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## British Optical Instruments.

PROGRESS in nearly every branch of scientific investigation is dependent on the provision of suitable measuring apparatus. As the science develops, an ever-increasing degree of accuracy of measurement is required, which in its turn involves a correspondingly higher degree of refinement in the measuring apparatus. Many of the measuring instruments employed are essentially of an optical nature, and thus the optical instrument maker has been truly described as the tool-maker for all branches of scientific investigation including his own. It is the function and the duty of such a tool-maker to keep himself familiar with the latest advances in science, so as to be able to understand or even to anticipate the requirements of the investigator, and to meet these requirements by the provision of suitable practicable devices. That the British optical instrument maker has successfully fulfilled this function was clearly indicated by Mr. F. Twyman, who, in his recent presidential address to the British Optical Instrument Manufacturers' Association, discussed the capacity of the industry for invention, development, and production. His survey contained a record of notable achievements in regard to instrument design and construction of which any body of workers might justly be proud.

The economic stringency and the increased competition experienced during the past few years have stimulated the industry to increased efforts towards perfecting the quality and widening the range of its products, and towards improving and increasing its equipment for producing. Technically, the industry is in a healthy condition. Its research organisation, the British Scientific Instrument Research Association, has already proved of inestimable value. In addition, many of the individual firms in the industry actively prosecute research in their own laboratories; and these investigations are not simply directed towards putting forward new processes or improvements, but are often of a fundamental nature. This activity in research is reflected in the numbers of papers which have been published in recent years in the Transactions of the Optical Society and elsewhere, giving results of many important investigations carried out by the scientific staffs of optical firms. Educational facilities in all branches of technical optics are provided in London at the Optical Engineering and Applied Optics Department of the Imperial College of Science and at the Northampton Polytechnic Institute. Thus, the scientific, technical, and educational equipment of the industry is such as to lead one to anticipate a continuance of the notable attainments which have characterised it in the past.

The story of these achievements of the British optical instrument industry has never been sufficiently proclaimed, and the industry's commercial activities have probably not equalled, in extent or intensity, its technical and scientific abilities. For many years, German optical instruments have held a high reputation. This reputation has been well deserved. It has been built primarily on quality; but quality has been backed up by publicity, by advertisement, and by efficient commercial methods which, above all, rendered the selection and purchase of a suitable instrument a relatively simple matter. To-day, the products of the optical glass industry and the optical instrument industry of Great Britain are well able to compete with those of any other country, and in many directions they have established a distinct supremacy.

If an examination were made of similar types of optical glasses obtained through the ordinary commercial channels from British and from foreign makers, we believe that the results would show that the former are in several respects superior to the latter. It is unfortunate that no detailed authoritative statement on this subject has yet been published. In regard to microscopes, the best British stands have been, for long, unsurpassed, and many notable advances have recently been made in the optical parts. British microscope manufacturers have now provided a series of apochromatic objectives which are superior to any made in any other country. They have also introduced improvements in illuminating systems, a dark-ground illuminator having been developed which permits the use of higher powers than was hitherto possible.

The superiority of British camera lenses has been frequently demonstrated. Photographic lenses for aerial survey, the specification for which is particularly severe, have been supplied to foreign countries by British makers in open competition with the rest of the world. The photographic lenses of aperture F/2 recently produced in Britain were the first lenses of such great rapidity, and are still distinctly the best of their class. The only foreign-made lens of an equivalent speed covers about two-thirds the width of field of the British lens. The telephoto lens, which originated in Britain, has been improved so as to suit the varied and extended uses to which it is now being applied, and the British lens of this type still holds a foremost place.

For astronomical instruments and for instruments used in astrophysics, no country stands higher in reputation than Great Britain. Since the War, British makers of surveying instruments have re-designed most of their instruments, and have effected improvements, not only in design, but also in construction and in subsequent performance. The quality of the instruments is indicated by the fact that satisfactory sales are being effected abroad in the face of particularly severe competition from other countries. The best British binoculars now being manufactured are a little better than the best of the same class made abroad, and in addition, binoculars have now been made here which have a larger field of view than any others at present on the market.

For many years, the premier manufacturers of range-finders in the world have been British, and before the War, foreign governments were probably their best customers. During these latter years, these manufacturers have continued to develop and improve their products, which for quality and efficiency are still unsurpassed.

British optical instruments for physical research form another branch with a deservedly high reputation. Complete equipments for dealing in a broad way with various special fields of research, such as the electron theory of matter, have been supplied by British manufacturers to laboratories in practically every country in Europe, as well as to the United States of America, Japan, and various parts of the British Empire. It is probable that most of the research of the world in certain fields of prime importance in modern physics is being done with British-made instruments.

On its own initiative, the optical instrument industry during the past ten years has developed apparatus for the testing of optical elements and optical instruments. This apparatus, in one or other of its various forms, will measure interferometrically the errors and imperfections of any kind of optical instrument, such as, for example, an astronomical telescope, a microscope, camera lens, or binocular. Photographs of the imperfections can easily be obtained, and these constitute unquestionable records. The apparatus in now in use in Britain and also in certain factories and State testing institutions abroad. It is thus possible for manufacturers to have applied to their lenses a test which is free from all elements of judgment, and to have the results stated in numerical measurement.

Enough has been said to show that, from a technical point of view, the British optical instrument industry is active and vigorous. The existence of such an industry is vitally essential to progress in science and to the healthy development of the nation. Close co-operation between the scientific investigator and the optical instrument maker will facilitate a continuance of that progress and development. Reference may be made in this connexion to recent investigations on filter-passing micro-organisms. Adequate instrumental facilities for investigations on such organisms were not in existence a year or two ago. The investigators knew the limita-

tions of their apparatus and knew what their requirements were. They placed their knowledge and requirements before the instrument maker, and in a comparatively few months were supplied with the instruments which enabled them to go further and deeper into their work and to obtain those important results which have recently been published. The work involved the construction of a microscope stand with an accuracy of focussing and a rigidity not provided by any existing stand, and also of an entirely novel combined illuminator, in which a high aperture dark-ground illuminator is mounted concentrically with, and encircling, a quartz condenser. The former secures visibility and is used to locate the micro-organisms, while the latter is used with ultra-violet light to obtain the image on the photographic plate.

Many examples could be given of the services rendered by the optician in the provision of special apparatus, often very complex and ingeniously designed, for the control of industrial processes. The efficiency of the British optical instrument industry has been, to a large extent, responsible for the rapidly growing use of optical projection apparatus in connexion with industry.

It is obviously in the interests of the scientific investigator, whether his work lies in the academic or in the industrial field, that there should be in the country in which he works, a progressive and efficiently equipped optical instrument-making industry. Such an industry does not exist on the production of specialised instruments alone. The more frequently recurring demands for instruments of the less elaborate types have also to be met. The production of these provides training and experience for the members of the industry. Production is regulated by demand. The greater the demand for British-made optical instruments, even of the simpler type, the wider will be the field from which may be recruited the craftsmen, the artists, and the scientific designers, all of whom are required in the production of many of the masterpieces which emanate from the optician's workshop or laboratory.

The contributions made by the optical instrument industry of Great Britain both to science and to industry entitle it to support and encouragement by every section of the nation. During times of peaceful progress, as much as during war and strife, a prosperous and active optical instrument industry is an important national asset, the influence of which may extend far beyond mere national boundaries. It should only be necessary for the users in Great Britain of optical instruments to be made fully aware of the industry's attainments and capabilities, and also of the range and quality of its productions, to ensure that such support and encouragement will not be lacking.

## Modern Physics.

(1) *Die Methoden der theoretischen Physik.* Von Felix Auerbach. Pp. x + 436. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1925.) 13 gold marks.

(2) *Introduction to Theoretical Physics.* By Prof. Arthur Haas. Translated from the third and fourth editions by T. Verschoyle. Vol. I. Pp. xiv+331. (London, Bombay and Sydney: Constable and Co., Ltd., 1924.) 21*s.* net.

(3) *Physics: a Text-book for Colleges.* By Prof. Oscar M. Stewart. Pp. viii+723. (Boston and London: Ginn and Co., 1924.) 17*s.* 6d. net.

(4) *Lehrbuch der Physik in elementarer Darstellung.* Von Arnold Berliner. Dritte Auflage. Pp. x+645. (Berlin: Julius Springer, 1924.) 18·60 gold marks.

IN the older British universities the term natural philosophy is still used to denote one of the main branches of study. In 1747 we find Mr. David Young appointed to be "professor of natural and experimental philosophy" in the United College of St. Salvator and St. Leonard in the University of St. Andrews. In the Scottish universities, applied mathematics fell within the province of the department of natural philosophy. There lies before us an M.A. diploma of the University of Glasgow, dated 1863, signed, amongst others, by Gul. Thomson, *Phil. Nat. Prof.* There is something to be said for retaining the more sonorous designation natural philosophy, at least for official purposes, in preference to the more compact term physics. It is the science which treats of the general properties of natural bodies. "The philosophy of science," says Prof. Whitehead, "is the endeavour to formulate the most general character of things observed." The changes which have taken place in our outlook upon natural phenomena during the first quarter of the present century have been profound, but yet they must be described as evolutionary rather than as revolutionary in character. Not only have there been brilliant experimental discoveries, resulting in entirely new methods of investigation, but also during the same period new theoretical conceptions have been introduced by Planck, Einstein, and Bohr, which have led to much questioning as to the fundamentals of our philosophy.

These developments, which have been discussed in a very large number of special treatises, have tended to render many of the older text-books, if not obsolete, at least imperfect and incomplete. The time has now arrived when it appears necessary to make provision for the new knowledge by revised and extended treatment. The task is no easy one, partly because of the rapid accumulation of new material and partly on account of our imperfect grasp of the new theories

Another and very serious difficulty is the amount of mathematical knowledge and training required for the full appreciation of old and new theories alike. As Prof. Donnan says in his foreword to the volume by Prof. Haas:

"A sure understanding of the quantitative principles of physical science is nowadays a necessity for everybody—for the chemist, engineer, and physiologist as much as for the physicist. Nobody can afford to say that he is not a physicist and so expect to be forgiven for his ignorance. Nevertheless, the difficulty is a real enough one for the many who fear the mathematical reasoning and the wealth and subtlety of physical science."

This raises the important question of the relation between the teaching of mathematics and the teaching of physics. If, as is now the custom in most, if not all, British universities, the teaching of each subject is undertaken by a separate department, it is clearly desirable that the teacher of applied mathematics should be in sympathy with the experimental work of the science student, and if possible be himself in some sense an experimenter. To the reviewer, who has had experience of the Mathematical Tripos of former days, it seems only a truism to say that in a well-arranged university course the mathematical and experimental work should proceed side by side, acting and reacting upon each other to the mutual advantage of both.

In the Rouse Ball Lecture for 1924, Dr. Horace Lamb has emphasised the condition for mathematical progress stated by Fourier: "The profound study of Nature is the most fruitful source of mathematical discoveries." The tendency, which has unfortunately prevailed at Cambridge, to separate mathematics and physics into watertight compartments, must be strenuously resisted.[1] The same may be said, in perhaps lesser degree, of other branches of science.

(1) The problem referred to above has been encountered by Dr. Auerbach, of Jena, who states that his experience proves that a student who attends without preparation courses on the special branches of theoretical physics (mechanics, heat, electricity, optics) does not appreciate the meaning of the whole or understand the methods employed in obtaining the results. On the other hand, he found that an introductory methodical course (largely concerned with mathematical processes) attracted a large number of students, who afterwards attended special courses with much greater benefit. This volume is the outcome of such a preparatory course of lectures. The author starts with the fundamental principles and then proceeds to deal systematically with the methods, passing from ordinary language to the language of mathematics, from the elementary to the more advanced, from the infinitesimal to the statistical, from the arithmetical to the geometrical. Examples illustrating the mathematical methods are drawn from all branches of physics. The resulting impression conveyed is that of a rearranged text-book of physics in which the subjects are now grouped so that each individual experiment or theoretical investigation serves as an illustration of a particular type of mathematical equation or method. Thus cubic equations are illustrated by the example of the equation of state of Van der Waals, maxima and minima by the greatest range of a projectile and the position of minimum deviation of a prism.

If the point of view taken by the author be conceded, the resulting treatise may be regarded as satisfactory, for the work has been well done and the exposition is clear. The title chosen is slightly misleading, as it does not convey to the casual reader the fact that by far the most important function of the book is to elucidate mathematical methods in their physical applications. In a book of this character dealing with complex functions, differential equations, and spherical harmonics, it is remarkable that vector methods are not introduced until page 407 is reached.

(2) In writing his text-book, Prof. Haas, of Vienna, states that his aim is to provide an exposition which, while modern in treatment and outlook, would give a survey of the present state of theoretical physics, its principles and problems, without going too far into details. On looking over the pages for the first time, it might be inferred that this was a book for the mathematical physicist. It is true that symbolic and vectorial methods are employed and the principal rules of differential and integral calculus are assumed, but let the non-mathematician take heart—he is led on by gradual stages from the more familiar to the more abstruse. Prof. Haas is a skilful teacher, and the earnest student who follows him with care should finish the volume with greatly widened knowledge and sincere appreciation of the help rendered. To quote again from the foreword by Prof. Donnan: "The whole structure of physical theory is built up piece by piece, with an exposition so sequent and crystal clear that we can pass through and understand the great luminous building without painful effort." This first volume deals with mechanics, with the general theory of vector fields, of vibrations, and of potential, and also with the theory of the electromagnetic field and of light. The important subject of atomistic physics is postponed to later volumes. In an appendix of 20 pages a convenient summary is given of the contents of Vol. I.

An eminent exponent of the principle of relativity is credited with the dark saying that the mathematician is never so happy as when he does not know

[1] See NATURE, vol. 114, p. 460, 1924.

what he is talking about! He rejoices in the breadth of his generalisations and may say with the poet:

"There are nine and sixty ways of constructing tribal lays,
And every single one of them is right."

Perhaps! But the historian may attach very different values to them as accurate or even approximate records of tribal history. It is often difficult to determine at what point in a mathematical argument some tacit assumption is made, the rejection of which would invalidate the subsequent reasoning. As a rule, Prof. Haas is very careful in this matter, but consider the statement on page 211: "It is *impossible* for a *single magnetic source to exist* by itself" (italics as in the original). This is said to be a fact which necessarily follows from the definition of magnetism. Doubtless—if the author's definition is accepted; but should the physicist isolate a magnetic pole to-morrow, the mathematician would have no difficulty in formulating a new definition of magnetism.

(3) The college text-book of physics by Prof. Stewart is of a more elementary character and does not call for detailed criticism. It should prove suitable for students who expect to specialise in agriculture or medicine, or for those who are taking physics as part of a general course in arts and science. The author realises that there is a more important purpose than that of merely giving useful information. "The great discoveries and applications of science, to which we are to-day so indebted, have been due primarily to the development and diffusion of what may be called the modern scientific method of reasoning. The study of physics offers unusual opportunity for acquiring this method." Stress is laid on the importance of grasping the fundamental principles of the subject; but only after the student has had the opportunity of becoming familiar with the facts, are deductions or generalisations made. The principles are illustrated by a large number of examples drawn from common experience. An interesting and valuable feature is the introduction of a chapter on meteorology, "the physics of the atmosphere," with special reference to the United States and Canada. The volume is well illustrated and is liberally provided with numerical problems.

(4) Dr. Arnold Berliner, editor of *Die Naturwissenschaften*, has faced and accomplished successfully the difficult task of revising his "Lehrbuch der Physik," which now appears in a third and enlarged edition. The author acknowledges his indebtedness to Profs. Geiger and Henning for assistance in dealing with the subjects of atomic physics, radioactivity, and heat. The amount of information contained in these 645 quarto pages, many of them closely printed, is extraordinary. The standard is about the same as that of Ganot or Deschanel, but the range is wider, and modern work is discussed from the beginning of the book. As illustrating the mixture of old and new, we may note that the quantum theory of specific heat comes only six pages later than the description of Lavoisier's ice-calorimeter; a few pages further on follows a well-illustrated account of the steam turbine.

The author realises clearly the restrictions imposed upon him by the elementary character of the work. While this makes a certain breadth of treatment—even amounting to prolixity—inevitable, it demands many sacrifices as regards strictness of demonstration and fullness of detail. The stringent claims of the professional physicist must sometimes be disregarded, and on didactic grounds only what is essential must be retained. It is remarkable, however, how much can be accomplished without the employment of advanced mathematical methods. Not many authors, for example, would care to face the task of presenting in some half-dozen pages an outline of both the special and the general theory of relativity. It is open to question whether the author is justified in adopting the bold plan of stating the principles of thermodynamics, including Nernst's heat theorem, before giving an account of the fundamental methods of thermometry and calorimetry.

British physicists are, as a rule, generously treated, and quotations are made from the writings of Faraday, Maxwell and Tyndall; but it may be pointed out that, long before Helmholtz in a celebrated memorial lecture emphasised the work of Faraday, the latter had formed a clear conception of the existence of atoms of electricity. The sections dealing with the development of the electron theory deserve a special word of praise; these take up in turn the subjects of discharge in gases and the phenomena of ionisation, Röntgen radiation, radioactivity, and the structure of the atom. In the last-named section a very lucid and interesting picture is given of the atomic model due to Rutherford and Bohr, together with a short account of its application to the explanation of the hydrogen spectrum. The work of Moseley on X-ray spectra and that of Aston on isotopes is briefly described, and Einstein's photo-electric equation is discussed. The numerous diagrams, though reproduced on a small scale, are remarkably clear and add greatly to the value of the book.

Of special interest is the chronological table which fills the last three pages of the volume. This contains the names of the leading natural philosophers of all nations from A.D. 1500 to the present time, and shows at a glance the life-period and the contemporaries of each. Such a table in the form of a wall-chart would be invaluable in the lecture-room of any department of physics.

H. S. ALLEN.

## Our Climatic Environment.

(1) *Civilisation and Climate.* By Ellsworth Huntington. Third edition, revised and rewritten, with many new chapters. Pp. xix+453. (New Haven: Yale University Press; London: Oxford University Press, 1924.) 23*s.* net.

(2) *Principles of Human Geography.* By Ellsworth Huntington and Sumner W. Cushing. (Huntington Geography Series.) Third edition, revised. Pp. xviii+430. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1924.) 15*s.* net.

(3) *Climatic Laws: Ninety Generalisations with numerous Corollaries as to the Geographic Distribution of Temperature, Wind, Moisture, etc.; a Summary of Climate.* By Prof. S. S. Visher. Pp. 96. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1924.) 7*s.* 6*d.* net.

(1) FROM archæological studies in Asia and Central America, Prof. Ellsworth Huntington was convinced that at certain periods in the past the population of these regions was not only larger than at present, but also more energetic and progressive. He also found evidence that in the arid parts of Asia these more populous periods were blessed with a greater rainfall. Hence he developed the "pulsatory" hypothesis of climatic changes. This hypothesis has met with a considerable amount of criticism, the most obvious of the alternative views being that with proper irrigation the land is still capable of supporting a large population, and that the inhabitants have to thank their idleness and improvidence, or the lack of enlightened government, for conversion of their fields into deserts. It must be agreed that the present inhabitants of Mesopotamia or the Indians of Central America would provide very poor stuff on which to build up a great empire like those of antiquity. Huntington has frankly admitted the point, and has turned the tables on his critics by making the variation of human efficiency with changes of climate an essential part of his theories. In so doing he has achieved a great deal of useful work in what may be termed the science of "applied climatology."

The first edition of "Civilisation and Climate" appeared in 1916, and opened with a detailed analysis of the amount of work done under different climatic conditions by a number of groups of people, mainly in the United States. The conclusion arrived at was that the most favourable conditions for human efficiency were a mean temperature in the neighbourhood of 60° F., a moderate seasonal range, a moderate variability of temperature from day to day, and a considerable degree of "storminess," the latter condition providing a stimulating series of weather changes. The material was good so far as it went, but being based mainly on a single country within the north temperate belt, it did not seem to provide a sufficient groundwork for a discussion ranging from the tropics nearly to the poles. In the third edition, the basis has been extended by a detailed discussion of the death rates in a number of large towns, in relation to daily and seasonal changes of weather.

The results confirm those obtained from measurements of work done under varying conditions, but the basis is still predominantly American. The mean annual temperature of the eastern United States ranges from about 50° F. in the north to 70° F. in the south, and the optimum temperatures for health and physical energy range from 58° F. in Connecticut to 68° F. in Florida. For mental energy the optimum is lower, but the data are few and incomplete. In the north, where buildings are warmed in winter, the average annual temperature in which people live is higher than the mean temperature of the open air, so that the conclusion can legitimately be drawn from Huntington's figures that people are healthiest and work best in the temperatures to which they are most accustomed. One would like to see this part of the book extended to include the work of native races in the tropics and in the far north, but it is admitted that the necessary data would be hard to obtain. The other climatic factors of efficiency, variability of temperature and weather, are not open to this objection to quite the same extent, and there seems to be no doubt that these factors are responsible for small variations of 2 or 3, perhaps 5 per cent. in the output of work. Whether these variations are large enough to be significant in human progress remains doubtful.

On the basis of the results for temperate eastern America, the author proceeds to calculate the energy value of the climate of each part of the globe. The formula employed is arbitrary, and perhaps assigns too much importance to temperature, but granting the initial assumption that the climate of New England is highly favourable, it appears to fulfil its purpose sufficiently well. This map of climatic energy is compared with a map of "civilisation," according to the opinions of fifty competent authorities. The agreement of the two maps is striking, and really forms the main justification for the book.

The concluding chapters deal with the civilisations of antiquity, and the opinion is expressed that they grew up along the storm belt when it lay much farther south than now. But in the efficiency formula the temperature terms predominate, and since these have admittedly not changed appreciably, this amounts to an assumption that the optimum temperature was also higher; in other words, that the needs of the human

species have changed since that date. Hence it seems that the effects of storminess and especially of rainfall need to be considered in greater detail, and quite apart from temperature. Criticisms such as these are, however, matters of detail; the book certainly succeeds in its main object, which is to bring out the importance of climate in human activity and well-being. It remains only to add that it makes very interesting reading and is well illustrated, while the general appearance is excellent.

(2) The "Principles of Human Geography" is a text-book dealing with the relation of man's activities to the environment in which he lives. The first nine chapters deal with the more strictly geographical aspect—latitude, land-forms, bodies of water, soil, minerals and sources of power—and show how these control human life in different regions. The remainder of the book deals with the influence of climate, through its effect on plants and animals and on human efficiency, according to the views of "Civilisation and Climate."

Each of the different climatic regions has its own series of plant and animal products and its especial climatic advantages and handicaps. In the regions where the "climatic energy" is least, man is the slave of his environment, while in more favourable climates he begins to overcome his handicaps and improve his opportunities. In this way arise a number of characteristic cultures, which are skilfully described and analysed. Finally we come to the regions of cyclonic storms, the fortunate inhabitants of which rise superior to their environment, reaching out to the ends of the earth to gather the products of all countries, and to dominate their weaker neighbours, and the last few chapters may be described as the epic of "cyclonic man."

