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Remaining Possibilities of Water-borne Diseases.

THE greatest public health triumph of the last half-century has been the almost complete conquest over water-borne infections. In Great Britain the chief of these is enteric or typhoid fever; and the reduction of the death-rate from this disease in England and Wales from 332 per million of population in the average experience of 1871–80 to 25 per million in the average experience of 1921–25, shows that this disease is following typhus fever and becoming a disease of rare occurrence in the country. Although reduction of personal infection by better nursing and hospital treatment, the increased protection of foods which, like oysters, are eaten raw, and the help which bacteriology has given in securing prompt diagnosis of enteric disease in 'carriers' as well as in clinical cases of the disease, have all borne an important part in bringing about this remarkable result, the chief factor has been the protection of the public water supplies of Great Britain.

The substitution of supplies controlled by municipalities or by large commercial companies for smaller supplies inadequately protected has formed an important element in securing clean water. Although when accidental contamination occurs—as in the historical Maidstone and Worthing epidemics of enteric fever—the unification of water supplies for large communities may imply widespread disease, the standard of precautions has steadily improved, and the communal supply of water by a single authority in each area has been the chief means for protecting the communities concerned by means of safe drinking water.

A very large part of the total drinking water supplied in England is derived from rivers; and its protection necessarily implies serious difficulties. Of the two alternatives, that of keeping the water pure and that of purifying it after contamination so as to render it safe for drinking, the first is obviously preferable; but in most modern communities this is impracticable to the extent which would obviate the need for supplemental purification. In this connexion much interest attaches to the report of a deputation which waited on the Earl of Balfour (on behalf of the Prime Minister) on Feb. 15 last. This deputation represented the British Waterworks Association and the Salmon and Trout Association, and it urged on the Government the need for the creation of a national co-ordinating authority with powers to set up rivers- and watershed boards for all rivers in England and Wales.

This was urged in view of the risks to health of the increasing volume of river pollution, the threat to fish life, and the impairment of the beauty of the country caused by the increasing volume of pollution of our rivers. The facts are not in dispute. There is perhaps ample law to enable pollution of rivers to be controlled; but responsible authorities are inert, or fail to co-operate.

Lord Balfour's reply to the deputation took in part the form of most pertinent queries and showed the difficulties of the problem. Is the proposed central authority to have executive powers, and how are these to be related to those of existing authorities? Leaving administration for science, Lord Balfour pointed out that the essence of the problem consists in the purification of effluents before they are discharged into streams. It is evident that rivers inevitably must act both as sources of water supplies and as recipients both of domestic sewage and industrial waste products. The danger that domestic sewage will cause infectious diseases, and the effect of trade effluents on fish life, form two separate problems, of which the former can be much more easily controlled. As regards trade effluents, there must always be involved a balanced consideration of the expense of complete purification and of the loss implied—to fish life and to æsthetics—in neglecting it.

The deputation should, however, do good. Research has generally shown that purification of effluents is economical to the manufacturer as well as beneficial to the public; there is already in many instances adequate knowledge to secure purification; and the pressure of public opinion as well as the utilisation of existing powers is called for to secure the adoption of measures of purification now feasible.

London is the greatest example in the world of a public water supply derived chiefly from sewage-contaminated rivers, which for many years has been distributed daily to several million people without any serious outbreak of enteric fever or cholera attributable to it. This has occurred during a long series of years, in which chief dependence has been placed on sand filtration of the crude river water, and more recently on additional prolonged storage in large reservoirs; and it is a great tribute to the large London water companies in the later years of their experience, and to their still more efficient single successor, the Metropolitan Water Board, that this gigantic experiment on human beings has been so uniformly free from ill results. Under the guidance of Sir Alexander Houston the last-named Board has steadily increased the use of an additional safeguard, and now about 76 million gallons of Thames water are chlorinated daily. Since 1916 some 2 millions of people have daily drunk this water after filtration without detecting any difference in its taste. Without entering into detail, it is interesting to note the statement made by Sir Alexander in the twentieth annual report of the Metropolitan Water Board that, judged by bacteriological quality of the water supplied to London, "it would be safer to drink 1000 fluid ounces or fifty pints of some of the stored waters than one fluid ounce of the raw river water antecedent to storage."

The steadily favourable experience of the metropolis has some bearing on a report by Dr. Hancock just issued by the Ministry of Health on an outbreak of illness at Poplar suspected to be due to local pollution of the water supply. The illness in question was diarrhœa associated with fever, and between July 11 and 12, 114 cases occurred, and probably many more. Foods, including milk, were excluded, as the result of investigation on well-known lines, as possible causes of the outbreak, and suspicion turned to water as a possible vehicle of infection. The water in the implicated area gave unsatisfactory bacteriological results; and investigation showed that in the special area implicated in the "veritably devastating" local outbreak there existed a complex arrangement of water pipes, those of the local gas works being supplied in part from the River Lea, opposite the gas works, which in this locality is heavily polluted. It is possible that some of this contaminated water had by reflux got into the water mains of the district and thus caused a serious outbreak of illness. Actual proof that such inter-communication of pure and contaminated water had occurred could not be obtained; but the cross pipes have been disconnected, and the report has a high value in directing attention to the possible dangers attaching to such arrangements.

Some interest attaches to the bacteriological side of the investigation. No dysentery-like bacilli were identified and agglutinin tests were negative; but, as is pointed out by Dr. W. M. Scott in a supplementary report, a similar experience occurred recently in Hanover. In the Hanover experience a serious typhoid outbreak followed; fortunately this was escaped in Poplar.

The report should be studied by health officers and water engineers; and it reminds us once more that the price of immunity from water infection is uninterrupted vigilance both on the engineering and the chemical side of public health.

The Mechanism of Gaseous Reactions.

The Kinetics of Chemical Change in Gaseous Systems. By C. N. Hinshelwood. Pp. 204. (Oxford: Clarendon Press; London: Oxford University Press, 1926.) 12*s.* 6*d.* net.

