interest. In every case the standard attained is high, the contribution notable, and if we have any adverse criticism to make, it is that, from the point of view of the lay reader, too many of the addresses are concerned with specialised and recondite topics to the exclusion or subordination of matters which are of more obvious interest and importance; in other words, they may appear dull to the average man.

The meetings of the British Association are most useful in bringing together workers in many branches of science. In recent years the institution of joint discussions on border-line subjects has increased their utility; and of late there has been a noticeable levelling-up in the scientific value of the papers presented; all of which is to the good. The problem, therefore, consists in realising a harmonious balance between the requirements of the specialist and those of the lay public. It will, we believe, be generally admitted that addresses and papers should not, as a rule, resemble those which are given at ordinary meetings of specialised societies: the treatment should be broader and more in touch with human welfare—not necessarily material welfare.

[1] The Advancement of Science, 1925. London: British Association, Burlington House, W.1. Price 6s.

From this point of view, some of the addresses and papers contributed to the recent meeting are open to criticism. About one-half of the addresses printed in the annual volume are obviously written by the specialist for the specialist. Although subjects relating to education (upon which nearly every other man claims to speak with authority) and to economics lend themselves more readily to popular treatment than others, it has been repeatedly shown that even in very recondite branches of science it is possible to introduce matter which appeals to the man of average intelligence and education. As examples in point, we may refer to the addresses given this year to the physiological and psychological sections. The physiology of muscular exertion and the theory of intelligence do not at first sight appear inviting topics to the non-specialist, but the manner of treatment as well as the matter treated secured in these cases extended notices in the daily papers. Prof. Parks' address on the cultural aspects of geology was also framed in a manner likely to appeal to a wide audience. We do not, of course, wish to plead for a stereotyped form of presentation, and we are well aware of the great difficulties inherent in popular exposition, but we do urge that the interests of the Association would be better served if greater use were made of its unique opportunities for securing the infiltration of scientific learning into all classes of the community.

Possibly the specialisation of scientific work must prevent the proceedings of the sections from making more than a sectional appeal. If this be so, then the Association must be regarded chiefly as a professional organisation, like the British Medical Association and similar bodies, neither desiring nor expecting members of the general public to attend its meetings. Even then, we urge that more serious attempts should be made to improve both literary and oral exposition in presenting papers. We plead for a style of composition and exposition suitable at least for a general scientific audience, even if the lay public is left out of account. It is surely a reflection upon scientific training that so few who represent it are able to address a public or any other audience in a manner which will command attention or stimulate interest.

A few lecturers of this kind are available, and the Association does its best to secure them for the public lectures delivered to citizens, and to children, at each annual meeting. These lectures are not intended for members of the Association, and arrangements for them are in the hands of the Local Executive Committee. In these days of many kinds of entertainment and obtrusive advertisement, it is obvious that wide publicity should be given to the citizens' lectures if good attendances are to be secured. This was not done at Southampton, with the result that the attendances at both these lectures and the children's lecture were far smaller than the lecturers or their subjects merited. Any good lecture agent would have secured large audiences for these lectures if they had been business undertakings, but as they were not, very few people in the town or neighbourhood were aware of them. This is not the way to further the purpose of the Association "to obtain more general attention for the objects of science."

The History of Telephony.

The History of the Telephone in the United Kingdom. By F. G. C. Baldwin. Pp. xxvi+728+75 plates. (London: Chapman and Hall, Ltd., 1925.) 42*s*. net.

THIS large book on the history of the telephone in the United Kingdom gathers together in a single volume an immense amount of valuable historical research on the development in Great Britain of one of the epoch-making inventions of electrical science. The invention of the magneto-electric telephone and the reproduction by it of articulate speech at a distance is a striking example of the solution of a technical problem, long recognised as possible of solution, attacked by several inventors with very little success, yet finally accomplished by a stroke of genius in the very simplest manner.

The speaking telephone, far more than many other electrical inventions, may be credited to a single inventor, in that Alexander Graham Bell was the first to discover a method, imperfect though it was, of translating the changes of air pressure constituting speech wave sounds into corresponding changes of electric currents in a line wire, and the conversion of them back into sound waves at the receiving end. This use of what was then called an undulatory current in a circuit never completely opened made possible the electric transmission of speech as compared with the transmission of mere musical sounds. Like many other inventions, Bell's success came as a kind of accident in the manipulation of an appliance called a harmonic telegraph which was not originally intended or hoped to function as a speaking telephone. Mr. Baldwin sketches in brief outline in his first chapter the stages by which Bell was thus led to success.

The remarkable thing about the Bell magneto telephone, with its steel diaphragm, having such a limited number of modes of vibration, is that it should be able to transmit intelligible speech sounds at all. It is probable that a large part of its success depends not so much upon its own intrinsic powers as upon the wonderful ability of the human ear to guess from a mere suggestion of a speech sound the intellectual meaning which that sound is intended to convey. The true air wave-form, with its complicated outline, is in fact very imperfectly reproduced by the telephone receiver diaphragm, but a mere hint enables the trained ear to interpret it.

Bell's invention, though effective as a receiver, was a very ineffective device as a transmitter, and if it had not been supplemented by the invention by Edison of the carbon transmitter, and by Hughes of the microphone, it is highly improbable that it would have fructified into practical utility or even passed beyond the stage of a scientific curiosity. The combination, however, of the variable resistance or microphonic carbon transmitter and the induction coil as a means of translating sound-wave motion into electric current variation, together with Bell's magneto-receiver for effecting the reverse transformation, gave a completely practical and simple solution of the telephone problem.

In his second chapter Mr. Baldwin describes the early operations and subsequent union of the Bell and Edison inventions and the early stages of invention in connexion with the evolution of a telephone exchange. But for this latter conception, which originated in America, the use by the public of the electric telephone would have been extremely limited. The pioneer work of the original Bell and Edison Telephone Companies in London, in establishing rudimentary telephone exchanges, is described by Mr. Baldwin in his second chapter, and also the story of the initial litigation between the Companies before the United Telephone Company was formed.

Chapter iii. opens with an account of the important litigation started by the Crown against the United Telephone Company to enforce against it the rights gained through the Telegraph Acts of 1863, 1868, 1869, under which the State purchased for about 10 million sterling the business of the pioneer electric telegraph companies. These original telegraph companies conducted their operations with diverse kinds of signalling instruments, and before long there arose a movement for "nationalising," as it is now called, the new methods of intercommunication. In order to prevent the Government monopoly being infringed by the possible invention of new types of electric telegraph, the Acts were drawn in such general terms that, when the telephone inventions made it possible to establish commercial exchanges worked for the convenience of "subscribers," the question was before long raised by Post Office officials, alarmed about their monopoly, whether the telephone was a telegraph within the meaning of the Acts.

The case was tried by Mr. Baron Pollock and Mr. Justice Stephen in November 1880 and decided against the Company. Unfortunately, the case was never taken to the Court of Appeal or to the House of Lords for confirmation or reversal. The directors of the Telephone Company, doubtful of the issue and perhaps reluctant to dissipate their available funds on further litigation, accepted a proposal of the Post Office that they should bow to the decision of the Court of First Instance and take a licence from the G.P.O. for a term of years, and the payment of a royalty of ten per cent. of their gross receipts from all exchange business carried on within five miles of the General Post Office, London. Thus it came to pass that the fetters of State control were riveted on the limbs of the new industry; and in the following thirty years the General Post Office was able to extract from the telephone more than a million sterling in the form of royalties, for which the State had given no equivalent of actual value.

The important question, from the point of view of the general public, is whether it is to the advantage of the community that a business so technical, and involving the necessity for so much invention and scientific knowledge, should be under the control of the State at all. Arguments can be given for and against the contention. Government departments certainly do not provide a congenial soil in which enterprise, invention, or economical commercial progress can flourish. No young man entering a Government department finds that originality or initiative is encouraged or that it tends to fame and fortune for himself; in short, it does not pay, and hence he soon settles down to a steady but slow-going officialism. Moreover, Government departments are subject to the changes of policy incidental to successive administrations. Thus it has come to pass that succeeding governments in Great Britain have played with the telephone as a cat plays with a mouse. The dual control, partly by the G.P.O. and partly by a limited company, was for years disastrous to progress.

The history of the telephone in Great Britain is therefore in great part a revelation of Government ineptitude, and supplies solid reasons against that nationalisation of technical industries with which present-day socialists are so enamoured. It is sufficiently suggestive that none of the great inventions in connexion with telephony have originated with British Government officials. They did not invent the telephone itself, or originate the telephone exchange, or the dry core cable, loading coil, uniformly loaded cable, phantom circuit, automatic telephone exchange, or the thermionic telephone repeater. All these important inventions originated with private inventors and came to us mostly from the United States, where the telephone is not under Government control but is a private enterprise. Furthermore, the ideas of scientific men such as the late Mr. Oliver Heaviside or Prof. Silvanus Thompson, who suggested improvements, were not followed up but even resisted by official electricians, and telephonic invention in Great Britain languished accordingly.

Returning, then, to Mr. Baldwin's book, we find that in the following twenty chapters he gives us an excellent account of the development of the great inventions which have been enumerated above. The gradual evolution of the telephone switchboard is illustrated by numerous valuable diagrams, and the replacement of the human element in it by the fully automatic exchange is outlined. The completely automatic telephone exchange by which, without any human intervention, a subscriber calls up another, finds out if he is already engaged, if not, converses with him, and finally switches himself out, is one of the most marvellous pieces of mechanism which the human mind has ever devised. Its elaboration has been due to many clever brains directed to a surpassingly difficult problem. The G.P.O. has now established in Great Britain a considerable number (about 25) of these automatic exchanges on various systems.

In the chapter on long-distance transmission, Mr. Baldwin only devotes a paragraph or two to another invention of cardinal importance, namely, the thermionic repeater, which has enabled a vast extension of telephonic range to be obtained. Suffice it to say that telephone electric currents are weakened by travelling along aerial lines or in cables. But a device called a thermionic repeater, which is a development of the thermionic valve invented by the present reviewer, is employed to reinvigorate these currents and send them on a farther stage with fresh energy. The importance of this invention is that it enables wires of smaller section, and therefore cheaper, to be employed. If the trunk telephone lines of Great Britain had to be relaid, it would be possible to save hundreds of thousands of pounds in mere cost of copper.

Taking the volume as a whole, we can say that Mr. Baldwin has given us a very readable and interesting history of the telephone in Great Britain. The book contains a large number of illustrations showing the development of various appliances, whilst much useful information in the form of tabular statistics is contained in the appendices. A good index completes a book which will certainly be highly appreciated by all telephone men and those who have to explore the history of any part of the subject. Lastly, a short introduction by Mr. Frank Gill, who was for eleven years engineer-in-chief of the National Telephone Company, and intimately acquainted with the history as well as technique of the subject, gives the reader an assurance of the trustworthy character of the history so well presented.

J. A. FLEMING.

The Contact Process for Oleum Manufacture.

The Manufacture of Sulphuric Acid (Contact Process). By F. D. Miles. ("The Manufacture of Acids and Alkalis," by Prof. George Lunge. Completely revised and rewritten under the editorship of Dr. A. C. Cumming. Vol. 4.) Pp. xv+427. (London and Edinburgh: Gurney and Jackson, 1925.) 36s. net.

IN the realm of pure chemistry, few better examples than the chemical change between sulphur dioxide and oxygen can be selected to illustrate the general principles involved in gas reactions, whilst its value in the elucidation of the mysterious influences at work in the field of catalysis cannot be overestimated. The fundamental features of the contact process, as we now know it, were first described by Peregrine Phillips, a vinegar manufacturer of Bristol, in his patent of 1831, and to him belongs the credit of making the original scientific discovery and of realising its commercial possibilities. Nevertheless, no practical success had been attained when, in 1868 to 1872, the synthetic production of alizarin removed one of the chief reasons for this slow development—the absence of a market for fuming sulphuric acid.

At this time the sole maker of fuming acid was Baron Stark in Bohemia, the process used being substantially that of Basil Valentine (born 1394)—the decomposition of ferric sulphate obtained from "copperas-slate." No wonder that chemists turned their attention to the production of fuming acid in other places and by other methods. The publication in 1875 of a paper by Clemens Winkler, professor in the School of Mining at Freiberg, marked the beginning of most important developments. He recommended platinised asbestos as the catalyst in preference to platinised pumice or porcelain, and, in order to obtain the best results, postulated the necessity for having the sulphur dioxide and oxygen present in the stoichiometric ratio necessary for acid formation. The fact that for many years the latter statement was accepted and quoted by all classes of chemists shows how little attention the Law of Mass Action, enunciated by Guldberg and Waage in 1867, was receiving in 1875. Any chemist acquainted with this law could have shown the error in Winkler's conclusions by pointing to the equation of the reaction. Almost on the same day that Winkler sent in his manuscript, an application by W. S. Squire was lodged for a British patent, embodying the joint invention of Squire and Messel. The process was established at Silvertown and produced several tons of trioxide per week. The loss of activity of the catalyst, due to its accumulating such impurities as flue dust, was first noted by these workers, but its sensitiveness to specific poisons such as small traces of arsenic was not known until many years later.

In 1901 Knietsch gave his famous lecture to the German Chemical Society, in which he described some of the work which had been carried out in the laboratories and on the plant of the Badische Company.

"This discourse," says Mr. Miles, "in spite of defects and notwithstanding its many omissions, is still the most important ever recorded on the scientific and technical aspects of the oxidation of sulphur dioxide. Not only had Knietsch and his collaborators examined the behaviour of platinum and other catalysts under various conditions of temperature and rate of flow of gas and supplied much-needed information about the physical properties of fuming acid and sulphur trioxide and their action on iron and steel; they had also found solutions of all the technical problems which had made difficult the use of pyrites burner-gases, abandoned the theory of Winkler, arrived at the unexpected conclusion that contact vessels require cooling and not heating, and had in general rendered the contact process so successful that it could henceforward not only produce fuming acid cheaply but actually compete with the chamber process for ordinary concentrated sulphuric acid."

Yet, prior to the War, the number of plants manufacturing oleum in Great Britain could be counted on the fingers of one hand. With the outbreak of war, a large supply of fuming acid became an urgent necessity, and the existing sources were quickly supplemented by many plants of great size and varying design.

Such are some of the main points in the fascinating history of the manufacture of oleum with which Mr. Miles begins his excellent book on the contact process. A survey of these facts fully supports the author's contention that the contact process is one of the foremost achievements of technical chemists, for undoubtedly the many difficulties that arose in the course of the pioneer work were solved more or less empirically by dint of hard work, the running of careful trials, and the gradual accumulation of data. However, Mr. Miles is optimistic and appreciative of the results which can and should accrue from the linking up of purely scientific and technical discovery, for, as he says, "the barriers dividing knowledge are broken down and we may hope to have in regard to the contact process in both technical and scientific aspects a body of information which from every point of view is equal to that applying to any other chemical change."

With the general treatment of the subject no one who peruses this volume can fail to be impressed. The author mentions as one of his aims the avoidance of a too sharp distinction between the technical and scientific aspects of the subject. In this respect he has been exceptionally successful, attaining an almost perfect blending of the theoretical and practical considerations. How complex and intriguing are the numerous factors to be considered in the formation of the trioxide and its absorption may be gauged from the chapters on the properties of sulphur trioxide and oleum, gas equilibrium and velocity of reaction, catalysis and contact mass, gas purification and absorption of the trioxide. All these phases are dealt with in a lucid and authoritative manner, interposed with valuable suggestions for future research and development. The last three chapters in the volume describe Grillo-Schröder plants and the Tentelew and Mannheim processes, and contain important information of practical significance. Replete with excellent illustrations and nomographic charts, this volume is in every respect a noteworthy production, fully maintaining the great traditions which will always be associated with Dr. Lunge's treatises. W. W.

British Scientific and Technical Books.

A Catalogue of British Scientific and Technical Books: Covering every Branch of Science and Technology, carefully Classified and Indexed. New edition, entirely revised and enlarged. Pp. xxii+489. (London: British Science Guild; A. and F. Denny, Ltd., 1925.) 12*s*. 6*d*. net.

THE British Science Guild performed in 1921 an extremely useful public service in issuing a catalogue of British scientific and technical books. By donations from interested bodies and a number of publishers, and with the aid of what must have been a considerable amount of voluntary labour, the Guild has found it possible to issue a new edition without undue drain upon its own slender resources, and the result is eminently one upon which it may be congratulated.

In this edition the terms "scientific" and "technical" and the term "book" have been broadly interpreted, with the result that it contains more than 9500 titles, an increase of nearly 50 per cent. on the first edition. The entries are grouped into classes corresponding with the main and recognised divisions of scientific work, each division being arranged in sections on a subject basis, the entries in each section being in alphabetical order of authors. It is easier to criticise such a classification than to suggest an improvement, and it is hoped that the newly formed Association of Special Libraries and Information Bureaux will be able to render assistance in such matters as this. Undue dependence on the main classification is avoided by excellent author and subject indexes, but an illustration of the classification difficulty is provided, for example, by Prof. Burstall's "Energy Diagram for Gas," which is readily traceable through the author index, but is not referred to in the subject index except under "Thermodynamics." In the body of the book the entry is made in the section on General Physics, Section ii.d, Gases, whereas its place is preferably under Mechanical Engineering, Section xviii., Internal Combustion Engines. It is also surprising to find Dr. Aston's "Isotopes" grouped in Chemistry, Section v.b, Physical Chemistry, and not referred to at all in the section on physics. It is placed consistently with the scheme of classification, but this tends to be a Procrustean bed to which the books have to be fitted. The grouping of the metallurgical section illustrates the main difficulty of making mutually exclusive sections when one section relates to materials (iron and steel, non-ferrous metals), while other sections relate to processes and methods (heat treatment, foundry practice, etc.). Close inspection of several of the main sections shows that nothing has been omitted.

It is, of course, impossible for the inexpert student to dispense with the advice of a specialist in utilising an uncritical or unannotated collection, but this volume illustrates in an admirable way what British material is available, and it will be found constantly useful in both general libraries and the ever-increasing number of specialised technical libraries all over the country. In view also of the high reputation of British books abroad, it may well act as very valuable propaganda on behalf of British scientific literature.

Palæolithic Art.

Les Combarelles aux Eyzies (Dordogne). Par Dr. L. Capitan, l'Abbé H. Breuil, et D. Peyrony. (Institut de Paléontologie humaine: Peintures et gravures murales des cavernes paléolithiques.) Pp. iv+192+58 planches. (Paris: Masson et Cie, 1924.) 200 francs.

THIS superbly illustrated volume, recording the palæolithic art of the cave of Combarelles, is the latest of the well-known series of works which started under the auspices of the late Prince of Monaco with "Altamira" in 1906 and continued with "Font de Gaume," "Les Cavernes de la région Cantabrique," and so on. These monographs have finally and for all time presented the palæolithic art of France and Spain to the student of prehistory, enabling him to do his work without having always to be visiting out-of-the-way localities and difficult caves.

More even than this has been accomplished, however, for in the texts will be found careful accounts of the systematic work done in the caves themselves, where the significance of every superposition of drawings was noted; also comparisons with outside matter are included. For example, in the volume under review, the chapters on the types of horse figured at Combarelles and their relationships with the various breeds surviving to-day will not only be read with interest by prehistorians but will also be equally appreciated by the zoologist. The virgin ground broken long ago by Piette, Munro and Cossar Ewart has here yielded a rich harvest.

The cave of Combarelles is one of the most important palæolithic temples in the Dordogne. Although the art is nearly all engraved, there being scarcely any paintings, the beauty of the drawings and the skill employed has rarely been surpassed elsewhere. The animals figured include: horse (in large numbers), mammoth, reindeer, bison, ibex, bear, tiger, rhinoceros, fox, wild-ass, humans (sometimes masked), signs and so on. The age of most of this art is adjudged to be Lower Magdalenian—that is, a Magdalenian before the appearance of the barbed harpoon.

The present volume opens with an account of the discovery of the art and the situation of the cave, and this is followed by a description of finds from sites nearby, as well as an account of one or two objects from Combarelles itself. An inventory of the art on the walls and ceiling of the cave follows; the work concludes with important comparative chapters on the occurrence of the various species of animals and the figures of humans found, and a short discussion as to the age of the ensemble.

It is the plates, however, which naturally first attract the student. Even those of us who knew and had studied Breuil's tracings and photographs, both in the study and on the spot, will be delighted with the results appearing here. It was no mean feat for Breuil and his photographer to have worked for months on end in that most awkward of tunnels. Besides the clear, distinct figures there are numbers of intricate panels representing a series of complicated palimpsests. Although Dr. Capitan and M. Peyrony have done their part, to the Abbé Breuil remained by far the largest bulk of the work in the cave as well as the actual writing and preparing for press.

A monograph of high scientific importance like "Les Combarelles" ought to make our English publishers and printers pause and think. The price (200 fr.) is not excessive, and it is grievous to remember that no work of this standard could ever be produced in England at even triple the price. Once more is the Institut de Paléontologie humaine to be congratulated, and it is only to be hoped that further volumes will be soon appearing, giving prehistorians some more of that mass of unpublished material Breuil possesses. Perhaps next time there may appear an account of that equally important and still less known Spanish rock shelter art (Spanish group III.) belonging to the Late Neolithic and Copper ages.

M. C. BURKITT.

Our Bookshelf.

The Physical Chemistry of Igneous Rock Formation: a General Discussion held by the Faraday Society, the Geological Society, and the Mineralogical Society, October 1924. Pp. 411-501. (London: The Faraday Society, 1925.) 6*s.* 6*d.* net.

THE discussion on this subject arranged by the Faraday Society excited great interest, and the collected papers contain much that is of value. Whilst most of the speakers dealt with heterogeneous equilibria, and particularly with the crystallisation of minerals from magmas, one rather elaborate memoir on homogeneous equilibria was communicated by Prof. Niggli, of Zürich, in which certain considerations relating to the formation and decomposition of compounds in solution are applied to rock provinces of the Pacific, Mediterranean, and Atlantic types, a diagram being used to indicate the relationships, in such a way as to point to the differentiations which may be expected to occur during cooling.