The authors have kept a restrained and lucid style throughout, while the book is well printed and illustrated. Each chapter concludes with a series of interesting problems requiring independent research, and one can readily accept the authors' statement that the students tackle them with great enthusiasm and interest.

(3) "Climatic Laws," unlike the two preceding books, appears to be the result, not of original thinking, but of much reading. It presents ninety generalisations, which are considered to correspond with the "laws" of other sciences. The idea is good, but the author's methods result in a heterogeneous mixture of dogmatic statements. Some are so obvious that it does not seem necessary to commit them to writing (*e.g.* the "law" that days and nights vary in length in middle and high latitudes); some are not true (*e.g.* "There are for most places two diurnal maxima and two minima for precipitation. . . . The maxima usually are at 2–5 P.M. and 3–6 A.M."); the remainder are useful summaries of facts. The book is also marred by several examples of loose writing. Its most valuable feature is the long list of references, but the author would have been well advised to quote more extensively than he has done and also to add a few pages of tables.

## The Tetraphyllid Cestodes.

*A Monograph on the Tetraphyllidea: with Notes on related Cestodes.* By Dr. T. Southwell. (Liverpool School of Tropical Medicine. Memoir (New Series) No. 2.) Pp. xv + 368. (Liverpool: University Press of Liverpool, Ltd.; London: Hodder and Stoughton, Ltd., 1925.) 20*s.* net.

THE most difficult group of helminth parasites to deal with from the morphological point of view is the Cestoda. They have superficially a very considerable resemblance to each other and an elaborate technique is necessary before their internal anatomy can be satisfactorily studied. The older naturalists in their classifications based their systems largely on the external characters—characters which in a colourless animal such as a tapeworm are unsatisfactory, and are rendered even more unsatisfactory by the extremely muscular nature of the parasite and the absence of any supporting skeleton to retain a permanent shape. Moreover, the complicated life-cycle of these animals has made confusion worse confounded and our knowledge of the whole group is in a very chaotic condition indeed.

At present four orders of Cestoda are generally recognised. These are (1) the Cyclophyllidea, which contains most of the common forms from mammals and birds and on that account has had the greatest amount of attention; (2) the Pseudophyllidea, which includes the Broad tapeworm of man and has recently been the subject of a monograph by Nybelin; (3) the Trypanorhyncha, which is at present in a state of the utmost confusion; and (4) the Tetraphyllidea, which is the subject of the present able monograph To these four Dr. Southwell has added a fifth and smaller order, the Heterophyllidea. This new order is considered exhaustively in the present work.

Dr. Southwell has been engaged in the study of the cestodes of fish for about sixteen years—especially in connexion with the Ceylon Pearl Fisheries and as Director of Fisheries in India—and the present volume is the result of that research. This work, supplemented by a recent paper on the Tetrarhynchids (the Tetrarhynchidæ is one of the two families composing the Trypanorhyncha) found in Ceylon Marine Fishes (*Ann. Trop. Med. and Paras.*, 1924, 18, pp. 459-491), forms a complete monograph on the cestodes of fish.

This volume consists of four parts, of which the first is of more general interest than the others. It is devoted mostly to a critical examination of the present systems of classification of the whole group. Dr. Southwell believes that the five orders can only be separated naturally by means of the shape of the head. Thus the Cyclophyllidea have four suckers, the Pseudophyllidea either one (rarely) or two (commonly) bothria or sucking grooves, the Tetraphyllidea have four lappet-like outgrowths from the head called bothridia, while the Trypanorhyncha have four proboscides each of which is armed with spines. Forms which cannot be included in any of these four are referred to his new order, the Heterophyllidea. The Cyclophyllidea he proposes dividing into two sub-orders. The first of these, the Univitellata, which is equivalent to Stiles' superfamily Tænioidea, is characterised by the possession of a single unpaired vitelline gland. The second sub-order, the Multivitellata, has more than one yolk-gland and contains the Proteocephalidæ and the Lecanicephalidæ of Braun. While no system of classification in a subject so imperfectly known as this one can be regarded as permanent, this scheme, even in the light of our present knowledge, is not fully satisfactory. Where in it, for example, can we place the genus Mesocestoides? This genus consists of forms with a four-suckered head and a typical Cyclophyllidean anatomy; but the genital opening is ventral, not lateral as in most forms of this order, and there are *two* discrete vitelline glands in a posterio-median situation. It does not seem to find a place in Dr. Southwell's scheme. It is so obviously a close relation to the Tænoid cestodes that it would seem that Dr. Southwell's Univitellata will have to be modified to include it.

The remaining three parts are of interest more to the specialist than to the more general zoologist or parasitologist. Part ii. deals with the Tetraphyllidea, part iii. with the Cyclophyllidea in fish, and part iv. with the Heterophyllidea. These sections, which are illustrated with nearly 250 drawings, discuss in a lucid and exhaustive manner all the forms belonging to these orders found in fish. Apart from the fact that future workers are now provided with modern and comprehensive accounts of these parasites, Dr. Southwell has rendered a very considerable service to science by greatly reducing the number of described species.

The task which Dr. Southwell had set himself was one of great difficulty: the result is a work highly creditable to himself and a contribution of considerable value to zoology.

The volume is introduced by a very characteristic foreword by Sir Arthur Shipley, and forms the second of the series of memoirs being published by the Liverpool School of Tropical Medicine.

## The Internal Combustion Engine.

(1) *Automobile Engines in Theory, Design, Construction, Operation, Testing and Maintenance.* By Arthur W. Judge. (Motor Manuals: a Series for all Motor Owners and Users, vol. 1.) Pp. vii + 189. (London: Chapman and Hall, Ltd., 1925.) 4*s*. net.

(2) *The Testing of High-Speed Internal Combustion Engines: with Special Reference to Automobile and Aircraft Types and to the Testing of Automobiles.* By Arthur W. Judge. Pp. xvi + 392 + 54 plates. (London: Chapman and Hall, Ltd., 1924.) 25*s*. net.

(3) *Cost of Power Production by Internal Combustion Engines.* By G. A. Burls. Pp. iv + 56. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1924.) 5*s*. net.

(1) THERE is something to be said for the point of view that an elementary book on the internal combustion engine should really be an elementary book on the heat engine and should therefore contain an account of the steam engine in addition to those basic principles of the theory of heat which are common to both forms of prime mover. But in practice some differentiation is very usual; the number of readers interested in one is so vastly greater than the number interested in the other. Mr. Judge's book, which appears as one of a series specially written for "all motor users and owners" is an example of this.

We should at one time have expected to find a good proportion of motor owners but ill-equipped for the reading of such a book as Mr. Judge's, but the intense interest taken by a very large section of the public in the technicalities of radio broadcasting shows that we must be prepared to enlarge our ideas as to the receptiveness of the general public to technical writings. If this receptiveness applies now, or can be made to apply hereafter, to the study of automobile engines, Mr. Judge's book should prove to have achieved its object. It contains a great mass of information of the familiar type, and it presents it in a convenient and orderly form. The subject-matter is brought up-to-date; for example, the methods of supercharging automobile and aero engines are described, as are also the features of the modern anti-detonation substances for admixture with ordinary engine fuel.

(2) This book, also from the pen of Mr. Judge, is a very complete statement of the technics of the testing of high-speed internal combustion engines. In the course of its nigh on four hundred pages, the requirements of manufacturers, of inspectors and of laboratory assistants, appear equally to be met, but it is scarcely a book for general reading: those, however, whose work leads them to consult it will be grateful to the author for the painstaking way in which he has

collected information dealing with every aspect of testing, whether relating to stationary engines, automobile engines, or aircraft power plant.

(3) Mr. Burls is well known as a capable writer on the subject of the internal combustion engine, and we received with interest his new volume on the cost of power production by these engines. The period of time covered by this inquiry, as the author points out, includes that of the War, and many of the figures given are of special interest as showing the rapid increase in costs as hostilities proceeded, and the subsequent slow decline as the world gradually returned towards peaceful conditions. Apart from this, there is the factor that if the interest taken in this engine is to bear fruit, it is necessary that information giving up-to-date figures of capital and working costs, particularly in comparison with other forms of power production, shall be ready to hand. It is rather a shock to notice on p. 44 of this new book that some of the statistics go no later in date than June 1921, although on the same page there is other information dated August 1924.

An especially interesting point is made by the author when dealing with the power capacity of large gas engines. He quotes Sir Dugald Clerk's view of the limiting factor in terms of heat units per cubic foot of piston displacement, and shows that this is much better expressed as a limiting mean effective pressure on the basis of a constant thermal efficiency. As applied to the large gas engine, this leads to the range of 55 to 65 lb. per square inch, and the author quotes 64 lb. as representing current practice in 1924. This makes a bulky installation compared with that of a steam plant, and unless it were for the great difference in the average over-all thermal economy (as 15 per cent. is to, say, 8·5 per cent.) the internal combustion engine would come badly out of such a comparison.

Mr. Burl's book will be of very real use to the engineering profession.

## Fossil Man.

*Human Origins: a Manual of Prehistory.* By Dr. George Grant MacCurdy. Vol. 1: The Old Stone Age and the Dawn of Man and his Arts. Pp. xxxviii + 440. Vol. 2: The New Stone Age and the Ages of Bronze and Iron. Pp. xvi + 516. (New York and London: D. Appleton and Co., 1924.) 42*s.* net.

DURING the past thirty years Dr. MacCurdy has paid frequent visits to the Old World to study on the spot the various discoveries of prehistoric man and his handiwork. For some time he has also directed the American School of Prehistoric Research in Europe. He has taken part in several diggings, notably in the exploration of the cave of La Combe (Dordogne) by the Peabody Museum of Yale University in 1912. He is curator of anthropology in this museum, and has had much experience in teaching. Dr. MacCurdy is therefore well qualified to produce a students' manual of prehistory with first-hand information, and his two handsome volumes now before us will be widely welcomed. He is cautious—perhaps too cautious—in expressing opinions of his own, but his work is most exhaustive in summarising the conclusions of the authors quoted by him. He has discussed the various subjects with most of these authors, and so is able to present them to the student in the most satisfactory manner.

The first volume begins with a useful glossary, and the second ends with tables of the stratigraphy of palæolithic sites, a repertory of palæolithic art, and a list of the prehistoric monuments of France. Numerous authoritative synoptic tables, besides bibliographies, are also scattered through the text. Dr. MacCurdy has thus provided not only a readable story, with excellent illustrations, but also a work of reference of the greatest value.

After a brief history of the development of prehistoric chronology, there is the usual attempt to correlate the successive races of palæolithic man with the various phases of the ice age which are recognised in the Alps. Late glacial and postglacial time is measured by discoveries in the geology of Scandinavia. The extent of the ice-sheet at the successive periods is shown in a new map which has been compiled from many sources. The handiwork of eolithic and palæolithic man is then treated in several chapters, which are illustrated by photographs of sites taken by the author and by numerous new figures of stone implements in the Yale University collection. Finally, the known remains of the skeleton of palæolithic man are briefly described, with numerous illustrations. Dr. MacCurdy is careful to emphasise the doubts about several specimens of which the antiquity is very uncertain, and he emphatically rejects the discoveries of Ameghino in South America.

A whole chapter is devoted to the Azilian and other stages which belong to the interval between the palæolithic and neolithic periods. Their wide geographical distribution seems surprising when they are tabulated on Dr. MacCurdy's plan. The neolithic period is then concisely treated from every point of view, concluding with an account of the megalithic monuments. There is, however, no allusion to the temples in Malta which have been described as of neolithic age. Fire, hunting, fishing, navigation, the wheel, the domestication of animals and plants, commerce, healing, and magic or religion during the stone

age are then considered in general; and the work concludes with some account of the ages of bronze and iron.

Among the numerous treatises on prehistoric man which have appeared during recent years, the new one of Dr. MacCurdy is assured of a high place, and we cordially recommend it to the notice of all serious students. A. S. W.

## Our Bookshelf.

*University of London: Francis Galton Laboratory for National Eugenics. Eugenics Laboratory Memoirs, 22: The Treasury of Human Inheritance.* Edited by Karl Pearson. Vol 3: *Hereditary Disorders of Bone Development.* Part 1: Diaphysial Aclasis (Multiple Exostoses), Multiple Enchondromata, Cleido-Cranial Dysostosis, by Dr. Percy Stocks; with the Assistance of Amy Barrington. Pp. vi+182+16 plates. (Cambridge: At the University Press, 1925.) 45*s.* net.

Of the twenty-two valuable memoirs issued by the Francis Galton Laboratory for National Eugenics, eight form part of the "Treasury of Human Inheritance." These Treasury memoirs deal exhaustively with inborn anomalies, disorders of growth or pathological conditions, all of which may pass from parent to offspring and therefore afford opportunities of studying the laws of heredity as they affect man. Former memoirs have been devoted to anomalies of the foot and hand, to cleft palate, hare-lip, deaf-mutism, imperfect differentiation of sex, hæmophilia, dwarfism and anomalies of the eye; the memoir under notice, the eighth of the Treasury series, deals with those disorders in the growth of bones known to medical men under the names of *Diaphysial aclasis* (multiple exostoses) and *Cleido-cranial dysostosis*.

The present memoir, for which Dr. Percy Stocks is mainly responsible, maintains the high standard set by former numbers of the series; it will remain for many a day the source from which students and experts must draw information concerning some of the most obscure disorders which overtake the bones of growing children. Diaphysial aclasis affects chiefly the growing ends of the long bones. Dr. Stocks has found 976 cases of this disorder in medical literature; 183 families gave rise to 765 cases; there was evidence of heredity in 69·6 per cent. of the cases tabulated. Transmission is stronger through the male than through the female. Another, but rarer, disorder of growing bones is also dealt with, namely, multiple enchondromata, which may be associated with diaphysial aclasis, and is certainly related to it in nature. In the condition known as cleido-cranial dysostosis there is a partial failure in the formation of the clavicle, and with this there is usually associated an irregular formation of the vault of the skull. Records of 144 cases of this disorder have been collected; the condition was familial in 96 instances.

Prof. Karl Pearson is rendering a most valuable service to all students of the human body by securing the preparation and publication of these memoirs, and it would be a thousand pities if the series were to come to a premature end for lack of public support.

*Handbuch der Zoologie: eine Naturgeschichte der Stämme des Tierreiches.* Begründet von Prof. Dr. Willy Kükenthal. Herausgegeben von Dr. Thilo Krumbach. Erster Band: Protozoa, Porifera, Coelenterata, Mesozoa. Vierte Lieferung. Pp. 513-608. 5·40 gold marks. Fünfte Lieferung. Pp. 609-736. 7·20 gold marks. (Berlin und Leipzig: Walter de Gruyter und Co., 1925.)

The greater part (pp. 522-686) of these two sections of the Handbuch is devoted to an account of the Scyphozoa contributed by Prof. T. Krumbach, of Berlin. He defines the class and gives a short history of the Scyphozoa, in the concluding paragraph of which he refers to the *Tessera princeps* of Haeckel and remarks that this owed its existence to Haeckel's need for a primitive form which, however, never existed in life. The *Tesserantha connectens* of Haeckel is a larval form of the imperfectly known rhizostome Leonura, and a similar larval form is known in the genus Cassiopea. The author describes each of the five orders of Scyphozoa, beginning with the Lucernariida and ending with the Rhizostomeæ, giving under each a definition, a short history, the characters of the principal genera illustrated by schematic diagrams, accounts of the morphology, development, and physiology, references to recorded abnormalities, and brief discussions of the ecology, geographical distribution (with maps), and phylogeny. Appended to each section is a useful bibliography of the order.

Under the order Coronata is an excellent account of the strange genus Tetraplatia, but the author is careful to point out that there is not sufficient evidence to establish the relationships of this genus.

This is an admirable memoir on the structure, biology, and physiology of the Scyphozoa, and the author is to be congratulated on having brought it, including the references to published works, so well up-to-date—the MS. was closed on December 28, 1924. While the account is well illustrated, there are lacking a few figures which would have been helpful to the reader, *e.g.* of the remarkable tentaculocysts of Charybdea and the tentaculocyst of the adult Aurelia.

The remainder of the fifth Lieferung contains a portion of the description of the Octocorallia by the late Prof. W. Kükenthal—one of the outstanding authorities on this sub-class—and he has given a worthy account of the orders Alcyonaria (Alcyonacea) and Gorgonaria (Gorgonacea).

*The Subject Index to Periodicals, 1921.* Issued by the Library Association. K: Science and Technology. Pp. 126. (London: Grafton and Co., 1924.) 21*s.* net.

The Library Association has issued a new instalment of its valuable Subject Index to the periodical literature of science and technology. The section covers the literature published in 1921 but contains some papers of earlier date. There are about 6000 entries obtained from the examination of 290 periodicals.

The periodicals selected are, for the most part, those printed in the English language, being published in the British Empire or in the United States of America. We notice, however, that titles in French and German have been taken from the following periodicals: *Bulletin de la Société pour l'Encouragement de l'Industrie nationale, Revue des Deux Mondes, Scientia, Journal*

*Économique, Chemiker-Zeitung, Physikalische Zeitschrift, Sitzungsberichte der Preussischen Akademie, Forschungsarbeiten des Ingenieurwesens, Gewerbefleiss, Zeitschrift des Vereins der Ingenieure, Zeitschrift für historische Waffenkunde, Preussisches Lehrbuch, Zeitschrift für Reproduktionstechnik,* and *Veröffentlichungen des Militär-Sanitätswesens.* This list of foreign periodicals consulted is taken from the first half only of the index which extends to 252 columns, and must not be taken as exhaustive, but it does suggest the question as to whether the Library Association could not see its way to include a greater number of foreign papers in its subject indexes.

The range of subjects catalogued in this section is so wide that any one interested in science will find his own branch of study dealt with under many of the headings, which are arranged in alphabetical order. A few such headings may be quoted as examples: Aeronautics, airships, alloys, aluminium, artillery, atoms, petroleum, relativity, ship propulsion, spectrum, wireless telephones, thermionic valves, vitamins, and parasitic worms. It would be impossible to include every scientific paper published in 1921 without making the list too bulky and too expensive for ordinary subscribers, so that a selection has had to be made.

It will be evident that the compilers of this index must have had great difficulty in deciding what papers should be included and which excluded. We think they have exercised a wise judgment in their selection.

*Studies in Ampullaria.* By E. G. Alderson. Pp. xx+102+19 plates. (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin, Marshall and Co., Ltd., 1925.) 21*s.* net.

THE scope of the work under notice is not what the author originally intended it should be. He had hoped to produce a complete monograph of the genus, but the necessary material could not be got together and Mr. Alderson has unfortunately made use solely of shells in his own possession. This is a very great pity, for the subject even thus restricted has been so ably handled that the wider work would have been warmly welcomed by conchologists—we cannot say malacologists, since all allusions to anatomy and ecology are rigidly excluded.

The author candidly admits that Bolten's name of Pila for the genus, or at all events a section thereof, has priority over Lamarck's, and so by the Rules for Zoological Nomenclature should be employed, but seeks to justify his preference by the stale excuse that Ampullaria is the more familiar name; thus he misses his chance of assisting in forwarding the cause of uniformity in nomenclature in the sole way in which it can be attained.

The work opens with a full and carefully compiled "Critical Bibliography," which in itself is of great value, but by a strange oversight omits Dall's important proposed classification published in 1904, although one of Dall's names is incidentally referred to later on. Then, after a brief "Introduction," the systematic descriptions of the species follow, each accompanied by a synonymy which seems to have been very thoroughly worked out. Any shortcomings that there may be in a work of this technical character will only reveal themselves to the student who uses it. The nineteen plates of figures, reproduced by half-tone process from the author's own drawings, are exceedingly good: they are plain, but a limited edition of fifteen coloured copies is announced. The printing and general appearance of the book are admirable.

*The Platinum Metals.* By Ernest A. Smith. (Pitman's Common Commodities and Industries Series.) Pp. xii+123. (London: Sir Isaac Pitman and Sons, Ltd., 1925.) 3*s.* net.

MR. ERNEST A. SMITH has produced a useful little work upon platinum and the metals associated with it, though it must be admitted that the latter receive but little, most people will probably say too little, attention. Some of them, such as iridium and palladium, deserve considerably more consideration than the book before us has given to them. Upon the whole the work may be described as accurate, although the author has not availed himself so fully as he might have done of previously published and readily available information. For example, his description of methods used in the Urals for working and washing the platiniferous gravels shows a good many omissions, which a more careful study of existing literature would have avoided.

Interest in platinum has been stimulated greatly within the last few years by the sensational discoveries in the Transvaal, though it cannot be said that the economic importance of these is even now at all known. Mr. Smith's book was written in 1924, and it is therefore no fault of his that it contains nothing more than a casual reference to the occurrence of platinum in the veins in the Waterberg district of the Transvaal. It was only towards the end of 1924 that the discoveries, possibly likely to be fraught with much greater importance, of the occurrence of platinum in the western part of the Lydenburg district were made, and these have only been quite recently described, as for example in two important papers by Dr. P. A. Wagner in the Transactions of the Geological Society of South Africa for 1925, and the *South African Journal of Industries* 1925, respectively. This fact, however, only affords one more illustration of the difficulty of writing any book on a technical subject which shall not be, in some respects at any rate, out-of-date before it issues from the press.

*Board of Education. Catalogue of the Collections in the Science Museum, South Kensington; with Descriptive and Historical Notes and Illustrations.* (1) Water Transport. 2: Steam Ships of War. Compiled by G. L. Overton. Pp. 102 + 8 plates. (2) Land Transport. 2: Mechanical Road Vehicles. Compiled by E. A. Forward. Pp. 87+10 plates. (London: H.M. Stationery Office, 1925.) 1*s.* net each.

(1) THERE are four considerable collections of warship models in London, those at the Imperial War Museum, at Greenwich, at the Science Museum, and at the Royal United Service Institution. The largest and most important is, however, that at the Science Museum. This collection had its birth when the Admiralty in 1864 sent to South Kensington a number of models for the use of the students of the Royal School of Naval Architecture, for though most of these were afterwards transferred to the Royal Naval College, Greenwich, a nucleus remained, and this has been developed from time to time. Of the sailing men-of-war, a catalogue

was issued a year ago, and the catalogue of the steam men-of-war deals with the second part of the naval collections. Compiled by Mr. G. L. Overton, the catalogue shows signs of great care; its illustrations are good, while the historical notes, though brief, are excellent summaries of the progress of warship evolution down to the *Hood*.