MR. HINSHELWOOD'S book provides an opportunity for the general reader to make himself acquainted with a branch of chemistry which is developing rapidly at the present time, but of which the importance may not be appreciated by those who do not profess and call themselves physical chemists. These new developments may be summed up in the term 'activation.'

This conception has been introduced in order to account for the slowness of chemical change, and in particular for the fact that molecules which are capable of dissociating or of undergoing isomeric change do not do so all at the same time, and immediately, giving rise to instantaneous reactions. This delay can sometimes be traced to the fact that the action is conditioned by association with some foreign substance, *e.g.* moisture, and that the molecules which wish to undergo change have, as it were, to form a queue and take their turn in receiving the necessary dispensation from the appropriate official; but since even the wettest and dirtiest materials do not change instantaneously, there must be some condition of 'activation' within the molecule itself which is a necessary precedent to chemical change. An exception to this rule is found in ionic double decompositions, where the ions behave as if they were already activated, and therefore interact as fast as they can come into contact with one another. It is therefore an attractive proposition to associate reactivity with a condition analogous to ionisation, and for this view there is considerable justification in the case of actions which take place in liquid media. But in the case of gaseous reactions, at least, it is probably more to the point to think of activation in terms of energy, and to regard an activated molecule as one which contains a larger supply of energy than its inactive neighbours, since, when once this reserve of energy is created, it can be drawn upon to overcome whatever obstacles may be found to impede the progress of chemical change.

Physical chemists claim, however, not only to know of the existence of this process of activation, but also to be able to give a numerical estimate of the degree of excitement which precedes chemical changes of the most diverse character. The most familiar method is to deduce a value for the heat of activation from the effect of temperature on the velocity of the reaction. The relationship which Arrhenius used for this purpose is expressed by the formula,

$$d \log k/dT = A/RT^2,$$

where A is the 'heat of activation' and k is the velocity coefficient at temperature $T°$ abs. This is almost identical with Van 't Hoff's formula,

$$d \log K/dT = Q/RT^2,$$

whereby the heat of a reversible reaction Q can be deduced from the variation of the equilibrium-constant K with temperature; but whereas Van 't Hoff's formula depends on strict thermodynamical reasoning, and can be tested by direct experiment, Arrhenius's formula is necessarily of a more speculative character, since the hypothetical heats of activation to which it leads cannot be measured by any direct process.

The validity of the formula finds some support, however, in the fact that a very accurate linear relationship is revealed in a large number of cases when $\log k$ is plotted against $1/T$. When this relation holds good, as in the decomposition of hydrogen iodide into hydrogen and iodine, or the thermal decomposition of ammonia in contact with a tungsten filament, one is tempted to believe that the 'heat of activation' deduced from it may perhaps represent a real physical property. A similar statement can be made in reference to those cases in which this method of plotting gives rise to two straight lines with a rounded intersection. This characteristic is observed in the union of hydrogen and sulphur, which Norrish and Rideal formulate as depending, in the lower ranges of temperature, mainly on an interaction at the surface of liquid sulphur, and, at higher temperatures, mainly on an interaction in the gaseous phase.

The chief interest of Mr. Hinshelwood's book is to be found in his description of a second method for determining the energy of activation. This is limited to gaseous reactions, but has a much stronger theoretical basis than the somewhat speculative relationship of Arrhenius. It depends on calculating, by means of the kinetic theory of gases, the number of collisions which take place in unit time between the molecules of a gas, and then comparing this with the actual number of molecules which undergo chemical change in the same unit of time. This calculation shows that in a number of typical bimolecular reactions only a minute fraction of the total number of collisions is effective in producing chemical change. The next step is to calculate from the probability law

what excess of energy the reactive molecules must be supposed to contain in order that it may be possessed only by this minute fraction of the total number of molecules. The excess of energy thus postulated is taken as the heat of activation of the bimolecular reaction.

The data for the decomposition of hydrogen iodide provide a coincidence between the values calculated in this way and those deduced from Arrhenius's formula, which can only be accidental, since it is obviously far more exact than the experimental methods on which it is based. In this case the two values for the energy of activation are 43,900 and 44,000 cal., and the calculated velocity coefficient, $3{\cdot}5 \times 10^{-7}$ at 556° abs., is therefore practically identical with the observed coefficient, $3{\cdot}52 \times 10^{-7}$. A more typical case is that of the union of hydrogen and iodine, where the calculated velocity constant at 700° is 0·14, whilst the experimental value is 0·064. This is claimed as "a very good agreement" in view of the fact that, since the two methods of deducing the energy of activation are entirely independent, the calculated velocity coefficient might very well be 10,000 times larger or smaller than the experimental value if the theory now put forward were incorrect.

The method described above is particularly applicable to the study of bimolecular actions, which obviously depend in the first instance upon collisions taking place between appropriate pairs of molecules. In several of these cases it has been established clearly that the majority of the collisions are ineffective and result only in the rebound of unchanged molecules from one another; moreover, a quantitative interpretation of the phenomena can be given by supposing that the effective collisions are those which take place between molecules possessing a high energy content. The general reader may, however, be surprised to learn that when two atoms of bromine meet, the collision is ineffective in 999 cases out of 1000. It is difficult to admit that the two free atoms are insufficiently energised to combine, although this conclusion is not completely excluded; but the quantum theory allows us to suppose that in many cases the fundamental difficulty is to get rid of the energy which the atoms already possess, and it is clear that a molecule from which this energy had not yet been dissipated would be liable to break up again on the slightest provocation.