Another question which recurs frequently in the discussion is that of the influence of volatile constituents on crystallisation. The possibility that pressure gradients as well as temperature gradients may be important is suggested by W. H. Goodchild and supported by G. W. Tyrrell, and the presence of volatile constituents is also invoked to explain the formation of alkaline rocks. Since experiments on magmas containing volatile substances can only be made in special apparatus capable of withstanding very high pressures, it has been urged that provision should be made in Great Britain for research in this field, and the paper by Dr. J. W. Evans outlines a very extensive programme of work which should be undertaken if means permitted, including the effect of shearing forces as well as of hydrostatic pressure.

Bowen's reaction principle comes in for some discussion, and the question is raised whether the methods used in metallography require much modification when they are applied to the study of such viscous and highly associated liquids as rock magmas. Prof. J. W. Gregory's detailed survey of the subject of magmatic ores leads to the remarkable conclusion that ores of magmatic origin are probably quite unimportant, all the famous deposits to which such an origin has been assigned having been shown to have been formed in other ways. The little volume is most interesting and suggestive.

A German-English Dictionary for Chemists. By Dr. Austin M. Patterson. First edition, with Addenda. Pp. xvi+343. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1924.) 12*s.* 6*d.* net.

To compile a small dictionary from data easily available in larger works, is a comparatively simple task. To compile a small dictionary of a special character, like that now under review, requires not only judgment, accuracy, and application, but also a good knowledge of the languages and the science concerned. These qualifications Dr. Patterson possesses to an eminent degree, and therefore it occasions no surprise to learn that his "German-English Dictionary for Chemists" has been reprinted no less than five times, and that 21,000 copies of it have been sold since the first impression was made in 1917.

The book is excellent so far as it goes. It is obviously not intended for the linguistic expert, the professional translator, or for other serious students of German, but for the ordinary run of chemists, who to-day know little French and less German, it is remarkably good, being exactly what they require. With the aid of this small dictionary, such a chemist will be able to "make out" the meaning of almost any passage in a German chemical work; he will not, however, always be able to render it into precise and good English, because he will not always find the exact English equivalents of the German compound words he encounters. As a rule, such words are easy to understand, but alas! they are also easy to mistranslate; and they occur frequently in such branches as metallurgy, spectroscopy, atomic structure, economic and engineering chemistry. We hope, therefore, that when the work is revised, it will be found possible to include exact renderings of many more German compound words, so that we may be spared from errors like that made by the Frenchman who, when endeavouring to translate "hemisphere," looked up "hemi" and "sphere," and then, uniting the French equivalents in unholy wedlock, wrote down the word—*demi-monde*!

Electrical Circuits and Machinery. By Prof. John H. Morecroft and Prof. Frederick W. Hehre. Vol. 2: Alternating Currents. Pp. xi+444. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1924.) 20*s*. net.

THIS is the second of three volumes intended for the use of students in engineering colleges. The first was on continuous currents (now generally called in Great Britain direct currents). The final volume will describe "experiments." We think the authors have discussed their subject in a way which will be appreciated by the average student, who has generally a very limited time at his disposal. Although it is not sufficiently thorough to satisfy the consulting engineer, yet wherever possible without dragging in advanced mathematics, proofs are given. The art of the electrical engineer is ever advancing. Both the mercury arc and the thermionic valve rectifiers are included. Sub-stations with all their apparatus in the open air (outdoor sub-stations) are described. We notice that in the United States every large electrical company has an oscillograph, generally mounted on a truck, so that it can easily be transported to any point of the supply network.

We are glad that the authors insist that students must know the theory of the instruments they use. In too many cases students consider an ammeter, for example, as a piece of apparatus having two terminals, a pointer and a scale, and know little or nothing of what is happening inside. In alternating current machinery armature reaction plays the leading part, and due stress is laid on this. Particular attention is very properly devoted to the current and voltage relations of polyphase networks. Too many students are content simply to memorise the necessary formulæ without taking the trouble to understand their proofs. This slackness on their part will probably give them much trouble in the future, and they will never gain that confidence which is requisite for success.

The Fauna of British India, including Ceylon and Burma. Edited by Sir Arthur E. Shipley; assisted by Dr. Hugh Scott. Coleoptera. Clavicornia. Erotylidæ, Languriidæ and Endomychidæ. By G. J. Arrow. Pp. xvi + 416. (London: Taylor and Francis, 1925.) 30*s*.

THIS volume, which is the third contributed by Mr. G. J. Arrow to the "Fauna of British India" series, deals with three very closely related families of clavicorn Coleoptera, namely, the Erotylidæ, Languriidæ, and Endomychidæ. They are all tropical groups that are but poorly represented in temperate regions. The Erotylidæ recorded from the Indian fauna number 129 species, and Mr. Arrow has established the new subfamily Euxestinæ for four exceptional genera which possess a rounded, solid club to the antenna. The Languriidæ, with 110 Indian species, are not usually regarded as a separate family and most authorities place them among the Erotylidæ. Mr. Arrow, however, considers them sufficiently distinct to merit family rank, but their affinities are so intermingled with the Erotylidæ, Endomychidæ, and Cryptophagidæ that their taxonomic status is largely a matter of individual opinion. Unlike the Erotylidæ and Endomychidæ, the Languriidæ feed as larvæ in stems and the imagines are very characteristically elongated. The third family—the Endomychidæ—includes 120 recorded Indian species included in three subfamilies.

It may be mentioned that in two features the present volume differs from its predecessors. First, there is a folding map of India and Ceylon, and secondly, there is an index of plant names. Both innovations add to the convenience of the users of the book. The illustrations include a chromolithographic plate and 75 excellent text-figures.

The whole work is well up to the standard of the previous volumes on Coleoptera, and Mr. Arrow is fortunate in being able to examine the original type-specimens in a large proportion of the species, a feature which gives additional value to his identifications.

A. D. I.

Christian Missions and Oriental Civilizations: a Study in Culture Contact. The Reactions of Non-Christian Peoples to Protestant Missions from the Standpoint of Individual and Group Behaviour: Outline, Materials, Problems, and Tentative Interpretations. By Dr. Maurice T. Price. Pp. xxvi+578. (Shanghai: Edward Evans and Sons, Ltd.; London: G. E. Stechert and Co., 1924.) 16*s*.

THIS book makes a wide appeal. It is of interest to those who are actively concerned with the work of Christian missions, to anthropologists, to psychologists, and sociologists, and to those who have to deal with the practical problems of administration. It approaches the work of the missionary from a novel point of view. It does not deal with spiritual, theological, or metaphysical interpretations as such; but it examines the reactions of non-Christian peoples to the Christian Church's attempt to convert them—both the initial and temporary responses and those which are more permanent. Missionary effort during the last one hundred years is surveyed from this point of view.

For the first time missionary effort has been studied as a natural phenomenon and as a social psychological process, without partisanship or bias. The reader must not seek here for any panacea for the many ills arising out of the clash of cultures and ideals from which we are at present suffering in many parts of the world. This study is purely analytical. As the author points out, it is incomplete in the sense that further research is needed and consideration of the data available must be carried further in later volumes. The method is capable of an application wider than the mission field, and therefore deserves the careful consideration of all who are interested in the urgent problem of the future of primitive peoples.

Mechanical Design of Overhead Electrical Transmission Lines. By Edgar T. Painton. Pp. viii + 274 + 26 plates. (London: Chapman and Hall, Ltd., 1925.) 21*s*. net.

THE successful transmission of thousands of electrical horse-power by overhead wires over hundreds of miles is not only feasible, but has also been proved in almost every country to be attractive from the commercial point of view. Satisfactory operation has been attained by the continual attention that electrical engineers have been paying to the technique of design, and to the improvement of the quality of the materials used in construction. Continuous laboratory research and long experience have enabled them to anticipate operating difficulties, and combat them by selecting suitable materials and altering the design so as to raise the factor of safety. Of recent years long reports, papers, and patent specifications have been issued almost daily, and there are few who have the ability and the time to separate the grain from the chaff. This volume describes the latest constructional details, and makes references to the latest specifications issued by the British Engineering Standards Association, the American National Electric Light Association, and the Verband Deutscher Elektrotechniker. References are also given to many important papers published in the transactions of scientific institutions both at home and abroad. Novel data in connexion with steel cored aluminium conductors are given. These conductors are being extensively used, and necessitate changes in the details of transmission line design. This book can be recommended to both the practical and the academic engineer. The latter will see how many theorems given in examination papers have been modified to make them useful in practice.

Round the World in Folk Tales: a Regional Treatment. Sixteen Stories from Various Lands, with a Chapter on their Meaning. Compiled and edited by Rachel M. Fleming. (Folk Stories for the Geography, History, and Reading Lesson.) Pp. xi + 49 + 8 plates. (London: B. T. Batsford, Ltd., 1924.) 2*s*. net.

THE value of folk tales as illustrative material in education is now generally recognised. Miss Fleming has added to the indebtedness of teachers to her by the publication of this third collection of stories. It comprises sixteen stories drawn from widely scattered areas—Australia, Melanesia, Japan, China, America, Africa, Russia, and Brittany, to name some of the sources only. The bearing of the stories upon points of geography is perhaps more apparent than it was in the earlier volumes, and is further emphasised in an introductory note. For example, "The Legend of the Flowers" from Australia is made to illustrate the effect of climate on vegetation and animal life, and in the same way, one of the Russian stories, extremes in climatic variation. Again character and quantity of food supply is a not unimportant feature which receives frequent mention, while the stories from Ireland and Brittany show the effect of the introduction of Christianity. The Bushman boy's account of some of the things told him by his mother might very well be used as the basis of a contrast in educational methods among civilised and uncivilised peoples. The bibliographical references are a useful guide for further study and add to the value of a book which should be widely used. The illustrations are interesting and well chosen, but might with advantage have been reproduced on a larger scale.

The Principles of Thermodynamics. By George Birtwistle. Pp. ix + 163. (Cambridge: At the University Press, 1925.) 7*s*. 6*d*. net.

THIS admirable little book, based on lectures given by the author in the University of Cambridge to students of varied scientific interests, contains an account of the fundamental principles of thermodynamics and their main applications to the various branches of science. It opens with a brief account of the historical preliminaries leading to the two fundamental laws and the idea of entropy. After an account of the chief characteristic equations for fluids, the usual mathematical relations involving the thermodynamic potentials are discussed and applied to the more elementary cases of simple and compound systems. The book closes with four chapters dealing respectively with osmotic and vapour pressure, thermoelectric phenomena, specific heats, and radiation.

The whole treatment of the subject is brief and almost sketchy; but it is up-to-date, well-balanced, and wholly adequate, as no essential step is missed either in the physical argument or its mathematical development. The author has had the courage to cut out ruthlessly all matter which is irrelevant to his main theme, and the result is a thorough but handy account of the subject, in which the component parts are presented in their true aspect. No attempt is made at a critical survey of the fundamental ideas or at a discussion of the extensive statistical side of the subject; but these would obviously have been out of place in a first book on the subject. We may, perhaps, hope that the author has intentions of writing a second volume.

G. H. L.

Drogen und Drogenhandel im Altertum. Von Dr. Alfred Schmidt. Pp. viii + 136 + 8 Tafeln. (Leipzig: J. A. Barth, 1924.) n.p.

IT has been well said that no branch of knowledge can be adequately understood without an acquaintance with its history, and this applies in full measure to a knowledge of drugs. The study of the history of drugs, cosmetics, balsams, unguents, spices, etc., from the earliest written records to the present time, is so intensely interesting as to make it appear strange that so few pharmacognosists have devoted themselves to it. True, Tschirch, Schelenz, and a few others have collected data, but they have, as a rule, failed to present them in an attractive form.

From isolated details scattered among the works of numerous authors, Dr. Schmidt has endeavoured to build up a picture of the trade that was done in these materials, the extent to which they were used, and the routes by which they reached the various markets. He makes one realise that it was so considerable, and the traders so numerous, that thousands of years ago there were streets mainly occupied by their shops, and one can imagine one sees the buyers congregating there and comparing the wares offered.

To accomplish this has been a task of no inconsiderable magnitude, as any teacher can testify who has attempted to compile for his students a concise but intelligible history of drugs. To any one fairly conversant with German, the work is so fascinating that it can be read again and again. It contains a bibliography, and in addition there are numerous references in the text; it is full of most interesting details and is a valuable addition to the literature of pharmacognosy.

Qualitative Analyse und ihre wissenschaftliche Begründung. Von Prof. Dr. Wilhelm Böttger. Vierte bis siebente umgearbeitete und erweiterte Auflage. Pp. xvi + 644. (Leipzig: Wilhelm Engelmann, 1925.) 19 gold marks.

ON reading this valuable work one is impressed by the fact that although the experimental data underlying qualitative analysis have changed but little, their interpretation has in many respects been revolutionised: the applications of the law of mass action and of the ionic theory of solution have brought order into the chaos and transformed what was once little more than a handicraft into a consistent and coherent science. Nearly twelve years have passed since the third edition of Böttger's work was noticed in these columns (December 18, 1913); the new edition is a very worthy successor to the old and gives a good idea of the advances that have been made in the interval. The first and more difficult part, dealing with the theoretical foundations, is particularly well done; the language is clear and simple, and the experimental illustrations are well chosen. Modern views on valency and molecular structure are treated at length, and there is an interesting section on electrolytes and Werner's theory.

In the experimental part are to be found many reactions of recent discovery, some of which are sufficiently specific to be used as tests without recourse to separation. The treatment generally is very full, and microchemical reactions have not been neglected. Books of this type are very few in these days of costly printing, and the appearance of the new and enlarged "Böttger" will be welcomed by all who are interested in this very old but still very fundamental branch of chemistry.

British Birds. Written and illustrated by Archibald Thorburn. In 4 vols. Vol. 1. New edition. Pp. xii + 176 + 48 plates. (London: Longmans, Green and Co., 1925.) 16*s.* net.

WE have received the first of the projected four volumes of a smaller and less costly edition of Mr. Thorburn's "British Birds," a book first issued on a sumptuous scale in 1915 and now out of print in its original form. The coloured plates, a new series, are again the principal feature, for Mr. Thorburn has a well-earned reputation as an ornithological artist. They are usually clear and accurate, often beautiful, and on the whole well reproduced; a few, however, are noticeably less successful than the others. The text is undistinguished, consisting of very brief summaries of the usual text-book information plus a few comments, frequently in the form of quotations, upon habits or special points. This is unfortunate, for it is difficult to see what function a still rather expensive book giving so little information can fulfil.

One feels that the book should either have been brought within smaller compass altogether or have been expanded considerably in dealing with the more important birds. Either of these courses could have been followed had Mr. Thorburn been less subject to the fetish of that arbitrary category known as "the British list." Thus, no less than seven kinds of wheatear are each given a page, and all but two of them a place in the plates, whereas only one species is anything more than a very rare accidental wanderer to Britain. In a popular work there would be every advantage in dismissing accidental rarities with a bare mention. The confusion that there has been in ornithological nomenclature is to be regretted, but it does not help matters, now that some uniformity is being reached by general agreement, to find an author harking back for his standard to a work which was published in the previous century.

A Monograph of the Mycetozoa: a Descriptive Catalogue of the Species in the Herbarium of the British Museum. By Arthur Lister. Third edition, revised by Gulielma Lister. Pp. xxxii + 296 + 223 plates. (London: British Museum (Natural History), 1925.) 31*s.* 6*d.*

A THIRD edition of the monograph of the Mycetozoa by Arthur Lister has been prepared by Miss G. Lister and issued by the Trustees of the British Museum. Few groups of organisms have been so well catered for in the way of an accurate and well-illustrated systematic monograph: and the appearance of a third edition tells at once of the attractiveness of the organisms themselves and of the interest stimulated in any group when a sound treatise is available.

Biologists may have imagined that the Mycetozoa were fairly thoroughly known when the second edition, published in 1911 (which also introduced a revised nomenclature in accordance with the International Rules), included all additions to date. It is surprising, therefore, to note that no less than three additional genera, 46 species, and some 50 additional varieties, are incorporated in the present volume. The results of recent biological research are also included.

The work of revision having been in the experienced and accomplished hands of Miss Lister gives assurance that the new edition is of the same standard of excellence as its predecessor.

Faune de France. 8: *Diptères; Tipulidæ.* Par C. Pierre. (Fédération Française des Sociétés de Sciences Naturelles: Office Central de Faunistique.) Pp. 159. (Paris: Paul Lechevalier, 1924.) 25 francs.

THE present instalment of this useful series deals with the crane flies. Since the work is primarily intended for the identification of the adult insects, there is only a short account of their biology and metamorphoses.

Osten-Sacken's division of the family into Longipalpi and Brevipalpi is followed and four subfamilies are recognised, namely, Tipulinæ, Cylindrotominæ, Limnobiinæ and Trichocerinæ. For the venation Tillyard's modification of the Comstock-Needham system is adopted.

The method of treatment of the family is by means of keys, which take the reader step by step from the subfamilies to the tribes and thence to genera and species. In the case of the larger genera the species are sorted out into groups in order to facilitate identification. The specific characters are further enumerated in a little more detail in the lists which follow the keys, and notes are given as to distribution and so on. The numerous text-figures are almost entirely devoted to the genitalia and venation, excepting two pages of illustrations which depict the larval and pupal characters of the Limnobiinæ. The work will prove useful to English dipterists, as very little has been published on the British forms for nearly forty years, excepting Edward's revisional notes (1921). A. D. I.

The Botany of Crop Plants: a Text and Reference Book. By Prof. Wilfred W. Robbins. Second edition. Pp. xxi+674. (Philadelphia: P. Blakiston's Son and Co., 1924.) 3.50 dollars.

THE usefulness of this volume is indicated by the fact that a second edition has been called for in the comparatively short period of seven years. Opening with an outline morphological sketch, the author proceeds to give an account of the various crops grown in the United States, gathering together information that is otherwise very scattered. The crops are dealt with under the headings of their respective natural orders, the more important, chiefly cereals, being described in some detail. Bibliographies are appended to each crop or group of crops, but do not pretend to be complete. The classification of the varieties or types of crop is simplified by the free use of keys, many of which are original. A feature of the book is the "direct" method of labelling the very clear illustrations, thus rendering them more easy of reference for the student. A glossary of botanical terms and a good index round off a book that should prove of considerable value to agriculturists as well as to botanists.

Pecan-Growing. By H. P. Stuckey and Prof. Edwin Jackson Kyle. (The Rural Science Series.) Pp. xiii+233+12 plates. (New York: The Macmillan Co., 1925.) 12*s.* 6*d.* net.

THE growing importance of the pecan-nut in American commerce has justified the production of this book dealing with the crop in all its aspects. The pecan, *Hicoria pecan*, is closely allied to the walnut, and now ranks second to the latter in the nut production of the United States. Propagation is not easy, and special attention is devoted to descriptions of the various methods of budding or grafting that it is necessary to employ. An interesting feature is the account of the National Pecan Growers' Exchange, an organisation for marketing the nuts by means of a grower's co-operative non-profit association without capital stock. Such a body tends to raise the standard of the crop owing to its system of careful grading and differential prices. Lax supervision in the earlier years of cultivation favoured the introduction and spread of many insect and fungus pests, which now need to be combated to prevent serious reduction of the nut crops. The volume concludes with a discussion of the food values and descriptive accounts of the many varieties of the pecan.

Distillation Principles. By C. Elliott. (Chemical Engineering Library: Second Series.) Pp. 166. (London: Ernest Benn, Ltd., 1925.) 6*s.* net.

MR. ELLIOTT's book contains, on the whole, a clear and readable account of a subject which most students find difficult. In a few places the text is not so perspicuous as it might have been, but the general treatment is sound. Particular stress is laid on the work of Rosanoff, which the author says he has found helpful, and the methods adopted certainly appear practical and useful. A fair amount of mathematics is essential, but the full discussion of numerical results gives the treatment a sense of reality which is most gratifying. It may be noted (p. 24) that the molecular weight of hydrogen is not 2, and that 2 grams of hydrogen do not occupy 22·412 litres. Biot's vapour pressure formula (p. 21) is the only one given, whilst Kirchhoff's is perhaps more useful; Avogadro's law does not state (p. 34) that "the volumes of gases are proportional to their molecular weights." Useful tables are given in an appendix. The book can be recommended as a concise and accurate account of a difficult subject.

An Introduction to the Literature of Chemistry: for Senior Students and Research Chemists. By Dr. F. A. Mason. Pp. 41. (Oxford: Clarendon Press; London: Oxford University Press, 1925.) 2*s.* net.

THE idea of assisting the research student by explaining how to make use of the literature is a good one, and a satisfactory book on these lines would be most useful. Unfortunately, Dr. Mason has not made the most of his opportunity. He has omitted to mention many of the best works of reference, and his critical remarks are not always such as would meet with general agreement. The section on physical chemistry is particularly unsatisfactory, and no guidance as to consulting the literature is given in this part. In future editions, the author would do well to seek advice from specialists, and to find out what books are, in fact, most consulted in the large libraries. His lists read as though based on a rather arbitrarily selected private library.

Acid-Resisting Metals. By Sydney J. Tungay. (Chemical Engineering Library: Second Series.) Pp. 136. (London: Ernest Benn, Ltd., 1925.) 6*s.* net.

MR. TUNGAY deals with various types of acid-resisting metals, such as silicon-irons, lead and regulus metal, aluminium, stainless steels, monel metal, cast iron and steels, nickel and chromium alloys, copper and copper alloys, in an interesting way, and has succeeded in giving a large amount of useful information in small compass. The use of acid-resisting metals has changed many aspects of chemical engineering practice and holds out prospects of further applications. The information in the book, when it is not directly based on the author's own experience, is carefully compiled from good authorities, and the result is that one can rely on the correctness of the statements. The book can be warmly recommended.

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.*]

The Future of the British Patent Office.

THE burden of Mr. Wyndham Hulme's letter (NATURE of September 5) is that, as regards basic principles in the granting of patents for inventions, there should be a reversion to the principles which obtained during Elizabethan and early Jacobean times, and that in every particular Patent law should be made subservient to the successful establishment of industries in Great Britain. Thus although a "manufacture" might have already been known, yet if it had not been reduced to practice, a valid patent should be obtainable by anyone who was the first to put the "manufacture" into practice. Further, Mr. Hulme contends that, if novelty is to be the test for validity of a patent, it is practically impossible for a thorough search to be made by a body of officials, and that since an administrative search for novelty has long been an economic absurdity, the growth of British industry should be stimulated by a relief of the patentee from an unduly high legal standard of novelty.