(2) The second catalogue under notice deals with the second group of the Land Transport Section of the Museum—mechanical road vehicles. We here meet with the steam carriages of Cugnot, Murdoch, Trevithick, Gurney, and others, as well as the petrol cars of Benz, Panhard, Daimler, and Rolls-Royce. The motor section often has up-to-date bicycles, engines, etc., on loan, but these do not appear in the catalogue. Many of the early historic petrol cars in the possession of the Museum are still stored in the basement.

*Biochemistry: a Laboratory Course for Medical Students.* By I. Frost. Pp. ii+56. (Madras: Government Press, 1924.) Not for sale.

THE multiplication of manuals dealing with practical biochemistry for medical students appears to be an expression of the differences existing between the courses in this subject in the various schools. Each teacher selects from the large number of possible exercises those which both fulfil the requirements of the examination his students must pass and at the same time appear to him most suitable. Each school thus tends to develop its own course in biochemistry, with the result that a course which reaches publication as a small manual may fail to meet the requirements of other schools, which are, however, induced by its appearance to publish their own course.

The manual before us appears to us to strike a distinctly original note; Dr. Frost has apparently kept in mind the fact that biochemical investigations nowadays come to the aid of the clinician, and that an acquaintance with the methods used in the laboratory is essential for a true evaluation of the results of these investigations in relation to the clinical findings. The book opens with some experiments on colloids, together with examples of the colorimetric estimation of the hydrogen ion concentration of solutions: the proteins and blood pigments are only briefly treated, but a selection of the modern methods used in the examination of the blood and urine is given, each method being fully described.

We have noted a few misprints, especially on p. 24, where some decimal points have gone astray. Our impression is that the book sets a high standard in biochemistry for the medical student who is not reading for a science degree also.

*An Introduction to the Strowger System of Automatic Telephony.* By H. H. Harrison. Pp. vii+146. (London: Longmans, Green and Co., 1924.) 7*s.* 6*d.* net.

IT is not very generally known that the engineers of the British Post Office have begun to change the telephone system of London into a fully automatic one. The task is enormous and it will be fifteen years before it is completed. During part of this time the system will be partly manual and partly automatic, but satisfactory arrangements have now been made so that this will cause no inconvenience. This book is therefore very timely. It deals exclusively with the Strowger system, which is the one adopted by the Post Office. In this system there is a dial with 10 finger-holes punched in it. If a subscriber wants to call up Gerrard 8830 for example, he has to perform seven operations. He first puts his finger in the digit-hole with a G in it and moves it round to the stop and lets it go. He then repeats the operation with E and R the second and third letters in Gerrard; this connects him to the exchange. He then performs the same operation in the digit-holes marked 8-8-3-0 respectively. This calls up the subscribers. If the line is engaged the usual engaged signal is heard. The causes of delay at present are mainly due to indistinct articulation and to congestion of traffic during the "busy hour." Automatic telephony eliminates the former hindrance and diminishes the latter. As the change-over is effected, the number of telephone girls will be gradually diminished, the exchanges being entirely automatic, but the number of engineers and workmen required will be increased. This book will make a good text-book for class instruction on automatic telephony.

*Switchgear for Electric Power Control.* By E. Basil Wedmore and Henry Trencham. Pp. xii+335. (London: Oxford University Press, 1924.) 25*s.* net.

THE electric power engineer will find much in this book that will be of value to him. As electrical stations increase in size, the amount and the cost of the requisite switchgear increase very rapidly. Devices are required for protecting the machines and for protecting the distributing mains. The question often arises whether it is worth while to instal a very expensive protection device in order to protect a main, thus paying a heavy annual insurance, or to run the small risk of having the main broken down. Cable manufacturers naturally favour the latter alternative, whilst manufacturers of protective switchgear favour the former. The authors rightly point out that the psychological device of calling a piece of apparatus a "lightning arrester" alone ensures a market for it, even without the accompaniment of a "publicity campaign." Many English engineers have had the temerity not to use them. It has to be remembered, however, that in Great Britain we rarely have severe thunderstorms. The British Electrical and Allied Industries Research Association is carrying out valuable researches on switchgear, and Mr. Wedmore's official work keeps him in close touch with the most modern developments. The book discusses the latest practice.

*Elements of Statistics.* By Prof. F. C. Kent. Pp. xi+178. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1924.) 10*s.* net.

Is it possible to present the elements of statistics in an intelligible form to students almost devoid of mathematical training? The present volume professes to accomplish this, but it does so, if at all, only by an enormous restriction of the scope and depth of the subject. Mere tabulation and pictorial representation of statistics will not in themselves suffice in general unless accompanied by a searching scrutiny of the data,

not merely by applying formulæ to them but also in the light of the principles of the theory of error and of correlation. In the present volume, when a formula is required, it is usually either quoted without proof and used for numerical computation or deduced from one already quoted; but surely the results of such a computation can be appreciated only when examined in relation to the basic assumptions made in deducing the formula. Within the narrow limitations the author has imposed upon himself, the treatment is good and the exposition clear. The book is excellently produced.

*Pathologie du sympathique: Essai d'anatomo-physico-pathologie clinique.* Par Prof. Maxime Laignel-Lavastine. Pp. v + 1080. (Paris: Félix Alcan, 1924.) 90 francs.

THIS volume is an exhaustive thesis dealing with the anatomy, physiology, and clinical aspects of the sympathetic system. Few details are omitted from this ponderous work; indeed, the fault lies in the enthusiasm which tends to implicate the sympathetic system in many conditions of obscure origin. Thus few will agree with the author in associating glaucoma, purpura, and osteodystrophies with sympathetic disturbances. In many instances the evidence in favour of autonomic nervous origin is not sufficiently dealt with; for example, in the section concerning gastric crises in tabes, the rôle played by the vagus is briefly dismissed, and the possibility of "vagal crises" as an entity is not mentioned. It is a pity that such an exhaustive work should have just preceded the valuable contributions of Hunter and Royle; their work on the sympathetic innervation of striped muscle and on treatment by ramisectomy is of course not included. The volume concludes with a very full bibliography.

*Les edifices physico-chimiques.* Par Dr. Achalme. Tome 3: La molécule minérale. Pp. 350. (Paris: Payot et Cie, 1924.) 20 francs.

THE principal feature of this book is a series of elaborate diagrams, first of the structure of *atoms*, which are represented as aggregates of spheres of various patterns, and then of *molecules*, which are represented as aggregates of these aggregates. The author has thus succeeded in building up a very elaborate series of molecular models; but as the details of these are purely speculative, they are not of any value as an aid to the study of chemistry. On the contrary, the author's system appears to call for a draughtsman to express even the simplest formulæ, and equations which can be written down in a few seconds in ordinary symbols become as complicated as the design of a new pattern for a carpet. It is difficult to see what can follow from such a system except to create a mistaken impression of the complexity of chemical science.

*Organisation of Vocational Guidance: a Companion Volume to Administration of Vocational Education.* By Arthur F. Payne. Pp. xvi+438. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925.) 17*s.* 6*d.* net.

ALTHOUGH the subject of vocational guidance is as yet in the experimental stage, the literature connected with some of its many aspects is increasing at a very rapid rate—evidence at least of a fairly general interest in it.

This book gives a survey of the chief work done up to the present time and is intended to be of use to all those responsible for advising people about their work in life, and for managers in stores, factories, and workshops. It discusses the various systems of testing intelligence and special aptitudes, normal and abnormal behaviour, physical stigmata, job analysis, as well as the organisation of a vocational guidance bureau. There is a useful bibliography and a large number of charts; it will be a valuable book of reference.

*School Geography: a Critical Survey of Present Day Teaching Methods.* By E. J. G. Bradford. Pp. 104. (London: Ernest Benn, Ltd., 1925.) 7*s.* 6*d.* net.

GEOGRAPHY as taught in schools at the present day shows great advances compared with a generation ago, but Mr. Bradford concludes from a wide experience of teachers and teaching that the tendency is to lay too excessive stress on causal connexions. This results in incoherence and a failure of the pupils to visualise world conditions. While deprecating any return to the mere iteration of facts which of old was the whole content of the subject, he pleads for the need of dwelling on other than causal relationships, especially more insistence on location and quantity. In short, he wants to give more precision and coherence to school geography, and this he believes would increase its educational value. The book is a thoughtful contribution to a difficult problem.

*Low Temperature Distillation: Home Oil Supply and the Utilisation of "Waste" Coal.* By Sydney H. North and J. B. Garbe. (The Specialists' Series.) Pp. vii+216. (London: Sir Isaac Pitman and Sons, Ltd., 1925.) 15*s.* net.

THE authors give a reasoned and critical account of the various processes used in the low-temperature distillation of coal. The problem is one of very great importance, and although authorities differ in their estimates of the usefulness and economics of the method, it is certain to attract an increasing share of attention. The present volume may be welcomed as a useful contribution to the literature of the subject. It is well illustrated.

*Agitating, Stirring and Kneading Machinery.* By Hartland Seymour. (Chemical Engineering Library: Second Series.) Pp. 139. (London: Ernest Benn, Ltd., 1925.) 6*s.* net.

THE various types of machinery used for mixing liquids and solids are described, but theory has been omitted, "in the belief that this method of treatment will be of more service to the practical chemical engineer." A little theory would perhaps have been found interesting by the general scientific reader, who must feel that the book lies outside his province. It should be useful to those to whom it is addressed, and is well illustrated.

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ERRATUM.—By a most regrettable oversight, the notice of the volume "The Atmosphere and its Story," by Ernest Frith, and that of "Why the Weather?" by Dr. Charles Franklin Brooks, were transposed. That appearing in NATURE of August 8, p. 204, refers to Dr. Brooks' book, while the notice in the issue of August 15, p. 241, should have appeared under the bibliographic details of Mr. Frith's book.

## 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 Nature of Radiation.

BOTHE and Geiger have recently performed an experiment on the Compton effect (*Die Naturwissenschaften*, 13, p. 440, May 15, 1925; *Zs. f. Phys.*, 32, p. 639, 1925) indicating that the recoil electron, and the photoelectron emitted by the scattered radiation, appear simultaneously. Prof. A. H. Compton has made another experiment (Proc. Nat. Acad. Sci., 11, p. 303, 1925), showing that the direction in which the scattered radiation acts in producing ionisation, and the direction of the recoil electron, are related. The natural interpretation of these experiments is in terms of a corpuscular theory of radiation, in which a corpuscular quantum, glancing off a scattering atom with emission of a recoil electron, very soon hits another atom and emits a photoelectron. This contradicts the suggestion, discussed by Bohr, Kramers, and the writer (*Phil. Mag.*, 47, p. 785, 1924), that there was a virtual field, like the ordinary fields of optical theory, emitted during the stationary states of the atom, the function of which was to induce a probability of transition; for on that view the probabilities of ejection of electrons by the scattering and absorbing atoms would be independent, both being induced by a radiation field existing continuously, and the two electrons would be in general ejected at different times and in unrelated directions. I wish to point out, however, that a corpuscular theory still is not in conflict with the main part of the idea of virtual fields.

The possibility of harmony between a virtual radiation field and a corpuscular structure of light was discussed with great penetration by Prof. Swann, in his address at the meeting of the American Association for the Advancement of Science last Christmas (*Science*, 61, p. 425, 1925). Prof. Swann suggested the existence of a field, obeying Maxwell's equations, the function of which should be to guide corpuscular quanta, which might travel along Poynting's vector. This was also the idea on which the writer was working when he first considered a field emitted during the stationary states, although Prof. Swann was not aware of this. (NATURE, 113, p. 307, 1924; *Phys. Rev.*, 25, p. 397, 1925.)

The theory in this form was developed in England, under the guidance of Mr. R. H. Fowler, to whom my sincerest thanks are due. The essential feature was the emission of the field before the ejection of the corpuscle; that is, during the stationary state before the transition. By this device were avoided the difficulties of explaining coherence, of the "size of quanta," of the presence of interference phenomena in weak light. When this view was presented to Prof. Bohr and Dr. Kramers, they pointed out that the advantages of this essential feature would be kept, although rejecting the corpuscular theory, by using the field to induce a probability of transition rather than by guiding corpuscular quanta. On reflection, it appeared that no phenomena at that time known demanded the existence of corpuscles. Under their suggestion, I became persuaded that the simplicity of mechanism obtained by rejecting a corpuscular theory more than made up for the loss involved in discarding conservation of energy and rational causation, and the paper already quoted was written. The changes made in adopting this view were thus not fundamental; it might be mentioned that they were not new, the failure of conservation having been suggested by D. L. Webster and others, and the idea of a field to induce a probability of transition being due to Jeans.

The present experiments, however, seem to show definitely the characteristic properties of corpuscles: the localisation of the active power of a light wave in space (Compton) and in time (Bothe and Geiger), although of course the evidence is as yet meagre. The simplest solution of the radiation problem then seems to be to return to the view of a virtual field to guide corpuscular quanta. One slight difficulty in the way of carrying this out should be mentioned: the velocity of a corpuscle should transform under the Lorentz transformation as a velocity, and Poynting's vector does not so transform. There are other difficulties as well, but one may hope that none of them are insurmountable.

It seems to me of particular value to realise that the facts of optics are, in general, satisfactorily described by theories of the electromagnetic field; that it is highly improbable that any essentially different theory could also explain such an extended set of facts; and that consequently we must expect to find this theory appearing in some form or other in our final description of radiation, whatever that may be, and whether it include corpuscular quanta or not. Some physicists have been tempted to throw away the great work of Maxwell and Lorentz, because there are phenomena which suggest light corpuscles. This seems to me a very doubtful policy; for a corpuscular theory of the kind now indicated would by no means take the place of the electromagnetic theory, but would rather supplement and extend it. Some of the material for this extension must naturally come from such experiments as those of Bothe and Geiger and of Compton.

J. C. SLATER.

Jefferson Physical Laboratory,
Harvard University,
July 25.

### The Effect of Diluents on the Initial Stages of Catalytic Action.

IT has been long known that the presence of diluent vapours in the reactants depresses the reaction velocity at a catalyst surface. The following quantitative treatment has been confirmed by experiments on the effect of water vapour on the initial stages of the dehydrogenation of alcohol by copper. Let $p$ = the fractional partial pressure of the reactant $A$, hence $1-p$ = the fractional partial pressure of the diluent $B$. Then the rate at which the reactant molecules arrive at the surface is proportional to $p/\sqrt{2\pi MRT} = \mu_A p$, say. Thus the probability that a reactant molecule should bombard a given portion of a catalyst at a given instant is

$$\frac{\mu_A p}{\mu_A p + \mu_B(1-p)},$$

*i.e.* the fraction of $A$ molecules in the impinging stream of $A$ and $B$ molecules. According to the conception of Langmuir and Frenkel, a molecule that hits another adsorbed molecule is immediately reflected, whereas when it strikes the bare surface it remains for the short period of time $\tau$. It is also known that chemical action occurs on definite centres on the catalyst surface.

Let $n$ be the number of times one of these centres becomes momentarily vacant in $t$ units of time, then $\mu_A . p . n/\{\mu_A p + \mu_B(1-p)\}$ molecules of the reactant are adsorbed, and they occupy the centre of activity for a fraction of the total time $= \mu_A \tau_A p n/\{\mu_A p + \mu_B(1-p)\}$.

Similarly for species $B$. If the surface is saturated, the time during which a centre is left vacant is negligible compared with the time it is covered, and

$$t = \frac{\mu_A \tau_A p n + \mu_B \tau_B (1-p) n}{\mu_A p + \mu_B (1-p)}.$$

Thus the fraction of the total time the centre of activity is occupied by the reactant is

$$\frac{\mu_A \tau_A p}{\mu_B \tau_B (1-p) + \mu_A \tau_A p} = v,$$

and is the fractional reduction in the reaction velocity. Thus

$$1/v = (1-\lambda) + \lambda/p, \quad . \quad . \quad . \quad (1)$$

where $\lambda = \sqrt{\frac{M_A}{M_B}} \cdot \frac{\tau_B}{\tau_A}$ and $M_A$ represents the molecular weight, and $\tau_A$ the mean life of the molecule $A$ on the surface. This formula may be written

$$(1-v)/v = \frac{\tau_B}{\tau_A} \cdot \frac{\mu_B (1-p)}{\mu_A p},$$

and the fraction $(1-v)/v$ is the ratio of the number of molecules of $B$ to the number of molecules of $A$ present on the surface. $\mu_B(1-p)/\mu_A . p$ is the ratio of the number of molecules of $B$ to $A$ bombarding the surface $= n_B/n_A$. Thus if $n_B/n_A$ be multiplied by the ratio of the mean lives of molecules $B$ to $A$ on the surface, we obtain the composition of the adsorbed gas film for saturated surfaces. The composition of the adsorbed gas film in equilibrium with a mixture of gases $A$ and $B$ is given by

$$\frac{x_A}{x_A + x_B} = \frac{1}{1 + \sqrt{\frac{M_A}{M_B}} \frac{\tau_B}{\tau_A} \frac{p_B}{p_A}}. \quad . \quad . \quad (2)$$

These formulæ have been verified for partial pressures of alcohol in water varying from 0·02 to 1·00 times the total pressure.

| Fractional Reaction Velocity observed. $v$. | Calculated from $[1/v = 0{\cdot}64 + 0{\cdot}36/p$. | Fractional partial Pressure of Alcohol in Alcohol Water Mixtures $= p$. |
|---|---|---|
| 1·00 | 1·00 | 1·00 |
| 0·94 | 0·92 | 0·80 |
| 0·83 | 0·81 | 0·60 |
| 0·60 | 0·65 | 0 40 |
| 0·40 | 0·41 | 0·20 |
| 0·22 | 0·24 | 0·10 |
| 0·10 | 0·13 | 0·05 |
| 0·05 | 0·05 | 0·02 |

The agreement between the observed and calculated values is within the limits of experimental error.

The apparatus with which these measurements were made has already been described (Proc. Camb. Phil. Soc., vol. 22, pp. 738-50) and is very convenient for obtaining the wide variations in partial pressure necessary.

F. H. CONSTABLE.

St. John's College,
Cambridge, July 30.

### On the Origin of Species in Flowering Plants.

THE origin of species is the origin of the difference between two species. The existence of a peculiar difference between good species, which does not exist between varieties, has long been realised by systematists and others. This essential difference expresses itself, in part, in flowering plants, in the abortion of pollen and ovules in the hybrids, which springs, in typical cases: (*a*) from a different distribution of genes between two or more chromosome pairs; so that vital genes are omitted after the reduction division in some or all of the groups of chromosomes of the $F_1$ of the cross. An example of this is probably afforded by the crosses of certain species of Stizolobium (Mucuna) (*Zeitsch. f. ind. Abst. u. Vererb.*, pp. 303-342, 1914), two non-homologous chromosomes appearing to have interchanged genes in one of the species. In the second case (*b*) the attraction between chromosomes which should be homologous fails in the reduction divisions of the $F_1$ plant, so that non-conjunction (*Journal of Genetics*, 1925) takes place with regard to one or more pairs. Thus there is an absence of vital chromosomes or the presence of extra chromosomes in some of the pollen and ovules. This is illustrated by the two cannas "Austria" and "Italia," which belong no doubt, as their history states, to the $F_1$ of species crosses. In "Austria," for example, the 18 single chromosomes show only 1-3 pairs at the reduction divisions. All the other chromosomes segregate at random, so that no more than one pollen-grain or embryo-sac out of thousands contains only the 9 chromosomes from one parent, and survives. In the cross of radish and cabbage, as Karpechenko (*Journal of Genetics*, vol. 14, pp. 375-396, 1924) has lately shown, chromosome conjugation is absent. This has also been shown in certain Digitalis crosses.

Hence the origin of species is effected, *inter alia*, by (*a*) segmental interchange between non-homologous chromosomes, of which some evidence has lately been gathered in Datura, and (*b*) by the loss of attraction between chromosomes which were homologous, producing non-conjunction (*Journal of Genetics*, 1925). The hypothesis of the origin of species from crosses between species in a genus posits the existence of allied species, and can thus only be applicable in more or less exceptional cases.

The species listed in any genus may consist of forms each showing one or more of the following differences from the nearest allied species:

(1) Mendelian differences in one or more pairs of genes;

(2) Mendelian or other differences permanently sustained by propagation by apogamy;

(3) Shifting of some genes in one species between two or more non-homologous chromosomes;

(4) Loss of mutual attraction between two or more corresponding chromosomes in the two species;

(5) Different chromosome numbers or sizes.

Of course the mere possibility or impossibility of securing an $F_1$ between two species may often be due to other more superficial causes than these fundamental differences.

JOHN BELLING.

Carnegie Institution of Washington.

### The Structure of Benzene and Cyclohexane and their Optical Anisotropy.

IN a recent paper (Roy. Soc. Proc., A, vol. 107, p. 684), I have shown that the optical anisotropy of the gaseous molecules of a number of di-atomic and tri-atomic compounds which is evidenced by the polarisation of the light scattered from them, can be explained by the mutual action of the electrical doublets induced in the different atoms of the molecule by the electric field of the incident radiation. Each atom was assumed to behave isotropically. Satisfactory agreement was obtained between the observed and calculated values of the depolarisation of the scattered light in the case of the molecules $CO_2$, $N_2O$ and $CS_2$.

The investigation has now been extended to the organic molecules benzene and cyclohexane. Experiment shows that the depolarisation (*i.e.* the ratio of the weak component to the strong) of the light scattered in a direction perpendicular to the incident beam in benzene vapour is 0·067. Assuming that the six carbon atoms in benzene are arranged in a puckered ring as in diamond, with the distance between two neighbouring carbon atoms of 1·5 Å.U., and that the hydrogen atoms are joined to the carbons at the tetrahedral angle at a distance of 1·42 Å.U. (the sum of the "radius" of a carbon atom and half the distance between the optical centres in a hydrogen molecule as calculated from its optical anisotropy), and assuming that the refractivities of the hydrogen and carbon atoms are those appropriate to the respective atoms in the hydrogen molecule and in diamond, the anisotropy comes out to be 2·63 : 2·63 : 1. This gives a value of 0·074 for the depolarisation of the transversely scattered light.

If the atoms are assumed to lie in a plane with the carbon atoms arranged as in a graphite ring, the depolarisation comes out to be 0·10 Even in the absence of the hydrogens, the six carbon atoms alone would in this case give rise to a depolarisation of 0·083. If, therefore, we are to retain the plane structure for benzene, it will be necessary to assume that the polarisation of the carbon atoms when the field is perpendicular to the plane of the ring is greater than that when it is parallel to the plane of the ring.

Cyclohexane vapour at pressures less than one atmosphere shows a depolarisation of only 1·1 per cent. This small value is what should be expected from the known structure of cyclohexane. The six extra hydrogen atoms place themselves on opposite sides of the mean plane of the carbon atoms on either side alternately, and the mutual action of the induced doublets causes the average polarisation parallel to the mean plane of the carbon atoms to be diminished while the polarisation perpendicular to the plane is increased, both contributing to a diminution of anisotropy. Calculation on the same lines shows the depolarisation to be expected to be 0·8 per cent.