The study of unimolecular reactions is much more difficult, since, if only a single molecule is really involved in the change, there is at first sight no obvious reason why the change should depend on collisions at all. It is not surprising, therefore, that there has been an energetic controversy proceeding for several years as to the mechanism of the action. Mr. Hinshelwood defines a unimolecular action as one in which the proportion of molecules undergoing change in a given time is independent of the pressure. Perrin has assumed that this law still holds good at infinite dilution, and that isolated molecules in interstellar space would have the same average life as in a closed vessel. Since this life depends on the temperature, but by hypothesis is independent of collisions with other molecules, as well as of the unknown velocity of the molecules in absolute space, Perrin and Lewis have postulated that the chemical change is due to radiation, and that its velocity is dependent on the 'radiation-density' in the space which contains the gas. This hypothesis leads to such wildly impossible conclusions (as, for example, that an aqueous solution of a sugar should be hydrolysed with explosive velocity when exposed to the dazzling light of a tallow candle) that its survival in any form is a thing to be marvelled at.

In order to avoid these grotesque conclusions, Lindemann has recently put forward an alternative theory, in which collisions play an essential part, and give rise to a definite proportion of activated molecules. The velocity of reaction must then fall off at extreme dilution, but calculation has shown, in the particular case of nitrogen peroxide (see below), that even when the pressure is reduced to 0·01 mm., the number of collisions is still far greater than the minimum number required to activate the molecules which undergo chemical change under these conditions; it is therefore impossible to make a direct test of the two alternative views at present. Mr. Hinshelwood has, however, recently described two thermal decompositions, taking place at much higher temperatures, in which a 'unimolecular' action is retarded on reducing the pressure, in accordance with Lindemann's postulates.

Most of the work on unimolecular actions has been built upon imaginary cases. Thus, when Perrin and Lewis put forward their explanation of these actions, no single case was known which has survived later criticism, since all the examples that were then cited have been proved to take place at the surface of the containing vessel and not in the interior of the gas. After much searching, the solitary case of the decomposition of nitrogen pentoxide

$$N_2O_5 \longrightarrow 2NO_2 + O$$

has emerged, as being independent of the area of the surface of the vessel, and of the pressure of the gas down to 0·01 mm.; and Mr. Hinshelwood himself has recently added to this exiguous list the thermal decomposition of acetone

$$(CH_3)_2CO \rightarrow CO + 2CH_3 \ (?),$$

and of the isomeric propionaldehyde; but these are queer reactions which cannot yet be represented by chemical equations, since the nature of the products is unknown, although they are obviously complex.

In all these discussions the eminent president of the Chemical Society stands in the background in the unpleasant rôle of the spectre at the feast, since, if it be true that chemical change in simple systems generally (and perhaps always) depends upon the presence of moisture, what are we to think of speculations in which so essential a factor is ignored? The quantities of moisture that are involved are now becoming known in certain cases, and they correspond very well with those required to produce a unimolecular film on the surface of the containing vessels. Norrish has therefore put forward the bold but fascinating hypothesis that, in the particular case of hydrogen and chlorine, the formation of a water-film on the surface of the vessel is a necessary precedent to the occurrence of chemical change in the interior of the gas. This hypothesis may not be true, but it has at least the merit of assigning a plausible rôle to the water in changes in which it plays a vital part, as well as to the various agents, such as ammonia, by which its action may be inhibited. In the cases now under consideration, it is claimed that "the observed rates of reaction are constant and reproducible, whether the gases have been dried carefully or not," and that "in no homogeneous reaction which proceeds with measurable and reproducible velocity has the inhibition by drying been demonstrated" (p. 103); but the outside observer, remembering the difficulties that have been experienced in the past by those who have tried merely to repeat the published work of H. B. Baker, will probably remain unconvinced by statements of this kind, until Baker himself has announced that he has tried to arrest these reactions and failed.

Termolecular reactions are almost as rare as genuinely unimolecular reactions, since many of those which are represented conventionally as an interaction of three molecules, either proceed in two successive stages or take place at the surface instead of in the interior of the interacting gases. Up to the present three such cases have survived criticism, namely:

$$2NO + Cl_2 = 2NOCl,$$
$$2NO + Br_2 = 2NOBr,$$
$$2NO + O_2 = N_2O_4.$$

The most remarkable feature of the last action is that it has a negative temperature coefficient, the interaction at 662° abs. being three times slower than at 273° abs. This is accounted for by the fact that "owing to the increasing molecular speeds there is less and less chance, at great temperatures, that two molecules shall still be within range of each other when a third one approaches. It is to be noted that the velocity of reaction falls off only very slowly, so that the diminishing frequency can account for the retrogression without undue strain" (p. 111).

About one-third of the book is occupied with a description of heterogeneous reactions, but these are less uniquely the province of the author, and it will therefore suffice to say that all the main problems of the effects of adsorption, of molecular orientation, and of the texture of the catalytically active surface are discussed in a clear and satisfactory manner. In conclusion, it should be added that whilst the whole book has a definite mathematical basis, it can be read with profit by those whose ignorance of mathematics, or lack of interest in the details of mathematical processes, compel them to practice the gentle art of skipping. The book has, in fact, been written by a chemist for the benefit of other chemists, and the author's mathematical deductions are treated throughout as a means to an end and not as a final goal.

The Theory of Perception.

An Introduction to the Theory of Perception. By Sir John Herbert Parsons. (The Cambridge Physiological Library.) Pp. viii + 254. (Cambridge: At the University Press, 1927.) 18*s.* net.

THE continuity of race of the present fauna of the earth is due to many different factors. In the case of what we call the higher animals—slow-breeding, exposed to the attack of many sorts of enemies, in some cases subsisting on many forms of prey—accurate choice of reaction in each of a multitude of different circumstances has been, and is, a prime factor in the maintenance of race. Even where the choice of reaction may be limited, as between attack, flight, and no action at all, the determination of choice may be complicated; for the numbers of objects to which the choice is to be applied may be almost infinite.