There is of course always much which deserves close attention in any of Mr. Hulme's observations upon Patent law and its administration and I regret therefore that I am not altogether in agreement with the views he is now expressing.

Dealing with the topics touched upon by Mr. Hulme, I think the nature of the consideration for a patent is quite clear, namely, the publication through the Patent Office of an invention which was new when the application for the Patent was made. I agree that the meaning of the term "new invention" has changed considerably during the last three hundred years. There is not much doubt that during early Jacobean times the test for novelty lay in the direction of discovering whether or no the patented invention had been "manufactured" in England. This arose from the fact that knowledge of an invention was much more likely to have been secured through it having been manufactured than through its having been described orally or in writing. But I doubt not that, even in these early times, "novelty" would have been destroyed if on a test case having been brought before the Courts, it had been proved that the industry or invention had been known in some way or other. Unfortunately, so few cases have been reported where patents were fought in early times. The decisions of the Privy Council are all right so far as they go, but the Council often acted despotically and was not very anxious to abide by the letter of the law where the supposed interests of the nation or the interests of favoured individuals were primarily concerned. A discussion, however, of the relation of the Privy Council to the Courts of Law is one that cannot be entered upon here beyond saying that there is ground for supposing that the Privy Council often usurped jurisdiction where patents for invention were in question.

When writing became a general method of transmitting information, it was not surprising that, early in the eighteenth century, the means for imparting information concerning a new invention was concentrated upon the "Specification" and that, in consequence, the prior publication, among other things, of a writing which described an invention, should be held to be destructive of validity of a patent granted for that invention.

I think that there is a good deal to be said for the view that the original object of granting patents was the establishment of industries in England, and that if a patent was found not to have resulted in the establishment in this country as opposed to establishment in other countries, the consideration for the patent had failed. It is clear that the Courts of Law receded further and further from this view of the early law and that statute law attempted and still attempts to reinstate the original condition for the granting of patents. Whether the statutes have been successful or no is a matter upon which much diversity of opinion is present, and together with the question whether such restriction is advisable are subjects too big to deal with here.

As regards Mr. Hulme's two basic principles (*a*) and (*b*), I do not think that they are necessarily antagonistic, for in numberless instances the institution of a new industry has followed upon the disclosure of an invention. Indeed, I think it would be so difficult as to be impossible to grant patents upon the strength of the setting up of a new industry as opposed to the disclosure of an invention in writing deposited in a public office.

With respect to the granting of patents with relatively narrow claims, that necessarily and rightly follows when a search has shown that wider claims would interfere materially with the existing rights of the public. It is only just that when an inventor has added but little to the stock of public information, his monopoly rights should be proportionately reduced, and that when by an official search an inventor has been shown to be worthy of little protection, his patent rights should be virtually negligible. There is no reason, however, that when an individual has truly discovered an invention of immense and wide importance his patent, as is the case at the present day, should not be proportionately broad and his security of the highest. This means that I do not agree that when security is at its highest, restraining power is necessarily at its lowest.

The anonymous letter which Mr. Hulme quotes scarcely seems relevant. The practice of the United States Patent Office as regards claims and the law of the United States in respect of the interpretation of specifications and claims differ so much from ours that, granting what is said to be correct, the letter is but a complaint about patents granted in the United States of America.

With respect to search for novelty to which Mr. Hulme also refers, the complaint really comes down to saying that since perfection cannot be obtained in practice, it were better to have no search at all. I cannot agree to this; and I should have thought that the more thorough the search the more secure is the patent.

As regards relief of the patentee from the unduly high legal standard of novelty as mentioned by Mr. Hulme, it must be remembered that members of the public have the right to employ any extant information which has not been the subject of a patent, the term "extant information" including the associated knowledge which is the property of the expert or operative. It can scarcely be right that a patent should be granted to one who for his own purposes selects extant information, and that the public should be restrained from utilising what, before the patent was granted, they had a right to employ.

Concerning overlapping claims, I understand that it is the practice of the Patent Office to prevent this so far as it is possible. All of us are desirous of simplifying procedure, but in our zeal for simplification we must be careful not to admit abuses.

I agree entirely with Mr. Hulme's conclusion; it is only when we face at close quarters the means to be adopted that we may find ourselves at variance.

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The Theory of Hearing.

A SERIES of communications by Scripture, Wilkinson, and Hartridge concerning the mechanism of hearing has recently appeared in NATURE. In Prof. Scripture's most recent letter (February 14, p. 228), the work of Fletcher (*Phys. Rev.*, March 1924) and that of Wegel and Lane (*Phys. Rev.*, February 1924) are stated to be irreconcilable with the so-called "resonance theory" of hearing and as being in accord with a "pattern" or "deformation" theory which he advocates.

The definition of resonance in the popular sense involves the psychological factor of perceptibility of continued free vibrations after the driving force has ceased to act. If "resonance" is understood in this popular sense, the "resonance theory" of the cochlea is improperly named. Helmholtz took great pains to show that in order to explain "shakes," the vibrating areas on the basilar membrane cannot be "resonant." The damping of these selective areas obtained from data given in the Wegel and Lane paper indicates for the mid range of audible frequencies that the amplitude of free vibrations of each area diminishes to a value $1/e$ (roughly $1/3$) of its initial value in from 1 to 10 vibrations or in from 0·01 to 0·001 seconds. The vibrations are apparently not aperiodic but are highly damped. We may, therefore, conclude that the theory in question amply accounts for the suppression of free vibrations, *per se*, beyond the point of perceptibility, and, consequently, does not lead to the prediction of what Prof. Scripture calls "jangle" or "noise and jumble of sounds."

A description of the pattern of vibration of the basilar membrane as predicted by the "resonance theory" will perhaps make the matter clear. Fig. 1

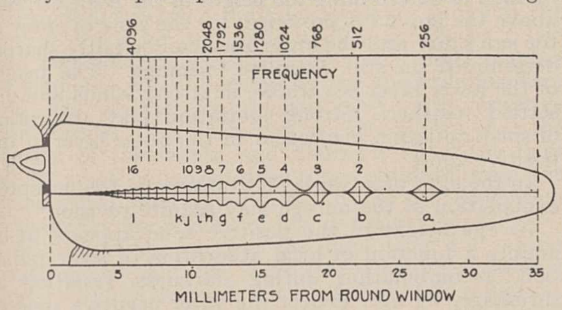


FIG. 1.

shows, in longitudinal section, the pattern of deformation of the basilar membrane in response to a sustained musical tone of pitch 256 (middle C). The amplitudes are, of course, enormously magnified when compared with the length of the membrane. This figure is made from quantitative data obtained from the paper (Wegel and Lane) referred to above. The pattern consists of a series of vibrating areas on the basilar membrane roughly elliptical in contour. These areas are larger and farther apart at the apical end of the membrane and closer together and tending to overlap near the basal end. The area, *a*, vibrates at 256 cycles or vibrations per second and corresponds to the fundamental or cord tone described in Prof. Scripture's book "Elements of Experimental Phonetics." Area *b* vibrates at 512 cycles and corresponds to the second harmonic or first over-tone. Each harmonic is represented by a characteristic area. At points where two successive areas overlap, the membrane vibrates at the two frequencies simultaneously, causing a more or less irregular stimulation of the nerve terminals. If the relative amount of higher harmonics, which produces the overlapping areas, is so great that the resultant sensation is largely due to them, the sensation is that of poor musical quality.

If the pitch of the tone is changed, the pattern moves bodily along the membrane without great change in form. When, however, the pitch is exceedingly low, the areas, *a*, *b*, *c*, tend to be closer together and wider. When very high the maxima of the overlapping areas are crowded closer together. The loudness of the note depends on the absolute amplitudes of vibration of these areas and the quality depends chiefly on the ratios between the amplitudes. The sounds from a bell or cymbals, or from a vibrating plate or bar, produce patterns on the basilar membrane consisting of vibrating areas differently spaced from those shown in the figure. A noise disturbs the whole membrane instead of exciting separate areas in the simple manner indicated in the figure. Owing to the high damping, the vibrations of the membrane remain sensible only while the sound continues.

When a musical chord is sounded the pattern is more complex than in Fig. 1. The pattern for a tone of pitch 512 is like that in the figure for 256, except that it is displaced to the left a distance *a b*. If both tones are sounded together the resultant pattern consists of a superposition of the two patterns. The areas set in vibration by the higher tone coincide exactly with the even numbered areas excited by the lower one. The resulting amplitude at any one of the even numbered areas may be either smaller or greater than the amplitude there produced by either tone alone, depending on the phase differences of the tones. If the octave is not exact, beats result at the even numbered areas. If these beats are very rapid a discord results. A chord, consisting of several notes, results in a pattern on the basilar membrane consisting of the superposition of a number of patterns, properly spaced, each like that in the figure, one for each note in the chord.

The portamento or glissando, in order to be well executed, must take an appreciable time, say $\frac{1}{4}$ or $\frac{1}{2}$ second. A portamento through the octave 256 to 512 is represented by a shift of the pattern in the figure through a distance equal to *a b*, the pattern at any time being identical in position and form, so far as it would be possible to distinguish, with a pattern produced by a sustained tone of the identical pitch falling on the ear at that instant. The pattern resulting from the sound of Prof. Scripture's accelerated toothed wheel behaves similarly. A voiced sound in speech is represented by an appearance of such a pattern on the basilar membrane, a movement to and fro to correspond to the variation in pitch of the chord tone, a correlated variation in actual and relative amplitudes of vibration of the areas to correspond to changes in loudness and quality respectively, and a disappearance, all in sensibly exact synchronism with the spoken sound.

The sense of pitch of a tone is determined from the position of the root area, *a* (Fig. 1), of the series of areas on the membrane. When, for some reason, the lower harmonics are very faint or absent from the tone, the root and first few areas are missing from the pattern, but the root position, and therefore the pitch of the tone, may be inferred by a psychological process of association. The habit of association of the root area with the pattern position, therefore, accounts for Fletcher's experiments independently of the existence of non-linearity in the ear. When more and more low harmonics are eliminated, *e.g.* with filters, as in Fletcher's experiments, the sense of a definite pitch fades and merges into a high pitched noise having poor musical value.

At the higher levels of loudness, however, non-linearity (presumably greatest at the malleo-incal joint) undoubtedly comes into play. This compensates to a certain extent for cutting out the missing lower frequencies by resupplying them in more or less reduced amounts as difference tones, to the complex vibrations entering the cochlea. The result of this process is to give a more definite sense of pitch than association alone could do. Just what relative parts are played in Fletcher's experiments by association and by non-linearity is not certain, but experience certainly indicates that for loud sounds the latter plays a considerable part.

It will now be seen that Prof. Scripture's remarks concerning his own hypothesis apply equally well to the "resonance theory." Quoting from his article above referred to: "According to this [Scripture's] theory, the basilar membrane alters the linear movement of the stapes into a change of form in three dimensions. Every external vibration produces a pattern deformation of the membrane. This pattern is communicated to the brain. A single vibration of a clarinet tone produces a definite pattern in three directions on the basilar membrane. The mental quality of the clarinet tone represents this pattern. When this vibration is repeated regularly, the clarinet quality appears to be based on a tone of definite pitch."

An extended Helmholtz or resonance theory is the only present dynamical theory which conforms to the well-known laws of vibrational mechanics. The cochlear model of Wilkinson (*Journal of Laryngology and Otology*, September 1922) has demonstrated concretely that this type of mechanism is selective after the manner supposed by the resonance theory.

Progress in this field of investigation would be more rapid if those who are at work in it made greater efforts to understand each other's methods and terminology. R. L. WEGEL.

Bell Telephone Laboratories, Inc.

The Distribution of the Two Electrical Zones in the Atmosphere.

I HAVE examined the fair weather potential gradient on several mountains in the Bernese Oberland, and find that the positive zone, in summer at midday, extends from sea-level to above the Jungfrau (13,671 ft.). When observations at greater heights are available it may be found that it reaches up to between that and 20,000 ft. above sea-level in Central Europe.

As the positive potential was lowest before sunrise, and reached a maximum in the afternoon which was maintained until near sunset, it is possible that the outer negative zone approaches near to the earth's surface during the night, and recedes during the hours of daylight.

That the properties of this zone on the mountains are due to positive gas ions, is proved by the study of mountain mists. In the simplest cases the formation of mountain mists can indeed be followed by the eye, but at times those drifting from and covering the Bernese Oberland extend for several miles, and their origin and nature are then uncertain.

In most cases I find, on electrical examination, that the "clouds" surrounding the mountain tops in summer are in reality ground mists. They proved to be positively charged on the Eiger, Jungfrau, Fischerhorn, Wetterhorn, and Faulhorn, and in each case they possessed the property of increasing the fine weather positive potential at the position temporarily, due to causes I have already described (NATURE, May 30, 1925, p. 836).

Electrical examination seems to be the only certain method of distinguishing between mountain mists and clouds, for on one occasion during broken weather a true upper cloud, negatively charged and optically indistinguishable from mist, descended for a time and surrounded the summit of the Faulhorn. Significantly, the temperature, which had stood at 10° C. for some hours, fell to 4° C. very rapidly. Hail, rain, and snow on the Faulhorn (8800 ft.) were always negative after the passage of the positive sheath.

When the magnificent panorama, seen in cloudless conditions from the summit of the Faulhorn, was examined about sunset I noted that there are *two optical zones* in the atmosphere, which are not noticeable at lower altitudes or when the sun is higher in the sky. The upper was clear and brilliant, and there was a lower, grey, hazy zone which rose from the ground-level to several thousand feet above Pilatus (7000 ft.) and Nollen (8800 ft.). The zones were most easily traced against the darker northern background, being lost among the dazzling snow-capped peaks of the Oberland.

During a cloudless sunrise the same zones were apparent, but the junction was considerably nearer to the summit of Pilatus than at sunset. It was when the lower edge of the sun's disc entered the lower zone that its red coloration became visible, and the Alpine glow commenced. As the lower zone extended higher above the horizon in the evening than at sunrise, this seems to account for the superiority of the sunset coloration, for at sunrise the solar disc quickly emerges above the lower zone.

It seems to me probable that the two optical and electrical zones are identical, and that the red colorations of sunset and sunrise are therefore largely due to absorption of solar radiation by positive gas ions (together with associated water molecules?). If further investigation confirms this view, an optical method of determining the height of the positive layer above the ground is provided, for the time of entry of the sun's disc into the lower zone can be fairly sharply determined on still cloudless evenings. The height of the lower layer is variable in strong winds and unsettled weather. Strong ionisation and absorption of solar radiation may occur in the outer layer of the positive zone.

In the light of a two-layer atmosphere the accepted explanation of the mirage may require revision.

As the height of the positive zone appears to be mainly a function of local absorption of solar radiation, recombination during darkness, resulting in shrinkage, we may expect the outer negative zone to approach much closer to the earth's surface in the Arctic and Antarctic circles during polar winters, and such thinning out of the positive zone may be a factor in the phenomena of the Aurora. A significant fact in this connexion is the absence of thunder and lightning near the Poles, to which Dr. Simpson has directed attention (NATURE, April 14, 1923, Supplement, p. x). I recently explained (*ibid.*) that disruptive discharge is due to the intense electrification resulting from the formation of the positive sheath about the negative clouds when the latter descend quickly into the lower positive zone, especially about the vanguard. Where the clouds do not descend into the positive layer there would be no sheath and no lightning.

Observations of the height of the positive zone during daylight and darkness are urgently wanted.

Ticlio (15,885 ft.), at the head of the Peruvian Central Railway, should provide an accessible site for the tropics. Alpine meteorologists have their choice of several positions. The mountains of northern Scandinavia, and Spitsbergen, would provide valuable data nearer the Pole. Once charted, mathematicians can calculate from the relative motion of the upper air and the earth how much of the earth's magnetism is explicable, and wireless experts can appraise the influence of the zones in long-range transmission.

In conclusion—a word of warning. I have previously shown that the enormous quantities of positive gas ions poured out from steam locomotives makes observation in England uncertain, and near towns entirely misleading. In Swiss valleys this factor is now negligible; but another disturbance exists there. At Grindelwald the spray from the turbulent Lutschine, and numerous waterfalls and cascades, carries its negative charge to considerable distances—200 yards on either side of the stream near the gorge. Water (like all conductors) in the open air has an induced negative charge on it in fair weather, and on severance the spray carries the negative charge with it.

WILLIAM C. REYNOLDS.

"Wharfedale," Upminster,
Essex, August 20.

The Motion of Eruptive Solar Prominences.

IN the issue of NATURE for July 4, p. 30, Mr. Evershed has reviewed a paper by Edison Pettit on the "Forms and Motions of the Solar Prominences." Dealing with the motion of eruptive prominences, Evershed thus summarises the opinion of Pettit: "The memoir concludes with a theoretical discussion of the nature of the repulsive force acting on prominences. Radiation pressure is rejected as inadequate, and the periodic ejection of showers of electrons from a disturbed area in the photosphere is suggested tentatively."

I have recently contributed a paper to the *Astrophysical Journal* in which the motion of eruptive prominences is discussed at some length. Working on the lines initiated by Saha and Milne, I have shown that selective radiation pressure provides the motive force for the motion of prominences. The selective radiation pressure is due to the bright patches or filaments which develop on the solar photosphere and are always found associated with eruptive prominences. St. John has recently shown that the spectra of the faculæ and filaments show the lines of Ti^{+} much enhanced over those obtained from the undisturbed photosphere, and hence the conclusion is that they are regions of higher temperature.

Milne has shown that the high level Ca^{+} atoms emitting H and K lines are supported against gravity by the pressure of the photospheric radiation. When regions of the photosphere get locally heated the equilibrium in the region above is disturbed, and Ca^{+} emitting H and K and hydrogen atoms emitting the Balmer lines acquire an accelerated velocity. The motive power is thus obtained from the excess of radiation pressure due to the development of filaments at the base over the solar gravity.

Pettit, however, has shown that the motion is not accelerated but uniform for some time and then actuated by impulses. A steady velocity can only be reached if the particles move in a resisting medium. Probably the frictional force is supplied by the Einstein coefficient of resistance

$$R = \frac{8\pi h^2\nu^4}{3c^5} \cdot \frac{e^{h\nu/kT}}{e^{h\nu/kT}-1} \cdot \frac{B_{1\to 2}}{1+e^{-h\nu/kT}},$$

where $B_{1\to 2}$ is Einstein's probability factor of absorption. Thus Pettit's results are not inconsistent with the theory. But in some cases, as Evershed has remarked, the motions of the eruptive prominences decidedly show continuous acceleration. These cases may be explained thus: The Einstein coefficient of resistance R works out to be a small number. The radiation pressure, on the other hand, may increase to a sufficiently high value, if the fluctuation of temperature or the size of the bright patch at the base is large enough. In this case the prominence will reach a great height before anything of the nature of a constant terminal velocity is acquired. In the meantime the velocity will continually increase, but the absolute magnitude of the acceleration will continually decrease. The impulsive increments in velocities are due to the sudden changes of temperature at the base.

All electrical theories must be discarded, for large motions are observed in the case of lines of hydrogen which are due to neutral atoms. Electrical forces cannot act on neutral atoms.

For detailed argument reference is to be made to the original paper.

RAMANI KANTO SUR.

Physics Department,
Allahabad University,
July 29.

I AGREE in a general way with the view that the motion of the eruptive prominences, and of the absorbing gases in novæ, may be best explained by selective radiation pressure.

The structure of the chromosphere itself suggests an outward movement along innumerable streams or jets, which are perhaps based on the brighter spots in the rice-grain structure of the photosphere.

There is a difficulty when we study the distribution of the larger eruptive prominences with respect to the faculæ, or brighter regions of the sun's disc. While it may be difficult to locate precisely the origin of eruptions when observed at the limb, they often seem to occur in high latitudes outside the spot-zones, and they appear usually to be connected with the larger patches of absorbing gas which are photographed on the disc of the sun in the calcium lines or in Hα. These patches tend to lie outside the faculous regions, either in high latitudes or in longitudes intermediate between the great regions of sunspot disturbance. There is thus no evidence that the photosphere underlying these prominences is brighter than normal.

On the other hand, eruptions of a somewhat different character are observed in the immediate neighbourhood of sunspots, and these may be connected with the faculæ. In rare instances they are accompanied by a phenomenon suggestive of the outburst of a nova, namely, a great but temporary increase of brilliancy in the photosphere, such as was observed by Carrington and Hodgson in 1859. Such disturbances are usually associated with line-shifts indicating motions of the order of hundreds of kilometres per second.

J. EVERSHED.

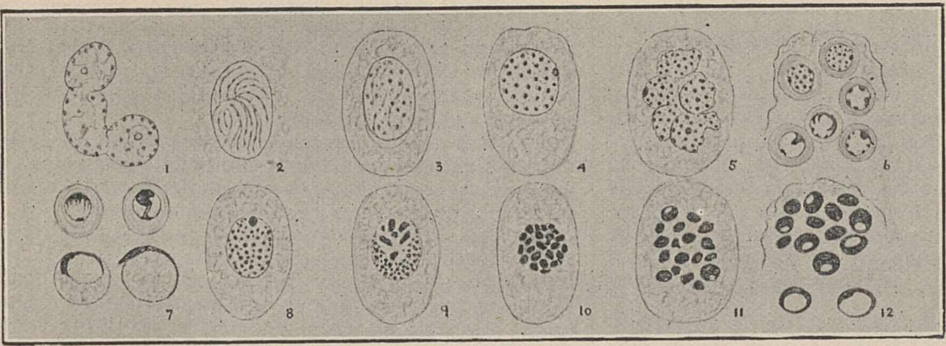
Spermatogenesis of Spiders and the Chromosome Hypothesis of Heredity.

FROM certain observations which I have recently made, it would appear that the spermatogenesis of some spiders exhibits interesting peculiarities which do not readily accord with the rigid scheme required by the chromosome hypothesis of heredity.