K. R. RAMANATHAN.

Physics Department,
University College, Rangoon,
July 18.

### Magnetic Conditions in Tube Railways.

THOSE who have occasion to make frequent use of the tube railways in London can minimise the monotony of such journeys by taking with them a small pocket compass.

Using one day a pocket compass to determine whether my hurried choice of a train was indeed taking me in the westerly direction I desired, I was astonished to find that this old and valued guide was of two minds, if no more, as to where magnetic north really lay. As the train proceeded, the compass needle oscillated, made a sudden 180° turn and pointed south, and in a few moments reversed its direction again.

Repeated observations show the needle to be scarcely ever steady, and this makes it difficult to distinguish the acceleration effect which must be present: such accelerations when nearly at right angles to the magnetic meridian should produce an angular motion of the needle equal to the angle of change of the "apparent vertical" multiplied by the tangent of the angle of dip. I have noticed motions of the right sense and of about the right amount, but it has not been possible to compare the amount of the accelerations so indicated with those determined by other methods.

I do not know whether any one else has noticed the complex magnetic condition of tube railways, but I do know that any visitor who relies for directional advice upon a pocket compass may be led sadly astray.

H. E. WIMPERIS.

August 4.

### Fine Structure of Optically Excited Spectrum Lines.

IN the course of investigations on the optical excitation of gases in this laboratory, we noticed the interesting fact that the spectrum lines emitted by mercury vapour illuminated by an intense mercury lamp have a much simpler fine structure than usually. For example, the green line 5461, the complexity of which under ordinary conditions is well known, presents no components besides the central line, which when viewed through a 30 cm. Lummer plate, is resolved in 3 components only. The violet line 4359 exhibits the same features, the intensity of the stronger satellites as compared with that of the central line being very much less than in the arc. The same seems also to be true for the yellow line 5770. On the other hand, the lines 4047 and 5791 show all the strong satellites.

This absence of some of the satellites which are intense in the arc affords an argument in favour of the view that these are not due to isotopy.

E. GROSS.
A. TERENIN.

Optical Institute,
Leningrad,
June.

### Science and Intellectual Freedom.

DR. NORMAN R. CAMPBELL (NATURE, August 8, p. 208) writes with a certain lack of charity about the numerous men of science, medical men, publicists, and so forth, who have ventured to inform themselves about birth control. To seek knowledge about the origin of species, he informs us, may be honest and honourable, but "knowledge concerning contraception is sought, either from mere prurience, or from intention to practise it or to teach others to do so." But that is just what a Tennessee Fundamentalist would say about interest in evolution. He would say men wanted to know they were beasts in order to make beasts of themselves. It is impossible to let Dr. Campbell's sweeping indictment pass unchallenged. People in general want to know about this matter in order to judge it; they want to know the nature, the naturalness, the physical good or evil of these practices and what the mental and social reactions of this or that line of action may be. It is no more "prurient" to be intelligently interested in the question than in dietary. No one wants the publicly paid medical man to "propagate" this knowledge where it is not desired. But we do want to see him free to give it, cleanly and discreetly, to people who know already that it exists and who will, failing him, probably seek it in shameful and dangerous ways. We object to any sect or section of the community coming with threats of dismissal and injury between him and those who want to know. That is what is done at the present time. And while this is the case in Britain I decline to line up to sneer at the Fundamentalists of Tennessee.

H. G. WELLS.

## The Theory of Photographic Sensitivity.

By Dr. T. SLATER PRICE, F.R.S., and S. O. RAWLING.

SINCE 1920 our knowledge of the formation of the latent image has been greatly increased by investigations which divide themselves roughly into three chapters. The first notable advance was made by Svedberg during the years 1920–1922, and consisted in the proof that the latent image consists of small centres distributed on the silver halide grains of an exposed photographic plate, the distribution of the centres being entirely according to the law of chance. A grain is not developable unless it contains at least one such centre. The second step was to decide upon the origin of these development centres. Two theories were advanced. In one of these it was assumed that the light itself formed the centres, the grains themselves being supposed to be homogeneous. In the other, it was assumed that there exist in the grains, prior to exposure, nuclei which are not silver halide and which are formed during the manufacture of the emulsion, and that the action of light is to change their condition in such a way that they become centres at which development can start. The first theory was extensively investigated and modified by Silberstein and others in the Research Laboratories of the Eastman Kodak Company, whilst the second was developed by Toy in the laboratories of the British Photographic Research Association. Direct evidence in favour of the second theory was at length obtained by Clark in the latter-named laboratories.

The third advance has recently been concisely summarised by Sheppard (Jour. Franklin Inst., 1925, 200, 51), and deals with the nature of the nuclei postulated in the second theory mentioned above. If the nuclei are light sensitive, and are essentially different from silver bromide, their spectral absorptions should determine the spectral sensitivity of the material, or, at any rate, powerfully affect it. The relative spectral sensitivity of plates before and after desensitising with chromic acid is found to be the same, however, and the distribution of sensitivity corresponds approximately with the absorption spectrum of gelatino-silver bromide (Sheppard, Wightmann, and Trivelli, Jour. Franklin Inst., 1923, 196, 653). Moreover, the experimental relation between the quantity of the incident light energy and the photographic effect produced is just what is to be expected when allowance is made for the light absorption of the silver bromide, the agreement being all the better when the light absorbed is reckoned in quanta (Toy and Edgerton, *Phil. Mag.*, 1924, 48, 947).

As a result of the consideration of the above facts, the following theory of the nature of the nuclei has been arrived at. It is assumed that the action of light is to decompose the silver bromide into bromine and silver, and that the apparent sensitising action of a nucleus or "speck" is confined to increasing its size by accretion of photochemically reduced silver atoms until it is large enough to form a development centre. The mechanism by which this accretion is supposed to be brought about is, apparently, that light is absorbed all over the grain and that the energy of vibration of the electrons in the atoms of the silver halide crystal is thereby increased; but, as a rule, the transfer of an electron from bromine to silver only occurs in the boundary layer at the surface of the specks. Thus energy flows from the surrounding crystal lattice to the specks where it is released as chemical work, the transfer from distant atoms occurring by radiationless collisions (vibrations) through neighbouring atoms until the edge of the speck is reached. It may be noted that Toy (*Phot. Jour.*, 1921, 61, 420) ascribed to Slade a somewhat similar idea as to the transference of energy within the crystal; at that time, however, the attempt was made to explain on this basis how development centres might be formed by light action without the aid of sensitising specks, the mechanism of the action being a kind of "surging" of energy within the crystal and the consequent formation of development centres where energy sufficient to bring about the necessary chemical decomposition is momentarily concentrated. The new theory may thus be considered to be an extension of Slade's original idea to that of the existence of sensitising specks.

According to Sheppard, the formation of the specks is due to casual adsorption and reaction with the silver bromide of a substance present in the gelatin. The theory given leads to the conclusion that once a speck is formed it tends to increase in size; further, not only will the average number of specks on large grains tend to be greater than on small ones in the same emulsion, but also the average size of speck will be greater. It further follows that the sensitising power of any speck is a function of its size. A large speck would not require so large an amount of chemical decomposition in its neighbourhood as would be required by a small speck in order to make a development centre. Svedberg had already touched on the idea that a certain minimum size of speck is necessary before it can act as a development centre, and Clark had deduced that it must be such that it contains somewhere about 300 atoms of silver.

The theory of the distribution of the specks is therefore in striking agreement with the conclusion arrived at by Toy in 1922 (*Phil. Mag.*, 1922, 44, 368) that there are two reasons why large grains are, on the average, more sensitive than small ones. First, there are more nuclei (specks) present in the larger grains, so that a single grain has a greater chance of having at least one; and secondly, the average sensitivity of the nuclei increases with the size of grain.

There is a third factor which may possibly assist in making large grains more sensitive than small ones. Specks on large grains have a greater volume of silver halide from which the absorbed energy necessary to produce the photographic effect may be drawn.

The investigations which led up to the point marked by the theories outlined above furnish no direct evidence of the chemical nature of the specks. Rapid advances were being made in various laboratories towards the solution of the problem, when a paper of Sheppard, from the Research Laboratories of the Eastman Kodak Company, appeared, in which it is

shown that silver sulphide is a substance which can act as a general sensitiser of the kind described. Sheppard (*Phot. Jour.*, 1925, 65, 380) directs attention to the well-known fact that some gelatins are photographically active, whilst others are relatively inert. Making use of the unrivalled facilities of such an organisation as that of the Eastman Kodak Company, which has its own gelatin manufactory, several thousand gallons of deliming liquor, which is formed in the manufacture of gelatin, and was found to be photographically active, were concentrated by appropriate treatment, active fractions being separated from time to time. Ultimately, after some years of investigation, the active substance was tracked down and identified as allyl isothiocyanate, or allyl mustard oil. In the course of manufacture of a photographic emulsion, this substance reacts with the silver halide grains to give the silver sulphide specks to which reference has been made above. It is estimated that photographically active gelatin contains only about 1 part per 1,000,000 to 1 part per 300,000 of the sensitising substance. Other sulphur compounds have been found to act in a similar manner, a necessary condition seeming to be that the sulphur must be doubly linked to another atom, and not singly linked to two other atoms. The analogous compounds of selenium and tellurium act in a similar way.

The presence of a speck of silver sulphide in the silver halide crystal would result in a disorientation of the silver and halogen atoms at the common boundary, and consequently give rise to a region of instability in its neighbourhood, a view which is supported by the work of von Hevesey (*Z. physikal. Chemie*, 1922, 101, 337).

In all the work which has contributed to the achievement of the present position in regard to photographic sensitivity, it is remarkable how interwoven the ideas of various investigators have become. A mass of evidence from very different sources has now been accumulated in support of the theory that the high sensitivity of the modern photographic plate is due to the presence, before exposure, of minute traces or specks of some "impurity" on the surface of the silver halide grains in the emulsion. The work of Sheppard is a great step forward and opens up new avenues of research, but much work remains to be done before the problem of photographic sensitivity is finally solved.

## Sino-Himalaya.[1]

By F. KINGDON WARD.

THAT "Any Man's Land" where China, Tibet, and India meet has come into prominence amongst botanists in recent years by reason of the remarkable wealth of flora discovered there; and connected with the problems of plant distribution which arise is the no less interesting problem of geological structure and history. A brief description of the physiography of this region may serve to illustrate the nature of these problems.

We have as a starting-point the great Himalayan range and the mountainous area of western China. East of the 93rd meridian the Himalayan axis trends towards the north-east. It seems probable that this axis is prolonged across China, and that structurally it could be traced in that direction to the plains.

However, what the traveller, who is unable to follow the strike of the rocks composing a great mountain chain like the Himalaya, sees, is something rather different. He sees the Himalayan range ending abruptly at the gorge of the Tsangpo in the great peak of Namcha Barwa; and even if he recognises the peak of Gyala Peri, which forms with Namcha Barwa the gateway to the gorge, as being on the main Himalayan axis beyond the Tsangpo, he can follow it no farther, for the country is unexplored. From the Tsangpo gorge eastwards he perceives rather a wide breach in the Asiatic divide, beyond which in the complex skein of mountains which form a network over western China he is unable to pick up the dropped thread of the Himalayan axis, though the facts of both animal and plant distribution in eastern Asia point to its former, if not to its continued existence.

That this supposed breach in the Himalayan axis does really exist seems clear enough; though whether at the eastern extremity or in the middle of the range is not so clear.

Rising on the plateau of Tibet are several great rivers whose sources are far apart and whose mouths ultimately open on different seas; but all of them, rolling down from the highlands, converge on one another, squeeze through a narrow gap flanked by lofty snow peaks, and separate again as they emerge from the mountains. In the west is the Brahmaputra (Tibetan Tsangpo), which, after rounding the great gable end of the Assam Himalaya, swings away to the west. In the extreme east is the Yangtze (Chinese Kin-sha), which, after squeezing through the breach, swings away to the east to cross China. Between them, but closer to the Yangtze than to the Brahmaputra, flow three other big rivers, the Mekong, Salween, and Taron (or eastern branch of the Irrawaddy).

The extreme breadth of this river gap is about 200 miles; but a much smaller distance—namely, 70 miles—will span the gap between the Yangtze and the Taron, including the gorges of the Mekong and Salween. That is to say, these four rivers, where they flow parallel to one another for a depth of about 100 miles, are confined to a strip only 70 miles wide. A further peculiarity about this strip is a pronounced tilt from east to west, whereby these rivers flow at successively lower and lower levels as we proceed westwards from the Yangtze to the Irrawaddy.

The reasons for this may be at least partly explicable on the theory of isostasy, the vast area of deposition towards the head of the Bay of Bengal being counterbalanced by a rise in the country to the east, which is essentially an area of denudation. Even the progressive lowering of the river beds might be due to a detailed isostatic equilibrium, being proportional to their

[1] Substance of two lectures delivered at the Royal Institution on April 3 and 30.

powers of erosion and capacity for deposition, according to the views of Colonel Tandy.[2]

That the grading of the river beds should follow mechanically from the proportionate rainfall in the gorges seems to us quite untenable. If we accept the view that a river is primarily erosive in action, then the Yangtze, with its much greater and more powerful stream and its larger volume of glacier water, should have cut out the deepest channel; but it has not. On the other hand, if we accept Colonel Tandy's view that a mountain river bed is primarily an area of deposition, then the Yangtze, which certainly receives a much greater dead-weight load from its arid cliffs than does the forested Taron, should still have sunk its bed lower. Moreover, the several source streams of the Irrawaddy show the same progressive decrease in altitude from east to west, though their respective volumes steadily decrease also; and here the rainfall is obviously constant for all.

We must not, however, lose sight of the fact that the breaching of the Himalayan axis was probably due in the first instance to tectonic causes, not to river action; and that therefore the parallel gorges owe their origin at least in part to tension, and follow lines of weakness in the crust. Here again the weight of material which the crust, immediately to the west, has to support, dragging on the folded rocks of the Burma-Yunnan arc to the east, may have cracked the synclines; for the Burma-Yunnan arc is probably of the same age as the main Himalayan uplift.

Prof. J. W. Gregory indeed refers to the Mekong, Yangtze, and other rivers of Chinese Tibet being formed as "tension clefts by the rupture of hard rocks which were pulled apart on the stretched upper side of an arch."[3] However, I can deal here only with results, whatever the causes.

The south-west monsoon, blowing up from the Bay of Bengal, strikes against the south face of the Himalaya and drops the bulk of its moisture. Thus it crosses the line of high peaks a comparatively dry wind, and the plateau country behind the Himalaya is in consequence semi-desert.

The Burma-Assam re-entrant, however, forms a funnel-like approach to the Himalayan gap, and the monsoon rushes like a bore through the neck of the funnel and up the river corridors of the Tsangpo, Irrawaddy, and Salween; with the result that the region lying at the head of the gap, and partly behind the Himalaya, is also drenched with rain. Thus the breach, or gap, as we have called it, is the meeting ground of several floras. To the north is the Central Asian flora—more particularly the Tibetan element, pressing southwards through the gap; while to the south is the Indo-Malayan flora, squeezing northwards up the river corridors until it makes contact with the former. In the east is the Chinese or Oriental flora, while confined to the ranges which form a network over the whole area is the Alpine or Himalayan flora.

On the parallel ranges of the Burma-Yunnan arc is found a flora related on one hand to the Chinese flora generally, on the other to the Himalayan flora; and it would appear that these mountains, having received contributions from both the broken ends of the Sino-Himalayan ranges, have carried this flora far to the south.

Nothing was previously known of the flora round the knee-bend of the Brahmaputra, however, and it was not until 1924 that, through the kind offices of the Indian and Tibetan governments, permission was granted for a botanical expedition, financed by the Royal Society and the Percy Sladen Memorial Fund.

One would naturally suppose that the alpine flora of the Assam Himalaya would more closely resemble that of the Sikkim-Bhutan Himalaya than it does that of the Burma-Yunnan arc; for while the Assam Himalaya stand about midway between Sikkim and Yunnan, the Himalaya form a continuous uplift from Sikkim to Namcha Barwa, whereas the Yunnan ranges are a separate uplift sundered from the Himalaya by several deep river gorges. Yet the reverse was found to be the case.

If we examine the more prolific genera, such as Rhododendron, Primula, and Meconopsis, we find groups common to the Assam Himalaya and to Yunnan which have no representatives in Sikkim. To take a few examples. There exist a group of creeping Rhododendrons of the 'Sanguineum' series, previously known only from Yunnan and Burma, now recorded from the Himalaya; they do not extend so far west as Sikkim. Similarly with the undershrub Rhododendrons belonging to the 'Saluenense' and 'Campylogynum' series.

Coming next to Primula, the section known as 'Sikkimensis' has representatives both in Sikkim and in western China, but hitherto no purple-flowered species was known to occur west of the Mekong; yet such purple-flowered species are abundant in the Assam Himalaya and to the north. Again, the queer Primulas which fall into the section 'Maximowiczii' have hitherto been regarded as confined to western China; but two species, possibly identical with the Chinese types, have now turned up in the Assam Himalaya.

Two species of the section 'Dryadifolia,' one of them *P. dryadifolia* itself, hitherto known only from Yunnan, are now definitely recorded as Himalayan, while the 'Nivalis' section, so richly represented in China and so poorly in Sikkim, obtains additional support as a Himalayan group in half-a-dozen species from Namcha Barwa.

In the genus Meconopsis we find exactly the same thing—a closer association with Yunnan than with Sikkim. Amongst the 'Grandes,' for example, we find in the Assam Himalaya two yellow-flowered poppies almost exactly like the Chinese *M. integrifolia* and its so-called variety *M. integrifolia* var. *Souliei*; while a species closely allied to *M. impedita* is abundant. The only Sikkim species met with were such as are common to Tibet or to the Himalaya generally, *e.g. M. simplicifolia* and *M. horridula*.

One could multiply examples, but enough has been said to bring out the Sino-Himalayan relationship. I have selected these genera as being those with which, from a horticultural point of view, I am best acquainted; but I believe that when the whole collection has been worked out, this unexpected relationship will be more strongly emphasised. There is also, of course, a considerable endemic flora.

From this it would seem that not only is the present breach between the Himalaya and the Burma-Yunnan

[2] *Geographical Journal*, May 1921.
[3] *Geographical Journal*, March 1923.

arc recent, but that the linking up of the Assam and Sikkim Himalaya is also recent; otherwise their floras should more closely resemble one another, since they are under almost identical conditions.

The most striking feature of the country immediately to the north of the Tsangpo bend is the number of ice-worn valleys and the extent to which deglaciation has gone on and, judging by the retreating glaciers, is still going on. The Tsangpo valley above the gorge seems to have been in part at least formed by ice action. At all events it is certain that the glaciers of Namcha Barwa once crossed the present valley, since one sees huge amounts of moraine material, continuous with "living" moraines on the right bank, piled up on the north bank, and afterwards cut through and stranded, terrace on terrace, by the river. The gorge itself, however, is clearly due to water erosion, though at one point a glacier does actually reach the river bed from the north bank. This retreat of the ice must be due to gradual desiccation rather than to a general increase of temperature, since lakes are also drying up, and these would scarcely be affected by a small rise of temperature. This ice action is far more conspicuous in the Assam Himalaya and on the ranges to the north of the Tsangpo bend than in other regions we visited; and it might be that the elevation of the Assam Himalaya is of more recent origin than that of the Himalaya as a whole. If, as Sir Sidney Burrard [4] has suggested, the Tsangpo originally flowed from east to west, then there must have been much less accumulation of silt in the Assam valley formerly than there is now, with the result that there would be less "compensation" needed. The cutting through of the Himalayan axis by the Dihang and the "capture" of the Tsangpo would soon alter this, and the Assam Himalaya might have been considerably raised as a result. But with the rise of this great rain screen, the doom of the glaciers to the north was also sealed. The removal of this enormous weight of ice, and the consequent transport of a huge amount of abraded material by water to the Bay of Bengal, would still further have loaded the crust in that direction and released it in the Himalayan area.

The numerous considerable falls in the Tsangpo gorge and the steep grade of the bed suggest that this river is much newer than the Salween or the Mekong. Thus the Assam Himalaya might be regarded rather as an outlier of the Burma-Yunnan arc, severed from it by the cutting back of the Brahmaputra (or Dihang), and still bearing a very close resemblance to it in its flora.

[4] "A Sketch of the Geography and Geology of the Himalaya and Tibet."

## Science and Intellectual Freedom.

By WATSON DAVIS and Dr. FRANK THONE, Science Service, Washington, D.C.

AMERICAN men of science naturally felt considerable interest in the trial of John T. Scopes, high school teacher, at Dayton, Tennessee, for the alleged violation of the now famous anti-evolution act on the statute books of that State. Relatively few scientists in this country are directly threatened by the epidemic of anti-evolution legislation; for this is at present confined largely to the southern States, and the majority of the more important colleges and universities, both independent and State-supported, are in the north and west. However, interest in the continued academic independence of their colleagues in the south brought a number of scientists to Dayton as scientific coadjutors for the defence counsel, while many more had signified their willingness to attend if called upon. They would have appeared as expert witnesses also, had the judge not ruled against the admissibility of scientific testimony.

Certain aspects about the outcome of the case may possibly need a word of explanation to those unfamiliar with American law procedure and with the somewhat peculiar circumstances of this particular trial. The defence did not attempt to prove that their client, Mr. Scopes, had not violated the statute as interpreted by the court. They stated that they intended to prove that the law was contrary to the constitution of the State of Tennessee and to the constitution of the United States, and that it was so vague and unscientific in its structure as to be meaningless. For this reason they wished to introduce scientific testimony; and when the court ruled that such testimony was irrelevant, the ground was cut from under their feet. It was conjectured, however, with a good deal of probability, that two or three men on the jury, irritated over the conduct of the case, were prepared to "hang the jury" and prevent the unanimous verdict necessary to convict. The counsel for the defence wished to prevent such an outcome, for then the case would have had to be tried all over again before another jury, with the outcome just as unpredictable as it was the first time. Therefore we were treated to the unprecedented spectacle of the chief counsel for the defence virtually appealing to the jury to convict his client, so that the case might be carried to a higher court on appeal.

Mr. Scopes was accordingly adjudged "guilty"; and the case will come before the supreme court of the State of Tennessee in September. This tribunal may do one of two things: either decide that the lower court was in error in certain of its rulings and remand the case for re-trial, or declare the statute to be contrary to the constitution of the State. Appeal may also be taken to the United States supreme court, on the ground that the statute is in violation of certain clauses in the Bill of Rights appended to the United States constitution. Of course it is impossible to predict the outcome of either of these appeals.

Certain after-effects of this case have already been making themselves felt. An anti-evolution bill, similar to the Tennessee statute, offered in the Georgia State legislature, was decisively defeated by a viva voce vote. The "fundamentalists" wish to introduce a similar measure at the next session of the national congress, but so far have been unable to find a member willing to sponsor such a bill. An effort to enforce a dead-letter clause in the regulations of the Washington, D.C., schools appears to have gone off as a flash in the pan.