While the primary reactions (such as those mentioned above) may be classified with comparative simplicity, each individual reaction has to be modified in countless ways in accord with the variety of the object. Such ways may be briefly indicated by the expressions 'mode of attack' and 'direction of flight.' In man, the biological value of team-work has been given effect to by a great development of the mechanism of spoken-speech and heard-speech; and man probably alone of all animals is able to convey to a comrade an accurate description of the objects and changes which he observes in his immediate or distant surroundings. His behaviour, both as an individual and as a member of a team, depends, as do the reactions of other animals, upon the distinguishing of differences in the surrounding environment.

Sir John Herbert Parsons compresses into scarcely 250 pages a wealth of information with regard to the perception of phenomena. To him, as to Lloyd Morgan, the progress of evolution from the more simple to the more complex is accompanied at various points by the 'creation' of new developments. It is a creed of emergent evolution, which he uses as a scientific method. In its light, the property of water is an emergent which could not have been foretold from the properties of the hydrogen and oxygen which combine to form it. There are many levels of emergence, and many sub-levels, within the main line. 'Effective consciousness'—that which enables the animal to guide its actions in the light of previous experience and to exercise choice—is one such emergent.

Consciousness involves a subject and an object. The object is a sensory presentation. The sensory presentation is brought about by stimulation of receptor end-organs, and the conscious subject is aware of this stimulation. The author supposes that the simplest form of consciousness is a mere sentiency—an awareness tinged with affective tone, with a minimum of cognition, and possessing a primitive meaning, and that the subject responds with an appropriate motor reaction—"consciousness on the reflex plane." By further differentiation and integration 'awareness' leads to 'interest'; 'affective tone' emerges in 'emotion'—"consciousness on the plane of instinct." Yet further differentiations and integrations by means of memory and association give the emergence of higher ideation and conceptual consciousness—"consciousness on the plane of intelligence." At every level the object of a sensory presentation has to pass through the entry enforced by the receptor organ, and differentiation of receptors—and of the whole receptor mechanism—plays a chief part in analysing the properties of the object. A consideration of data from many sources—general morphology, animal psychology, morphology of the peripheral and central nervous systems, the physiology of reflex phenomena, and observation in man—leads the author to maintain the following thesis:

Primitive sentiency is essentially tactile. At higher levels response to radiations emerges and specific receptor organs of many varieties evolve. Parallel with this evolution there is an evolution in the complexity of the central nervous system—with the development and dominance of the segments at the anterior end of the axially arranged animal, and the elaboration there of central ganglia for the distance receptors so clearly emphasised by Sir Charles Sherrington. An evolution in perception and in consciousness parallels these morphological evolutions. On the physiological side, reflex action emerges from less differentiated response; and it is inferred that the afferent impulse arouses a vague sentience analysable into two parts—into the germ of affective state and into the germ of cognitive state. The instinctive plane is an emergent from the reflex plane. There is a concomitant complexity of conscious experience, an integration without complete synthesis. Before the instinctive act occurs there is an unfocussed affective state—'coenæsthesis'—which acts as a background, and is derived from all the receptors then in activity. Upon this background emotion impinges "like a splash of vivid colour." The more discriminative reactions of the higher vertebrates are emergent from this instinctive level.

In consonance with Sir Charles Sherrington's use of the term 'receptor,' the author suggests 'reception' and 'recept' for the act of sensing and the object sensed. Perception consists for him in the integration of recepts. Differentiation, segregation, and integration result in the emergence of a perception, which is not a mere summation of sensations. The latter "have been integrated into patterns, in which the whole is greater than the sum of its parts; something new has emerged in consciousness." The recept is more differentiated the higher we go in the scale of evolution and concomitantly with the differentiation of receptors. At the primitive level it is dyscritic—having little differentiation and little discrimination. The constellation of recepts there merely gives a change in potential in the primitive stream of consciousness. The affective tone becomes more

pleasant or more unpleasant, and the motor response is correspondingly a mass reaction. In a higher level of evolution, the epicritic stage, differentiation of recepts is made possible by differentiation of receptor mechanisms. The recepts form a perceptual pattern of such a differentiation that the diverse sensations are discriminated. Awareness is focussed upon the features of the pattern and becomes attention. At still higher levels, the syncritic stage, epicritic phenomena are integrated by the cortex cerebri; attention becomes interest and 'meaning' emerges in the perceptual pattern. The primitive dyscritic mass reaction becomes correspondingly differentiated. The perceptual pattern, at first "a buzzing, blooming confusion" accompanied by an awareness, becomes differentiated as the scale is ascended; its higher development is due to a double process—on one hand of differentiation and reintegration, on the other hand of sensitisation from higher levels which have evolved contemporaneously. In the higher stages the perceptual pattern comes more under the control of higher nervous centres. One or other modality of sensation becomes prepotent, the prepotent modalities being those of the distance receptors—smell, sight, hearing. But throughout there persists a dual mechanism in sensation, the dyscritic and the epicritic both persisting.

Such a brief account of the author's 'background' can give no indication of the wealth of vivid evidence from many fields which it serves, or of the facility of his presentation. Excellent and valuable accounts are given of the comparative anatomy of the central nervous system, of cutaneous sensation, of the dyscritic motor response, posture and attitude, of perception of space and of perception of movement. But the book will be valued not least for the author's description, in the chapters on vision, of the distance receptor which he has made his own more particular field; for, as Sir Herbert Parsons says, vision is the preponderant modality in man, and has undergone in him the greatest differentiation. T. GRAHAM BROWN.

Siberian Bronze Age Cultures.

Bronzezeit am Jenissei: ein Beitrag zur Urgeschichte Sibiriens. Von Gero v. Merhart. Pp. 190 + 12 Tafeln. (Wien: Anton Schroll und Co., 1926.) 12*s*.