I have more especially studied the spider *Palystes natalius* Karsch; but certain other spiders have similar peculiarities in their spermatogenesis. The spermatogonial nuclei divide by amitosis only, and no trace of mitosis was seen in the numerous sections examined (Fig. 1). The spermatocyte nuclei form a more or less typical spireme in which many "chromomeres" develop (Fig. 2). The spireme breaks down and the "chromomeres" are left free; they grow into rounded chromatin granules of considerable size (Fig. 3). From these spermatocytes, spermatozoa arise in two ways, as follows:

(1) The spermatocyte nucleus buds or fragments in a somewhat irregular manner and gives rise to a small cluster of nuclei, each of which becomes surrounded by differentiated cytoplasm (Figs. 4-7). These small cells are the spermatids, and with the most careful observation it is not possible to affirm that only four spermatids are formed from one spermatocyte; in fact the number seems to be irregular and usually more than four. The nucleus of the spermatid becomes hollow and the chromatin concentrates at one pole and gives rise to the spermatozoon, which afterwards becomes spread over the swollen cytoplasmic vesicle like a fish-embryo stretched over its yolk-sac.

(2) The numerous chromatin granules of the spermatocyte condense and form a considerable number of large masses resembling definitive chromosomes, but when first formed there seems to be no constancy in size, and also there is no definitely fixed number. Afterwards these chromatin masses become more or less rounded and uniform in size and the cytoplasm of the spermatocyte disappears almost entirely (Figs. 8-12). There is thus formed a compact cluster of oval, or rounded, free chromatin-bodies. Each of these bodies becomes hollow and produces one spermatozoon which is differentiated peripherally.



When mature the spermatozoa originating in this way are somewhat smaller than those formed according to the first method described above. These uncoiled or unexpanded spermatozoa may occur in abundance, mixed with expanded forms, in the semen contained in the spermathecæ of the female spider. From this account it is clear that the "spermatocyte" produces far more than four spermatozoa.

It is of special interest to note that in the second method of spermatogenesis, traces of achromatic spindles may occur sporadically in association with the clusters of chromosome-like bodies, and these bodies may even become temporarily arranged in an erratic manner in the equatorial plane. It is as though the ancestral condition is not completely forgotten.

These peculiarities in the spermatogenesis of Palystes are doubtless associated with the fact that in the development of the tissues of the embryo a very considerable amount of amitosis normally occurs, and with the present evidence it seems totally impossible to assume that the offspring of cells which have divided by amitosis are incapable of dividing by typical karyokinesis.

It would be obviously absurd to suppose that the mechanism of heredity differs fundamentally in certain spiders from that in other organisms, and if these observations are duly confirmed, and I can see no escape from them, the upholders of the chromosome hypothesis, which naturally hangs on its weakest link, will have to be content with a much less rigid chromosome behaviour than is usually assumed.

A detailed account of the observations is being prepared for publication. ERNEST WARREN.

Natal Museum.

The Transmutation of Uranium into Uranium X.

As described in the *Journal for Applied Chemistry* (Berlin, Leipzig, No. 32, 1924), the present writer succeeded in 1922 in observing the transmutation of mercury into other elements, when submitted to the effect of a strong electric discharge. This discovery was described in a manuscript deposited under G 56485 IV/12 h on May 3, 1922, in the German Government Patent Office, where it may be seen by anybody. It is therefore incorrect to state that Miethe first observed the transmutation of mercury.

This must be expressly stated here in order to assert the priority of the present writer and to justify the further experiments carried out during the period 1922–1925 in a domain which was offering no promise at all at that time. After the discovery of the transmutation of mercury, it was natural that other elements, especially uranium and thorium, which are subject to spontaneous disintegration, should likewise be examined for the possibility of artificial transmutation.

For this purpose the behaviour of uranium and thorium and their salts in the electric arc and in the glow discharge in evacuated tubes has been examined. In no case could there be observed an alteration in the radioactivity or in the chemical activity. A perceptible transmutation effect was, however, unexpectedly found when strong rushes of momentary high-tension currents were sent through a narrow fused quartz tube provided with tungsten electrodes and containing mercury and uranium oxide. The tube was fixed vertically in a stand, so that the mercury filled the lower part of the tube and one tungsten electrode was completely covered by it. On the surface of the mercury was a relatively thin coating of uranium oxide which had been carefully freed from radioactive by-products, especially from uranium X, before it was introduced into the quartz tube. The sparking distance between the tungsten electrode and the mercury-uranium oxide electrode was about 15 cm. The intensity of the electric discharge varied between 0·3 and 0·4 amp.

Under the influence of repeated electric discharges during about thirty hours, relatively strong and increasing radioactivity, measured according to the β- and γ-rays method, showed itself. The tube, hermetically sealed, was also laid on a photographic plate enclosed in an aluminium box. After six hours a very perceptible blackening appeared on the part of the photographic plate corresponding to the quartz tube. The contents of the tube were dissolved in nitric acid. From the solution the artificially produced radioactive material was separated by all the known methods by which uranium X can be separated from uranium. Observation of the decrease of the radioactivity showed the half-period time to be that of uranium X. The identity of the radioactive material generated with uranium X was thereby proved. The β and γ ray activity of the uranium oxide freed from the mercury varied between 1·4 and 20 times the radioactivity of an equally large amount of uranium oxide in equilibrium with its decay products, and increased proportionally to the energy applied and to the time.

One obtains even a greater production of uranium X if one makes, in analogy to the experiments of Nagaoka, as described in NATURE of July 18, the electric discharges pass within a thick-sided quartz or porcelain vessel between a tungsten point and mercury covered with a thin coating of vaseline and uranium oxide. This coating possesses such a high electric resistance that, even when applying the highest tensions which can be obtained, one is obliged to diminish greatly the sparking distance in order to obtain a discharge. This proceeding offers the advantage that the energy is concentrated into a very small space. Consequently one can show, after half an hour's work, the production of relatively large quantities of uranium X. It should be stated, of course, that before the tests all parts of the apparatus were examined as to radioactivity and found not to be radioactive.

The production of uranium X considerably in excess of that produced by spontaneous decay is to be explained only by the fact that, under the influence of the electric force, an acceleration of the radioactive transmutation of uranium takes place.

A. GASCHLER.

Motzstrasse, 72,
Berlin, W.30.

Some Simple Characteristic Relationships among the Ferromagnetics.

THERE are some simple relations existing among the ferromagnetic bodies which no doubt have a fundamental significance. If we calculate the ratio of the critical temperature on the absolute scale (θ) to the maximum intensity of magnetisation (I_0) for each of the ferromagnetics, we obtain the following values for θ/I_0.

Iron	$1058/1817 = 0{\cdot}58 = 2 \times \frac{8}{27}$
Cobalt	$1348/1422 = 0{\cdot}95 = 3 \times \frac{8}{27}$
Nickel	$661/552 = 1{\cdot}19 = 4 \times \frac{8}{27}$
Magnetite	$808/431 = 1{\cdot}83 = 6 \times \frac{8}{27}$

Thus θ/I_0 is proportional to the simple numbers 2, 3, 4, and 6. The fraction $\frac{8}{27}$ is the numerical constant in the equation to the critical temperature, namely,

$$\frac{\theta}{I_0} = \frac{8}{27}\frac{a'}{R'},$$

where a' is the constant of the intrinsic field and R' is the reciprocal of Curie's constant.

We may ask if a new ferromagnetic material were to be discovered would it fit into this scheme; in short, are these simple whole numbers necessary to ferromagnetism ?

In Heusler's alloy we have such a new ferromagnetic material, and an examination of its properties provides one answer to this question. Recently Prof. Thompson kindly supplied me with a sample of this alloy, prepared in the metallurgical laboratory of the University of Manchester, and experiments with it show that its critical temperature is 355° C. or 628° on the absolute scale, and the maximum intensity of magnetisation is approximately 420. Hence the ratio of θ/I_0 is $628/420 = 1{\cdot}50$, and this is very nearly $5 \times 8/27$. Thus Heusler's alloy conforms to the whole number rule, and, moreover, it fills the vacant space between nickel and magnetite, so that the consecutive numbers from 2 to 6 are now complete. These numbers are exactly whole numbers within the accuracy with which θ and I_0 are known.

When it is remembered that three of these ferromagnetics are metallic elements, one is a definite chemical compound and another is an alloy of three non-magnetic metals, these results are all the more remarkable.

There are one or two other simple relations closely connected with the foregoing : for example, the ratio of the maximum intensity of iron to that of nickel is 3·3, and the ratio of the intensity of cobalt to that of magnetite is likewise 3·3. Similarly the ratio of the critical temperatures of iron and nickel is 1·60, and of cobalt and magnetite 1·67 ; so that these ferromagnetics fall into two closely related groups.

J. R. ASHWORTH.

55 King Street, South,
Rochdale, August 20.

Planetary Densities and Gravitational Pressure.

WITH reference to Mr. Mallock's letter in NATURE of July 4, I beg to point out that the gravitational forces in his supposed envelopes will increase their density to a value comparable with that of a solid unless the planets are very hot indeed. The stability of the belts and spots on Jupiter and Saturn is a serious objection to the existence of such thick envelopes.

As to the compressibility of solids, the electrostatic theory of molecular structure is inconsistent with great increases of solid density. Surely Mr. Mallock's chalk experiment indicates that in the lower chalk the conditions are nearly crystalline and not that simple compression can produce important changes in density.

HERBERT CHATLEY.

Whangpoo Conservancy Board,
Shanghai, August 4.

The Word "Australopithecus" and Others.

IN answer to Dr. Lucas's letter (NATURE, Aug. 29, p. 315) it may be said that although scientific names need not be literature, and therefore need not follow any philological rules, yet where they pretend to be derived from Greek, or Latin, or any other particular language, good taste demands that they should conform to the structural system of that language.

We "scientists" are contemptuous when the unscientific misuse our terms : if we wish to avoid the contempt of literary folk, we should be careful how we use theirs.

F. J. ALLEN.

8 Halifax Road,
Cambridge,
August 30.

Organic Evolution.[1]

By C. TATE REGAN, F.R.S.

FOR any profitable discussion of the origin of species it is essential to know what we mean when we use the word "species." In Nature we find that a number of similar individuals, with similar habits, live in a certain area; such an aggregation of individuals may be termed a community. It is unfortunate that this word has sometimes been used for dissimilar and unrelated organisms that occur together—for example, the animals found on a muddy bottom in the North Sea, or the plants of a range of chalk hills—but I am satisfied that the word "association" is more appropriate to these, and that "community" is the right name for a number of similar individuals that live together and breed together. All this is preliminary to my definition of a species. A species is a community, or a number of related communities, the distinctive morphological characters of which are, in the opinion of a competent systematist, sufficiently definite to entitle it, or them, to a specific name. Groups of higher or lower rank than species can be defined in a similar way. Thus a sub-species is a community, or a number of related communities, the distinctive morphological characters of which are not, in the systematist's opinion, sufficiently definite to merit a specific name, but are sufficient to demand a sub-specific name. Similarly a genus is a species, or a number of related species, the distinctive morphological characters of which entitle it, or them, to generic rank.

There are, of course, many species so distinct from all others and so uniform throughout their range that every one is agreed about them; but frequently the limits and contents of a species, as of a genus, are a matter of opinion. No systematist has, or should have, any rule as to the amount of difference required for the recognition of a species or a sub-species; he is guided by convenience. In practice it often happens that geographical forms, representing each other in different areas, are given only sub-specific rank, even when they are well defined, and that closely related forms, not easily distinguished, are given specific rank when they inhabit the same area but keep apart.

I have seen a species defined as a stable complex of genes—or words to that effect—and Bateson, without exactly defining a species, has insisted that those systematists who distinguish between good and bad species are right, and that the distinction between the two is not simply a question of degree or a matter of opinion. There is some truth in this; in the absence of exact knowledge, seasonal or sexual differences have been regarded as specific, and hybrids, as well as varieties that differ from the normal in some well-marked character, have been given specific names: these are certainly bad species. There is truth also in Bateson's contention that species are qualitatively different from varieties, if we restrict this word to the kind of varieties he has specially studied and do not use it for communities that differ from each other in morphological characters.

According to Bateson the principal qualities of species are morphological discontinuity and interspecific sterility; but to the implication that these have been suddenly acquired, I would reply that in Nature there is every gradation from communities that are morphologically indistinguishable to others that are so different that every one is agreed that they are well-marked species; and it is not surprising that when morphological differentiation has proceeded to this extent it should generally, but not always, be accompanied by mutual infertility. That morphological discontinuity in a continuous environment which appears to Bateson to support the theory of the discontinuous origin of specific characters is seen to be the final term of a habitudinal discontinuity that began with the formation of communities that were at first morphologically identical. Bateson's argument that the Natural Selection theory, or any theory of gradual transformation, demands that the ancestral form from which two species have diverged should persist as an intermediate is seen to be quite fallacious if we get a firm grip of the idea of the division of a species into communities, followed by the evolution of each community as a separate entity.

A great deal of work has been done, especially on our more important food-fishes, in making biometrical analyses and investigating the life-histories of the different communities.

I have studied with particular attention the fishes known as char, or salmonoid fishes of the genus Salvelinus. Char are very like trout in appearance, but have orange or scarlet spots instead of black ones; they inhabit the Arctic Ocean and in the autumn run up the rivers to breed in fresh water, often forming permanent freshwater colonies in lakes. There are many such colonies in the lakes of Scandinavia, of Switzerland, and of Scotland, Ireland, and the Lake District of England; the formation of these colonies must date back to glacial times, when these Arctic fishes occurred on our coasts and entered our rivers to breed. These lacustrine communities show considerable diversity in habits and also in structure; for example, the char of Lough Melvin in Ireland are quite unlike those of Loch Killin in Inverness in form, in coloration, in the shape of the mouth, and in the size of the scales; these differences are sufficient to entitle them to be regarded as different species, and I have so regarded them; but now I doubt whether it is not better to look upon all these lacustrine char, however well characterised, as belonging to the same species as the migratory char of the Arctic Ocean, for once you begin giving specific names to lacustrine forms of char you never know where to stop. But if we were to exterminate the char in the British Isles and on the Continent, except in a dozen selected lakes, we should have left a dozen well-marked forms which it would be convenient to recognise as species. A somewhat similar problem arises in the classification of man; it is convenient to place all the living races in one species. But if there were only Englishmen and Hottentots we should probably regard them as specifically distinct.

In our British char, habitudinal segregation—the formation of communities in lakes—has been followed by a geographical isolation which commenced at the

[1] From the presidential address delivered at Southampton on August 28 before Section D (Zoology) of the British Association.

end of the glacial period, when the migratory char retreated northwards. The char of each lake have evolved separately, and one can see clearly how many of the differences between them are related to the conditions of life; for example, the large eyes of the Loch Rannoch char, which lives in a very deep lake, and the blunt snout and rounded subterminal mouth of several kinds which always feed at the bottom. I confess that I do not understand why the scales are much smaller and more numerous in the char of some lakes than in those of others, but I suspect that these differences in scaling are the expression of physiological differences, and are the result of differences in the environment or in the activities of the fish.

The genus Salmo comprises about ten species from the North Atlantic and the North Pacific, and I have shown that the salmon and trout of the Atlantic form one natural group and those of the Pacific another. Our own salmon and trout are two closely related species; both of them range in the sea from Iceland and northern Norway to the Bay of Biscay, both enter rivers to breed, and in both the young fish, known as parr, remain in fresh water until they are about two years old and six inches long, and then go to the sea. From Mr. F. G. Richmond, a well-known pisciculturist, I have the information that although at certain seasons the parr of both salmon and trout may eat the same kind of food—for example, both take flies at the surface—yet on the whole their food and feeding habits appear to be different. Salmon parr seek their food, such as insect larvæ, small molluscs and crustaceans, on the bottom, whereas young trout tend to keep in mid-water and to subsist more on water-borne food; thus the salmon parr may be hunting for food in a stretch of shallow rapid water, while the young trout wait for it in the quieter water just below. When they are about six inches long the parr of both species become silvery and are termed smolts; the trout smolts go to the sea in a leisurely manner, hanging about the estuaries, and the older fish frequent the coastal waters; but the salmon smolts make straight for the open sea and there grow much faster than the trout, attaining a weight of several pounds in a year.

I have gone into these details because I think it is important to establish that two closely related species in the same area have different habits, and to a large extent avoid competing with each other.

The morphological differences between salmon and trout are slight. The salmon, more active and a stronger swimmer, is more regularly fusiform in shape and has a more slender tail and a more spreading and more deeply emarginate caudal fin, differences of the same kind but not of the same extent as between a perch and a mackerel. The rows of scales between the adipose fin and the lateral line are usually fewer (10 to 13) in the salmon than in the trout (12 to 16); but this may be directly related to the fact that the tail is more slender. On an average the salmon has one ray more in the dorsal fin than the trout, and I am tempted to regard this as a step towards that increased number and concentration of the dorsal rays which is so characteristic of swift-swimming pelagic fishes. The last difference between the two species—the smaller mouth of the salmon—may be related to the food and feeding habits of the parr. In structure as in habits the salmon is more specialised than the trout, and may have evolved from it. The salmon is found on the Atlantic coast of North America, where there are no trout; but I think this is because its habit of going farther out to sea has given it a greater opportunity of extending its range. There can be little doubt that the differentiation of these species has been not geographical but habitudinal, comparable to the differentiation of the coastal and open-sea herrings.

In every river and lake that it enters, the trout forms freshwater colonies, and on the other side of the Atlantic the salmon does so fairly readily, although not nearly so generally as the trout does on this side. In Europe, trout being present, the salmon forms freshwater colonies only in exceptional circumstances. Thus Lake Wenern in Sweden, now cut off from the sea by inaccessible falls, has a stock of salmon; there can be no doubt that in former times salmon entered the lake and bred in its tributaries, and that some of the smolts, when they reached the lake on their seaward migration, considered this very large lake a sufficiently good substitute for the sea to stay there, and so founded a lacustrine race.

Freshwater colonies of trout are found in the Atlas Mountains and in the countries north of the Mediterranean eastwards to the Adriatic, proving that in glacial times the range of sea-trout extended southward to the Mediterranean. The rivers of Dalmatia and Albania are inhabited not only by trout but also by fish of another species, known as *Salmo obtusirostris*. This little fish, which never grows larger than fifteen inches long, has all the structural characters that distinguish salmon from trout, and, indeed, looks very like an overgrown salmon parr; but when compared with salmon of the same size it is seen to differ in having a considerably smaller mouth, weaker teeth, and more numerous gill-rakers (15 to 18 instead of 11 to 14 on the lower part of the first arch). In fishes generally the number and length of the gill-rakers—projections from the gill-arches that prevent food from entering the gill-chamber with the respiratory current—are related to the nature of the food; thus, in exclusively piscivorous fishes, such as the pike, they are represented by a few short knobs, and in feeders on minute plankton organisms they are very numerous, long, slender, and close-set. It has been recorded that *Salmo obtusirostris* subsists mainly on the larvæ of Ephemeridæ, which are very abundant in the rivers it inhabits, and there can be no doubt that the small size of the mouth, the feeble dentition, and the increased number of gill-rakers are related to this diet.

The presence of this fish in the rivers of the east side of the Adriatic seems to me to point to the probability that in glacial times salmon, as well as trout, occurred in the Mediterranean, and that in these rivers some of the salmon parr, tempted by the abundance of parr food, preferred to continue the parr life instead of going to the sea as smolts, thus forming a freshwater colony in quite a different way from the salmon of Lake Wenern. The question may be asked: If these fishes are derived from salmon and live in the same way as salmon parr, how can their differences from salmon be adaptive? The reply to this is that the size of the mouth in the salmon parr must have some relation to the fact that it is going to become a salmon, feeding on fishes in the sea, and that, as *S. obtusirostris* grows to twice the length of a salmon parr, we should expect the number of gill-rakers to be increased, for it is not number but the size of the interspaces that is important in relation to food.

The work of Dr. Johannes Schmidt on the viviparous blenny (*Zoarces viviparus*) is of great interest. He found that samples of Zoarces from various parts of the Kattegat and Baltic differed slightly, but generally had an average of about 118 vertebræ, but that in the shallow Danish fiords the number was less, and decreased progressively the farther the distance from the sea. Conditions of temperature, salinity, etc., are very different in the different fiords, and I am inclined to think that the critical character common to all of them is that they give the Zoarces an opportunity of leading a quiet life amidst a plentiful supply of food; hence the fiord Zoarces can be distinguished at a glance from those outside by their shorter and deeper form. For example, in the Mariager Fiord, a narrow inlet about twenty miles long, the average number of vertebræ decreases from 115 at the mouth to 111 about seven miles inland and 110 about fifteen miles inland; two samples from the extreme end of the fiord and from a point four miles from the end both showed exactly the same average, 109·3.

There can be no doubt that the fiords were originally populated from the outside, and it seems likely that the decreased number of vertebræ in the fiords is related to the lesser activity of the fiord fish. Evolution has proceeded to such an extent that the Zoarces of the Roskilde Fiord differs from that of the Kattegat more than does the European eel from the American, and these are generally regarded as good species. But the repetition of the same phenomenon in different fiords, and the continuous gradation from one form to another, make it impossible to recognise species here. Zoarces are very stationary, but possibly the young are more migratory than the adults. If we suppose that these fishes move on an average a mile a year, or even less, and mate with the nearest fish of the opposite sex, we can understand how the tendency to form a pure fiord race is hampered by continuous interchange, and how the influence of the outside form gradually diminishes until in the innermost waters it is not felt at all and isolation is accomplished. In each fiord a series of intermediates, hybrids if we like so to term them, connect two well-differentiated communities, one in the sea, the other in the inner waters of the fiord.

These detailed examples are sufficient to illustrate my view that some form of isolation, either physical or produced by localisation or by habitudinal segregation, is a condition of the evolution of a new species. The effects of physical isolation, due to the formation of a barrier, are well seen in comparing the fishes of the Atlantic and Pacific coasts of Central America, most of which can be paired, one species being found on the Atlantic side and its nearest ally on the Pacific side. The effects of habitudinal segregation are, as it seems to me, seen in the cichlid fishes of Lake Tanganyika, where there are ninety species that appear to have evolved in the lake from two ancestral forms; the differences between these species in the form and size of the mouth, and in the dentition, are an indication that their diversity is related to specialisation for different kinds of food.

The whole of my work leads to the conclusion that the first step in the origin of a new species is not a change of structure, but the formation of a community either with new habits or in a new or a restricted environment. For some species we know fairly certainly what has happened, and where, when, and why: Shall we ever know how? Experimental attempts to repeat the operations of Nature might perhaps give us a clue, but I do not expect one from experiments of the kind that are so fashionable nowadays.