The effort to force an Old Testament theocracy upon the American people will continue, but now that the only champion of the movement who enjoyed national prominence has passed away, his cause will probably dwindle accordingly.

## Relativity Displacement of Spectral Lines and Stellar Constitution.

NOT many months ago, a very careful and critical examination by Dr. C. E. St. John of the wave-lengths of the lines in the solar spectrum was sufficient to convince a large body of astronomers that the displacement towards the red of spectrum lines originating in a region of high gravitational potential, required by Einstein's theory of relativity, was an actual phenomenon. An element of doubt remained, however, owing to the exceedingly small amount of the displacement in question and the unknown effects of convection currents and other disturbing influences in the solar atmosphere.

At the time when Dr. St. John's investigation was made, it appeared that no source of light other than the sun could afford a satisfactory test of Einstein's prediction; and that for two reasons. In the first place, the smallness of the displacement to be measured demanded a degree of dispersion and perfection of detail in the spectrum which it was impossible to obtain with the light of any other astronomical body. The relativity displacement depends on the gravitational potential at the surface of a star—that is, on the star's mass divided by its radius—and for no star was this quantity believed to be large enough to give a displacement of more than one or two hundredths of an Ångström unit. In the second place, owing to the identical character of the relativity displacement and the Doppler displacement arising from motion of a source of light away from the observer (both displacements are proportional to the wave-lengths of the lines concerned), it was necessary to select a body the motion of which relative to the earth was known from independent evidence. Since the radial velocities of the stars can be obtained only by means of the Doppler effect, the sun was for this reason also the only body available for the Einstein test.

The restriction thus doubly imposed has now been removed, thanks jointly to some remarkable theoretical predictions by Prof. A. S. Eddington and the extremely fortunate circumstance that Nature has provided a means of testing those predictions. Certain facts of observation recently led Eddington to the conclusion —which he immediately saw to be a natural consequence of his theory of the constitution of the interior of a star—that matter under stellar conditions might attain densities many thousand times greater than those with which we are familiar among terrestrial materials. Not only so, but in the stars known as "white dwarfs," of which two are known, it appeared that these high densities might actually be realised. These stars are abnormally faint for their spectral type and colour—a fact which suggests that they have very small surface areas and correspondingly large densities; a given spectral type or colour denotes a definite surface brightness per unit area, and an abnormally small total output of light must therefore mean an abnormally small radiating area. Further, the stars are members of binary systems, and their masses can be determined and hence the order of magnitude of their densities. One of the white dwarfs is a companion of Sirius, and therefore one of the nearest of the stars. This fortunate circumstance has just enabled Dr. W. S. Adams of Mount Wilson Observatory (Proc. Nat. Acad. Sci., Vol. 11, No. 7, July 1925) to observe its spectrum in spite of its low intrinsic brightness, and thereby to confirm both Eddington's prediction and the reality of the Einstein gravitational displacement.

The existence of stars having the extraordinary qualities of the white dwarfs removes the necessity of confining the Einstein test to the sun. The extreme compression of the material of the star involves a very high value of the gravitational potential at the surface, and the relativity displacements are of the order of half an Ångström unit. There is therefore no need to use the high dispersion which would be necessary with normal stars. Further, owing to the fact that the star is a companion of Sirius, the space velocity of the two stars must be the same when allowance is made for the orbital motion. All that it is necessary to observe, therefore, is the difference in displacement between the lines of Sirius and those of its companion. This difference, except for the known amount due to orbital motion, must therefore be due to the excess of Einstein displacement in the companion over that in Sirius itself. Working on these lines, Dr. Adams has found almost indubitable evidence of the existence of an Einstein shift of the expected order, and a mean density of the order of 53,000 (water = 1).

This remarkable result, which marks a very definite advance in our knowledge of both the foundations of science and the constitution of matter, is interesting on account of the chance which has made it possible as well as for its own intrinsic importance. Had it not been for the fact of the existence of a white dwarf which is, at the same time, one of the nearest of the stars and a member of a binary system of which the other star is a normal one, the confirmation could not have been made.

## Current Topics and Events.

IN *Die Naturwissenschaften* of July 17 there appears a report of an address by Prof. Miethe on the production of gold from mercury, from which it seems that, in a mercury vapour lamp operated under suitable conditions, gold actually makes its appearance in amounts amenable to chemical tests. The necessary conditions are rather difficult to define, but with a suitable form of discharge, the gold yield is proportional to the current strength and the time. A definite potential is necessary before any appreciable quantity is observed. A mercury vapour lamp *in vacuo* is ineffective, but the same discharge in air at atmospheric pressure gives measurable amounts of gold. Again, gold is found after a discharge between two mercury electrodes in paraffin wax; in this case the gold makes its appearance not in the liquid mercury but in the wax along the path of the discharge. In certain experiments even greater quantities of a metal which closely resembles silver are found.

These results are largely confirmed by Prof. Nagaoka's work recently described in NATURE of July 18, p. 95. Prof. Miethe attributes the appearance of the gold to the disintegration of mercury atoms under the influence of electronic bombardment. In this report no reference is made to the energetics of the problem, nor is any suggestion given as to the mechanism of disintegration. The author admits that the appearance of silver, if silver it is, as a disintegration product of mercury is certainly not to be expected, although, under suitable energy conditions, the conversion of mercury into gold might be anticipated. In the same issue there is published a letter from Dr. Hönigschmidt giving 197·26 as the atomic weight of the gold thus produced, a value identical with that of ordinary gold. This determination, in conjunction with Dr. F. W. Aston's measurements of the isotopes of mercury reported in a letter to NATURE of August 8, p. 208, throws doubt on the transmutation theory.

THE Forestry Commissioners' fifth annual report for the year ending September 30, 1924, shows that steady progress in the work of afforestation in Great Britain has been maintained. During the five years, 1919–1924, the area actually planted by the Forestry Commission was 39,469 acres, of which 37,790 acres were with conifers and 1679 acres with oak, beech, and other hardwoods. In addition, grants made to public bodies and private persons have resulted in the planting (or preparation, with undertaking to plant) of 42,082 acres. The total area planted under the auspices of the Commission was thus 81,551 acres. The Commissioners' planting work is entirely dependent on the timely acquisition of suitable land and on the raising of sufficient young trees in forest nurseries. It is satisfactory then to learn that the Commission has acquired 141,470 acres of plantable land, of which approximately 100,000 acres represent an addition to the existing forest area of Great Britain, the remainder being felled or devastated woodlands. The nurseries established are extensive, and last year's planting of 10,519 acres absorbed more than 22 million young trees. On April 1, 1924, the Crown Woods, aggregating 120,648 acres, were transferred from the Commissioners of Woods and Forests to the Forestry Commissioners, and will be managed on the same principles as estates acquired for afforestation. The sixteen Crown Woods (New Forest, Dean Forest, etc.) and the new areas, thirty-four in England and Wales and twenty-eight in Scotland, where planting on a large scale is being carried on by the Commission, are shown in two maps. The largest of these planting centres is near Thetford in East Anglia; and here a forest of 20,000 acres is in the making. The report gives a full account of the various forestry operations, and is replete with tables and statistics. It has been issued as a Parliamentary Paper (No. 107, price 1s.).

SIR ARTHUR KEITH'S description of the fragments of the skull found by Mr. Turville-Petre in a cave near the Lake of Galilee, which appeared in the *Times* of August 14, confirms the preliminary report that it is to be assigned to the Neanderthal type. It departs from that type, however, in certain characters in which it appears to approach the type of modern man. Although resembling most closely the Krapina variety of Neanderthal man, the Galilean man differs from that and all other European specimens in having a narrow and high-vaulted skull, and though the eyebrow ridges are massive and strong, the bone enclosing the brain is not thicker than is the rule among modern Europeans. The breadth above the ear-holes is estimated at 120 mm. and the extreme length at 200 mm., while the volume of the brain may be inferred to have been little short of that of the average modern Englishman, which measures about 1480 c.c. A further note by Mr. Turville-Petre suggests that the flint implements represent a transition culture between Acheulean and Mousterian. The predominant types are *coups de poing*, mainly small in size, side-scrapers, trimmed flakes, narrow blades, many retouched along one edge, and small amygdaloid flakes retouched on the upper surface to form Mousterian points. Anthropologists await with much interest the fuller report on the skull, and the account of the excavation of the cave to be given by Sir Arthur Keith and Mr. Turville-Petre to the anthropological section at the forthcoming meeting of the British Association at Southampton.

WE have received from Mr. W. Spencer Lake, 248 Valentine Street, Bendigo, Australia, a letter in which he comments on Prof. Lloyd Morgan's article on "Optical Records and Relativity" (NATURE, October 18, 1924, p. 577). In view of the divergence of view with respect to interpretation of *mental reference* to what we speak of as objects of vision, Prof. Lloyd Morgan asked whether it is *for the physicist* to pronounce judgment. Mr. Spencer Lake is of opinion that though most physicists appear to subscribe to the hypothesis of direct apprehension, yet it is doubtful if many could be found who would assert this unshaken confidence in it. Rather would they admit that they are concerned with sensual images and a "construct-world" formed by them therefrom. It seems to him that the physicist is not called upon to explain to which hypothesis he subscribes because it can in no way affect the physical issue. With regard to the transformations of relativity, they refer not to events in general but to measures and to physical quantities defined by these measures. These measures—spatial and temporal—are arbitrary. They depend upon "local spaces" and "local times." What relativity asserts is that, underlying all points of view and all measures, however arbitrary, there is some element of "invariability," not in the absolute sense, but in the sense that there is something which is independent of point of view, independent of the particular measure-code adopted, and to be regarded as a "law of Nature." The transformations of relativity apply to the quantitative equations by which these laws are expressed. Thus relativity helps to bring us to a better knowledge of the physical world by eliminating what, in our experience, depends upon the local space and time system, for example, the very special space-time frame of classical mechanics. It is not a question of whether the laws

of classical mechanics stand in need of revision or not, but whether the physical world is the same for us as it was before the advent of relativity.

WE have received Vol. 1, Part 1 of the Journal of the Ipswich and District Natural History Society. It will be remembered that this Society was founded on January 1, 1924, as the result of an amalgamation of the Ipswich and District Field Club and the Ipswich Scientific Society. The Society now numbers 250 members, and is divided into six sections, dealing respectively with botany, conchology, agriculture, prehistoric archæology, microscopy, and photography. The president is Mr. J. Reid Moir, whose address on "The Antiquity of Man in Ipswich" appears as the first communication in the Journal. Other communications deal with the evolution of the river Stour, by Prof. P. H. G. Boswell; the Suffolk and Essex Crag Pits, by Mr. Alfred Bell, Mr. J. Reid Moir, and the late Mr. S. A. Notcutt; and the Suffolk Coast, by Major E. S. Cooper, who traces changes in the coast-line from the earliest times. In view of the importance of the subject we may direct the special attention of students to the paper by Messrs. Bell, Notcutt, and Reid Moir, in which the two former give a list of the crag pits, the types of deposit to be found in each, and directions for reaching them, while the latter deals with the character of the sub-crag detritus beds, and the implements found therein, as well as sites on which each may be best studied.

THE Report of the Board of Visitors appointed by Congress to inquire into the work of the Bureau of Standards at Washington has been issued, and contains much valuable information as to the benefits which have accrued to the United States from the activities of the Bureau. The motor car industry alone has been able to effect economies amounting to 3,000,000*l.* per annum on account of the investigations on fuels, tyres, and brake linings carried out at the Bureau, while the annual grant to the institution has been less than 400,000*l.* The Board emphasises the necessity of more fundamental scientific research, which runs the risk of being given a secondary position in an establishment on which the public makes demands for immediate and profitable returns. A similar point was made by the president of the Société d'Encouragement pour l'Industrie nationale in France in his address at the recent annual meeting, when he spoke of the importance of aiding those who are carrying out research by placing in their hands the instruments they need and the books and periodicals they must read. Owing to the extensive adoption in France of the English Saturday half-holiday, the number of readers who consult the library of the Society on that day has greatly increased.

H.M. STATIONERY OFFICE has of late earned our gratitude by producing many valuable reports in a form that is not merely cheap but also pleasing. Now it has still further marched with the times by placing on sale (price 3*d.*) at the Government Pavilion of the British Empire Exhibition a "Brief Guide to Government Publications," which is as well and attractively written as any advertisement by a large business house. The section on "Science and Technology" occupies five of the twenty-two pages devoted to a descriptive classification, and that without including archæology, agriculture, or fisheries. For details the reader is referred to the lists issued by the Departments concerned. It is a pity that the Stationery Office should not feel called upon to mention the numerous and important publications of the British Museum; at any rate it publishes the Annual Return of that establishment. But even as it is, the field to which this pamphlet guides one is astonishing in its extent and variety; few can be familiar with more than a small corner of it.

AN interesting account by Francis Buckley of the glasshouses on the Wear in the eighteenth century appears in the Journal of the Society of Glass Technology for June. Between 1696 and 1737 at least three glasshouses were built on the Wear, probably by a syndicate called the "Company of Glass-Owners at Sunderland." It is interesting to note that the owners either let the glasshouses or, failing that, worked them themselves. About 1741, many glass-makers on the Tyne considered it advisable to acquire the two glasshouses at Sunderland, but the project fell through. The paper contains many interesting extracts from contemporary newspapers.

THE ever-increasing interest in the problem of securing a purer atmosphere with its resulting benefits should receive further impetus from the Conference to be held at the Palace Hotel, Buxton, on October 2-5, under the auspices of the Smoke Abatement League of Great Britain. Practical proposals for reducing both domestic and industrial smoke are being prepared by the League for full consideration by those attending, and prominent individuals have agreed to open discussions at various sessions. It is hoped that a constructive programme of useful work will be initiated, the results of which can be reviewed at the Smoke Abatement Exhibition and Conference at Birmingham in 1926.

DURING Lord Burnham's absence abroad the Duke of Atholl has consented to act as chairman of the Special Appeal Committee of the Imperial College of Tropical Agriculture. The first large donation received since he has "fathered" the Fund is one of 1000*l.* from Messrs. J. and P. Coats, Ltd. This generous gift, following closely upon a contribution of 1000*l.* from the Liverpool Cotton Association, is evidence of the interest which is taken in the Imperial work of the College by the cotton industry. Further contributions from those whose interests lie in tropical agriculture should be sent to Mr. Algernon Aspinall, Secretary, The Imperial College of Tropical Agriculture, 14 Trinity Square, London, E.C.3.

DR. GEZA RÓHEIM, of Budapest, whose reputation as an exponent of the application of psycho-analytic methods in anthropological research has grown steadily since the War, and whose study of Australian totemism on psycho-analytic lines has recently been published in Great Britain, will visit England in the

month of September. During his stay he will read a paper on Hungarian folklore and primitive beliefs at the Royal Anthropological Institute on a date to be announced later. Arrangements are also being made for Dr. Róheim to deliver a course of four lectures on psycho-analysis and primitive religion and magic for the Institute of Psycho-Analysis. Further particulars may be obtained from Mr. John Rickman, the hon. secretary of the Institute of Psycho-Analysis, 26 Devonshire Place, W.1, or at 42 York Terrace, N.W.1. There will be no charge for admission to Dr. Róheim's lecture at the Royal Anthropological Institute, but application for the admission of non-members should be addressed to the hon. secretary, 52 Upper Bedford Place, W.C.1, after September 1.

MR. F. EDWARDS, 83A High Street, Marylebone, W.1, has just issued an interesting catalogue (No. 471) of second-hand books, maps and charts relating to nautical subjects and the South Seas. Nearly 1400 works are listed, some of which are rare. The list can be obtained upon application.

IN catalogue No. 429, Messrs. Bowes and Bowes, Cambridge, offer for sale some 1100 second-hand volumes from the library of the late Dr. F. J. H. Jenkinson, librarian of the University of Cambridge. The books are of a miscellaneous character, but include some dealing with scientific subjects.

MESSRS. W. Heffer and Sons, Ltd., Cambridge, announce for publication in the autumn "Stars and their Uses," by E. B. Leggett, a little volume in verse beginning with an introductory definition of common astronomical terms and proceeding to treat of the earth in its relation to the universe. In successive chapters it deals with the constellations, circumpolar, zodiacal, and otherwise, and concludes with remarks on the general composition of celestial bodies.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: Two assistants in the department of zoology and comparative anatomy of University College, London, namely, a man, preferably with some training in physiology or chemistry, for an appointment renewable annually, and a man or a woman to take the place of an assistant absent on a year's leave—The Secretary (August 24). An assistant lecturer in the department of pharmacy of the Technical College, Sunderland—The Chief Education Officer, 15 John Street, Sunderland (August 31). A research chemist, a research engineer, and some junior research chemists at the Chemical Laboratory of the Department of Scientific and Industrial Research, Teddington—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, Westminster, S.W.1 (September 4). An assistant lecturer in building construction at the Municipal College of Technology, Manchester—The Registrar (September 25). A senior lecturer in philosophy in the University of Melbourne—The Agent-General for Victoria, Melbourne Place, Strand, W.C.2 (October 15). A temporary engineering assistant in connexion with the Air Ministry—The Secretary (S.I./437), Air Ministry, Adastral House, Kingsway, W.C.2. A junior assistant in the Agriculture Science Bureau of the International Institute of Agriculture—The General Secretary, International Institute of Agriculture, Rome.

## Our Astronomical Column.

BORRELLY'S COMET.—A third periodic comet of the six that are due at perihelion in the present year has been found. M. Schaumasse found Borrelly's comet on August 14 at $3^h\ 18{\cdot}2^m$ univ. time in R.A. $5^h\ 4^m\ 24^s$, N. Decl. 2° 4′. It was of magnitude 13; the date of perihelion is about October 7·75. The following ephemeris (for $0^h$) should be near the truth:

| | R.A. | N. Decl. |
|---|---|---|
| Aug. 22 | $5^h\ 26{\cdot}5^m$ | 3° 57′ |
| ,, 30 | 5 49·0 | 5 56 |
| Sept. 7 | 6 12·0 | 7 58 |

It is a morning object, being on the meridian about $7^h\ 15^m$.

COMET HUNTING.—Mr. W. Reid, who has been the most successful comet hunter of recent years, contributes an interesting note on his methods to the Journal of the Astronomical Society of South Africa, vol. 1, No. 5. It is particularly seasonable, since there are apparently no systematic workers in this field in the northern hemisphere, so that an amateur would have good prospects of success in it.

Mr. Reid laid down for himself the large programme of sweeping the whole southern hemisphere once a month: he found it advisable to map all the nebulæ that might be mistaken for comets. His instrument is a 6-inch Cooke photo-visual equatorial; its definition is very fine, a point that he lays stress upon. He makes north and south sweeps in a fixed hour angle, the diurnal motion sufficing to give a new star field at each successive sweep. One night is devoted to the western sky, another to the eastern. There is little use in sweeping in moonlight or with bad seeing. He notes that he often sweeps for five hours or more on a good night, and yet his catches average about one per annum, so that the work requires much patience and perseverance, but he notes the sense of intense satisfaction that success brings.

NORMAN LOCKYER OBSERVATORY, SIDMOUTH.—The report of the Director of the Norman Lockyer Observatory, Sidmouth, for the year ended March 31 last, shows that much valuable work has been accomplished during the year. Five papers on various branches of astronomy have been published, and six others are in preparation. The year was, nevertheless, a very unfavourable one with respect to weather conditions, only 133 nights having been sufficiently clear for observations to be possible; of these, all but three were utilised. During the year the first assistant, Mr. W. B. Rimmer, left the Observatory to take up an appointment at the Canberra (Australia) Solar Physics Observatory, and from November 29 onwards the work was conducted entirely by the Director (Dr. W. J. S. Lockyer) and the chief assistant (Mr. D. L. Edwards). The principal work undertaken and completed during the year was the determination of the spectroscopic parallaxes of certain stars and the study of the spectra of some bright-hydrogen-line stars. The accounts show an excess of 73*l.* of expenditure over income, but it is hoped that, by the formation of an endowment fund, the deficiency of assured income below normal expenditure will be considerably reduced.

## Research Items.

A LATE BRONZE AGE SITE IN SOUTHERN BAVARIA.—The results of an investigation of a site near Istein in Southern Bavaria are described by Dr. R. Lais in vol. 24, Pt. 2, of the *Bericht der Naturforschenden Gesellschaft zu Freiburg*. The finds, some of which have an important bearing on the distribution of ceramic ornament in this part of the Central European area in the later Bronze Age, were derived in part from the surface, in part from excavation. Among them were a very fine triangular arrow-head of chert, polished stone axes, stone knives, clay spindle-whorls of double-cone shape and pottery, mostly fragmentary, but of sufficient size to show the character of the ornamentation. The decoration was in the form of rings in relief, incised dots and marks in lines and groups, parallel grooves, zigzags and dog's tooth. It was uniformly geometric with the single exception of a garlanded ornament or series of festoons composed of grooves. In regard to dating, the arrow-head, axes and knives clearly belong to the Neolithic Age, as do the numerous flint-flakes which were found, although some of these would appear to have been used later for the purpose of strike-a-lights. The pottery, however, belongs to a later period and may be an extension of the culture of the Black Forest. It is compared with pottery from an urn-burial at Rheinweiler, 5 km. to the north, and from Aichen, 50 km. to the east. These two finds are to be attributed to the Bronze Age rather than the early Iron Age as has been suggested. The Istein finds may be assigned to the latest phase of the Bronze Age.

ABILITY OF TERMITES TO LIVE ON PURE CELLULOSE.—In his studies on termites, Dr. L. R. Cleveland has shown that through the agency of the protozoa in their alimentary canal, they are able to digest wood and utilise the products. He has kept numerous termites belonging to two genera Termopsis and Reticulitermes in glass vessels and has fed them for eighteen months on cellulose alone, *e.g.* filter paper (*Biol. Bulletin*, April 1925). These termites fed on a pure cellulose diet have behaved exactly as the controls fed on wood. Many of the nymphs have become sexually mature adults and have laid a large number of eggs which have hatched normally. Larvæ from these eggs have grown even more rapidly than those from eggs laid by some of the wood-fed controls. In all the experiments the larvæ now present are greater in number and in weight than the individuals present at the beginning, and no deaths have occurred. Some of the colonies which began with ten adult termites now include more than two hundred half-grown individuals. Attempts have been made to determine whether atmospheric nitrogen is being fixed in connexion with the formation of proteins, but no definite result is as yet forthcoming.