A BRIEF but very interesting account of the Bronze Age cultures of the Minussinsk area, and a review of the literature on the subject, is given in the work under notice; the author has also some rather revolutionary ideas to put forward. The region is one of peculiar interest, lying as it does far up the Yenisei valley and forming an island of steppe country cut off on three sides from intercourse with the rest of the prehistoric world, for to the south lie mountains and to the east and west were formerly forest lands. To the north, however, lay a natural east-west passage-way formed by the more or less connecting river systems of the Obi, Ket and Angara leading to Lake Baikal. The author stresses the contention that the early Bronze cultures of the district owe nothing directly to the west, *i.e.* to the Bronze cultures of the Ural mountains, though both may originally have had a common source. He believes that it was not until very late that any western connexion was established, and that similarities in the two cultures can then be explained by a parallel reception of Scythian influences.

To the reader it is not quite clear from exactly where the author would like to derive the people whose industries he is describing. South, east, and west being blocked, as already described, they must have arrived as a back-wash from the north, following the Yenisei southwards, but where they originally came from seems uncertain. Having settled, however, in this blind-alley district, it would appear that a slow development took place which was at first little influenced from outside owing to the peculiar geographical position of the area. A very late chronology is adopted; in fact round about 600 B.C. is given as a mean date for the full Bronze culture here.

The chapters devoted to a description of the finds themselves are very interesting, and the illustrations quite adequate. An earlier and a later type of grave (called respectively 'corner stone' and 'collective' graves) are described, from which it would appear that an outside influence must have penetrated the region, but not a new race, as many of the old characteristics continue in the new graves. Finds unconnected with burials are also discussed. Of these the Krasnojarsk celt is the most important, and its distribution problems are very complex. Several chapters are devoted to typological study and decoration motifs.

The only regret one has when putting this book down is that the author has kept so rigidly to the period under review. One would like to have known what he thinks existed before the first culture with which he is concerned. Again, there are rock engravings not so far off from his region, some of which are probably of late date, but others

may be very early indeed. A brief mention of them would have been welcome.

The book is very interesting, deals with a little-known but important area, and the author is to be congratulated upon having tackled his subject in a systematic and scientific manner.

M. C. BURKITT.

Our Bookshelf.

The Whitworth Book. Prepared by the Whitworth Society (an Association of Whitworth Scholars, Exhibitioners, and Prizemen). Honorary Editor, Prof. David Allan Low. Pp. vii + 316. (London: Longmans, Green and Co., Ltd., 1926.) 10*s.* 6*d.* net.

THE career of Sir Joseph Whitworth, one of the greatest engineers of his time, is especially interesting, since he was the first man to grapple successfully with the problem of obtaining precision of workmanship and the standardisation of screw threads.

It is difficult to realise now that, when he began work rather more than one hundred years ago, it was exceptional to find men able to make parts of machines to an accuracy of one thirty-second of an inch. His epoch-making discovery of a method of making a true plane by a process of scraping and comparing three plates together made it at once possible for engineers to produce work of the utmost precision. This was followed by the manufacture of very accurate screws and the construction of workshop machines to measure lengths to one ten-thousandth of an inch. Indeed, Whitworth was successful in constructing a machine capable of detecting a difference of one millionth of an inch. His surface plates, gauges, and measuring machines soon became established in all engineering workshops and revolutionised their practice, while his machine tools were admittedly unsurpassed.

Although others had attempted the standardisation of screw threads, no one had been able to effect this until Whitworth took the matter in hand and, by adopting the best features of existing systems, brought about an agreement which has received world-wide recognition. In his later years Whitworth was equally successful in improving the manufacture of rifles, large calibre guns, and fluid-compressed steel.

Whitworth's practical mind also realised the necessity to the engineering industry of a continuous supply of young engineers who, in addition to workshop experience, were thoroughly conversant with applied science. Having acquired a large fortune in his manufacturing career, he was able to put his ideas into practice by setting aside £3000 a year for scholarships, and at his death £100,000 was handed over to the State to carry on the scheme associated with his name.

The Whitworth Book is the "Who's Who" of about one thousand Whitworth Scholars appointed under this munificent scheme. Its pages show how vast an effect this scheme has had on modern engineering in every direction of activity. Probably no engineering work of this great man has been more successful than this final one. The Whitworth Society, and especially the honorary editor, are to be congratulated on having produced a very interesting work of permanent value.

E. G. C.

History of the Sciences in Greco-Roman Antiquity. By Prof. Arnold Reymond. Translated by Ruth Gheury de Bray. Pp. x + 245. (London: Methuen and Co., Ltd., 1927.) 7*s.* 6*d.* net.

PROF. REYMOND begins his volume—the outcome of lectures before both science and arts students at Neuchâtel—by outlining the scientific attainments of the Egyptians and Chaldeans prior to the epoch with which he is mainly concerned. He divides the rest of the book into two parts.

Part I. gives a historical and biographical survey of the development of the sciences during the Hellenic (650–300 B.C.), Alexandrian (300 B.C.–A.D. 100), and Roman (A.D. 100–600) periods. Part II. deals with the principles and methods, and traces the development and characteristics of Greek mathematics and mechanics. The works of Euclid and Archimedes are ably discussed, especially from the point of view of their indebtedness to predecessors.

Whilst these sciences were well developed, others remained almost neglected. Chemical knowledge was practically confined to the preparation of a few salts, extraction of minerals, mixing of paints and concocting drugs. Medicine and surgery were, however, systematically practised and reached a high degree of perfection, as indicated by the comprehensive set of instruments discovered at Pompeii. Aristotle had established a scientific basis for natural history, introducing a classification founded largely on his own observations. His pupil, Theophrastus, catalogued more than 500 plants.

It may be noted how Greek science, first centred at Athens, finally flourished on the periphery of the Hellenic world, especially under the Ptolemies at Alexandria.

Prof. Reymond has dealt with every phase of the teachings of the different schools of the sciences in Greco-Roman antiquity, and students of the history of science will be grateful for this translation of his work.