For example, if *Salmo salar* and *Salmo obtusirostris* could be bred together, it would not matter much whether the hybrids were sterile or fertile; and if they were fertile it would not interest me to know that the variation in their offspring could be squared with the factorial hypothesis by the ingenious assumption that there were several factors for both larger mouth and smaller mouth and for fewer gill-rakers and more gill-rakers. Even if the number of gill-rakers in either species could be increased or decreased by thyroid extract, I should still be unconvinced that we had got much nearer to the root of the matter. . . .

Throughout, the evolution of fishes illustrates the same principles. Changes of structure have been intimately related to, and may even be said to have been determined by, changes of babits, and especially changes of food and of feeding habits. Evolution has been adaptive, but modifications of structure that were originally adaptive persist when they are so no longer; they become historical and the basis for further adaptive modifications. I am satisfied that these principles, which I have illustrated by examples from the group I have specially studied, have a general application.

Darwin's theory of evolution was that it had been accomplished mainly by natural selection, aided by the inherited effects of use and disuse. Whether that theory be permanent or not, it was put forward by a man pre-eminent for his wide knowledge and his great reasoning powers, who knew the facts that had to be explained and gave us a theory that explained them. The "Origin of Species" still remains the one book essential for the student of evolution.

Darwin has been criticised because, we are told, he did not know that there were two sorts of variations—mutations, which are inherited, and fluctuations, which vary about a mean and are not inherited. But when you point out to a mutationist that the heredity of many fluctuating variations has been proved—parents above the mean, for example, giving offspring above the mean—he tells you that that shows that the variation is not really fluctuating, but only apparently so, and that a large number of "factors" must be involved. This is in effect a complete withdrawal, for it amounts to an admission that Darwin was right if he considered that these types of variation differed only in size and frequency.

There are other critics, however, who admit that at any rate some fluctuations are inherited but say that the effect produced on a population by selection is limited; elimination of certain types will change the average, but will produce nothing new. This criticism has also, as it seems to me, been disproved experimentally; for example, by De Vries, who from two plants of clover in which a few leaves were four-lobed produced by selection a variety in which the number of lobes of the leaves varied from three to seven, fluctuating about a mean of five. Incidentally this experiment shows the relation between mutations and fluctuations.

The criticism that many specific characters are non-adaptive merely amounts to this, that we do not know the meaning of many specific characters. Moreover, we are not likely to for a long time, for a prolonged study would be necessary to understand fully the meaning of the differences between any two species, to determine which characters were adaptive, which historical, which due to the environment, and which the expression of metabolic differences.

If these criticisms of the natural selection theory can be met, it does not follow that it is a complete theory. It may be a sufficient explanation of certain types of evolution, and one cannot wonder that those who have studied mimicry in insects are firmly convinced of its truth; but the evolution of the dodo, and of the blind fishes of subterranean waters, put rather a strain on the theory and almost demand the recognition of the inheritance of the effects of use and disuse.

If this be admitted, if the adaptive responses of an organism to changed habits and changed conditions make it possible for subsequent generations to respond with greater effect, then the part played by natural selection in evolution of this kind would be subsidiary, the selection of those individuals who responded earlier or better than their fellows. How well this idea fits in with that fundamental generalisation, the law of recapitulation, which states that ontogeny tends to repeat phylogeny, and that the more remote the ancestor the earlier it will be represented in the developmental history! This generalisation, based on embryological data, has since received strong support from palæontological evidence.

Most people are aware that a flat-fish when first hatched is symmetrical and swims vertically, but that at an early age one eye migrates round the top of the head to the other side, and the little fish sinks to the bottom and henceforth lives with the eyed side uppermost. But perhaps it is not so well known that it has been shown that almost as soon as the fish is hatched the cartilaginous supraorbital bar above the eye that is going to migrate begins to be absorbed, and is eventually represented only by short processes of the otic and ethmoid cartilages, with a wide gap between them. Through this gap the eye migrates, with the result that, when ossification begins, the main part of one frontal bone is on the wrong side of its eye. The flat-fishes are an offshoot of the perch group, and it is known that some of these have a habit of resting on one side. If such a fish found it profitable to lie in wait for its prey in this position, it would naturally try to make some use of the eye of the under side, pressing it upwards against the edge of the frontal bone. In the flat-fishes the migration of the eye into and across the territory of the frontal bone, prepared for by the absorption of the cartilaginous precursor of the frontal bone before the eye shows any sign of migration, may well be interpreted as the final stage of a process thus initiated.

You will have seen, then, that I am inclined to accept Darwin's theory as a whole, including both natural selection and the inherited effects of use and disuse, at any rate until some better explanation of the facts is forthcoming. But still there are difficulties, and to illustrate them I must give one more example from the fishes.

The most primitive spiny-rayed fishes are the Berycoids, which flourished in Cretaceous times; in some of these the vertebræ number 24—10 præcaudal and 14 caudal. In many families of Percoids, not at all closely related to each other, we find this number of vertebræ is a constant family character; for example, all the genera and species of sea-breams (Sparidæ), red mullets (Mullidæ), chætodonts (Chætodontidæ), grey mullets (Mugilidæ), and barracudas (Sphyrænidæ) have 24 (10 + 14) vertebræ. The conclusion is inevitable that this is a primitive percoid character derived from a berycoid ancestor. Yet we have clear evidence that whenever the circumstances demanded it this number could be decreased or increased. There is no variation and therefore no material for selection; also the number of vertebræ is settled at a very early stage, and no fish can increase or diminish that number in its lifetime. Psettodes, the most primitive living flat-fish, has 24 (10 + 14) vertebræ; it is simply an asymmetrical perch. It has a large mouth and strong, sharp teeth, and its principal movements are probably short dashes after fishes that come near enough to be caught. But in other flat-fishes the number of vertebræ is greater: in the sole, which feeds on small invertebrates that it finds in the sands, and swims along with undulating movements of the whole body, the number is about fifty, and in the tongue-soles (Cynoglossus) there may be so many as seventy vertebræ.

We are almost compelled to believe that muscular movements, the efforts of a fish to swim in a certain way, may lead to an alteration in the number of muscle segments of its descendants; the number of vertebræ is, of course, determined by the number of muscle segments. This is an extension of the Lamarckian theory, and some may regard it as a teleological speculation unworthy of serious consideration; some may even think that, as my suggested explanation is incredible, we have here another example of the truth of the mutation theory, which in effect states that it is only by accident that a structure has a function.

Many biologists have adopted Weismann's germ-plasm hypothesis so whole-heartedly that they seem to regard it as a final disproof of Lamarck's theory. But when we consider that in progressive evolution, as in the development of the individual, increasing complexity of structure and localisation of functions is accompanied by co-ordination of the activities of all the parts, that differentiation and integration go together and the organism remains a unit, the so-called "inheritance of acquired characters" seems no more unlikely in the most advanced Metazoa than in the simplest unicellular organisms; and in some of these it has been proved.

When I read Huxley's essays as an undergraduate I was greatly impressed with his remark that "Suffer fools gladly" was very good advice. If a man does not agree with you, try to find out why he thinks as he does; you may discover the weakness of your own position. We should not adopt theories as creeds and denounce other theories as heresies. We are more likely to make progress towards the solution of the problem of evolution if we keep open minds and take broad views.

The British Association: Connexion with Oxford.

AT the close of the first meeting of the British Association, held at York in 1831, the assembly stood adjourned to Oxford, the Rev. Prof. William Buckland becoming president-elect. Before the meeting dissolved, a speaker declared that in his opinion the Association was destined "greatly to enlarge the boundaries of science, and in so doing advance the many interests of human nature which depend upon the improvement of knowledge." It was all very tentative then, a matter indeed of faith, and faith sustained hope.

The train was thus laid for the second meeting held at Oxford in 1832. Since that date three other gatherings have met in the city, namely, 1847 (Sir R. H. Inglis, Bart., F.R.S., president); 1860 (Lord Wrottesley, F.R.S., president); 1894 (the Marquis of Salisbury, K.G., F.R.S., president). Next year, as we know, H.R.H. the Prince of Wales will occupy the presidential chair at Oxford.

Buckland, at the time of his appointment as president, was an enormous asset to the well-being of the first-born of York—a child able to walk, scarcely to run. He was a fellow of the Royal Society, and a past-president of the Geological Society. Moreover, he possessed agreeable social qualities, not least of which was a keen sense of humour. He had a habit of carrying about with him a large blue bag, containing fossils. Once, he said, he paid a visit to Sir Humphry Davy. "Has Dr. Buckland not called to-day?" inquired Sir Humphry. "No, sir," said the servant, "there has been nobody here to-day, but a man with a bag, who has been here three or four times, and I always told him you were out."

Buckland's address upon taking up the duties of his office was brief, in no way comparable with present-day extended surveys. He, however, gave a lecture on the fossil remains of the Megatherium. Cuvier had died on May 13 in the same year, and Buckland took occasion to give eloquent expression to the loss sustained by the death of that illustrious naturalist and leader. In the mid-week, at a general meeting, the first award of the Wollaston gold medal was made by Roderick Murchison, the president of the Geological Society, to William Smith, the acknowledged "Father of English Geology."

A voluminous report was presented by J. F. W. Johnstone on the recent progress and present state of chemical science. At an evening meeting Dr. Ritchie delivered a lecture on "Magnetic Electricity," with reference especially to recent discoveries of Faraday. Brunel gave an account of the attempt to carry a tunnel under the Thames.

At a Convocation, honorary degrees were conferred on Sir David Brewster, Robert Brown, John Dalton, and Michael Faraday, a "hodge-podge of philosophers," commented Keble.

Fifteen years had elapsed before the Association met again at Oxford in 1847. By then the permanence and stability of the organisation was fully assured, the boundaries of scientific effort advanced in all directions. The chair was taken by Sir Robert H. Inglis, member of Parliament for the University. We may conclude that the latter qualification really led to his selection. He was a politician, one who opposed the repeal of the Corn Laws; a country gentleman with a genial manner, and capable of making friends; one also who took great interest in learned and religious societies, but, as chronicled by his biographer, "with many prejudices and of no great ability." We get a glimpse of views entertained by the president of the wonder-working electric telegraph. Sir Robert Inglis expressed regret that so great a discovery had been inadequately welcomed in Great Britain. Yet in the discharge of public business was it not important? He had had an opportunity of examining the telegraph in the lobby of the House of Commons, by means of which communication passed to distant rooms. He gave specimens of information thus conveyed: "Committee has permission to sit until five o'clock"; and among questions sent down were the following: "What is before the House?" "Who is speaking?" "How long before the House divides?"

John Couch Adams, the discoverer of the planet Neptune, made personal acquaintance with Leverrier at this meeting, and both were Sir John Herschel's guests. Leverrier's indications had supplied the basis for the location of the planet in 1846, but months earlier Adams had set down the data.

Dr. Schunck discoursed on colouring matters. Edwin Lankester read a paper "On the Plant which yields Gutta Percha," and prophesied its application as probably "very extensive." Owen, too, was at the meeting, and Ruskin, as secretary of the Geological Section. The youthful Huxley sent from H.M. *Rattlesnake* a paper on the corpuscles of the blood of *Amphioxus lanceolatus*. Faraday exhibited three specimens of diamonds received from M. Dumas, which had been subjected to intense heat. Joule read a paper (the third) on the mechanical equivalent of heat, which was, remarks Mr. Howarth, heard by both Faraday and Thomson (afterwards Lord Kelvin), the second of whom perceived that "it contained a great truth and a great discovery."

The Association did not return to Oxford until 1860, Lord Wrottesley becoming president. For four years (1854–58) his lordship had occupied the presidential chair at the Royal Society, earlier (1841–43) that at the Royal Astronomical Society. Hence he brought distinction and experience to his new office. Lord Wrottesley's address dealt rather fully with astronomical subjects. The important event of the opening of the New Museum at Oxford was referred to as an omen of bright hope in the diffusion of science. It is well to go back upon the past and quote the president's remarks respecting practical applications of chemistry. "We may refer," he said, "to the beautiful dyes now extracted from aniline, an organic basis formerly obtained as a chemical curiosity from the product of the distillation of coal-tar, but now manufactured by the hundred-weight in consequence of the extensive demand for the beautiful colours known as mauve, magenta, and solferino." In physiology, note was made of great and steady advances in the chemical history of nutrition, and of the electricity of nerves and muscles. The recent return of McClintock from the search for Sir John Franklin was alluded to. The "Voyage of the *Fox* in the Arctic Seas" had been published late in 1859.

Passing to sectional details, it is incumbent to recall two papers read at Oxford at this time, respectively by Dr. Daubeny and Prof. Draper, of New York. Darwin's "Origin of Species" had appeared in 1859, of which by 1860 no fewer than eleven editions had been issued. These communications offered but cautious approbation of Darwin's researches. In itself, Draper's paper embodied an attempt to show that the advance of man in civilisation does not occur accidentally or in a fortuitous manner, but is determined by immutable law. From his work on physiology, published in 1856, he gave his views in support of the doctrine of the transmutation of species, the transitional forms of the animal and also the human type, the production of new ethnical elements or nations, and the laws of their origin, duration, and death. We must go outside the official Report of the Association for the year to piece together the records of the controversy and storm of words which waxed and raged round these communications; in a sense they were but stalking-horses, in any event traps for the unwary. Yet, looking back upon this mixed chapter of scientific and clerical polemics, the happenings all seemed inevitable. The stage was set, the disputants in place. Prof. Buckman sent a further report on experimental plots in the botanical garden of the Royal Agricultural College, Cirencester, while Lawes and Gilbert again entered the domain of classic inquiries with a paper on the "Composition of the Ash of Wheat grown under various circumstances." Capt. Maury, of the U.S. Navy, had written to the president urging attention to Antarctic exploration, concluding cheerily with the words, "So trusting and hoping that you will join with me in the cry 'Ho for the South Pole!'" William Fairbairn reported experiments to determine the effect of vibratory action and long-continued changes of load upon wrought-iron girders.

In 1894 the Association again chose Oxford, after what Lord Salisbury, the president, and Chancellor of the University, termed "a long and dreary interval of separation of thirty-four years." Consequently a new generation participated in the proceedings of the reunion. The gathering was a great success, 2321 persons taking up membership, while no fewer than 77 foreign members attended, including Prof. Mittag-Leffler, Prof. Ludwig Boltzmann, Dr. S. P. Langley, M. Cornu, Prof. E. Van Beneden and Prof. Strasburger. One is painfully conscious in looking over the roll that time has brought about the removal of many eminent personalities in science since Oxford last received the Association.

Certainly the most notable occurrence at the meeting was the announcement by Lord Rayleigh and Prof. William Ramsay of the discovery of a new gas in the atmosphere—argon. It fell to Sir Henry Roscoe to propose a vote of congratulation.

The president's address was prefaced by the open confession that he was, after all, only a layman, and "all the skill of all the chemists the Association contains will not transmute a layman into any more precious kind of metal." Nevertheless, the discourse provided a distinctive summary of advances, and comments thereon. In Lord Kelvin's view there was throughout "the spirit of the student, the spirit of the man of science." Prof. Huxley seconded a vote of thanks. It was reserved for an eminent mathematician and publicist to write later: "We find nothing in it which shows either the student or man of science; it teems with fallacious conclusions; and whatever may have been intended by the author, it can only serve as an appeal to the gallery, which is occupied by the reconstructed theological party."

In one of the sections Hiram Maxim gave a description of his experiments on flying by means of aeroplanes. Mr. Henry Balfour, in a paper on the evolution of the bow as a musical instrument, gave the aboriginal races of Africa and India the credit of providing the prototype of many of our best stringed instruments. Mr. Preece discoursed on signalling through space. Sir Andrew Noble told of his methods for measuring pressures in the bores of guns; that the earliest attempt, by direct experiment, to ascertain pressures developed by fired gunpowder, was that made by Count Rumford; but Sir Andrew pointed out assumptions and erroneous determinations. Lord Salisbury attended Prof. Rücker's address in the mathematical section; afterwards an adjournment was made to the Clarendon Laboratory to hear Lord Kelvin describe experiments on the electrification of the air. Prof. H. B. Dixon, president of the section of chemical science, took as his subject "An Oxford School of Chemistry." "If it be a true saying," he remarked, "that men here imbibe a liberal education from the very air breathed by Locke and Berkeley, surely we also may draw scientific inspiration from this air, not only breathed, but first explained, by Boyle, and Hooke, and Mayow."

Two evening lectures were delivered (1) by Dr. J. W. Gregory, on "Experiences and Prospects of African Exploration"; (2) by Prof. J. S. Nicholson, on "Historical Progress and Ideal Socialism"; the lecture to the operative classes was by Prof. Sollas, on "Geologies and Delugies."

There was an overflowing attendance at the Sheldonian Theatre to hear Lord Salisbury's presidential address. It seems that numbers of volunteer helpers were swept aside, through the determined inrush of visitors, and thus were unable to perform their functions. An experience such as this will doubtless be borne in mind on the occasion of the meeting to be held next year.

T. E. JAMES.

Recent Developments in the Theory of Magnetism.[1]

By Prof. C. G. DARWIN, F.R.S.

THERE have been several important discoveries made in the theory of magnetism in the course of the last two or three years, and we shall discuss some of these; but in order to appreciate them it will be well to begin with a description of the general magnetic properties of matter. All magnets can be typified by the ordinary bar magnet, which has a north pole at one end and an equally strong south pole at the other. If such a magnet is cut in half, the north half grows a south pole at the section and vice versa. In consequence of this we do not take the magnetic pole as the working

[1] Discourse delivered at the Royal Institution on Friday, May 15.

unit, but the magnetic dipole. We imagine that each molecule of the bar has north and south poles, and that they are ranged end to end, so that all the middle ones cancel out and leave a free north pole at one end and a free south at the other. The measure of a magnet is then taken, not as the pole strength, but as the *magnetic moment*, which is the product of the pole strength into the length. The moment of the whole bar is the sum of the moments of its molecules.

There are two chief ways in which magnetic effects exhibit themselves. The first is that shown by a compass when it twists round so as to point along the direction of the earth's field. There is another effect which is very important, and to be distinguished from it, which arises when the field is not uniform. Then one end of the magnet will be pulled more than the other is pushed, and so the magnet will experience a force moving it bodily—this may be either an attraction or a repulsion. The first effect is usually easier to exhibit, but we shall be more concerned with the second.

Under the influence of a magnet all bodies become themselves magnetic, but there are three quite distinct types of behaviour. A piece of iron becomes strongly magnetic with a south pole next the north pole of the inducing magnet. Iron, nickel, and one or two other substances have this property to a high degree, but there are many others, for example aluminium, which show it feebly. For all these it is about a hundred-millionth less, and so a different name is used. Iron, etc., are said to be ferro-magnetic, the rest are called para-magnetic. If a paramagnetic rod is put between the poles of an electro-magnet, it becomes itself a feeble magnet with north pole next to the south pole of the inducing magnet. There exist many other substances, for example copper, having the opposite property. Facing the north pole of the electro-magnet there appears a feeble north pole. This property is called diamagnetism. The measure of the two properties is called *susceptibility*, and is positive for paramagnetic and negative for diamagnetic substances. It is found by making experiments in non-uniform fields. A paramagnetic substance tends to move into the strong field, a diamagnetic out of it. So a bar hung between pointed pole pieces will twist round towards the points in the first case and away from them in the second.

Magnetic action is exhibited by electric currents, as is typified by the galvanometer and every ordinary electrical measuring instrument. Now, in science one cannot admit that two radically different things can produce identical effects, so we are forced to conclude that either the current is really a magnet, or the magnet is really a current, and the second is certainly the correct alternative. In each iron atom there is a current circulating, and this current gives rise to its magnetic moment. We shall see now how this explains dia- and para-magnetism, taking for simplicity the supposition that we are dealing with a gas.

Suppose that we surround a cylinder of metal by a wire and then send a current through the wire. The current causes a magnetic field along the axis. At the moment of making, an eddy current will be induced in the cylinder in the opposite direction, but the frictional resistance to the flow of electricity will destroy this quickly. But if there were no friction (as is actually the case at very low temperatures) this current would persist indefinitely, and would exert a magnetic field weakening the other. This is exactly what diamagnetism does. So we say that the atom is something like a frictionless conductor. When a field is put on it induces opposing currents in the atoms, and these persist and exert a field opposing the external field.

We must next explain paramagnetism. We believe that every atom has the induced current of diamagnetism, but that this is overridden by a second property. Each atom of a paramagnetic gas has a magnetic moment, even when there is no field. If we could suppose them to be little bar magnets, they would swing to and fro in the presence of an external field, and would be oftener pointing down the field than up it. This would give an extra magnetic moment down the field and would be paramagnetism. Unfortunately the matter is not so simple as this, because the moment must be caused by a revolving electron, and this behaves quite differently. It may be likened to a top, which has the property of always moving at right angles to the direction in which it is pulled. So our atom will not go towards the field at all but will precess round it, and there will be no gain of magnetic moment in the direction of the field. In order to get this gain we have to allow for collisions between the atoms, for then the axes of the tops will be able to change, and will, in fact, have the tendency to point oftener towards than away from the field. The amount of the effect may outweigh the diamagnetism which is always present. The phenomenon shows a clear sign that it depends on collisions, for whereas diamagnetism is constant, paramagnetism depends on the temperature. When the gas is hot, the violence of the collisions makes nearly as many molecules point away as towards the field, but when it is cold the gentle collisions allow them nearly all to settle down along the field.

There is a most difficult point in the argument which is rather too abstruse to explain in detail. It turns on the proper way of taking the averages of the moments of the atoms. This must be carried out with the greatest rigour from dynamical principles. In the past many writers tried to make short cuts and obtained a variety of results. Some proved there could be no paramagnetism, some no diamagnetism, and some even that there could be neither. The essential point of the argument is that the atom must have somewhere the property of a top, which goes on spinning at the same rate however its axis may be altered. It must, so to speak, be able to remember for an indefinite length of time how it behaved when the field was first put on. At least that is how the matter stands on the classical theory. But, as we shall see later, there is definite experimental evidence which shows that the atom is only allowed to exist in a certain very limited number of states, and this rather eases the difficulty; for it need no longer remember its past history, but instead must conform to a rule, unexplained it is true, but in general conformity with other unexplained properties of matter.