THE OVIPOSITION RESPONSE OF INSECTS.—Bulletin 1324 (April 1925) of the U.S. Department of Agriculture is devoted to this subject. Its author, Mr. Charles H. Richardson, discusses the various stimuli which affect the oviposition reaction of insects, giving a large number of references to the literature on the subject. Temperature is an important factor, and within the range of each species of insect there is probably an optimum temperature for egg-laying. Thus, in the case of the Codling moth, oviposition becomes checked at 18·3° C. and was found to cease at 16·7° C. (Isely and Ackerman). Humidity is likewise very important in many but not all species: by increasing the atmospheric moisture from 55 per cent. to 96 per cent., egg-laying in *Tomicus typographicus* was delayed from 1 to 7 days (Hennings). Light stimulates oviposition in the house fly but is without effect on the egg-laying responses of *Drosophila melanogaster* (Adolph). Surface contact is a further factor and often very important: thus, in the webbing clothes moth, investigations by Benedict and by Titschack suggest that the tactile stimulus may be the determining factor regardless of the food value of the material for the future larvæ. Many insects have been found to be attracted by specific odours, but in many cases the nature of the substratum has also to be taken into account in order actually to induce oviposition. The simplest oviposition responses are probably shown by those insects which pass most of their lives associated with substances that serve as food for themselves and their offspring. Most free-living insects, however, require a chain of stimuli to induce normal egg-laying.

PIPERINE AS A MOUNTING MEDIUM.—Watsons' *Microscope Record* (No. 5, May 1925) contains a useful article by Mr. Chapman Jones, urging the value of piperine as a mounting medium for certain purposes. Its refractive index is 1·68 for the D line, and as it is colourless it is superior to realgar. To avoid crystallisation in permanent mounts, it should be heated to 180° C. for one hour before use, but this is unnecessary for temporary mounts.

TEMPERATURE OF GROUND WATER.—In a pamphlet issued by the United States Geological Survey (Water-Supply Paper 520 F), Mr. W. D. Collins gives a summary, with maps and diagrams, of water available for industrial purposes in the United States. The temperature of ground water is generally from 2° to 3° F. above the mean annual air temperature if the water is between 30 and 60 feet below the surface. At a depth of 10 feet the temperature may range from 10° above to 10° below the mean annual temperature. An approximate average increase may be taken as 1° for every 64 feet. The mean monthly temperature of surface water is generally within a few degrees of the mean monthly air temperature when the latter is above freezing point. In the warmer months the maximum water temperature is usually 2° to 6° higher than the mean monthly water temperature.

ANTARCTIC TERRESTRIAL MAGNETISM.—The first volume of Series B of the Scientific Reports of the Australian Antarctic Expedition of 1911–1914 under the leadership of Sir Douglas Mawson is devoted to terrestrial magnetism. The field observations are dealt with by Mr. E. N. Webb, and Dr. Chree discusses the magnetograph curves. The instruments were lent by the Carnegie Institution of Washington and consisted of two magnetometers, a Dover and a Lloyd-Creak dip circle. Observing stations were established on Macquarie Island, at Cape Denison Adelie Land, and at Queen Mary Land, and sledge journeys were made along the coast, across Adelie and King George Land, towards the magnetic pole, and across Queen Mary and Kaiser Wilhelm Lands. As a result, the south magnetic pole was found to be at 71° 10′ S., 150° 45′ E., and the lines of equal dip to be ellipses with their major axes north-west to south-east. The horizontal component of the field was found, partly by the magnetometer, partly by the dip circles, which were provided with deflecting needles. The polar diagrams showing the daily variation of the north and west components are slightly elliptic with their major axes east and west for Adelie Land, while the Scott expedition found them nearly circular for Cape Evans.

WEATHER AT HONG KONG.—An annual summary of the meteorological elements at Hong Kong, with the typhoon tracks in the neighbouring sea and the results of magnetic observations during 1924, are given in the *Monthly Meteorological Bulletin* for December last. The discussion is prepared under the direction of Mr. T. F. Claxton, the Director of the Royal Observatory. No text is given with the voluminous tables, but the latter are prepared with great care and precision. Barometric pressure uncorrected for height above sea-level ranged during the year from 30·31 in. in November to 29·37 in. in July; the highest monthly mean was 30·06 in. in January, and the lowest 29·60 in. in July. Air temperature in the shade ranged from 93° F. in September to 48° F. in January; the highest monthly mean was 82·2° F. in September, the lowest 60·3° F. in February. The total rainfall for the year was 98·57 in., which is nearly 14 inches more than the normal for 40 years; the monthly fall was heaviest in June, but the maximum in an hour was 1·74 in. in May. The brightest month was November with 254 hours of sunshine, and December was the next brightest with 238 hours. The maximum hourly wind velocity was 46 miles in October; the highest in a squall was at the rate of 69 m.p.h., also in October. Two plates are given showing the tracks of typhoons and depressions in the Far East during the year 1924; the tracks very often pass north-eastwards over the neighbouring sea, but others strike inland, passing from east to west in the neighbourhood of Hong Kong. The report of the Royal Observatory, Hong Kong, for 1924, shows that Hong Kong was not visited by a typhoon during the year.

THE DISINTEGRATION OF NITROGEN AND OXYGEN.—The volume of Communications from the Vienna Institute for Radium Research for 1923–24 contains a paper by Dr. G. Kirsch on the disintegration of nitrogen and oxygen by means of swift $\alpha$ particles from radium C. The nitrogen was prepared from the air by absorption, the oxygen from pure potassium permanganate, and the scintillations produced by the products of the disintegration were observed on a zinc sulphide-copper phosphide screen. For nitrogen the expelled $\alpha$ particles have ranges up to 11·4 cm., and the H particles up to about 28 cm. For oxygen the great majority of the $\alpha$ particles have ranges less than 9·3 cm., but there is evidence that for ranges in excess of 9·3 cm., H particles are present in greater abundance than $\alpha$ particles, so that it is not safe at present to conclude that in the disintegration of oxygen H particles are not produced. The author considers that the experimental facts support Pettersson's theory that the $\alpha$ particle causes an explosion of the nucleus, the products moving away in all directions equally, rather than the theory of Rutherford and Chadwick, that the momentum of the $\alpha$ particle is communicated by impact to a portion of the nucleus.

THE RESONANCE LINES OF NEON.—The spectrum of neon in the extreme ultra-violet has been recently investigated by Dr. G. Herz, using a vacuum grating spectrograph (*Zeitschrift für Physik*, June 30). Two strong lines, with the wave-lengths 735·7±0·5 Å.U. and 743·5±0·5 Å.U., have been photographed, the frequency difference between them being 1428±3 cm.$^{-1}$, which agrees with the difference between Paschen's $1s_2$ and $1s_4$ terms. The two lines are to be regarded as combinations of these two terms with the fundamental term, and are the resonance lines of neon. Paschen had already resolved the spectrum of neon into a complicated system of series; but the term corresponding to the normal condition of the gas was not determined by him, as these extreme ultra-violet lines had not been observed. The author concludes that the normal state of neon is a $p$ state, and that the inner quantum number to be ascribed to the fundamental term is $J = \frac{1}{2}$ (Lande's notation), or $j = 0$ (Sommerfeld's notation). A provisional value for the magnitude of the fundamental term is 173970±100 cm.$^{-1}$, but more accurate measurements of the wave-lengths are necessary to obtain a definite value. The paper contains an account of the apparatus made use of in obtaining these results. Owing to the strong absorption of the resonance lines in neon, it was necessary to use a low voltage arc in close proximity to the slit, in a space filled with pure neon at about 4·5 mm. pressure. The light passed through the slit into the spectrograph tube, the pressure of the pure neon in which was about one-thirtieth of this, so that although the light had to pass through a considerable distance to the grating and then to the photographic plate, the absorption was not excessive, and satisfactory photographs of the two lines were obtained. The two ionisation voltages of neon as calculated from these observations are 21·47 and 21·57 volts. This agrees well with the value 21·5 volts measured by Hertz, using the electron collision method.

NITROGEN FIXATION.—The mechanism of the fixation of nitrogen as sodium cyanide has been investigated by E. W. Guernsey and M. S. Sherman, who have published their results in the Journal of the American Chemical Society for July 1925. In the process, sodium carbonate and carbon are heated with finely divided iron as catalyst; the equation of the total reaction is $Na_2CO_3 + N_2 + 4C = 2NaCN + 3CO$. It is now shown that the intermediate reactions are (i.) the reduction of sodium carbonate to metallic sodium, (ii.) the formation of sodium carbide from the elements, and (iii.) the absorption of nitrogen by gaseous sodium carbide to form sodium cyanide. Iron has a marked catalytic effect on the absorption of nitrogen by sodium carbide but does not appear to be essential for the reduction of sodium carbonate or for the formation of sodium carbide.

ORGANO-ARSENIC COMPOUNDS.—An account of the chemotherapy of organo-arsenic compounds, by Dr. G. M. Dyson, is published in the *Chemical Age* for July 25. Ehrlich was the first to raise chemotherapy to the level of a science. Three separate aspects of disease treatment attracted his attention, namely, the disappearance of malaria parasites from the blood by the administration of quinine, the decrease of syphilitic symptoms with the use of mercury, and the destruction of various trypanosomes and spirillæ by the use of arsenic compounds. Ehrlich considered some chemical combination occurred between the drug and some specific chemical group in the parasite (receptor group), thus either killing the parasite outright, or preventing it from functioning in an injurious manner (parasitotropism). The most vital problem in the chemotherapy of receptor groupings is that of determining the relationship between chemical constitution of the curative compounds and their pharmacological action on the receptor groups. Working on these lines, Ehrlich discovered the enormous spirillicidal activity of compounds containing the arseno group, —As = As—. The manufacture of salvarsan, the most important and valuable remedy for syphilis, is described fully. Other arsenic compounds, still more or less in the experimental stage so far as therapeutic action is concerned, are also described.

## Southampton Meeting of the British Association.

PROVISIONAL PROGRAMMES OF SECTIONS.

FROM the local arrangements outlined in our issue of August 15, p. 251, and from the provisional programmes of the sections, it is evident that all who attend the Southampton meeting of the British Association will find that the time is very fully occupied. The brief statements below of outstanding features of some sectional programmes, for which we are indebted to the respective recorders, will serve to indicate the fare which is to be set before the members of the Association.

### SECTION A (MATHEMATICS AND PHYSICS).

The programme of Section A (Mathematics and Physics) presents some interesting and novel features. Under the presidency of Dr. G. C. Simpson, Director of the Meteorological Office, the subject of meteorology will naturally receive considerable attention, which is in keeping with the great present-day importance of this branch of science.

The business of the Section opens on Thursday, August 27, with a paper by Prof. Orstein of Utrecht, foreign guest of the Association, on the quantum theory of dispersion; he will be followed by several speakers on subjects in spectroscopy. The presidential address on Friday on the new ideas in meteorology will demonstrate the great strides which have been made in the subject in the last decade. The president will be supported by the leading meteorologists in Great Britain, several of whom have promised papers to which the Friday and a portion of the Tuesday sessions will be devoted. On Monday, August 31, there will be a joint discussion with Section C (Geology) on "Variations in Gravitational Force and Direction and its Relation to Geological Structure," a subject upon which a committee of the Section has been working for some time, and upon which many physicists will welcome information because of its considerable industrial import. On Tuesday, September 1, Prof. Appleton will discuss some problems in thermionic valves, and he will be followed by several speakers on allied problems.

An excursion to the Air Ministry Seaplane Station at Calshot has also been arranged.

### SECTION B (CHEMISTRY).

One of the features of the meeting of Section B (Chemistry) will be a joint discussion with Section G on the ignition of gases. This will take place on the Friday morning, and will be opened by Prof. H. B. Dixon. Two other discussions have been arranged by Section B, one on Thursday morning, having for its subject surface catalysis, which will be opened by Dr. E. K. Rideal, and the other on Tuesday morning, on the alternating effect in carbon chains, to be opened by Dr. B. Flürscheim.

The presidential address to the Section will be delivered on the Monday morning, when Prof. C. H. Desch will take as his subject "The Chemistry of Solids."

Among other papers of general interest which will be submitted to the Section, mention should be made of a contribution by Prof. E. C. C. Baly entitled "Further Investigations on the Photosynthesis of Naturally-occurring Compounds," a paper by Prof. H. E. Fierz, of Zürich, on "The Liquefaction of Wood and Cellulose and some General Remarks on the Liquefaction of Coal," and a paper by Mr. E. A. Ollard, of the Metropolitan-Vickers Electrical Company, on "The Resistance to Corrosion of Electro-deposited Chromium."

### SECTION E (GEOGRAPHY).

Owing to this year's meeting being held in Southampton, the home of the Ordnance Survey, Section E (Geography) will devote special attention to papers on survey and cartography. Col. Com. E. M. Jack will speak on the work of the Ordnance Survey and Captain J. G. Withycombe on its recent productions. Mr. O. G. S. Crawford will deal with archæology in survey maps. Mr. A. R. Hinks is to devote his presidential address to the science and art of map-making. The relations between geography and anthropology are evident in a paper by Mr. H. Sumner on geography and prehistoric earthworks in the New Forest. The present state of the international map on the scale of 1/1,000,000 is to be described by Major M. N. Macleod, and the question of pronunciation tables for the British sheets by Mr. J. H. Reynolds. In exploration and field work, Prof. J. W. Gregory will discuss the problems of the Queensland Barrier Reef and the most suitable site for boring, while Mr. F. G. Binney will give an illustrated lecture on his recent travels in North-East Land, Spitsbergen. Dr. Vaughan Cornish introduces a new subject in his paper on subjective variations of magnitude in natural scenery. A paper of current interest will be that of Mr. F. J. Richards on the cultural geography of India. Prof. W. M. Hobbs will contribute a paper on the glacial anticyclone.

### SECTION F (ECONOMIC SCIENCE AND STATISTICS)

Two matters of great importance at the present time, both to economists and to farmers, are to be discussed in a joint session of the Agriculture and Economic Sections. One is the question of farming costs in relation to farm management, on which a paper is to be read by Mr. J. Wyllie; the other will be raised in a paper by Mr. R. B. Forrester on the marketing of agricultural produce. In the present crisis in British farming these two papers are of especial interest.

At a time, too, when wages problems in our chief industries are pressing for solution, the address of the president, Miss Lynda Grier, on the meaning of wages is equally timely. This paper will be supplemented by one by Mrs. Stocks on the economics of family endowment, and another by Mr. R. F. Harrod dealing with trade crises and the distribution of wealth among the factors producing it. The problem of population is to be considered in two papers, one by Mr. G. F. Shove on the law of diminishing returns in agriculture and its bearing on population, the other by Mr. P. Sargant Florence on "Over Population and the Statisticians."

Two aspects of the financial situation will be considered. Mr. R. G. Hawtrey will deal with the gold standard and the balance of payments; and Mr. P. B. Whale with German finance and the Dawes report. In addition there are papers by Miss I. F. Grant on the enclosure movement and Scottish arable land, by Mr. Fabian von Koch on unemployment relief in Sweden, and by Dr. John Hulme on recent developments in Italy's textile trade.

A new feature this year is the Transport Subsection. Six papers are to be read, dealing with the technical and economic aspects of transport by railways, roads, canals, and docks.

### SECTION G (ENGINEERING).

The president of Section G (Engineering), Sir Archibald Denny, will deliver an address on "Fifty

Years' Evolution in Naval Architecture and Marine Engineering." During this period very remarkable developments have taken place in the construction and equipment of ships, and in this development science and scientific research have played a very important part.

After the presidential address Mr. Edwin R. Mumford will discuss the important question of the comparison between the speeds and powers of models and ships, and after an account of the pioneer work of Dr. William Froude, will show how the method has been applied to solve numerous problems of ship and propeller design; the problem of "cavitation" will also be discussed. Mr. Foster King will trace the development of the scantlings of modern steel ships and show the hindrance to development which resulted from strength calculations not having been used in wood construction. Mr. F. E. Wentworth Sheilds will describe the quay walls of Southampton, certain of which have been proved unstable owing to the nature of the foundations. He will give the history of the walls and discuss the various remedies adopted to render the walls stable. Mr. W. G. Turner will describe the electric power station at Southampton, and Mr. H. Wauchope will deal with the electric supply and plant of Southampton Docks. Mr. Stanley S. Cook will discuss the efficiencies of steam turbines for marine purposes and the problem of auxiliary machinery and fuel consumption, and Mr. Western Hutchinson will read a paper on "Sailing and Motor Craft, the Scientific Aspects of their Design."

At the joint discussion with Section B (Chemistry) on "Ignition of Gases," Prof. W. T. David will give some account of experiments on the spontaneous ignition of gases and upon the influence of nitrogen and other gases and also infra-red rays upon ignition temperatures and rates of ignition respectively. Mr. C. E. Le Maistre will read a paper on engineering standardisation, and Vice-Admiral Sir Robert Bland Dixon and Mr. T. Berry are to discuss the problem of technical training for naval constructors and engineer officers. Prof. David Ellis will give an account of an investigation into the responsibility of iron bacteria as constructive agents in the formation of incrustation in pipes. In the special case investigated, in spite of every appearance of bacterial responsibility, the incrustation in pipes was found to be due to other causes.

The problem of landslides will be dealt with by Mr. Edgar Morton, and Mr. Oliver E. Simmonds will describe the construction of modern seaplanes. Experimental demonstrations of flow of water in pipes are to be given by Prof. Eustice, and Prof. J. G. Gray is to give demonstrations with the gyroscope. Prof. J. J. Guest is to discuss the dynamics of motor cars. Visits are being arranged to the seaplane station, to Southampton Docks, to an Atlantic liner, to the railway works, aeroplane works, and to Agive oil works.

### Section H (Anthropology).

In Section H (Anthropology), Dr. T. Ashby in his presidential address will deal with "Engineering in Ancient Rome." In view of his special interest in Romano-British studies, a survey will be made of our present knowledge of Roman Britain in a series of communications dealing with recent excavations in England, Wales, and Scotland. Not only will much of the material of these papers be described here for the first time, but a great deal will be the result of work carried on during the present summer.

In prehistoric archæology may be mentioned communications by Miss D. A. E. Garrod on the Upper Palæolithic in Britain; on the Neolithic period by Mr. O. G. S. Crawford, who will deal with changes of climate and megalithic migrations; by M. Z. le Rouzic on megalithic monuments in Morbihan, France; and by Mr. E. T. Nicolle, who will describe the important Bronze Age mound recently excavated in Jersey. Mr. H. J. E. Peake will raise the question of archæological distribution maps. Certain aspects of the question of the antiquity of man will be discussed by Sir W. Boyd Dawkins, and Mr. W. P. Pycraft will offer suggestions for a new classification of man. Sir Flinders Petrie's description of recent finds of relics of early man in Egypt is of special interest in view of the correspondence which followed the preliminary announcement of these discoveries in the Press. The Section will also have an opportunity of discussing recent results obtained by the American archæological expedition to the city of Carthage, which will be described by Mr. Harden.

Other branches of anthropological studies will be well represented, as, for example, by Capt. Pitt-Rivers' account of the natives of the Island of Aua, New Guinea, and their customs and mode of life; and by Capt. Hilton-Simpson's description of the industries of the Shawîya of the Aurès Mountains, Algeria, which will be illustrated by cinematograph films taken by Mr. J. Haseler. Mr. Talbot Rice, a member of the Oxford expedition to Kish in Mesopotamia, will describe the physical characters of the modern Arabs in that area. Some interesting questions relating to heredity in man will be raised by Dr. R. N. Salaman's study of facial types in the Jewish community, which should give rise to a profitable discussion.

Exceptional interest attaches to Mr. Turville-Petre's account of his excavations on behalf of the British School of Archæology in Jerusalem, in caves near the Lake of Galilee, which have brought to light important evidence bearing on palæolithic man in Palestine, and Sir Arthur Keith's report on the skull showing affinities with the Neanderthal type discovered there. These communications are the first detailed description of this important discovery to be given in England.

### Section I (Physiology).

The programme of the Section of Physiology opens with three papers on carbohydrate metabolism; the first of these will be given by Prof. J. J. R. MacLeod, in whose laboratory at Toronto insulin was first prepared, and the second by Dr. C. H. Best, who, together with Dr. Banting, effected the preparation. Prof. MacLeod's communication deals with the carbohydrate metabolism of cold-blooded animals. Dr. C. H. Best will read two short papers on (*a*) the nature of insulin, (*b*) the mode of its action. A third paper of considerable interest will be that of Mr. H. P. Marks, who has made some striking observations in relation to the action of the thyroid gland in carbohydrate metabolism. He has found that after prolonged administration of thyroid gland by the mouth to rabbits, a condition ensues in which the injection of sugar produces the same train of severe symptoms as attends the injection of insulin. His results have an important bearing on the cause of the lowered sugar tolerance in hyperthyroidism.

Prof. A. V. Hill, whose work on the mechanism of muscular contraction was rewarded by a share of the Nobel prize for medicine for 1922, will deliver his presidential address on the physiological basis of athletic records on Monday, August 31, and the address will be illustrated by cinematograph. He has analysed the factors limiting muscular effort, and, as a result of observations on the isolated muscle of the frog, has been able to deduce what athletic records should be in man. Work recently carried out in Prof. Hill's laboratory, in which the processes

taking place during continuous activity of the isolated muscle of the frog and of human muscle are directly compared, will be described in a paper by Prof. K. Furusawa on Thursday morning, August 27.

A lecture will be given on Friday afternoon by Mr. J. E. Barnard on the microscopic observation of small bodies. Mr. Barnard's name has, of course, recently been associated with reports of the observation and photographic reproduction by means of ultra-violet light of a cancer virus, the existence of which was demonstrated by Dr. W. E. Gye. The size of some of the bodies has been closely determined and is believed to be 0·072$\mu$, so that Mr. Barnard's achievement is considerable.

On Thursday afternoon there will be a joint discussion with Section D (Zoology) on the functional significance of size, to be opened by Mr. J. B. S. Haldane. On Tuesday morning there will be a joint discussion with Section J (Psychology), to be opened by Prof. T. H. Pear, on the acquisition of muscular skill.

Sectional excursions have been arranged for Monday and Tuesday afternoons, the first to the Anti-Gas School at Tipnor and to the Diving Tank at Portsmouth, and the second to the Fort Grange aerodrome, where some of the tests applied to candidates for the Royal Air Force will be demonstrated.

### SECTION J (PSYCHOLOGY).

Differential methods have a prominent place in the programme of Section J at Southampton, where the term "differential" is applied either to a comparison of the reactions to a constant stimulus of two groups differing in one condition, or else to a comparison of the reactions of a group (or two equivalent groups) to two or more different stimuli. Thus a study has been made of special abilities in arts and science, where "special ability" is meant to apply to a facility developed through special environmental influences and individual interests acting over a number of years and the terms "arts" and "science" stand for the work involved in preparing for first degrees in the corresponding faculties.

Similarly the results of testing physically defective children at the Lord Mayor Treloar Hospital and elsewhere lead to the conclusion that physical defect, if widespread and of sufficiently long duration, produces the symptoms of some degree of amentia; and further, that this mental deficiency resulting from physical defect would appear to be appreciably alleviated by exposure to ultra-violet rays.