J. G. F. DRUCE.

Citrus Growing in South Africa. By R. A. Davis. Pp. 309. (Cape Town and Johannesburg: The Specialty Press of South Africa, Ltd.; London: L. Reeve and Co., Ltd.) 25*s.* net.

THIS work begins with a brief foreword by the author, in the course of which he suggests that the time appears to be favourable for the publication of such information as the book contains, because, he avers, "Citrus and, especially, Orange growing is 'booming,' and there are many thousands of new-comers to South Africa who are bent on Citrus culture as a means of livelihood." The introduction of citrus fruits into South Africa is

dealt with in Chap. i. It seems somewhat indefinite as to when they were first introduced; but oranges, lemons, and citrons are known to have existed so early as 1662, in the garden of the founder (Van Riebeek) of the first Dutch Colony, Cape of Good Hope, in 1652. The 'bitter Seville orange' and the ordinary 'rough lemon' have run wild in parts; both are used for stocks for grafting purposes, the 'rough lemon' (called 'Mazoe lemon'—the banks of the Mazoe River being in places lined with the trees) is described in Chap. v. on "Stocks for the Orange" as being the most widely used stock in South Africa.

As an industry, citrus cultivation, from comparatively small beginnings, dates from about 1907, until at the present time the productive area in the Union is estimated to cover about 25,000 acres, the exports including grape-fruit, *naartjes* (mandarin and tangerine oranges), and lemons.

Throughout the course of the whole twenty-six chapters the author has given a very complete record of the progress of production, based on scientific principles in developing the best varieties, the best methods of grading and packing of the fruit for export, and advice in the treatment of fungus diseases and insect pests. J. H. H.

Byways of the Tropic Seas: Wanderings among the Solomons and in the Malay Archipelago. By Hermann Norden. Pp. 250+30 plates. (London: H. F. and G. Witherby, 1926.) 16*s*. net.

MR. HERMAN NORDEN, already well known as the author of several books of travel, here records his impressions of a voyage to the Solomon Islands and thence to the island of Bali, that fascinating dependency of Java. Of the Solomon Islands he has nothing to say that is of moment to either the geographer or the anthropologist. His story depends for its interest upon his lively sketches of the sailors, traders, and natives whom he met. He gives a vivid enough picture of their life and the experiences which are likely to befall any one who makes a voyage among the islands in a small trading vessel. His account of Bali and its people, though somewhat superficial and new only in an impressionistic sense rather than as a record of fact, covers ground less known than the Solomons and will repay perusal by those who have neither the time nor the opportunity to read more serious treatises on the very distinctive culture of the island.

Mr. Norden was fortunate enough to see some of the principal ceremonials in the life of the Balinese, and describes the rites of their peculiarly modified form of Buddhism, including the *mudras*—the ceremonial gestures which have been carefully described in detail in a graphic style by Miss de Kleen—their cremations, their dances, their shadow puppet plays, and other features of their culture. Unfortunately, on the occasions when Mr. Norden ventures outside what he has actually seen, his statements are seldom free from error in anthropological matters. It surprises to find Polynesian and Melanesian alike described as "Aryan."

The Bryant and May Museum of Fire-Making Appliances: Catalogue of the Exhibits. Compiled, with an Introduction and Notes, by Miller Christy. Pp. viii+192+33 plates. (London: Bryant and May, Ltd.; Simpkin, Marshall and Co., Ltd., 1926.) 5*s*. net.

AN addition of a novel character to the museums of Great Britain has been made recently in the form of one devoted entirely to fire-making appliances. Fire making is of vital human interest, and here we see the many methods that have been used in past ages and in different climes. Messrs. Bryant and May's collection at their Fairfield Works, Bow, in the main is that formed by Mr. Edward Bidwell during a period of half a century. Perhaps this should have become a national possession, but within the last year it passed into the keeping of the firm, who have housed it admirably. Considerable additions have been made, and it includes every known method of fire making. It is, indeed, so comprehensive that it is difficult to conceive that it can ever be rivalled. The objects are classified under tinder; wood-friction methods; flint-and-pyrites methods; flint-and-steel methods; quartzite-and-iron methods; optical methods; compression methods; chemical methods; and finally the friction match. Of the exhibits, about half represent the flint-and-steel and friction-match methods. The museum is not open to the public indiscriminately, but is accessible to the student, societies, etc., without charge, during week-day afternoons or Saturday mornings, on application to the firm.

A Laboratory Book of Elementary Organic Chemistry. By Prof. A. Lowy and W. E. Baldwin. Pp. ix+182. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1926.) 15*s*. net.

THERE are several novel features about this laboratory manual. Two illustrations form the frontispiece, of which one depicts an alchemist at work, the other a research laboratory at the Mellon Institute, Pittsburg. Instructions to the student are freely illustrated, not only by line-drawings or pictures of apparatus, but also by sketches of industrial plant. The latter are most effective, helping as they do to correlate laboratory experiments with actual practice. The course of work is that adopted at the University of Pittsburg, and an essential part of the scheme consists in writing out a report on each experiment in the form of answers to questions upon perforated sheets, which can be detached when completed and handed to the demonstrator. Afterwards they can be gummed into place again, so that the student may eventually possess a well-illustrated and bound record of his work. Directions are given for the preparation and investigation of a number of fairly simple organic substances, but in the section on carbohydrates, prominence is given to the investigation of cellulose and to the preparation of viscose. Two pages are devoted to the application of dyestuffs, and a few of the more important reactions of heterocyclic compounds and of alkaloids are appended.

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.*]

Bands in the Absorption Spectrum of Mercury.

IN a paper just published in the Royal Society's *Proceedings* for May, it is shown that excited mercury vapour from a low-current discharge gives, in addition to the better-known feature of the mercury band spectrum, a series of bands which were observed from λ3055 to λ2697. I find that these bands converge to a point very near the resonance line 2537.