The question arises as to whether there would be any way of observing the magnetic moment directly. Such a way was suggested by Stern about three years ago, and the experiment which he carried out in conjunction with Gerlach is certainly one of the most remarkable of the present century. In a vacuum an atom of gas will go in a perfectly straight line until it hits the wall. If a source of atoms is in line with two fine slits, they will all hit the opposite wall in a narrow line. The atoms were obtained by boiling silver in a small furnace. Those which get through the slits strike the wall and stick there. Even after four hours nothing is visible on the glass, but there exist chemical methods of development whereby the invisible trace of silver attracts more silver from the developer and becomes visible. Now suppose that in their path the atoms encounter a non-uniform magnetic field. In the gaseous form the atoms of silver have a magnetic moment, and so they will experience a deflecting force. If the atoms were pointing arbitrarily in all directions, the character of the field shows that the fine line of the image should be spread out into a lens-shaped figure. What is in fact observed is quite different; the lens is there but it is hollow. The atoms are all pointing straight towards or straight away from the magnetic field.

This result would have been astonishing twenty years ago, but as a matter of fact the experiment was tried with a fairly strong expectation that it would turn out as it did. The quantum theory has illuminated many branches of physics, but none more than spectroscopy, and in particular it describes with complete success the influence of magnetic fields on spectra. According to this theory the atom is a very definite structure, and the definiteness extends not merely to size and shape, but also to its direction in space. The theory goes further and indicates that an atom ought to have a definite magnetic moment, which is called the " Bohr magneton," or in some cases a simple multiple or fraction of this. In silver the deflexion corresponds exactly to one magneton. Several other substances have since been measured, and most of the effects explain themselves on the same principles. Modern physical theory has to face a great many difficulties, and one of the severest is to explain how it is that half the atoms can point away from the field. Each atom evaporates in the furnace right outside the magnetic field and pointing in an arbitrary direction. As it enters the field, if it is to point away, it must gain energy, and there is nowhere from which the energy can come. This would have been a severe difficulty a few years ago, but dynamical toleration has grown recently, and it is becoming recognised as a probability that energy is only conserved on the average and not exactly.

The older calculations of para- and dia-magnetism depend essentially on assuming that the atoms can point in any direction, and they go wrong if this ceases to be true. We know it to be untrue in Gerlach's experiments, and the question arises as to whether it is true in other cases. This is the subject of some very remarkable recent experiments by Glaser. The susceptibility of gases is very small and hard to measure unless the gases are compressed. Glaser has perfected the arrangements of one method of experiment to such a high degree that he could measure the effect for very low pressures. The principle of his experiment can be described by analogy with the question of buoyancy. If a body is weighed in air and in water, the difference of the weights measures the weight of the displaced water. If a different liquid is used, a similar weighing will give its density in terms of water. Glaser takes a light rod of some substance, actually a slightly paramagnetic glass, and suspends it in a non-uniform field. In a vacuum the field twists the rod round by a definite amount. If it is surrounded by a gas which is also paramagnetic, it will not experience so great a twist, because it will, so to speak, be partly floated by the gas. Similarly, if the gas is diamagnetic, it will be more twisted than in a vacuum. The effect is very small and by no means easy to obtain, but by measuring the amount of twist a value can be found for the susceptibility. The diamagnetism stays constant down to a fairly low pressure, and then changes over to a larger value—actually three times as great. The work is very recent, and the theory is still more or less unknown. Superficially the phenomenon is rather like that of Gerlach, but a little deeper consideration shows that no very close analogy can be drawn between the two cases.

It is natural to suppose that the collisions between the molecules are somehow responsible for reducing the susceptibility at high pressures; but there is great difficulty in seeing how it comes about, for it must be remembered that even at high pressures a molecule is in collision for only a small fraction of the time it spends between collisions. Moreover, though it might be possible to explain in this way a change of susceptibility, there seems no chance of getting a factor so great as three to one. No doubt there will soon be more experiments to help us. For example, much could be deduced if we knew how the curves varied for different temperatures; and it would also be most interesting to know how other gases behave, in particular the strongly paramagnetic oxygen. Unlike the work of Stern and Gerlach, Glaser's experiments do not seem to fit in with the general scheme of things, and so we may perhaps hope that they will lead to some surprising new developments in physical theory.

Obituary.

MR. W. E. CUTLER.

WE regret to have to record the death, on August 30, of Mr. W. E. Cutler, the field palæontologist who was working in Tanganyika Territory for the British Museum on the Dinosaur-bearing beds near Lindi. Those who lead sheltered lives in Europe are sometimes apt to overlook the arduous character of the work on expeditions in tropical or arctic lands, where either endemic disease or extremes of temperature endanger human life, and we may venture to refer to an article in these columns on April 18, p. 573, of this year, in which it was pointed out that the region in which these wonderful relics of an ancient fauna exist is pest-ridden to an unusual degree.

Mr. Cutler was a Londoner by birth, but emigrated to Canada with his parents at an early age. As a young man he became attracted by fossil collecting, and for some time it is believed worked in that wonderful natural museum which exists in Wyoming; later on he made some fine collections from the Cretaceous beds of Alberta and elsewhere. He served with the Canadian forces during the War, and then returned to his adopted land to make collections for the University of Manitoba from the Ordovician beds of western Canada. He was about fifty years of age at the time of his death. He lived solely for his work, and had in the intervals of his collecting learnt a great deal about the anatomy of the creatures he sought for.

Brought up in a hard school, Cutler prided himself on going anywhere with a minimum of kit and the simplest of food, and it came as somewhat of a shock to him when he was equipped for the East African Expedition to find that his impedimenta contained tents, camp beds, mosquito nets and the like. He was impatient of such things, and inclined to look upon them as unnecessary luxuries which would need attention and therefore hinder his work. Maybe if he had more fully recognised the danger of the insidious Anopheles, he would have been spared to carry on his work.

Cutler's labours have been productive of fruitful results, and it is said that more than 600 bones have been collected, some of which have arrived, others being ready for despatch, and it will give some idea of the magnitude of the task when we learn that they will fill at least 120 cases. All these have been personally excavated and prepared for despatch by Mr. Cutler with the help of a few untutored natives—no mean task! They have, of course, not yet been worked out systematically, but it has been determined that bones of both armoured and probably carnivorous dinosaurs as well as herbivorous species are among the specimens. Such an enthusiastic worker will be hard to replace, but the work must go on, for what has been achieved only demonstrates the magnitude of the task and its importance. May this sad loss in the front line stimulate the public to support the expedition and enable it to continue with a staff much strengthened and supplied with every safeguard which the science of tropical hygiene can provide. C. W. H.

WE regret to announce the following deaths:

Dr. Hans Bunte, emeritus professor of the Technical Highschool in Karlsruhe, well known for his work in connexion with the German gas industry, on August 17, aged seventy-seven years.

Prof. Ernst Erdmann, director since 1922 of the Institute for Applied Chemistry at Halle, on August 19, at Rättvik, Sweden, aged sixty-eight years.

Prof. Georg Klien, director for more than forty years of the East Prussian Agricultural Institute, in Königsberg, on June 23, aged seventy-six years.

Prof. Otto Lummer, director of the Physical Institute of the University of Breslau, whose investigations dealt with interference phenomena and with the estimation of the sun's temperature, on July 7, aged sixty-five years.

Dr. Rudolf Martin, professor of anthropology in the University of Munich and an honorary fellow of the Royal Anthropological Institute, on July 11, aged sixty-one years.

Dr. Mansfield Merriman, professor of civil engineering at Lehigh University from 1878 until 1907, who was a pioneer in the development of technical education in the United States and also was distinguished for his work on mechanics and strength of materials, on June 6, aged seventy-seven years.

Current Topics and Events.

SIR DANIEL HALL, in the course of his presidential address to the Conference of Delegates of Corresponding Societies at the Southampton Meeting of the British Association, appealed for their help in studying the antiquities of the land and of farming. He pointed out that the opportunities in local societies for the study of natural history and archæology are rapidly becoming smaller, and even in such fields as botany and zoology the development of science is rapidly decreasing the sphere of activity available to the non-professional man. He therefore suggested that such individuals can profitably turn their attention towards recovering, before it is too late, the detailed agricultural history of the country. The Corresponding Societies can give invaluable help in discovering the original settlement of the land, the manors, the system of cultivation adopted before enclosure, and the date and method of enclosure. The need for this work has been made all the more urgent by the Law of Property (Amendment) Act of 1924, which practically does away with the manor as a legal entity, and by the recent sales and breaking up of many of the great estates. Title deeds and estate records in the hands of manor stewards, family solicitors and the like, may therefore become distributed and increasingly difficult to trace. In this connexion a request from a Society to be allowed to examine these records will carry far more weight than one from a private person. In addition, much useful information could be obtained in some districts by a close study of vestigial physical traces of the old farming, and by the examination of field names referring, for example, to crops that have now disappeared. Again, the preservation for local museums of old farming implements would be a valuable activity of a local society. Apart from the intrinsic interest of this work, it would find a useful and highly desirable application in country schools. A series of parish maps showing the change in agricultural customs, distribution of land, vegetation, and so on, would provide excellent material for showing how, in response to physical and changing economic environments, the present farming system has slowly grown up from its simple beginning far back in the past.

AMONG the interesting exhibits shown in Section B (Chemistry) during the session devoted to the ignition of gases at the recent meeting of the British Association at Southampton were the photographs taken at Sheffield by Prof. Wheeler and Mr. O. Ellis on behalf of the Safety in Mines Research Board. By arranging a camera to open at regular short intervals, they have been able to photograph the successive positions occupied by flames produced by the firing of explosive mixtures of methane and air in closed spherical and cylindrical vessels. When the gas was fired by a spark in the centre of a glass sphere, the successive images of the flame can be seen advancing uniformly so that the flame reaches the boundary simultaneously at all points; except for very slow flames, the effect of convection currents is inappreciable. Some of the photographs, first exposed when the flame had reached the walls of the vessel, show not only the ring of light outlining the circular image of the sphere, but also a re-illumination spreading outwards from the centre of the sphere. This after-burning affords a neat proof that the chemical action is not completed by the apparent passage of the flame through an explosive mixture. The illumination is due to pressure-waves reflected from the spherical surface meeting at the centre, and increasing the rate of the residual combustion. The phenomenon may be compared with the intense reflected waves sent back from the closed ends of short narrow tubes when the explosion-wave has not quite time to develop before the flame reaches the ends. Other photographs were shown in which the flames were started at the top, the bottom, and the side of the sphere. Such asymmetric ignition results in a retardation of the development of pressure and a lower maximum pressure compared with central ignition. When the gas was ignited in a cylinder, the flame progresses regularly until it touches the walls, then it appears to be squeezed slowly into the corners. The photographs have been reproduced in *Fuel in Science and Practice*, 1925, 4, 356.

THE Southampton meeting of the British Association came to an end on Wednesday, September 2, with a meeting of the General Committee, at which votes of thanks were passed to the mayor and corporation, local committee, officers, and all who had contributed to its success by their support and hospitality. At the meeting of the General Committee held on August 28, a deputation from Leeds attended to invite the Association to hold its meeting there in 1927, and the invitation was cordially accepted. The date of the Oxford meeting next year, at which the Prince of Wales will be president, is to be August 4-11. The following vice-presidents of the Association nominated from Oxford for the Oxford meeting have been appointed: The Chancellor of the University, the Vice-Chancellor of the University, the Mayor of Oxford, the Lord Lieutenant of Oxfordshire, the Bishop of Oxford, the Dean of Christ Church, Sir Charles Sherrington, Lord Valentia, Dr. Gilbert C. Bourne, Dr. G. Claridge Druce, Prof. E. B. Poulton, Mrs. G. H. Morrell, Sir Arthur Evans, Prof. H. H. Turner, and the Principal of University College, Reading. The local officers for the meeting are: *Treasurer*, Mr. B. Rowland Jones; *Secretaries*, Dr. F. A. Dixey and Brigadier-Gen. H. B. Hartley. The new members of Council of the Association are: Prof. A. L. Bowley, Dr. H. H. Dale, Sir Richard Gregory, Prof. T. P. Nunn, and Prof. A. O. Rankine.

POPULAR interest in natural history is on the alert. The records of museums, popular lectures, public libraries, press articles and natural history publications generally, even the upshoot of the "fundamentalists," all show that interest has been aroused in life and its workings. Here are evidences which the man of science cannot afford to ignore, for a widespread knowledge of the methods and discoveries of science must result in a fuller appreciation of scientific method and in the formation of a mass opinion which will thrust new power into the hands of the scientific worker. But the position also demands that science in its popular presentation shall be progressive. The day of the simple chronicle of the obvious has passed, and it is needful that the plain man should learn something of the more profound relationships and interpretations which now engage the investigator. Further, the people cannot safely be left to gain their impressions of the aims and conquests of science from the cheap trifles of the dilettante; the simple rendition of the subtleties of modern research, whether it be in the written word or in the museum exhibit, demands the application of the trained and fully stored mind.

BECAUSE of these things "The New Natural History," by Prof. J. Arthur Thomson (London: George Newnes, Ltd., 1925. To be completed in about 20 fortnightly parts, 1*s*. 3*d*. net each part), deserves a warm welcome. The first part, which has recently been received, suggests that the work is to take the form of a series of short unrelated essays dealing with various aspects of the manifestation of life: in the present 48 pages are compressed brief accounts under the headings of man's relations with other living creatures, the web of life, animal behaviour, the ways of monkeys, the beauty of life, the story of the bower-bird, everywhere there are fitnesses, everything in the light of its history, the hand of the past. In view of Prof. Thomson's own previous work and of the best popular natural history of the present day, the treatment is not strikingly "new," but it is new in the sense that it discards the stilted systematics of the past and emphasises the trend of modern zoology towards a fuller appreciation of the biological significances of structure, habit, and development. The work is to be completed in about twenty fortnightly parts. Should it share the success which met the earlier "Outline of Science" in Great Britain and in the United States it will exercise a wide influence in moulding popular knowledge of the attainments of scientific investigation of animate nature.

THE fourth autumn lecture to the Institute of Metals was delivered on September 1 by Sir John Dewrance on "Education, Research, and Standardisation." Using the word "education" in its broader meaning of education of the human race, Sir John emphasised the superiority of scientific method and of wisdom over mere knowledge, and asked for greater appreciation of those who have discovered new truths and made them available to mankind. Men with original minds should be spared from the necessity of earning a living by doing inferior work, but private benefactions for the furtherance of research being still inadequate, although increasing, the assistance of the State is imperative. After reviewing the main activities of the Department of Scientific and Industrial Research, and, in particular, those of the

National Physical Laboratory, Sir John Dewrance discussed the meanings of the words research, discovery, and invention, pointing out how closely they are interwoven, and urging a wide acceptation of "research" so as to include such activities as the designing of a new type of submarine, or the devising of a new method of production in a factory.

WITH regard to the use by Sir John Dewrance of the word "research" to cover historical studies, it may be pointed out that the business of the historian is not, strictly speaking, to discover new facts but to resurrect old. It is true that he uses the scientific method and, like the investigator of Nature, frames views or hypotheses to correlate observations and immediate inferences from them, but in view of the circumstance that, although his interpretation may be new, his facts are necessarily old, there is a distinct difference between them and creative scientific research. Sir John Dewrance proceeded to describe the enormous amount of work involved in devising standards. The British Engineering Standards Association, formed in 1901, is controlled by a main committee which presides over 400 sub-committees of engineers and other experts who give their labour gratuitously; and it is pleasing to hear that in a recent letter the Prime Minister expressed his appreciation of the valuable work done by the Association and his confidence in the application of its methods to the study of production costs, which is one of the most pressing industrial problems of the day. In Sir John Dewrance's view, the character of virtue is best seen in the life of an intellectual man devoted to the service of truth. The status of the discoverer and research worker is being gradually raised, and he hoped that his lecture would hasten progress. "All who have benefited by knowledge should feel it a duty to do something for the acquisition of further knowledge."

IN the early hours of September 3, the great United States airship *Shenandoah* was destroyed by a storm which broke the vessel into three pieces. The *Shenandoah* was noteworthy in that its gas-cells were filled with helium instead of hydrogen, and details of its structure were given in an article in NATURE of March 1, 1924, p. 313. It would appear that on September 3 the airship was travelling at an altitude of about 3000 ft. near Cambridge, Ohio, and according to a telegram to the U.S. Navy Department by Commander C. E. Rosendahl, the senior surviving officer of the airship, a mild storm was followed by a sudden line squall which caused enormous and uncontrollable angle strains and a rapid vertical ascent. This resulted in the ship's structure breaking when it got to a height of about 7000 ft. It is suggested in a message from the New York correspondent of the *Times* that the sudden rise of the airship caused undue expansion of the helium containers, straining the strut wires and girders and cracking the framework. Capt. Anton Heinen is quoted as stating that the disaster was indeed due to this cause, and that the number of safety-valves in the *Shenandoah* were insufficient to permit of the rapid release of gas necessary when a sudden ascent is made.

THE following Royal Commission has been appointed to inquire into and report upon the economic position of the coal industry in Great Britain and the conditions affecting it, and to make any recommendations for the improvement thereof: Sir Herbert Samuel (chairman), recently High Commissioner in Palestine, Sir William Beveridge, Director of the London School of Economics, General the Hon. Sir Herbert Alexander Lawrence, a managing partner of Glyn, Mills, Currie and Co., and Mr. Kenneth Lee, chairman of the British Cotton Industry Research Association and of Messrs. Tootal Broadhurst Lee and Co., Manchester. The following are to act as expert assessors: Mr. William Brace, Chief Labour Adviser to the Mines Department, Dr. Walcot Gibson, formerly of the Scottish office of the Geological Survey of Great Britain, Major H. M. Hudspeth, one of H.M. Divisional Inspectors of Mines, and Dr. C. H. Lander, Director of Fuel Research, Department of Scientific and Industrial Research. The secretary of the Commission is Mr. C. S. Hurst, Assistant Under-Secretary, Mines Department.

A PROVISIONAL programme has been issued of the second conference of the Association of Special Libraries and Information Bureaux to be held at Balliol College, Oxford, on September 25-28. The first session will be opened by Dr. R. S. Hutton, chairman of the conference, who will describe the present position of the Association, and in the general discussion which is to follow, Mr. A. E. Twentyman and Prof. F. E. Sandbach will speak. On the following day, the morning session will be divided between two discussions, on the special library movement in America and the Institut Internationale de Bibliographie, Brussels, respectively, while the afternoon will be devoted to papers on abstracting, cataloguing, indexing and filing. A discussion in the evening will show the relation of special libraries and information bureaux to the Press. Meetings will be held on Sunday, September 27, in the morning and evening, at which the relation of special libraries to patents, science, medicine, education, transport and other aspects of modern life will be discussed.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: The Dutton memorial professorship of entomology in the University of Liverpool—The Registrar, The University, Liverpool (October 1). Two chemists at the Naval Ordnance Inspection Centre, Holton Heath, Dorset—The Secretary of the Admiralty (C.E.), Whitehall, S.W.1. A biologist at the Kirton Agricultural Institute, Boston, Lincs.—The Principal. A cancer research worker at the Radium Institute—J. C. Mottram, Research Laboratories, The Radium Institute, 16 Riding House Street, W.1. Lecturer in mechanical engineering—Agent-General for Western Australia, Savoy House, Strand, London, W.C.2.

Research Items.

THE MAYAN CALENDAR.—An interesting contribution to the discussion of the calendar of the ancient inhabitants of Central America and its possible correlation with Christian chronology is made by Mr. J. E. S. Thompson in *Man* for August. Spinden, in his new scheme of correlation, has made the Mayan New Year Day fall on the winter solstice, which he says was arbitrarily chosen to initiate the calendar. But the names of the Mayan months appear to contradict his theory. Although data relating to the annual routine in agriculture of the pre-Spanish Maya are absent, it is justifiable, in view of their innate conservatism, to assume that modern Mayan customs give a fairly clear idea of the routine of their ancestors. When the agricultural operations are taken month by month, it is found that each of these is faithfully represented by the names of the month in the calendar. For example, in December and January the virgin bush is cut down, the scrub is left to dry until May, when it is burnt, whereupon the Mayans leave their villages to take up their residence in their *Milpas* (allotments). Then come the heavy, late spring rains, softening the ground, and sowing follows. In the Mayan calendar as given by Landa, *Mol* corresponds to December 12, meaning to pile or collect together, *i.e.* the brushwood was piled. *Ceh* or *Cel*—roasted, March 2, refers either to the burning of the brushwood or the condition of the soil after drought. *Muan*, May,—showery. *Pax* (May-June), to take possession, referring to the removal to the Milpas, and so on. Any correlation which does not conform to the naming of the months, such as Spinden's in making *Cumhu*, the sowing season, and *Pop*, maize leaves, mid-winter instead of June and July, must be rejected.

PALÆOLITHIC MAN IN MORAVIA.—The third instalment of the Abbé Breuil's survey of palæolithic sites in Central Europe which appears in Pt. 3-4 of Vol. 35 of *L'Anthropologie* deals with the Moravian caves, of which the most important are Kostelik and Kulna. At Kostelik, which is in the neighbourhood of Brno, the fauna is that of the mammoth and the reindeer. Notwithstanding the absence of stratigraphical evidence, some of the stone implements can be attributed with some certainty to the Acheulean-Mousterian; others belong to the Aurignacian and beginning of the Solutrean; others again are of a generalised upper palæolithic type and are to be assigned with some probability to the Magdalenian. Certain remarkable objects made from the jawbones of horses, which have been described ineptly as carvings representing fish, are in reality a kind of ornamented knife in which the curved part of the jaw without teeth has been utilised to form a handle. Both sides of the blade and handle are closely covered with an ornamentation of parallel curved lines alternating with short strokes and big dots. In some cases they are combined to form a very simple decorative *motif*, such as a group of chevrons, while in one case this may be a sketch of an animal's head. The remainder of the bone implements are Magdalenian, probably of various periods. A postscript describes a small statuette of a mammoth in clay found near Unter-Winternitz in 1924.