In another study, on the discrimination of wool fabrics by the sense of touch, an attempt has been made to define the differences in judgment between members of the wool trade and the consuming public, and the result suggests a method of measuring the wool-trade sense of touch. It is also suggestive of the times that the relationship between buyer and seller is studied psychologically in another paper, where an individual valuation is regarded not as a single price at which the individual concerned will be willing to complete his share of the transaction, but as a whole class of possible prices between which the probability of him completing his share ranges from zero to one.

Our final example is a study of the responses of children when taught by various methods, such as the cinema and oral lessons. The essays written after the various lessons differed in arrangement of material and also in mode of expression or style.

Prof. Spearman will open the sessions with his presidential address on "Mental Law of Diminishing Returns." Two joint discussions will be held, one with Section L (Educational Science) on "Recent Investigations upon Vocational Guidance," and one with Section I (Physiology) on "The Acquisition of Muscular Skill."

### SECTION K (BOTANY).

The presidential address of Prof. Lloyd Williams will deal with the Phaeophyceae and their problems. The investigation of this group of seaweeds has been comparatively neglected, and the conclusions of Prof. Lloyd Williams, who has devoted a life-study to these plants, are looked forward to with keen interest. The study of Algæ will also receive prominence by the communication of several papers on seaweeds.

The only joint discussion in which Section K is participating this year is one with Section E (Geography) on "The Evolution and Colonisation of Tidal Lands," to be opened by Prof. F. W. Oliver, who will speak principally upon the stabilisation of these migrating soils by various types of vegetation. On the geography side, Prof. J. W. Gregory will deal chiefly with the mode of formation of new land areas by the action of the sea. Other speakers in this discussion will be Prof. R. H. Yapp, Dr. Vaughan Cornish, Dr. E. J. Salisbury, and Prof. S. Mangham.

Within Section K there will be a discussion on the interpretation of "Adaptive Characters," which will be opened by Prof. F. O. Bower and contributed to by Prof. J. H. Priestley, Dr. D. H. Scott, and Mr. G. E. Briggs. The argument to be outlined by Prof. Bower will deal principally with certain characters in ferns, to which he has devoted special attention. Prof. Dame Helen Gwynne Vaughan will introduce another discussion on "Deviation from the Normal Course of Sexual Reproduction in Plants," on which Dr. K. Blackburn and Dr. M. Knight also will speak. Recent work has shown that apogamy is of such common occurrence in the plant kingdom that it is time again to take stock of the position.

Most branches of botany will be well represented in other parts of the programme, including physiology, genetics, cytology, plant pathology, morphology, palæobotany and systematic botany.

The popular lecture this year will be given by Dr. D. H. Scott, who will take as his subject "The Transformations of the Plant World in Geological Time." A full programme of excursions has been arranged.

### SECTION L (EDUCATIONAL SCIENCE).

On August 27 Section L (Education) opens its annual meeting under the presidency of Dr. W. W. Vaughan, headmaster of Rugby, with a discussion on "The Training of Teachers." Although inspired by the recent Government report, the discussion is expected to include the training of teachers for secondary schools as well as that for elementary school teachers.

Public attention is to be directed to those conditions of boarding-school dietary (institutional feeding), which experience has shown to be necessary for the health of the growing child. It is hoped to arouse general interest in the need for more careful attention to the many factors involved other than those of cost and calorific value of foods.

The disciplinary value of subjects taught in schools is to form the theme of a discussion immediately following the president's address on "The Warp and Woof of Education." Later on in the session a strong attack is to be made on those schemes of school science that do not include the study of living things; the biologist and zoologists are combining to represent the urgent need of a broader basis for science teaching than exists in the majority of schools,

in order to emphasise the educational value of a study of animal life as well as that of botany.

The psychologists and educationists, led by such practical observers as Prof. Cyril Burt and Messrs. Cox, Earle, and Salter Davies, are meeting in joint session to hear and discuss the latest results of research on vocational guidance. The education of the industrial worker and expert will be reviewed by Sir Robert Blair, who will open a discussion on "The Conditions of Success of Technical Institutions." Mr. Wickham Murray will deal with the handicap imposed by the present narrow spirit of university matriculation requirements on technical students, and Dr. W. M. Varley will speak for the claims of the "Local College" as a centre of educational activities for adolescents and adults, providing not only technical instruction but also opportunities of wide cultural study.

A lecture will be given by Dr. Ernest Barker on "Growth of National Character," and another by Mr. Percy Scholes on "Musical Education by means of Player-piano, Wireless, and Gramophone."

## Catalysis and Oxidation.[1]

By Prof. HENRY E. ARMSTRONG, F.R.S.

THE treatment of the subject must depend upon the definition that is given of the term. Is or is not *catalysis* to be regarded as the synonym of *chemical change in general*? Berzelius, the author (1835) of the term, who developed the conception, included among catalysts agents so diverse as sulphuric acid (*e.g.* the production of ether and the hydrolysis of starch); platinum, especially in the spongy form (*e.g.* the formation of water from hydrogen and oxygen and the oxidation of alcohol); and enzymes (*e.g.* the hydrolysis of starch by diastase). Such agents have, in common, the power of acting reversibly, so that they may eventually be recovered, if not soiled by some secondary change.

The need of a clear definition and limitation is obvious from the frequent use of the expression *contact catalysis*, as if there were several forms of catalysis. Such use of the adjective *contact* is superfluous, to say the least—as all chemical interactions necessarily involve *contact* of the substances concerned, whatever their character: if the expression have any meaning, it can only be that of chemical change in general, for which we need no other specific term.

I would urge that the term catalysis be limited to actions *at* and *influenced by solid surfaces*: in other words, the catalyst is either an extended solid surface or a finely divided, particulate agent—in suspension, not in solution. I have specially developed this view in my recent Messel Lecture to the Society of Chemical Industry (Journal, 1922).

Since 1885, my contention has always been that chemical change is an electrolytic process. On this assumption, whilst electrolytes, in solution, may interact directly, chemical action between non-electrolytes is an indirect process, determined by the presence of an electrolyte compatible with the substances ultimately brought into interaction through its agency, because of its power of linking them in a conducting circuit. This agent I would term the *determinant*; it is necessarily an electrolyte.

In general terms, the equation of interaction may be written

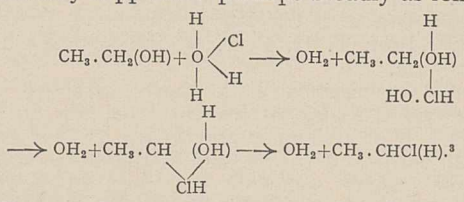
$$A_2+\epsilon\delta+B_2 \rightleftarrows AB+AB+\epsilon\delta,$$

where $\epsilon\delta$ is the electrolytic determinant.

I have specially considered the formation and nature of electrolytes in numerous communications to the Royal Society and elsewhere.[2] To give a specific illustration: alcohol and hydrogen chloride do not interact, except in the presence of water:

$$\left.\begin{matrix}\text{Et.OH}+\text{HCl}=\text{o}\\ \text{Et.OH}+\text{H}_2\text{O}=\text{o}.\end{matrix}\right]$$

Hydrogen chloride and water together, however, form an electrolyte. The process of interaction, in their presence in association (as a composite electrolyte), may be less direct and more complex than is commonly supposed: perhaps broadly as follows:



Having the postulate referred to above in mind, I was able, in 1885, to predict not merely that oxygen and hydrogen cannot interact but that water alone would not suffice as determinant—that the water must be impure, *i.e.* an electrolytic conductor. The forecast has been verified by H. B. Baker. The criterion is a simple one. Over and over again, the correctness of this postulate has been verified experimentally, especially by H. B. Baker, whose masterly, long-continued inquiries are in no way appreciated as they should be. It has led me to affirm that gases cannot interact—except in the presence of a liquid determinant, if not of a catalyst. Aitken's work on the condensation of hydrone, $x\text{OH}_2$, to water, $(\text{OH}_2)_x$, may be interpreted from this point of view.

At least the chief distinction to be drawn between changes influenced by catalysts and those which occur in a wholly liquid medium is, that whereas, in the latter, the extent to which change takes place diminishes as the concentration is diminished, in the presence of a catalyst the rate of change is constant over a considerable period and apparently independent of the concentration *in the solution*: because of the attractive influence exercised by the catalyst and the consequent uniform and continued concentration of the hydrolyte at its surface.

I have long thought—and the evidence in favour of the interpretation is increasing daily—that so-called gaseous interactions always take place at the surfaces with which the nominally interacting gases (plus the necessary determinant) are in contact—the surface playing the part of catalyst, by serving to attract and hold the determinant. It may be questioned whether Moureu's refined studies of oxidation do not furnish complete evidence of this view. In some instances the substances which he has successfully used as inhibitors of the oxidation of acrolein have been of such low volatility that they can scarcely have been present, except in most minute proportion, in the gas above the liquid: if so, it may be legitimate to suppose that oxidation is confined to the liquid state. All turns on the proportion of inhibitor that is necessary.

We are not entirely clear, however, as to the function of the catalyst—whether or no it be included

[1] Address delivered at the second of the triennial conferences of the Institut International de Chimie Solvay on April 22.

[2] Proc. Roy. Soc., 1886, 40, 268; A, 78, 264, 1907; A, 79, 586, 1908; A, 81, 80, 1910; A, 84, 1912; A, 86, 604, 1914; 90, 73. British Association Report, 1885; J. Chem. Soc., 1895, 1122.

[3] The H in brackets is that which may be supposed to take the place of (OH) originally in the alcohol. Some such process as this may be at the root of the Walden inversion.

in the circuit or whether it merely serve to attract and hold the determinant, together with the substances the interaction of which it determines. Taking the case of hydrogen and oxygen interacting at a platinum surface, it is open to question whether the platinum be coupled with both gases at adjacent points, the determinant acting as an electrolytic conductor between the two; or whether the determinant be merely adherent to and concentrated upon the platinum, the two gases being attracted to it: thus forming the circuit within which change takes place.

The balance of evidence would seem to be in favour of the former explanation. Thus, platinum influences the interaction of hydrogen and oxygen but not that of carbonic oxide and oxygen. Carbonic oxide and various hydrocarbon vapours even have a protective and preventive action and *apparently* can displace both oxygen and hydrogen from a platinum surface. It might be that carbonic oxide is also more attracted by the liquid determinant. It is almost impossible to grant that any one of the gases can monopolise the surface. The behaviour of carbonic oxide, in fact, is in many respects peculiar and needs special discussion.

Evidence on the point is, perhaps, to be found in recent observations on the interaction of hydrogen and oxygen in presence of silver and gold (D. L. Chapman, J. E. Ramsbotton and G. G. Trotman, Proc. Roy. Soc. A., 197, 92). Bone and Wheeler have shown that both metals are more active after heating in hydrogen but not if heated in oxygen. Chapman and his fellow-workers show that absorbed oxygen acts as an inhibitor, apparently owing to the formation of a film of metallic oxide, whilst absorbed hydrogen does not appreciably diminish or increase the activity of the metal. They have further found that the two gases interact, even at the laboratory temperature, in the presence of a silver film deposited on the inner surface of the vessel in which they are confined. The explanation of the inhibiting effect of the film of oxide may be that, being strongly alkaline, the film holds the *trace of acid* which normally serves as electrolytic determinant. Whether silver act as the catalyst and determine interaction at ordinary temperatures—because it merely attracts the electrolytic determinant and the two gases to its surface—or because either or both of these is absorbed by it, must apparently be left an open question.

The special activity of catalysts, due to their particulate character, may be ascribed to the influence they exercise in maintaining a high "surface concentration" of the interacting substances. On this account, the primary action exercised by the enzyme takes place during the earlier, in fact, a considerable period, at a linear rate; only as the products of change accumulate and the action is reversed to an appreciable extent or the enzyme is neutralised or lamed by products of change is the rate of change perceptibly diminished. This is well illustrated by curves showing how urea is hydrolysed by urease, according as the product of change, ammonia (which but lames the enzyme, as the action is not sensibly reversible), be allowed to accumulate or be neutralised by an acid too weak to affect the enzyme.

Enzymes have a peculiar and rigidly *selective* activity—it is on this account that they form a special class of catalyst. They, therefore, influence the hydrolysis of specific hydrolytes; there is no reason to regard their hydrolytic influence as exercised in any peculiar manner.

To make the argument clear, it may be well to recapitulate and consider the formation of hydrone from hydrogen and oxygen. Being non-conductors, by my postulate above, these gases cannot interact:

$$2H_2+O_2=0.$$

By this same postulate, even the presence of "water" would not suffice:

$$2H_2+(OH_2)x+O_2=0.$$

Action would only take place in the presence of an electrolytic determinant:

$$2H_2+\epsilon\delta+O_2=2H_2O+\epsilon\delta.$$

As, however, the determinant would only be an electrolyte if present as liquid; and moreover, as the formation of liquid appears to be dependent upon the presence of a nucleus, *i.e.* of a surface, it is conceivable that no change would take place unless a catalyst ($k$) were present:

$$2H_2+\epsilon\delta k+O_2=2H_2O+\epsilon\delta k.$$

Finally, as interaction takes place in an electrolytic circuit, hydrogen is but indirectly "oxidised" whilst oxygen is hydrogenised

$$\begin{array}{l} H\ HO....H\ O\ H_2O\ ....\ HO \\ |+\quad\quad +|=\quad +\quad\ +\ |. \\ H\ HO....H\ O\ H_2O\ ....\ HO \end{array}$$

As this illustration shows, oxidation is not a direct but an indirect, *depolarising* effect.

It may be questioned whether water itself, as liquid, should not rank as a catalyst. In the interactions considered, it appears only as part of the electrolytic determinant and is necessarily to be thought of as present in the liquid state. Supposing, however, that in an entirely gaseous mixture—say, under the influence of an electric discharge—a sufficient number of hydrone molecules were temporarily brought into conjunction and formed liquid drops, would these suffice to determine interaction independently of any solid surface? It is possible that they would, *if* drops were formed under such conditions. The water, however, would not then be acting as catalyst but merely as part of the determinant: the rate of change would not be raised, as it is by solid catalysts.

The argument may be extended to the reverse process—the electrolysis of acidified water between platinum electrodes—and the assumption made that the perhydrone produced during the first stage,

$$\begin{array}{l} H....OH \quad\quad H\ ....\ HO \\ \quad\quad\longrightarrow\ \cdot+\quad +\ \cdot \\ H....OH \quad\quad H\ ....\ HO \end{array}$$

is itself acted upon and hydroxylated during the second:

$$\begin{array}{l} H....OH\ HO \quad\quad H\ ....\quad\quad H \\ \quad\quad +\ \cdot\longrightarrow\ \cdot+\quad +\quad\quad >O+H_2O. \\ H....OH\ HO \quad\quad H\ ....\ HO.O \end{array}$$

The "oxoperhydrone" thus formed is then hydrolysed into oxygen and hydrone, being itself acted upon, perhaps, as a composite electrolyte:

$$H.O.O.O....H+HO....H\longrightarrow H_2O+O_2+H_2O.$$

If the electromotive force or the current density be increased and the rapidity of attack sufficiently raised, the "oxoperhydrone" may be further hydroxylysed:

$$\begin{array}{l} H....OH \quad\quad H \\ \quad\quad +\quad\quad >O\longrightarrow H_2+ \\ H....OH\ HO.O \end{array} \quad\begin{array}{l} HO.O \\ \cdot+H_2O. \\ HO.O \end{array}$$

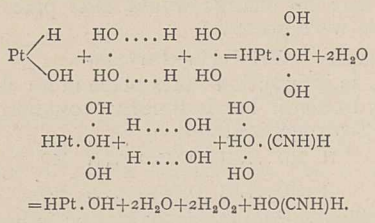
Ozone may be pictured as formed by the hydrolysis of a "dioxoperhydrone" (also, perhaps, in the form of a composite electrolyte) thus produced:

$$\begin{array}{l} H....O.O.O.OH \\ \Uparrow\quad\quad\quad\Uparrow \\ \Downarrow\quad\quad\quad\Downarrow \\ HO.....H \end{array} =H_2O+O_3+H_2O.$$

In like manner, when concentrated solutions, particularly of sulphuric acid, are electrolysed, peracids are formed, which, in turn, according to the conditions, give rise to perhydrone, to oxygen or to ozone when hydrolysed.

Oxidation phenomena in general may be interpreted in a similar manner.

The suspended or inhibited oxidations which Moureu and his fellow-workers have studied so thoroughly in recent years, seem to be consistently accounted for by regarding them as involving the continued backward and forward hydroxylation of competing or antagonistic oxidisable compounds—*i.e.* as interference or reversal effects. I have long thought of the inhibition by hydrogen cyanide of the decomposition of perhydrone by platinum or yeast as due to the formation, in the first instance, of perhydrols and their reversible interaction



$$=HPt.OH+2H_2O+2H_2O_2+HO(CNH)H.$$

In result, the interactions here pictured have the same effect as those postulated by Moureu, the main difference being that the process is more clearly defined, as it is represented as "electrolytic" in all its stages. Moureu has usually assumed that the substance primarily concerned is oxidised to a "peroxide," $A(O_2)$, from which oxygen is transferred to the inhibitor, a second "peroxide" $B(O)$ being formed, the primary "peroxide" being reduced to another "peroxide," $A(O)$: the original molecules are reproduced by the interaction of these antagonistic "peroxides":

$$A+O_2=A(O_2) \qquad A(O_2)+B=A(O)+B(O)$$
$$A(O)+B(O)=A+B+O_2.$$

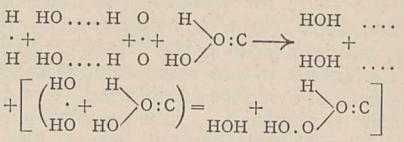
In their recent communication to the Chemical Society, however, Moureu and Dufraisse clearly contemplate the probability that platinum, acting as an oxygen carrier, oxidises the molecules of hydrogen and the interfering gas ($H_2$, CO, $C_2H_4$, etc.) simultaneously to form two antagonistic peroxides, which then interact, reducing each other.

The oxidation of the two oxidisable substances is and, indeed, must be effected in the same circuit, one of them acting as "depolariser," thereby raising the potential to the necessary extent: otherwise, one would not be oxidised at all or the "antagonism" would be incomplete.

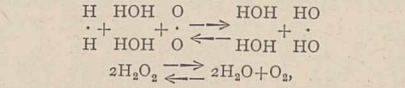
Carbonic oxide may be taken in illustration. I have long wondered at the peculiar behaviour of this gas, in fact since I first read in the early 'seventies Groves' fascinating memoir on his gas battery and Faraday's earlier more complete observations on the combining power of platinum; in the former it is shown that carbonic oxide cannot be coupled with oxygen, as hydrogen can, to form a gas battery. Then came H. B. Dixon's discovery of the incombustibility of the dry gas and the increase in velocity of the explosive wave as the proportion of steam present was raised up to a certain maximum. I have more than once discussed the problem, particularly in 1904, in a brief communication to the Royal Society on "The Retardation of Combustion by Oxygen" (Proc. Roy. Soc., 74, 86), in which I dealt with H. B. Dixon's observations on the retardation of the combustion of hydrogen by "excess" of oxygen and of Bone and Stocking's similar observations on ethane.

Accepting the postulate at the root of the argument in this essay, inasmuch as the oxidation of carbonic oxide is a process involving the electrolysis of water,

action should not take place at a platinum surface, at ordinary temperatures, because the heat of oxidation of carbonic oxide is below that of hydrogen: the change would be endothermic. Probably, the combustion of carbonic oxide is never a direct effect but is determined by a minute quantity of hydrogen, acting as adjuvant, produced initially when the combustible mixture is inflamed or sparked:



To repeat what I said in 1904, "It is necessary to remember, that whereas both oxygen and water molecules diminish in stability as the temperature rises, the stability of hydrogen peroxide must be at a maximum at a high temperature—since its formation from oxygen and water is an endothermic process. In fact, it is to be supposed that water is readily oxidised at temperatures such as prevail in combustions. If, however, the formation of water be regarded as involving the changes



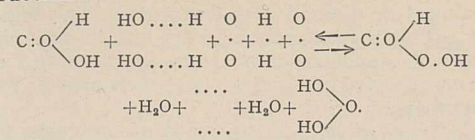
it follows that water and oxygen will mutually hold each other in check: so that when electrolytic gas is exploded there will be a deficiency of oxygen, as it were, owing to its conversion into hydrogen peroxide, which may be regarded as relatively if not entirely inoperative as an oxidising agent, at high temperatures, in presence of oxygen. On the other hand, when excess of oxygen is present, the water—which is the effective catalyst—will be more or less held back, also in consequence of its oxidation to hydrogen peroxide."

Whether or no the changes pictured above could equally well take place at a cold platinum surface would be open to question, were it not that platinum is known to determine the interaction of hydrogen and oxygen. There is no reason to suppose that carbonic oxide could not enter the circuit of change, as a depolariser, under such conditions. The difference in behaviour at low and high temperatures is, therefore, probably the consequence of differences in the stability of some of the compounds concerned.

As to the form in which carbonic oxide primarily enters into the circuit of change, it is not unlikely that it is as the hydrol $C:O\begin{matrix}H\\OH\end{matrix}$ rather than as formic acid. Obviously, such a compound would be of low stability and the need of a high proportion of steam, to secure the combustion of carbonic oxide at the maximum rate, may be accounted for by the assumption that the presence of this hydrol, in sufficient proportion, is only to be secured in this way.

The immediate product of the hydroxylation of the hydrol, $C:O\begin{matrix}H\\OH\end{matrix}$, would be the "perhydrol" $C:O\begin{matrix}H\\-OH\end{matrix}$, a still less stable compound. At ordinary temperatures, at a platinum surface immersed in an atmosphere of hydrogen, carbonic oxide and hydrone, this perhydrol would be antagonised by a corresponding "hydroxyperhydrone" or "oxoperhydrol" and

the two would interact reversibly to their mutual destruction:



At high temperatures, such perhydrols would no longer be formed and the direct combustion of the carbonic oxide with the aid of hydrogen, acting as depolariser, would be effected without their interference and with special readiness.

One other case of apparently anomalous protection against oxidation may be referred to—that afforded by so-called rustless steel and the more recently introduced soft alloy staybrite. The former is a chromium steel, the latter an alloy of iron, nickel and chromium, as free as possible from impurities. That chromic acid will protect iron against oxidation is well known. It may be supposed that, in an alloy of iron with chromium, in which the chromium is properly distributed, both materials undergo surface oxidation to perhydrols, which act reversibly, so that at most a layer of molecular thickness is affected, a coating being formed which may well correspond with the (?) unimolecular layer of oxide upon the surface of the far more sensitive metal aluminium.