I have now obtained bands of the same system in absorption by a long column of the vapour of boiling mercury, which shows that they involve transitions to or from the unexcited electronic state. These bands are allied to, but not identical with, the emission bands, and converge towards a point in the spectrum somewhat more refrangible than the resonance line λ2537. I have obtained about fifty of them. They are seen to best advantage on the border of the region of intense absorption which starts from the resonance line and extends towards the red. As the density of mercury vapour is increased, the region of intense absorption extends farther towards the red, and a part of the band system mentioned is blotted out by the intense general absorption. At the same time the increased quantity of mercury allows them to be traced farther towards the red, and the distinctness is improved. This is very like the behaviour of ozone in the absorption at the limit of the solar spectrum, and also in laboratory experiments, as traced in 1917 by Prof. Fowler and myself.

The mercury bands have not yet been satisfactorily analysed for classification by the quantum theory. There are certain suggestive differences in detail between the emission and the absorption bands. The spacing of these bands is of the order of 10 Ångströms.

In addition to this new system in the absorption spectrum of mercury, it is already known that there are diffuse absorption bands at λλ2345, 2338, 2334 and 2339, thus with a spacing of the order of 5 Ångströms. Closer examination of these has now shown that superposed upon this structure there is a much finer one, of the order of 1 Ångström. This occurs in and between the conspicuous bands named, and extends beyond them as far as λ2300 and possibly farther. The spacing becomes closer, and with the instrument at present available I have not been able to resolve the structure any further. In the paper cited I have shown the intimate connexion in *emission* between this part of the band spectrum and the 'forbidden' line λ2270. Neither this nor the other forbidden line at λ2656 can be detected in absorption.

The mercury absorption spectrum has often been examined before by experienced observers, and it may cause surprise that the features above described have not been noticed. It is due, I think, partly to insufficient length and density of mercury vapour, and partly to the use of an unsuitable bright source for observing the absorption. Bright lines in the source are very baffling.

It is hoped to examine exhaustively these and the remaining portions of the mercury band spectrum with adequate resolving power.

RAYLEIGH.

69 Cadogan Square, S.W.1,
May 16.

Modified Scattered X-Radiation due to Super-Position.

MAY I place on record what is, I think, the most direct evidence that the modified scattered radiation is due to the super-position of unmodified scattered radiations? When using a certain primary X-radiation, the scattered radiation from air was found to be totally unmodified radiation, *i.e.* a radiation with accurately the same absorbability as the primary radiation exciting it. The radiation scattered from paper or paraffin-wax was very definitely a modified scattered radiation, or contained a modified radiation, *i.e.* differed considerably in absorbability from the primary radiation. Also these two radiations scattered from paper and from paraffin-wax were equally modified—within a small possible error.

Such results have frequently been obtained in this laboratory. As previously recorded, we have even obtained modified scattered radiation from thick sheets of scattering material, when the radiation from thin sheets was an unmodified radiation as tested by absorption measurements.

In our recent experiments, however, we made a systematic examination of the radiation scattered from various thicknesses of scattering substance. It was found that with a certain primary radiation, when the sheet of paper or paraffin-wax was made gradually thinner, the difference between the primary and scattered radiations became smaller, and ultimately almost vanished, indicating very definitely a vanishing difference for an infinitely thin layer of scattering material.

The possibility of this effect being due in some way to a mere variation of the intensity of ionisation is quite ruled out of consideration by the facts that:

(1) A large variation of output of the Coolidge tube was entirely without influence on the measured difference between primary and secondary radiations, and that

(2) Equal degrees of modification of the rays scattered from paper and from paraffin-wax were produced by scattered radiations of quite different intensity. Thus the slab of paraffin-wax used as scattering substance had to be seven or eight times as massive as the slab of paper in order to produce an equal degree of modification in the scattered radiation as measured by absorbability. Under such corresponding conditions, the intensity of the scattered radiation from paraffin was, roughly, seven times the intensity from the paper.

Plotting the change of absorbability on scattering against mass per unit area of the scattering sheet, we obtained curves of form precisely like the familiar ionisation-pressure curves showing saturation current. In our experiments what was shown was a saturation amount of modification by scattering from thicker layers of scattering material. The maximum amount of modification was shown much earlier for a paper than for a paraffin-wax scatterer, but the two measures of modification were finally equal. Other experiments on this phenomenon—for it of course raises many questions—will be described elsewhere.

It should, however, be added that all X-radiations are not equally sensitive to a change in the amount of scattering substance. The scattering radiation was evidently near the critical condition for a change of its level of activity such as we have described in papers on the *J*-phenomenon. It afterwards settled down to a state in which thick sheets, thin sheets, and even air itself all produced a scattered radiation showing the full amount of modification such as had previously only been given by thick sheets. It is, of course, possible—indeed I think probable—that it was then

necessary only to experiment upon much thinner layers still, in order to obtain the vanishing amount of modification by scattering. This, however, was beyond the range of experiment.

What we have shown is that by experimenting on a suitable radiation, a perfectly regular development of the modified scattered radiation can be traced to the superposition of unmodified radiation from thin layers. This further illustrates what we have previously described as the coherence of superposed X-radiations. Neither quanta nor wave-trains within narrow limits of wave-length can be considered independent in their action; it is the whole stream of radiation which is effective.

C. G. BARKLA.

University of Edinburgh.

Philosophical Foundations of Quantum Theory.

IN his very lucid and interesting article (this is no empty compliment) in NATURE of April 16, Dr. Jordan makes two misstatements. On p. 569 he says that in C. T. R. Wilson's experiments the time of a single quantum jump is a measurable quantity. But those experiments involve no time measurements at all. Time enters only through the velocity of the particles; and if inquiry is made how it enters into the value assigned to this velocity, it will be found that the time measurements concerned are made on large aggregates of atoms and have nothing directly to do with quantum jumps. Again, he says that the experiments of Geiger and Bothe and of Compton prove that the interval between emission and absorption is exactly that of the light path between the atoms concerned. But all that these experiments proved was that the interval was less than 10^{-3} sec.; the interval of the light path was about 10^{-9} sec.