EYE FATIGUE.—In the Journal of the Franklin Institute (August 1925), Mr. Percy W. Cobb and Mr. Frank K. Moss give the results of some experimental work on eye fatigue in its relation to light and work. The problem of lighting is one of outstanding importance in industrial work; when work can be performed by daylight the problems are relatively simple, but as soon as artificial light has to be used new factors intervene. With the higher intensities of illumination people are apt to complain of eye fatigue. The laboratory experiments described in this article were an attempt to study the effect produced by visual operations under different intensities of illumination. An ingenious test was devised as a means of fatiguing the eye—and incidentally the attention—and the effect of the different intensities was measured by comparing the changes in the muscle balance of the subject before and after the test. The test itself, worked for 30 minutes, did affect the muscle balance significantly, but the change in the intensity of the illumination showed no significant difference either with regard to the amount of work done or the effect on the eye. The conclusion, though, cannot be expressed by the general statement that the higher intensity was in no way harmful or tiring to the eyes of the worker; all that can be said is that, under these conditions, no appreciable effect could be observed. The eye fatigue cannot be estimated apart from the effect of attention, and industrial conditions introduce still more complications.

INSECTS OF THE SWISS NATIONAL PARK.—Volume 60 (1924) of the *Denkschriften* of the Swiss Natural Science Society consists entirely of the second and third instalments of the results obtained under the Commission appointed by the Society for the study of the fauna of the Swiss National Park in the Lower Engadine. The Hemiptera and the Collembola are dealt with in the volume before us. Dr. Hofmänner began his special investigation in 1918 in company with Dr. R. Menzel, but lost that valuable colleague on his being called away for special entomological work in Java. His account of the Swiss Hemiptera deals with the Heteroptera and the Cicadine group of the Homoptera. Including previous records, and not adhering strictly to the confines of the National Park, he finds the list of Heteroptera to comprise 113 genera, 181 species and 6 varieties, while the Cicadinæ number 81 species and 15 varieties distributed among 28 genera. The most interesting conclusion arrived at is that the Hemiptera of the Lower Engadine are somewhat southern in character, and have a marked affinity with the fauna of the South Tyrol. Dr. Handschin's researches into the Collembola of the National Park have been very fruitful. He adds to the list of 65 hitherto recorded Swiss species no fewer than 30 species, of which 7 are new to science. Moreover, the abundance of his material has enabled him to show that several forms regarded as specifically distinct are in reality only colour variants. Thus he is led to suppress *Entomobrya lanuginosa* and *E. nicoleti* with its two varieties *muscorum* and *obscura*, all of which he finds to belong to the very variable species *E. nivalis*. Both authors give full details of horizontal and vertical distribution, and the plates are adequate. Altogether this instalment of the results of the Commission forms a handsome volume.

THE COLEOPTEROUS FAMILY BRENTHIDÆ.—*Indian Forest Records* (Entomology Series), vol. 11, Part iv., 1925, is devoted to studies on some Indian beetles of the family Brenthidæ. Herr Richard Kleine describes a number of new genera and species from British India and the neighbouring regions, bringing up the total number of known members of the family to 240 species. Dr. C. F. C. Beeson contributes an article on the biology of the family and its relations to forestry. This paper is the most important yet published on the subject and adds very considerably to what little was previously known. The family is divisible into two groups—(*a*) phytophagous, and (*b*) myrmecophilous, the latter only containing a few species. As regards group (*a*) Dr. Beeson's observations suggest that the Indian species (at any rate) are true wood-borers in the larval state and that their habitat is normally in felled or fallen timber and not in living trees. The adult beetles occur gregariously between the bark and wood of trees that have been attacked by bark and sapwood-boring larvæ (mainly Longicornia). The myrmecophilous species include symphilines living in association with ants, while others are robbers. Mr. J. C. M. Gardner describes the larvæ of two species of Cerobates and the pupa of *Cyphagogus corporaali* Kleine. The larvæ show characters common to the Rhynchophora, *e.g.* their curved form, the vestigial antennæ, the continuity of the mentum and prothoracic cuticle, etc. The presence of evident though minute thoracic legs is not incompatible with these affinities since many curculionid larvæ exhibit reduced ambulatory tubercles.

INDIAN LIMNÆIDÆ.—The last memoir from the hand of the late Dr. Annandale forms a revision of the recent Indian Limnæidæ, in which H. S. Rao collaborated (Records Indian Museum, vol. 27, Part 3, May 1925). The authors have offered this paper as a means of identifying the species of Limnæa found in the Indian Empire. They have had the advantage of studying the largest collection of shells and of material preserved in spirit ever accumulated from any oriental country, and they have had good opportunities of noting the range of variation. They discuss the characters of the jaws, radulæ, shell, and genitalia, and after concisely describing 21 species and their "forms," they provide a tabular key to the living species known from the Indian Empire and its immediate frontiers and a table of measurements of their shells. In Part 1 of the same volume is an obituary notice of Dr. Annandale and a list of his publications, which occupies 21 pages; it indicates the extraordinary range of his interests and the activity of his mind and his pen.

THE BOGHEAD COALS.—The United States Geological Survey has published an interesting paper (Professional Paper 132-I.), by Reinhardt Theissen, on the origin of the Boghead coals. This paper is a careful study of that group of coals which passes into true coal on one hand and into shale on the other, including, therefore, the substances usually spoken of as bituminous shales, oil shales, cannel coals, etc. The author shows that the yellow bodies characteristic of boghead coals are algæ of a somewhat unusual form; the name Elæophyton has been suggested for this organism, and its structure has been worked out in considerable detail. The paper is all the more interesting because it is practically contemporaneous with the work by Prof. Jeffrey of Harvard University, lately noticed in these columns, who discusses these bodies at considerable length, and proves quite definitely to his own satisfaction that the bodies in question are spores and not algæ. It is, however, clear that Prof. Jeffrey knew nothing of Mr. Theissen's work.

INDIAN METEOROLOGY.—The meteorology of India was dealt with by Sir Gilbert T. Walker, professor of meteorology, Imperial College of Science and Technology, in a paper read at the Royal Society of Arts on May 8, and published in the Society's Journal of July 31. As Sir Gilbert was chief of the Meteorological Department in India for more than twenty years, and until quite recently, many points of considerable interest were referred to. The characteristic feature of the south-west monsoon is explained, and the three weeks' journey of the air over the sea before it reaches India is said to afford time for air dry at its origin to become saturated with moisture to a considerable height, which is necessary to supply such rainfalls of 30 to 40 inches in a day, which occur in the western ghats and the corresponding hills near the Burma coast, combined with moderately heavy rain inland. Work carried on for the last forty years by Blanford and Eliot, and later by the author of the paper, with the view of forecasting the monsoon rains by the assistance of data in various parts of the globe, is explained. The difference between the air motions producing abundant and scanty rainfall is associated with marked differences in the conditions over a large part of the earth's surface. Abundant Indian rains are associated with low pressure in India, Java, Australia, and South Africa, and with high pressure in the Central Pacific and South America. The warning for storms at sea is assiduously carried out, and warnings are issued of the danger of sunstroke or heat apoplexy when the wet bulb temperature approaches 85° F.

A LABORATORY OZONISER.—A laboratory ozoniser, capable of yielding high concentrations of ozone (15 per cent.), is described by L. I. Smith in the July issue of the Journal of the American Chemical Society. The capacity of the ozoniser is more than 4 gm. of ozone per hour. The apparatus consists of three modified Brodie tubes, made of soft glass, connected in series and mounted in a large battery jar. All connexions which come in contact with ozone are arranged so as to be made through mercury seals. The battery jar is filled with distilled water, and serves both as an electrode and for cooling purposes. Owing to the high voltage used (about 8000) the resistance of the water is negligible, and thus there is almost no heating effect; a metallic cooling coil, however, is also immersed in the jar. The electrode inside the tube consists of mercury. Some observations on the action of various reagents on ozone are also recorded. These fall into two groups: (1) substances having only a very small effect, *e.g.* water, concentrated sulphuric acid, phosphorus pentoxide resublimed in oxygen, and (2) those having a great effect, destroying much or all of the ozone, such as ordinary phosphorus pentoxide and 5 per cent. sodium hydroxide solution.

DECOMPOSITION OF SULPHURYL CHLORIDE.—A paper by D. F. Smith in the July issue of the Journal of the American Chemical Society records some observations on the thermal decomposition of sulphuryl chloride. This is a first-order homogeneous gas reaction. Only one other such reaction is known, namely, the thermal decomposition of nitrogen pentoxide, investigated by Daniels and Johnston (1921). The data obtained for sulphuryl chloride fit the theoretical equations put forward by Trautz and Bhandarkar (1919). No theory of reaction rate yet proposed, however, fits in with the observations made in *both* of these reactions, so that none of these theories is of general application.

HYDROBROMIC ACID IN ACIDIMETRY.—The composition of an aqueous hydrochloric acid solution which boils at a constant temperature is sufficiently definite to permit its use as a standard solution in acidimetry (Hulett and Bonner, 1909). D. T. Ewing and H. A. Shadduck have published a paper in the Journal of the American Chemical Society for July, showing that hydrobromic acid solutions may be used for the same purpose. The constant-boiling acid boils at about 125° (760 mm.) and is 5·9061 *N* by weight. It contains 47·795 per cent. HBr.

Mosquito Control.

OPENING OF A NEW INSTITUTE AT HAYLING ISLAND.

A NEW phase in the control of the mosquito problem was reached last week when members of the Section of Zoology of the British Association attended the opening of the British Mosquito Control Institute, which has been founded and equipped by Mr. J. F. Marshall in his own grounds at Hayling Island, Hants.

The new building (Fig. 1) occupies two stories and includes a demonstration museum, a laboratory, drawing and record offices, photographic rooms, a library, and a mechanical workshop. There are also a number of smaller rooms designed for research students. It already contains a wealth of material for mosquito study not available elsewhere, and historical records of how the mosquito has been successfully combated on the island.

The formal opening, which took place on Monday, August 31, was presided over by Sir Richard Gregory, chairman of the Council of the new Institute. As a result of the preventive work undertaken, which has consisted largely of draining the inter-tidal areas, Hayling Island, which formerly was infested with "salt-marsh" mosquitoes, has now been practically cleared. In introducing the subject, the chairman pointed out that in many parts of the world the question was whether the mosquito or man should survive. It was, he said, one of the glories of British science that much of its best work had been done by men who were not professional workers but had studied Nature simply because of the desire to gain knowledge, and without any ulterior motive. Mr. Marshall had been responsible for work of that kind, and the result of it was the building that was about to be opened, the British Mosquito Control Institute.

FIG. 1.—The British Mosquito Control Institute.

Sir Ronald Ross, in opening the Institute, described his own experiences at Hayling Island some three years ago. He had, he admitted, been sceptical as to the accusations made against *Ochlerotatus detritus*, the salt-water mosquito. Mr. Marshall, however, had convinced him by taking him to a part of his garden and inviting him to observe the insects flying about in broad daylight. In the course of his observations, Mr. Marshall had proved his point by directing his attention to the fact that three of the insects were simultaneously extracting blood from the back of his neck. Sir Ronald Ross pointed out that when he began work on the mosquito there was not a book or a good article dealing with the mosquitoes in India. Much is now known, but, in addition to knowledge, energy is necessary for acting upon it. What has been done in the Panama, at Ismailia, and in the Federated Malay States is only a beginning. He insisted on the importance of controlling not only the mosquitoes but also all those dangerous and unpleasant pests that prey on man and on his crops and herds. It is ridiculous that while man dominates the earth, the sea and the air, he should continue to be the prey of bacilli and even die from such contemptible things as colds in the head and mosquito bites. Improved medical and sanitary science and administration have, in the last eighty years, increased the average length of human life in Great Britain by about fifty per cent., yet men still die of many diseases which will one day be conquered. Sir Ronald Ross pleaded for the expenditure of a million pounds a year on medical research so as to accelerate the conquest of disease. Such a sum would be trivial compared with the money now spent on tobacco, alcohol, and entertainment, without taking into account what is spent on education, armaments, and the "dole." While the work of the new Institute is to be general rather than medical, it will unquestionably keep the sanitary applications of mosquito control within range of its vision. The knowledge gained in the Institute will facilitate mosquito control in every region of the earth, and it is certain that the day will come when the fertile tracts now ravaged by king Malaria and king Mosquito will be laid open to civilisation. This happy result will, however, only be attained by more thought, by more research, and by a firmer determination to make the most of the beautiful world in which we live.

A vote of thanks to Mr. Marshall was proposed by Mr. C. Tate Regan and seconded by Col. James, of the Medical Department of the Ministry of Health. The Ministry, he said, greatly appreciates the good work done by Mr. Marshall. Col. James emphasised the importance of voluntary assistance given to the Government, and said that it is on this that the success of public health administration largely depends. He promised on behalf of the Ministry that it would watch the working of the Institute with great and, he hoped, helpful interest.

The ceremony concluded with a few words of thanks from Mr. Marshall, and it was announced that the composition of the Council of the Institute is as follows :—Major E. E. Austen, Dr. Andrew Balfour, Mr. F. Balfour-Browne, Sir James Crichton-Browne, Dr. H. Eltringham, Sir Richard Gregory, Col. S. P. James, Dr. G. A. K. Marshall, Prof. H. Maxwell Lefroy, Prof. E. B. Poulton, Sir Ronald Ross, Dr. Hugh Scott, Sir Arthur E. Shipley, Prof. Sir William Simpson, and Dr. C. M. Wenyon. The Trustees are Sir Richard Gregory and Mr. L. W. North Hickley, and the honorary director, Mr. J. F. Marshall.

Glutathione.

THE isolation by Hopkins of glutathione, the dipeptide of cysteine and glutaminic acid, was a definite advance in our knowledge of the processes of oxidation and reduction in living cells. The compound was found to exist in two forms, the reduced and the oxidised; the latter consists of two molecules of the former united by means of the sulphur atoms of their cysteine portions after the loss of two atoms of hydrogen. The oxidised form thus acts as a "hydrogen-acceptor"; in the reoxidation of this reduced form it is probable that active oxygen is set free for oxidation processes in the cell, oxygen also acting as the "hydrogen-acceptor"; whether the compound was present in the oxidised or reduced form seemed to depend largely on the hydrogen-ion concentration. It was suggested by Quastel, Stewart and Tunnicliffe that the dipeptide was formed by the linkage of the amino group of cysteine to that carboxyl group of glutaminic acid which is furthest away from its amino group; they based their conclusion on a study of the breakdown of the molecule in various directions.

Stewart and Tunnicliffe have now confirmed this view by preparing glutathione synthetically and finding it identical with the natural product (*Biochem. Journ.*, 1925, vol. 19, p. 207). Two methods were employed: in the first, glutaminic acid was converted to hydantoinpropionic acid, and the latter then converted to the acid bromide with phosphorus tribromide and coupled with cystine dimethyl ester hydrochloride. The hydantoin ring was opened by boiling with calcium hydroxide, and the resulting compound, probably a uramino-acid, converted to the dipeptide by treatment with nitrous acid in slight excess of the amount necessary to remove one nitrogen atom. The dipeptide was isolated from the products of the reaction by means of the mercuric sulphate compound. The glutathione formed agreed with the natural product in all its properties except that its rotatory power was considerably less. This is probably due to racemisation during the formation and opening of the hydantoin ring. This result led the authors to their second method of synthesis: by acting directly on glutaminic acid with phosphorus tribromide, the acid bromide was formed in which the bromine replaced the hydroxyl group in the carboxyl furthest from the amino group. The acid bromide was coupled with cystine dimethyl ester and the glutathione isolated as in the previous method. The compound was found to be completely identical with the natural glutathione.

The amounts of the dipeptide occurring in tissues are very small; quantitative determination by actual isolation of the substance can only lead to approximate results owing to the losses which are bound to occur. Tunnicliffe has elaborated a method which is both quicker and probably more accurate (*Biochem. Journ.*, 1925, vol. 19, p. 194). The tissue is ground with sand and 10 per cent. trichloroacetic acid and filtered. The filtrate is titrated with $N/100$ iodine solution, the reduced form of glutathione being thereby oxidised. The end-point is judged by the use of sodium nitroprusside as an external indicator, with which the reduced glutathione forms a purplish colour. The method estimates the —SH groups in the extract: glutathione is the only known substance present which will give the reaction, since there is no evidence that cysteine exists in the free state in the tissues normally. Most of the glutathione appears to be present as the reduced form in the cells. Skeletal muscle of the rat or rabbit contains about 0·03 to 0·04 per cent., and liver 0·2 to 0·25 per cent.; yeast contains about the same percentage as liver; it is completely absent from blood. The values obtained thus are three to five times greater than the amounts actually isolated.

The product obtained from tissues has been found to contain small quantities of iron: Harrison has determined its amount and obtained a value of 0·6 per cent. (*Biochem. Journ.*, 1924, vol. 18, p. 1009). Now the reduced form of glutathione undergoes spontaneous oxidation in air; recognising that iron frequently acts as a catalyst in oxidations, Harrison prepared a pure glutathione and examined its rate of oxidation in air. The uptake of oxygen was much slower than in the case of the impure preparation: the author considers that this may be due to traces of catalysts which have escaped removal. As with the impure compound, cyanides inhibit this uptake of oxygen, probably by forming a compound with the iron.

The oxygen uptake in these cases, including that of pure glutathione, is a linear function of the time over a large part of the course of the reaction: this is probably due to the fact that the rate of oxidation depends on the amount of dissociated ionised iron present; the sulphydryl group can lose its hydrogen more quickly than oxygen can be prepared to receive it. Increasing amounts of cyanide decrease the rate of oxidation by decreasing the amount of ionised iron present. On the other hand, when relatively large quantities of iron are available the rate of oxygen uptake decreases continuously, since excess of active oxygen is present throughout and the amount of the sulphydryl compound becomes the limiting factor and its concentration progressively decreases with its oxidation.

The inhibiting effect of cyanide is less marked in the presence of organic iron, for example hæmatin, and in correspondence with this, Harrison has found that cyanide has a less marked effect in reducing the oxygen uptake of glutathione in the presence of a thermostable preparation of muscle tissue, which has the power of reducing the oxidised form of glutathione to the sulphydryl compound.

Further light has been thrown on the mechanism of the action of glutathione in the oxidation processes of tissues by some recent experiments by Tunnicliffe (*Biochem. Journ.*, 1925, vol. 19, p. 199). The reduction of the oxidised form by the tissue preparation in the absence of oxygen is rapid for the first three hours and complete in about five hours: only a certain quantity can be reduced by any given tissue preparation, this amount being the measure of the labile hydrogen of the tissue. The same tissue will reduce a similar quantity of methylene blue. The nature of the buffer salts and the reaction of the medium have no influence on this reduction. On the other hand, the reverse change, the oxidation of reduced glutathione, proceeds more rapidly in a slightly alkaline medium than in an acid medium. In the presence of oxygen, the tissue will reduce the glutathione, which will forthwith become oxidised again and the process will only cease with exhaustion of the labile hydrogen of the tissue or of the oxygen supply.

If, however, the amount of oxygen actually taken up is measured, it will be found to exceed considerably that necessary to oxidise the reduced glutathione formed by the tissue: the excess is considerably greater in the absence of phosphate ions. Hence concurrently with the oxidation of the glutathione, oxidation of some other substance must be taking place, and Tunnicliffe considers it probable that this is of the nature of an unsaturated fatty acid, since Meyerhof has shown that the oxidation of linolenic acid is accelerated by the simultaneous oxidation of a sulphydryl group present at the same time. Thus the oxidation of the fatty acid depends on the presence of the reduced glutathione, which in turn is formed by the "hydrogen donators" of the tissues. When oxygen acts as a "hydrogen-acceptor," removing the hydrogen from the reduced glutathione which is thereby oxidised, part of the oxygen becomes activated and available for the oxidation of other substances present in the cell.

The Royal Observatory, Edinburgh, and Accurate Measurements of Time.

THE record of the work done in 1924 at the Royal Observatory, Edinburgh, recorded in the annual report of the Astronomer Royal for Scotland, Prof. R. A. Sampson, is of supreme importance to those interested in the accurate measurement of time.

For some years Edinburgh has taken the lead in this subject, and Prof. Sampson's papers before the Royal Society of Edinburgh and the Royal Astronomical Society on the performance of his clocks have been followed with keen interest in the observatories of the world. His three first-grade clocks are the Riefler No. 258, which, we understand, is one of the best turned out by the famous Munich firm; Leroy No. 1230, which is a duplicate of those at the Paris Observatory used in connexion with the time transmission from the Eiffel Tower; and Shortt No. 0, the original Free Pendulum of the Synchronome Co.

By means of an oscillograph and micro-chronograph, which resembles a cinematograph camera, Prof. Sampson's clocks are in effect *put under a microscope*, that is to say, their performance is observed and automatically recorded each day to an accuracy of one thousandth part of a second, a method which Prof. Sampson says "rarely fails to show when one or other of them has changed rate by as much as ·01 sec." The daily comparison, he continues, demonstrated a decided superiority in the rate of clock Shortt; indeed the other two were scarcely able to serve as a check upon it. Therefore, with the view of carrying time work to the limit that the appliances will allow, a second model of the clock (Shortt No. 4) was installed in January in one of the vacant clock cells in the basement. The connexions for temperature control are the same as in the other cells. The original clock of these series (Shortt No. 0) which was erected here for trial by Mr. Shortt in 1923, and has shown such remarkable going, has been generously presented to the Observatory by the Synchronome Company Limited, in association with whom Mr. Shortt had prepared his model. Briefly, it may be said the only discernible faults in the going of Shortt No. 0 are a small temperature coefficient showing when an accident disturbs the temperature control of the cell, and a minute leak in the case, which has not been located.

Prof. Sampson's investigations in recent years have focussed attention upon the lack of precision in transit observations, upon which, of course, all time determinations are based. Instrumental errors in the transit circle telescope have always been carefully measured and allowed for. They take a prominent part in the somewhat complex process of smoothing the clock rates. In the race for accuracy, the precision of the clock and of the means of comparison by wireless time signals have outrun the precision of transit observations.

Radio telegraphy has enabled distant observatories to compare their times with great precision, thanks to the rhythmic signals or "time-vernier," and they are found to disagree by amounts which, though they may appear trivial to a layman, are of considerable importance in an exact science such as astronomy. Astronomers have indeed been considerably perturbed at their lack of agreement, and Prof. Sampson had set himself the task of searching for the cause of the error which has been found to occur in time determinations at all observatories.