It is permissible to suggest that the influence of certain dyestuffs in checking the "fogging" of an undeveloped photographic plate may perhaps be traceable to the initial production of antagonistic perhydrols by simultaneous hydroxylation of the sensitive film and the coloured material.

Finally, some reference to the oxidases may not be out of place. These are commonly spoken of as enzymes but they are in no way comparable with these, in so far as they act selectively. They are only selective in the broad sense, that they are effective agents in determining the oxidation of compounds of a particular general type. Thus so-called tyrosinase will determine the oxidation of phenolic compounds of a certain type—not of tyrosin alone. This is true of "oxidising" organisms, such as *Bacterium aceti* and *B. xylinum*. The behaviour of *B. aceti* is altogether peculiar—although active towards ethylic and normal propylic alcohols, it has no action upon either methylic or isopropylic alcohol. At present we know so little of the process at work that it is impossible to attempt any precise explanation of these peculiarities. It may be suggested, however, that they are traceable both to configurational and energy differences in the systems concerned; moreover, it is clear that something more than the simple, direct oxidation of the alcohol is to be contemplated and that cross-interactions may be at work. Maybe we shall have little success in interpreting such actions until we no longer think "on paper" but have clear conceptions of the solid configuration of molecules. The oxidases may well be discarded from the class of enzymes and regarded as simple catalysts—of a parity with platinum black.

Not a few mysterious processes may be open to interpretation in accordance with the principle developed in this essay. The peculiar behaviour of phosphorus is a case in point—especially the dependence of the appearance of luminosity upon the partial pressure of the oxygen and the phenomena of intermittent luminosity to which Lord Rayleigh has recently directed attention. Little can be said with advantage, however, until we know far more of the several stages of the oxidation process—which may well be as complex as that of the interaction of nitric acid and metals.

## Genetical Investigations.

THE practical value of chromosome studies is perhaps nowhere better demonstrated than in the wheats, where the species belonging in different groups have different multiples of 7 as their chromosome number. In hybrids between species with different numbers of chromosomes, the peculiarities in the hybrid behaviour are largely explained by the history of the chromosomes, some of which pair in meiosis while others remain single.

Sax and Gaines [1] draw several conclusions from a study of hybrids between emmer wheats (28 chromosomes) and vulgare wheats (42 chromosomes), which have been grown through several generations. The various segregates tend ultimately to have the same chromosome numbers as the original parents. This is accomplished through sterility or loss of chromosomes in forms with intermediate numbers, as has been found also in the Œnotheras and in other cases. Segregates with 28 chromosomes resemble the emmer wheats, while those with 42 have most of the vulgare characters. This indicates that the 7 extra pairs of chromosomes determine most of the vulgare characters. The chromosome behaviour would lead to the expectation that ordinary Mendelian segregation would occur in characters, such as presence or absence of awns, yellow or black awns, and red or white grain, which are common to both the emmer and vulgare groups of wheats; while aberrant segregation would occur in regard to characters which distinguish the two groups. This is largely borne out by the results of experiment. Some of the segregates show combinations of typical emmer and vulgare characters, which indicates that the 7 unpaired chromosomes (which are irregularly distributed in meiosis) independently determine particular characters of the vulgare group.

Another interesting result, obtained by Mr. and Mrs. Sax,[2] is derived from a cross between *Ægilops cylindrica*, a grass found in Italy, the Balkans, and neighbouring countries, and Marquis wheat, one of the most productive varieties of *Triticum vulgare*. Ægilops, like the emmer wheats, is tetraploid, having 28 chromosomes. The $F_1$ hybrid with *T. vulgare* is pentaploid (35), but unlike the crosses between tetraploid and hexaploid wheats, there are only 6 or 7 bivalents in meiosis (instead of 14), the remaining 21 chromosomes remaining univalent or unpaired. Nevertheless, the tetrad divisions are run through with very few irregularities, some of the univalent chromosomes apparently dividing in the first meiotic division while others divide in the second. The $F_1$ hybrids are in general intermediate between the parents, and are almost but not completely sterile.

The authors point out that this species of Ægilops and another both contain all the characters which distinguish the vulgare from the emmer wheats; and they suggest that the hexaploid vulgare wheats may have arisen through a spontaneous cross between Ægilops and a tetraploid (emmer) wheat. Irregular distribution of the unpaired chromosomes, of which there would probably be 14, would occasionally

[1] Sax, Karl, and Gaines, E. F., 1924, "A Genetic and Cytological Study of certain Hybrids of Wheat Species," *Journ. Agric. Research*, 28: 1017-1032, pls. 2.

[2] Sax, K. and H. J., 1924, "Chromosome Behaviour in a Genus Cross," *Genetics*, 9: 454-464, pls. 2.

produce a gamete with 21 chromosomes. The union of two such gametes, if the chromosomes were balanced in qualities as well as in numbers, might have produced the first of the hexaploid wheats. Thus is crossing combined with chromosome aberrations made the basis for a theory of the origin of our cultivated wheats.

Contributions continue to be made to the study of size inheritance. The prevalent interpretation is that size in organisms and in their parts is controlled by cumulative polymeric size factors the various increments of which give the appearance of a continuous series. Much evidence is appearing in favour of this view. Sax [3] has recently, from experiments with beans, found evidence of linkage between certain seed-coat colour patterns and certain factors for size of seed. Cases have even been found in which a factor for large size was contributed by the small parent. Such a result might occur if the small parent contained a few factors for large in addition to a number which made for small size.

Closely related to size-inheritance are the problems of shape. The work with animals indicates that some size factors may affect the body as a whole while others independently determine the size of particular organs. These conceptions have already been applied by Davenport to man, and in a recent contribution [4] he considers the inheritance of body build. He recognises five classes of build, ranging from very slender to very fleshy. Two slender individuals usually have only slender children, while the progeny of fleshy individuals are much more variable. Such data lead again to the hypothesis of multiple factors, and it is believed that in some families so many as three genetic factors for increasing fleshiness are present. These factors are thought of as influencing size by the effect they have upon the activity of the thyroid, pituitary, and other endocrine glands.

Similar conceptions are being applied by Frets, Hildén, and others to the inheritance of head-shape. Thus it appears that several factors for broader head may change a dolichocephalic to a brachycephalic skull. Thus genetics is destined to have a fundamental effect upon the interpretations of anthropologists.

R. RUGGLES GATES.

## The Carbonisation of Coal.

THE Chemical Engineering Group of the Society of Chemical Industry met on July 16 at the forty-fourth annual meeting of the Society at Leeds. Three important papers on features of coal carbonisation were read before a crowded audience, and the discussion had to be adjourned to another session proposed to be held in Leeds in the autumn. Solid fuels were dealt with in two papers: "Smokeless Fuels—the Present and Future Possibilities," by C. H. Lander and Margaret Fishenden, and "Solid Smokeless Fuels," by E. C. Evans. In the former paper the British fuel situation was analysed, particularly with the view of estimating the possibility of establishing new carbonising industries. If all coal were to be pre-carbonised, the disposal of gas and tar would become considerable problems. If domestic fuel only were to be carbonised, this difficulty would be much less, but it was considered that a coke of much more suitable character than that currently produced in gas works would be required. The domestic fuel market is the most promising outlet for carbonised fuel of suitable character. It was concluded that the most suitable carbonisation process to meet this need cannot be defined with certainty. The solution of the problem may prove to be not in any single method of carbonisation but in several, each operating in circumstances most favourable to its requirements.

E. C. Evans gave a classification of smokeless fuels, directing attention to the properties of anthracite, for which there is a steady demand even to-day, in spite of its high price. This points a moral to those desirous of introducing carbonised domestic fuel. Gas coke he considered as far short of the ideal, particularly because of its high ash and moisture content. The reactivity of coke was treated at length, and the factors influencing it were analysed. Methods of low temperature carbonisation were discussed. In summing up, Evans thinks that low and high temperature systems are approaching one another, and that ultimately a compromise will establish itself. In the discussion it was significant that, in so representative an assembly of fuel technologists, no one could be found to assert confidently the commercial feasibility of existing methods of low temperature carbonisation which figures so prominently in the Press and on the platform.

F. S. Sinnatt and J. G. King brought forward a study of the tars and oils from coal. From an analysis of the economics of mineral oils and coal tars, they drew the conclusion that the prices obtainable for low temperature tars would, so far as present promise goes, be low and liable to great fluctuation. The calorific value of such tar is low, and the difficult miscibility with mineral fuel oil is a limitation. This is not necessarily fatal, for the Lessing process for separating the pitch-giving constituents, now under trial at the Fuel Research Station, shows considerable promise. Some account of these results was given. The limited knowledge of the chemistry of low temperature tar was emphasised, and it was suggested that organic chemists should take up the study of its properties. The production of liquid fuel from coal, either by hydrogenation of the coal or of the gasified product, was also discussed.

[3] Sax, K., 1924, "The Nature of Size Inheritance," Proc. Nat. Acad. Sci., 10: 224-227.

[4] Davenport, C. B., 1925, "Body-build: its Development and Inheritance," Eugenics Record Office, Bull. No. 24, pp. 42, figs. 25.

## University and Educational Intelligence.

"INFORMATION regarding courses and careers open to students of science" proposing to enter the Faculty of Science of the University College, Cardiff, is given in a little pamphlet issued this year for the first time by the College authorities. It follows the lines of the similar pamphlet issued by the University of Birmingham last year and represents a commendable anxiety on the part of the College to acquaint parents, guardians, and heads of schools with the opportunities it offers, so that the last year or two at school of those intending to go on to college may be utilised to the best advantage.

FROM the Royal Technical College, Glasgow, and the Merchant Venturers' Technical College, Bristol, we have received prospectuses for 1925–26. The former, which is the only institution in Great Britain providing regular courses in the technology of sugar manufacture, announces that to meet the requirements of the beet sugar industry, the lectures in this subject will begin in January and will extend over the summer session. Both Colleges give lists of the engineering firms which offer facilities to students for acquiring practical experience in their works. The Merchant Venturers' College offer, as alternative courses for the degree of B.Sc. in engineering, a

continuous 3-years' course, a 5-years' course of evening class work, and the Bristol sandwich system, which interposes practical training in a works for 14 months between the first and second sessions of academic work, for two summer months between the second and third sessions, and finishes with practical work for 14 months after the third session. Loughborough College, on the other hand, claims in its Calendar for 1925–26 to have found a better way of training by providing facilities for all necessary practical work in its own workshops, so that the theoretical work in the College may be made to keep step with the workshop training.

HONOURS courses in American universities and colleges are described by President Aydelotte of Swarthmore College, Pennsylvania, in a report recently published (Bulletin No. 52 of April 1925) by the National Research Council of America. So vigorous is the movement in the United States for liberalising higher education by the introduction of honours courses more or less like those open to students in English universities, that the number of institutions offering such honours work has doubled since the publication in January 1924 of the first edition of this report, when the number was about 46. The character of the movement is determined by the recognition of two principles which are regarded as the foundation of the success of the English honours system: the frank distinction between students who are really interested in the intellectual life and those who are not, and the recognition of the necessity of allowing the former more responsibility for working out their own intellectual salvation. President Aydelotte is careful to point out in concluding his report that "the system now being introduced need not mean any curtailment of the quality of teaching enjoyed by the average student. What our best students need is not coddling, not more attention, not more teaching, but only greater freedom and more severe requirements."

IN the report for the session 1923–24 of the Department of Coal Gas and Fuel Industries of the University of Leeds, the Livesey professor remarks that whilst the Department is developing satisfactorily so far as post-graduate work is concerned, the supply of students taking the normal three or four years' course of training in fuel, leading to a degree or diploma granted by the University, is inadequate to meet the demands of the fuel industries for trained fuel technologists. The University requires a steady supply of students, whose numbers may be depended upon from year to year, rather than any large increase in their number. Laboratory facilities at the disposal of the Department are at present inadequate to enable students of mechanical, civil, and electrical engineering to obtain desirable training in fuel technology and metallurgy. Through the generosity of Mr. Henry Woodall, and a number of gas companies and other industrial concerns, an experimental coal gas plant has been presented to the University, and has been employed in work carried out for the Gas Investigation Committee of the University and the Institution of Gas Engineers. Research work carried out in the Department relates to the influence of ash constituents in coal on the carbonisation process; the scaling of metals; the hardness of metals as affected by grain size; the transformation of quartz during the process of manufacture of silica bricks; metallic coatings resistant to oxidation at high temperatures; gas purification; the thermal expansion of metals and alloys and the changes occurring on heating clays, bauxites, etc.; the aeration of gas jets, and heat recovery by waste-heat boilers.

## Early Science at Oxford.

**August 26, 1684.** Dr. Plot, lately come from ye Royall Society, informes us, that in a meeting of that Society, on some day in this month, he saw a handkercheif, made of Salamanders Wool, or *Linum Asbesti*, shewn ye Royall Society by a merchant, who lately brought it from China. To try whether it was genuin, or no, it was put into a strong charcoal fire; in which not being injured, it was taken out, oiled, and put in again; ye oil being burnt off, the handkercheif was taken out again, and was altered onely in two respects; it lost two drachms and five grains of its weight, and was (as ye merchant affirmed) more brittle then ordinary; for which reason, it was not handled untill it was grown cold, by which time it had recovered its former tenacity, and in a great measure its weight.

The merchant, who oblidged ye Society with ye sight of so great a Rarity, acquainted them, that he received it from a Tartar, who told him, that the Tartars, among whom this sort of cloth is sold at £80 sterling for a China Ell, (which is less than our Ell,) use this cloth in burning ye bodyes (to preserve ye ashes) of great persons; and that in Tartary it is said to be made of ye root of a tree. The thread of it was (as ye Doctor affirms) very large.

He also acquainted us, that it haveing formerly been queried in ye Royal Society in London, whether ye Air contained in ye spirit within a thermometer, be not some cause of the ascent of that spirit in hot weather.

This quære was resolv'd by ye following experiment: a little Siphon was made to reach from ye top of the thermometer, to the receiver of Mr. Boyl's pump; ye air in the thermometer was drawn out, after which a warm hand being applyed to it ye spirit did *still* rise.

The observations of Mr. Bullialdus, Mr. Cassini, and Mr. Jacobs at Lisbon concerning ye last solar Eclipse, were presented our Society, and compared with those made here at Oxon:, and at Greenwich.

Mr. Boyle's booke of ye Porosity of Bodyes was communicated to our Society.

A Letter from Mr. Robert Spear to Dr. Wallis, dated from Port Royall in Jamaica, May 10, 1684, was read; it mention'd a Booke lately printed at Boston, in New England, entituled *An Essay for the Recording of Illustrious Providences*; in which, among other relations, there is an account of ye poles of some needles of Sea-compasses being burnd by thunder, and lightning, near New England; it is almost verbatim with the account of the same thing mention'd in ye Philosophical Transactions no: 157.

Dr. Plot shewed us some of ye *Risagone Ind:*, or Cassumminiar, a root found on ye mountains 24 gr: Lat: about Patmia near Bengal. Snow will not lye over it long; 'tis of very thin parts, bound up in an earthy matter; us'd in many disseases of ye head and nerves, and in dysenteryes; being ground to powder, and given in common water; a decoction of it is made in ye same manner as coffee.

The Doctor tells us, as he is inform'd by good hands, that Mr. Hugh Percy of Weymouth has enquired into ye nature of ye current at ye Streights mouth, by letting fall a bucket, and a weight with it, and that he found his bucket constantly carried outwards; it is to be wished that Mr. Percy be desired to give his own account of what he has done in this kind.

**September 2, 1684.** There being no great appearance of company, all business was deferred to some fuller meeting.

## Societies and Academies.

CALCUTTA.

**Asiatic Society of Bengal**, July 6.—Braja Lal **Mukherjee**: The Vrātyas and their sacrifices. Vrātyastoma is a social or religious penance for those who have in some manner or other defied or neglected religious law and order. Men originally belonging to the Vaidik community, but becoming alienated, and neglecting or defying Vaidik precepts, and creating disorder, were called Vrātyas.—Bimala Charan **Law**: Data from the Sumangalavilāsinī. An attempt has been made to present from the Sumangalavilāsinī (the commentary on the Dīgha Nikāya of the Sutta Piṭaka, written by Buddhaghosa), interesting materials for the study of ancient Indian life.

SYDNEY.

**Linnean Society of New South Wales**, May 27.—May M. **Williams**: Contribution to the cytology and phylogeny of the siphonaceous Algæ. (i.) The cytology of the gametangia of *Codium tomentosum*. In the nuclear divisions occurring in the cœnocytic threads of the vegetative parts of the plant, twenty univalent chromosomes are present. Reduction division occurs in the gametangium as the result of two nuclear divisions which occur there. Certain of the nuclei present in the young gametangium degenerate before these divisions occur. The selection of functional nuclei is associated with the presence of bodies of the nature of cœnocentra within the gametangium.—H. **Burrell**: Burrowing habits of Ornithorhynchus. A Platypus (usually the female), in excavating its burrow, will, if necessary, lie on its back to work. Its muscular and mobile movements are described, particularly with reference to the work of the hind feet, which have a "two-way" action, and are as versatile as those of a chimpanzee. The functions of the hind and front legs are interchangeable.—J. R. **Malloch**: Notes on Australian Diptera. No. vi.—G. D. **Osborne**: Geology and petrography of the Clarencetown-Paterson District. Part iv. The petrographical account of the Kuttung igneous rocks is divided into (*a*) a general discussion of such matters as the sequence of flows and their mutual relationships, and the presence of devitrification, of spherulitic structures, and in particular of evidence which has been interpreted as indicative of the operation in some rocks, after consolidation, of processes connected with the magmas from which these rocks were derived; (*b*) a petrographical description of the rocks, taken in groups.

**Royal Society of New South Wales**, July 1.—H. Leighton **Kesteven**: (1) A third contribution on the homologies of the parasphenoid, ectopterygoid, and pterygoid bones, and of the metapterygoid. (2) The parabasal canal and the nerve foramina and canals in the bird skull. The application of Gaupp's designation "parabasal" to the carotid canal and the demonstration of the course of the palatine branch of the facial nerve serve to emphasise resemblances to the reptilian conditions.—A. R. **Penfold**: Note on the identity of uncineol with eudesmol. Uncineol ($C_{10}H_{18}O$, $[a]_D$ 20° C. +36·99°; melting-point, 72·5° C.) is an alcohol which appears to bear a close resemblance to one of the terpineols, isolated in 1907 by Messrs. Baker and Smith from the essential oil of *Melaleuca uncinata*. The more recent investigation has shown this substance to be identical with the sesquiterpene alcohol eudesmol. The chemical and physical characters are: Melting-point, 80·5°-81° C.; boiling-point, 155-156° C. at 10 mm.; specific rotation, +33·45°; molecular weight determinations, 221 and 227; molecular formula (combustion results), $C_{15}H_{26}O$; melting-point of dihydrochloride, 75-76° C.—Sir George **Knibbs**: Multiple births, their characteristics and laws mathematically considered. Considering the question of masculinity of population generally, of live-births, and of the still-born, it is shown that the preponderance of males is most marked in the last, being about 21·9 per cent. greater than that of live-births. In Australia, as the masculinity of the general population decreases, that of the live-births increases. Applying the theory of probability to the occurrence of twins, about 76 per cent. of the cases are from two ova, and about 24 per cent. from one ovum. In the latter case the pair may be either both male or both female, and have a common chorion, while twins born from two ova are indifferently male and female, two males, or two females, and each has its separate chorion. Only about 10·9 per cent. of triplets are from three ova, while in 69·1 per cent. there is a division of one of the ova into two. There is an increase of the liability of twins with the age of the mother each year from 12 years to 39 years, when it diminishes, nearly by the same amount each year of age, until it becomes nothing at age 54. This greater liability with age to twins increases with the duration of marriage and with the number of previous confinements.

## Diary of Societies.

*WEDNESDAY*, AUGUST 26.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at Southampton), at 8.30 P.M.—Prof. H. Lamb: Presidential Address.

*THURSDAY*, AUGUST 27.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at Southampton), at 10 A.M.—Prof. W. A. Parks: The Cultural Aspects in Geology (Presidential Address to Section C).—Sir Archibald Denny: Fifty Years' Evolution in Naval Architecture and Marine Engineering (Presidential Address to Section G).—Prof. J. Spearman: Mental Law of Diminishing Returns (Presidential Address to Section J).—Prof. J. Lloyd Williams: The Phœophyceæ and their Problems (Presidential Address to Section K).—At 11.30 A.M.—A. R. Hinks: The Science and Art of Map-making (Presidential Address to Section E).—At 2.—Conference of Delegates of Corresponding Societies.—Address by Sir Daniel Hall, President of the Conference.—At 7.30.—Major A. G. Church: Science and the East African Commission (Citizens' Lecture).

*FRIDAY*, AUGUST 28.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at Southampton), at 10 A.M.—Dr. G. C. Simpson: The New Idea in Meteorology (Presidential Address to Section A).—C. Tate Regan: Organic Evolution: Facts and Theories (Presidential Address to Section D).—Dr. W. W. Vaughan: The Warp and the Woof in Education (Presidential Address to Section L).—At 11 A.M.—Miss Lynda Grier: The Meaning of Wages (Presidential Address to Section F).—At 11.30 A.M.—Dr. T. Ashby: Practical Engineering in Ancient Rome (Presidential Address to Section H).—At 2.30 (Section I).—J. E. Barnard: The Observation of the Infinitesimally Small (Lecture).—At 8 P.M.—A. V. Southwell: Aeronautical Problems of the Past and of the Future (Discourse).

*SATURDAY*, AUGUST 29.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at Southampton), at 3.—Dr. F. A. Dixey: Mimicry in relation to Geographical Distribution (Lecture for Young People).—At 8.—Prof. E. V. Appleton: The Rôle of the Atmosphere in Wireless Telegraphy (Citizens' Lecture).

*MONDAY*, AUGUST 31.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at Southampton), at 10 A.M.—Prof. C. H. Desch: The Chemistry of Solids (Presidential Address to Section B).—Prof. A. V. Hill: The Physiological Basis of Athletic Records (Presidential Address to Section I).—Dr. J. B. Orr: The Inorganic Elements in Animal Nutrition (Presidential Address to Section M).—At 3.—W. H. Barker: The Development of Southampton in relation to World Commerce (Lecture for Young People).—At 5 (Section K).—Dr. D. H. Scott: Some Points in the Geological History of Plants (Lecture).—At 8.—Capt. P. P. Eckersley: Some Technical Problems of Broadcasting (Citizens' Lecture).

*TUESDAY*, SEPTEMBER 1.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at Southampton), at 3.—Prof. W. J. Dakin: Whaling in the Southern Ocean (Lecture for Young People).—At 8.—C. J. P. Cave: The Highway of the Air (Citizens' Lecture).

*WEDNESDAY*, SEPTEMBER 2.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at Southampton).