Prof. Sampson now makes the definite statement that "owing to improvements in the clock and chronograph system in this Observatory, and in receiving apparatus for W.T. signals from other observatories, it has proved possible to bring this investigation to an issue. It has been found that during the whole of 1924 the whole of the large erratic or systematic errors are removed if the level error, determined as usual by the mercury bath, is rejected, and the observations reduced instead by an azimuth error derived from one of the collimators, in combination with the usual observations of polar stars. The implications of this result are of high interest and importance to astronomers and will be pursued."

Referring later to his automatic records of the numerous W.T. signals, Prof. Sampson says, "the comparison of time determined at this observatory with the same determined elsewhere exhibits features of the sub-systematic character that had been noted in previous years, though each observatory had cleared its determinations of all known errors. As remarked above, the source of these discrepancies appears now to be located, at least so far as the observatory is concerned."

F. H.-J.

World Meteorology and Long-range Forecasting.[1]

THE possibility of seasonal forecasts in India was first investigated by H. F. Blanford about 1876, using only the snowfall in the Himalayas. As the research proceeded, it was found necessary to consider conditions farther and farther away, until in the hands of Sir Gilbert Walker it developed into an investigation of the inter-relationships of weather in all parts of the world. A chart of the average barometric pressure over the globe shows a number of more or less permanent areas of high and low pressure; for example, the Azores high and the Icelandic low. In these areas the variability of pressure reaches a maximum, and they are accordingly termed "centres of action"; the pressure changes of intervening places, such as the British Isles, are dominated by those at the centres of action.

Sir Gilbert Walker has realised that these "strategic points" offered the best chances for an attack on the problem of long-range weather forecasting, and has studied in great detail the relations between twenty different centres of action. In "Correlation in Seasonal Variations of Weather," Part 8 (Memoirs of the Indian Meteorological Department), published in 1923, he laid down the groundwork of a theory of world weather and outlined the mechanism by which variations in one part of the world are transmitted to other parts of the world a few months later. The

[1] "A Further Study of World-Weather. Applications to Seasonal Forecasting in India." By Sir G. T. Walker. (Memoirs of the Indian Meteorological Department, vol. 24, Parts 9 and 10.)

problem is, however, too complex for a sufficiently complete theoretical solution to be possible at present, and the only method is the patient comparison of the pressure variations in each centre of action with the subsequent variations in all twenty centres. This laborious research has been carried out, and the results are presented in Part 9, "A Further Study of World Weather." The quarterly means are compared with those for two quarters before, one quarter before, the same quarter and one and two quarters after, at all stations—some 4000 correlation coefficients in all. From these coefficients 189 relationships are found which are probably significant according to the author's rigid standard, and are of value for seasonal forecasts either six months or three months ahead.

The consistency of the relationships is very remarkable, and "supports the view that seasonal forecasting is capable of wider application than at present." Most of the significant relationships discovered are between the different tropical and sub-tropical centres, at which weather abnormalities usually persist for several months, and the research indicates possibilities for the initiation or improvement of seasonal forecasting in such regions. For countries within the temperate storm belts, such as the British Isles, the outlook is not so hopeful; the significant correlation coefficients are fewer and smaller, and the fluctuations from month to month are often so great that the value of a general three-monthly forecast is limited. The final solution of the problem of long-range forecasting in temperate latitudes will undoubtedly have to take account of world-relationships, but only as giving a general tendency to the weather, the fluctuations of shorter period being determined by other and more local causes.

In Part 10 Sir Gilbert Walker returns to the original purpose of these studies and gives an example of the application of the results to seasonal forecasting in India. From the closest relationships found between rainfall in India and the preceding conditions in other parts of the world, greatly improved formulæ are deduced for forecasting the monsoon rainfall of different districts and the winter precipitation of the Himalayan region. The formulæ impress one very strongly with the meteorological unity of the world, that for Peninsula rain, for example, depending on the preceding conditions in such widely scattered regions as Alaska, South America, and Rhodesia. The statistical basis is sufficiently complete for the forecasts to be made confidently; and while in the story of Indian forecasting, begun fifty years ago, the final chapter is not yet written, we may reasonably believe that the main lines of the plot have been laid bare.

University and Educational Intelligence.

IN the course of an address delivered on September 4 at the opening of a new secondary school at Preston Lodge, East Lothian, Lord Balfour made some noteworthy remarks on the relation of schools to universities and on the importance of research in pure science. If the university is compelled to act the part either of the primary or secondary school its work is hampered, its utility diminished, and its wheels clogged. The purpose of the secondary school is, however, not merely to prepare students for the university, but rather to give an education by means of which those who are unable to go to the university can face life without feeling seriously handicapped. Referring to the importance of the practical teaching of science, Lord Balfour said he was glad to learn that science is to form a prominent part of the curriculum of the new school, and that it is to be taught by laboratory demonstration and experiments. "Industry in the future," he said, "must be based upon science." If industrialists imagine that science can be built up without a disinterested love of knowledge, they fall "into the most grievous blunder." The multiplication of subjects in modern secondary and university education and the specialisation it entails are regarded by some as disastrous to the progress of education and the highest interests of culture and learning. Lord Balfour stated that, if the dangers of specialisation are kept in view, they can be reduced to a minimum, and the necessary flexibility, variety, and complexity of modern education successfully maintained.

THE Geographical Association has been experimenting for some time in the matter of conducted educational tours for teachers under the direction of volunteer experts. Some teachers and members of several universities joined a group of honours students in geography, of the University College of Wales, Aberystwyth, at Easter, in a tour around France, under the direction of Miss S. Harris, of the staff of that College. At the beginning of August, two groups left England to study the Alps; one the western Alps, starting from Chamonix, and one the eastern Alps, starting from Innsbruck. They were under the leadership, respectively, of Mr. J. I. Platt and Miss S. Harris, both of the University College of Wales, Aberystwyth. Among their objects was the demonstration of the newer views of earth history, and especially of mountain building, to which MM. Argand and Staub have given expression in the last few years. The charabanc has made it possible for teachers to intensify their knowledge of Britain, and tours have been organised to various natural regions of England, and to North and Central Wales, to demonstrate structural and general physical features with particular reference to the ways in which these factors have affected settlement, industries and communications. These tours were organised under the leadership of Messrs. E. E. Lupton and V. C. Spary. The Tours Committee of the Geographical Association would like to experiment further by specialising on selected regions for more intensive study if a sufficient number of members and intending members care to take part. All communications concerning tours should be sent to the honorary secretary of the Tours Committee, Mr. E. E. Lupton, 73 Bierley Lane, Bradford.

THE Institute of Intellectual Co-operation, of which the governing body is the League of Nations Committee on Intellectual Co-operation, presided over by a French member of the Committee, is expected to open its doors towards the end of the year. The directorate of the Institute is composed of the following members: M. Bergson, M. de Reynold, Prof. Lorentz, Prof. Gilbert Murray, and Senator Ruffini. The Director is M. Julien Luchaire, Inspector-General of Education in France. The budget for 1926 amounts to 2,100,000 French francs, two millions of which represent the grant made by the French Government and 100,000 that of the Polish Government. The Committee at its meeting of July 27-30 approved of the adoption of an international students' card as recommended by the International Students' Federation. It took note of a memo by Dr. Hagberg Wright, Director of the London Library, on the subject of the international borrowing of books, and recommended a series of practical measures for facilitating such loans. It considered also questions relating to intellectual property, an international meteorological bureau, an international university for the training of statesmen, journalists and others, the unification of scientific nomenclature, and a loan for the development of intellectual life.

Early Science at Oxford.

September 16, 1684. Dr. Plot began reading his discourse *de Origine Fontium*; half of which being read, we proceeded to other matters :

A letter from Dr. Pit was read, which promises his discourse concerning Digestion; and gives an account of a woman, who, by reason of stoppages for three monthes, complained of a load, and fullness of her stomach; vomited blood, flesh, and blood-vessells, as big as goose quills; after which, by ye help of some Physick, she recovered.

A Letter from Mr. Molyneux, dated Dublin September ye 2nd, 1684, was read: It gave an account, that Mr. Osburn had observed ye last solar Eclipse near Tredagh in Ireland, lat: 53°. 40′. Initium. H.1.37′.30″. finis H.3.56′.20″.

Merchant Wayt's account of his peice of Incombustible Cloth was read.

A Letter, written at ye Request of this Society, by Mr. President, to be sent to ye head of each of the Universities in Scotland, for the establishing a Correspondence in that Kingdom, was read.

Sir Robert Sibbald's *Scotia Illustrata*, was presented ye Society.

Dr. Mark, an ingenious Brandenburg Gentleman, was proposed, in order to be elected a member of this Society.

September 23, 1684. Dr. Plot continued ye reading of his discourse *de Origine Fontium*, and severall other things were offered to ye Society, but ye company being very small, they were referred to another meeting.

September 30, 1684. Dr. Plot made an end of reading his Discourse *de Origine Fontium*, after which, ye Society gave him their thankes, for communicating to them so succinct an account, of what has been delivered by other writers, and of his own observations, on this subject; and also made it their request, that he would be pleased to print ye same.

A letter from Mr. Aston, dated September ye 25th, was read; in it were contained some observations of ye late solar Eclipse taken by severall French astronomers, and printed in ye *Journall des scavans*. They are translated into English, and will suddenly be printed in ye Transactions.

Part of a Letter from Dr. Cole of Worcester, dated September ye 27th, was read; which informed the Society, how very ready that learned physitian is to correspond with us, and to comunicate to us, whatsoever shall occurr to him fit to be imparted.

Dr. Plot comunicated an old silver ring, lately found in Staffordshire, with this motto, *in Godt al*; and an old Roman brass ring gilt about two ounces, 3 drams in weight, sent him by Mr. Packer, Physitian at Reading; this ring had a cornelian set in it, and four collets round ye cornelian, for as many stones more, three of which were lost.

A large stone, consisting of severall Branches, taken out of ye kidney of a woman by Mr. Packer, was communicated by Mr. Welstead. An Account of this Stone will be printed in a little time.

Spongia arborescens erythmiformis, i:e: of ye forme of Samphire, from Devonshire; and some of the button berries, from Jamaica; as also some Kelp, embroydered with ye shells of fish growing on ye leaves of that plant, (all which are a part of that present the generous Mr. Cole of Bristoll lately made this University), were communicated to us by Dr. Plot.

Dr. Caspar Marck haveing been proposed, Sept: 16th, his admission was now put to the Ballot, and carried in ye affirmative, after which he subscribed to the Articles.

Societies and Academies.

LONDON.

Institute of Metals (Autumn Meeting, Glasgow), September 3.—Robert J. **Anderson** and Everett G. **Fahlman**: The effect of low-temperature heating on the release of internal stress in brass tubes. The work was carried out to determine a suitable heat-treatment which would prevent warping of manufactures made of lead-brass tubing on standing for a period at the ordinary temperature, and at the same time effect stress release without material loss in hardness and strength. Heating for 2 or 3 hours at 325° C. or for 4 hours at 300° C. in the case of material reduced 22·4 per cent. in area is satisfactory, but the mill control of separate lots of tubing must be substantially identical if a given heat-treatment procedure is to be applied to the material.—L. H. **Callendar**: Passification and scale resistance in relation to the corrosion of aluminium alloys. Aluminium is a passive metal; its normal reactions are modified by the presence of a hydroxide scale of high mechanical, chemical, and electrical resistance. Corrosion in water may be started by solution or peptisation of this scale; it may be stopped by precipitation of scale on the metal surface. Chlorides reduce the resistance and adherence of these scales, and carbonates tend to increase scale resistance. Nitrates passify the metal by direct oxidation and anodic polarisation. Dichromates combine the passifying action of nitrates with the formation of a highly resistant scale containing chromate.—O. W. **Ellis**: The influence of pouring temperature and mould temperature on the properties of a lead-base antifriction alloy. Within the limits of the experiments, the replacement of lead by antimony increases the resistance to compression and increases the hardness. The replacement of tin by copper increases the resistance to compression but scarcely affects the hardness. Mould temperatures are more important than pouring temperatures. There is evidence of an intermetallic reaction in the copper-bearing alloy in the liquid state at 334° C.—R. H. **Greaves** and J. A. **Jones**: The effect of temperature on the behaviour of metals and alloys in the notched-bar impact test. Copper, aluminium, and lead showed a continuous fall in impact figure from $-80°$ C. to the melting-point. Maxima in the impact figure-temperature curves were shown by tin at 0°, zinc at 150°, duralumin at 400°, lead-free 70 : 30 brass at 800°, 60 : 40 brass at 715°, 10 per cent. aluminium bronze at about 750° C. On the other hand, 70 : 30 brass containing 0·02 per cent. or more of lead, and coinage bronze, showed no similar improvement in impact figure at high temperatures. A high notched-bar impact figure seems to indicate good rolling properties; for many alloys there is a range of temperature within which their behaviour on rolling is likely to be worse than at either higher or lower temperatures.—D. **Hanson** and Marie L. V. **Gayler**: On the constitution of alloys of aluminium, copper, and zinc.—Harry **Hyman**: The properties of some aluminium alloys. Aluminium alloys available for sand castings for engineering purposes generally possess low ductility, and this renders them difficult to manipulate in workshop practice; also they are readily susceptible to corrosion. A series of alloys was prepared with the view of passing a minimum test of 5 tons yield point, 10 tons breaking stress, and 5 per cent. elongation on sand-cast test-bars, and at the same time capable of undergoing a severe salt spray corrosion test without marked loss in weight. The alloy B.S.7, containing copper, nickel, iron, and magnesium, gave the most promising results, and has been adopted on a commercial scale.—Douglas H. **Ingall**: The high temperature-tensile curve: (*a*) Effect of rate of heating; (*b*) Tensile curves of some brasses. For any given load the breaking temperature and the critical inflection temperature are lower the slower the rate of heating. In the lower temperature, straight-line portion of the curve, the relationship between breaking temperature and rate of heating may follow a hyperbolic curve, which would establish a definite fundamental tensile strength for any given temperature. Alloying increases the number of loops in the higher temperature curve over a given range of temperature; this is probably due to space lattice distortion. The high temperature-tensile curves of the brasses indicate that the solution of zinc in copper, over the α-range of composition, is not simple.—George B. **Phillips**: The primitive copper industry of America. There was a pre-historic copper industry in America, carried on by aborigines, who made widespread use of copper for tools, weapons, implements, ornaments, and ceremonial objects. This extensive manufacture of copper implements of similar shape to take the place of the stone and bone articles formerly used seems to justify the claim of a primitive copper culture for the American Indians, suddenly interrupted by the arrival of the Spaniards.—D. **Stockdale**: The α-phase boundary in the copper-tin system. Specimens were brought into equilibrium by quenching from a high temperature followed by long heat treatments at the supposed temperatures of the transformations. At ordinary temperatures the solubility of tin in copper is much higher than any previous diagram indicates; it is 16·0 per cent. of tin by weight. This result does not affect bronze-bearing metals, because such material when originally cast consists of the α and δ phases, and the hard δ shows no tendency to dissolve in the soft α at low temperatures. The existence of a transformation in the β phase has been confirmed.

PARIS.

Academy of Sciences, July 27.—Henri **Jumelle**: The tombak tobacco of the Alaonites.—Alexandre **Rajchman**: Multiple convergence.—Th. **Vautier**: Secondary waves due to an aerial wave.—Nobuo **Yamada**: The long-range particles emitted by the active deposit from radium.—André **Graire**: The theoretical and practical conditions of reversibility of the reactions in the leaden chamber process.—Muncnari **Tanaka**: The quinonediazides of the anthraquinone series.—G. **Vavon** and P. **Peignier**: The preparation of active isoborneol. Two methods have been worked out and are described in detail, one starting with pinene hydrochloride, the other by the catalytic hydrogenation of camphor.—E. **Rothé**: The earthquake of February 22, 1924, in the Pyrenees. Discussion on the epicentre.— — **Gabriel**: The application to meteorology of the astronomical cycle of 744 years.—Mlle. G. **Bonne**: The retrogression bundles in the floral section of certain Rosaceæ.—Ad. Davy de **Virville**: The effect of hygrometric state and of submersion on the form and structure of mosses.—Antonin **Němec** and Mihovil **Gračanin**: The influence of the reaction of the soil on the absorption of phosphorus and potassium in the presence of various phosphatic manures.—R. **Hovasse**: The Ellobiopsidæ, propagated by flagellispores.—J. **Dumas**, G. **Ramon**, and Saïd **Bilal**: The immunising properties of dysenteric anatoxin.

SYDNEY.

Linnean Society of New South Wales, June 24.—J. R. Eyer and A. J. **Turner**: The Australian species of Oncopera (Hepialidæ, Lepidoptera). A key to the species is given, based on the characters of the male genitalia, as well as a key to the superficial characters. Two species are described as new, making four species in all in the genus.—A. B. **Walkom**: Fossil plants from the Narrabeen stage of the Hawkesbury Series. Near the base of the stage, a few species have been found representing a survival of the Glossopteris flora. Higher up, the flora is quite distinct from the Glossopteris flora, and about twenty species are known. No description of this flora has been published hitherto.—A. Eland **Shaw**: New genera and species (mostly Australasian) of Blattidæ, with notes, and some remarks on Tepper's types. Notes are given on many of Tepper's types in the South Australian Museum. Four genera and twenty-five species are described as new, and an attempt has been made to explain some of the peculiarities of structure in the Panesthiinæ most strongly evidenced in the earth-digging group.

Official Publications Received.

Proceedings of the American Academy of Arts and Sciences. Vol. 60, No. 2: New Researches on the Magnetization of Ferromagnetic Substances by Rotation and the Nature of the Elementary Magnet. By S. J. Barnett and L. J. H. Barnett. Pp. 125-216. (Boston, Mass.) 1.50 dollars.

Bulletin of the Geological Institution of the University of Upsala. Edited by Hj. Sjögren. Vol. 17. Pp. vi+450+11 plates. Vol. 19. Pp. iii+249+8 plates. (Upsala: Almquist and Wiksells Boktryckeri A.-B.)

University of Colorado Bulletin. Vol. 25, No. 6, General Series No. 219: Catalogue, 1924–1925; with Announcements for 1925–1926. Pp. 394. (Boulder, Colo.)

Imperial Economic Committee. Report of the Imperial Economic Committee on Marketing and Preparing for Market of Foodstuffs produced in the Overseas Parts of the Empire. First Report: General. (Cmd. 2493.) Pp. 38. (London: H.M. Stationery Office.) 9*d*. net.

Lawes Agricultural Trust: Rothamsted Experimental Station, Harpenden. Report 1923–24, with the Supplement to the "Guide to the Experimental Plots" containing the Yields per Acre, etc. Pp. 130. (Harpenden, Herts.) 2*s*. 6*d*.

Anatomical Society of Great Britain and Ireland. Proceedings, May 1921–February 1925. Recorded by R. J. Gladstone, edited by E. Barclay-Smith. Pp. 120. (London: Cambridge University Press.) 12*s*. 6*d*. net.

Bulletin of the National Research Council. Vol. 9, Part 3, No. 50: Bibliography of Bibliographies on Chemistry and Chemical Technology, 1900–1924. Compiled by Clarence J. West and D. D. Berolzheimer. (Washington, D.C.: National Academy of Sciences.)

National Association of Master Bakers, Confectioners and Caterers. Report on Research at the National Bakery School, London. By Dr. C. Dorée and J. Kirkland. Pp. 27+10 plates. (London: Regent House, Kingsway.) 2*s*. 6*d*.

Indian Forest Records. (Economy Series), Vol. 11, Part 9: Summary of Investigations on Bamboos and Grasses for Paper Pulp. By W. Raitt. Pp. ii+11+1 plate. (Calcutta: Government of India Central Publication Branch.) 8 annas; 9*d*.

Imperial Economic Committee. Report of the Imperial Economic Committee on Marketing and Preparing for Market of Foodstuffs produced in the Overseas Parts of the Empire. Second Report: Meat. (Cmd. 2449.) Pp. 35. (London: H.M. Stationery Office.) 9*d*. net.

Scientific Papers of the Institute of Physical and Chemical Research, Tokyo. Vol. 3, No. 32: On the Physical and Chemical Properties of Biosterin (a Name given to Fat-Soluble A) and on its Physiological Significance. By K. Takahashi, Z. Nakamiya, K. Kawakami and T. Kitasato. Pp. 81-146. Vol. 3, No. 33: Condensation of Nitriles with Thiamides, V. Action of Sulphur Monochloride upon Thiamides. By S. Ishikawa. Pp. 147-154. Vol. 3, No. 34: On the Behaviour of some Spark Lines of Carbon in an Electric Field. By S. Nakamura and Y. Fujioka. Pp. 155-162. Vol. 3, Nos. 35-36: A new Discussion of Bucherer's Experiment; On the Interpretation of the Results of Bucherer's Experiment. By U. Doi. Pp. 163-182. (Tokyo.)

Union of South Africa. Department of Mines and Industries: Geological Survey. Cape Sheet No. 5: Laingsburg. The Geology of the Country near Laingsburg: Explanation to Cape Sheet No. 5. By Dr. A. W. Rogers. Pp. 34. (Pretoria: Government Printing and Stationery Office.) 2*s*. 6*d*. net.

Report of the Aeronautical Research Committee for the Year 1924–25. Pp. 44. (London: H.M. Stationery Office.) 1*s*. 6*d*. net.

Aeronautical Research Committee. Reports and Memoranda No. 956 (Ae. 174): The Airflow round a Body as affecting Airscrew Performance. By C. N. H. Lock, H. Bateman, and H. C. H. Townsend. Pp. 22. 1*s*. 3*d*. net. Reports and Memoranda No. 969 (Ae. 185): A Note on the Katzmayr Effect, That is, The Effect on the Characteristics of an Aerofoil produced by an Oscillating Airstream. By W. L. Cowley. Pp. 5. 6*d*. net. (London: H.M. Stationery Office.)

University of Bristol. The Annual Report of the Agricultural and Horticultural Research Station (The National Fruit and Cider Institute), Long Ashton, Bristol, 1924. Pp. 135. (Bristol.)

Department of Industries, Madras. Report for the Year ended 31 March 1924. Pp. iv+89. (Madras: Government Press.) 6 annas.

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, St. Kitts-Nevis, 1923–24. Pp. iv+39. (Barbados.) 6*d*.