Of course Dr. Jordan knew that these statements were not wholly accurate; a limit to accuracy is always set by brevity, and he would doubtless reply that the inaccuracy does not affect his argument. But if there is anything in certain vague ideas which I have twice tried to present to physicists (NATURE, 107, 170; 1921; *Phil. Mag.*, 1, 1106; 1926), it does affect his argument very greatly. I must apologise if I am too pertinacious, but every serious writer on the difficulties of quantum theory gives me the same excuse as Dr. Jordan. They all develop their argument up to a point where (as it seems to me) they are bound to notice my suggestion, if only to reject it; they then make some statement about time that is patently false, and, without noticing it, proceed on some different line of thought. If only somebody would explain why the suggestion is too silly to be worth discussing, there would be an end of it, once and for all.

Briefly, the suggestion is that time is a statistical conception, significant only with regard to large aggregates of atoms; and that it is as meaningless to speak of the time interval between atomic events as of the temperature of an isolated molecule. If that suggestion is right, some of Dr. Jordan's questions are answered or become unanswerable. He asks: Will it ever happen that the time of a quantum jump is undetermined? Certainly, for there is no such time.

The conception of a statistical time is, of course, not easy. But the general nature of the influence which it would have on our ideas can be grasped by means of an analogy. If all 'regular' clocks were abolished from our laboratories, and we were forced to use radium clocks, in which the defining events are the disintegration of individual atoms, it would be very difficult to demonstrate some of the experiments on which our conceptions of 'continuous processes' and 'causal relations' are based. That difficulty, I think, is precisely the difficulty which we encounter when we proceed from the world of atomic aggregates to that of individual atoms.

NORMAN R. CAMPBELL.

I SHOULD like, first of all, to express my regret that up to now Dr. Campbell's most interesting papers have escaped my notice. The expressions which I used, and to which Dr. Campbell takes exception, would certainly have been more precise had I taken account of Dr. Campbell's work.

As for Dr. Campbell's idea, I should like in the first place to point out that the matter has been considerably advanced by two papers by Dr. Dirac (P. A. M. Dirac, *Proc. Roy. Soc.*, London) and by me (P. Jordan, *Z. für Phys.*, 40, 809; 1927) on the foundations of quantum mechanics, and by Dr. Heisenberg's "Über den anschaulichen Inhalt der Quantenmechanik," which is based upon them (W. Heisenberg, *Z. für Phys.*, in press). These investigations corroborate Dr. Campbell's opinion in certain respects; on the other hand, they indicate certain limitations. Heisenberg has explained how the Cartesian co-ordinates, *e.g.* of an electron in hydrogen atoms, can be regarded as exactly measurable; and correspondingly one must consider the 'fourth co-ordinate' $q_4 = ict$ as exactly definable and measurable. The difficulties of a measurement of t which are brought out by Dr. Campbell arise in the measurement of every physical quantity in an atom (*e.g.* energy). How and to what extent these difficulties can be overcome has been considered in detail by Heisenberg. In this respect, therefore, the quantum mechanical conceptions differ from those of Dr. Campbell.

In a certain respect Dr. Campbell's views are, however, confirmed by the quantum mechanics: for if the atom has specified quantum numbers, the time (and the co-ordinates) are statistically, and only statistically, defined. For the characteristic feature of the quantum mechanics is that one cannot specify simultaneously all of the $2f$ constants of integration of the classical dynamised system, and, in particular, that one cannot specify both a co-ordinate and its conjugate momentum. Similarly, one may specify the energies of the initial and final states of a quantum jump; then the time of the jump is indeterminate. But one can equally well specify the time of the jump, and leave unspecified the initial and final states; and within certain limits of accuracy one can specify both the initial and final states and the time.

Undoubtedly this discussion is too short and too inaccurate to elucidate the point completely. I should like, therefore, to refer Dr. Campbell again to Heisenberg's paper, in which these questions are treated in detail.

P. JORDAN.

The Law of Flame Speeds.

IN NATURE of Dec. 11, 1926, p. 837, Prof. W. A. Bone stated that he would at some future date publish the results of experiments on the 'uniform movement' of flame which disproved the law of speeds. The work referred to has now been published in the *Proceedings of the Royal Society* (A, 114, 420; 1927) and we can reply to Prof. Bone's letter. The principal mixtures he has chosen to test the law of speeds are of ethylene and acetylene with oxygen, and the choice is made because, to use Prof. Bone's own expression, these mixtures are so 'sensitive' (*i.e.* highly responsive to accidental changes in experimental conditions).

We have for some time been engaged in further study of the law of speeds with the view of ascertaining its meaning. We have not hitherto, in our experiments on the uniform movement, used mixtures of

combustible gases with oxygen, nor have we used acetylene, the very 'sensitiveness' of such mixtures being the reason for our not using them as means of elucidating the law. We have now, however, put in hand experiments with mixtures containing ethylene and acetylene with oxygen, and will publish the results.

Prof. Bone has also used mixtures of methane and hydrogen with air, the inflammable gases being in excess. We have directed attention in our papers in the *Journal of the Chemical Society* to the fact that divergencies from the law of speeds are to be expected, and have been found, with these gases when the oxygen is in deficit. This is admitted on p. 421 of Prof. Bone's paper, but overlooked on p. 438, when the methane-hydrogen experiments are discussed and divergencies from the law are emphasised. Thus it is true that the equimolecular mixture of methane and hydrogen with air in which the speed of uniform movement of flame is 30 cm. per sec. (combustible gases in excess) is not obtained with the calculated (blended) mixtures of methane-air and hydrogen-air having that speed of flame, but with a mixture containing slightly

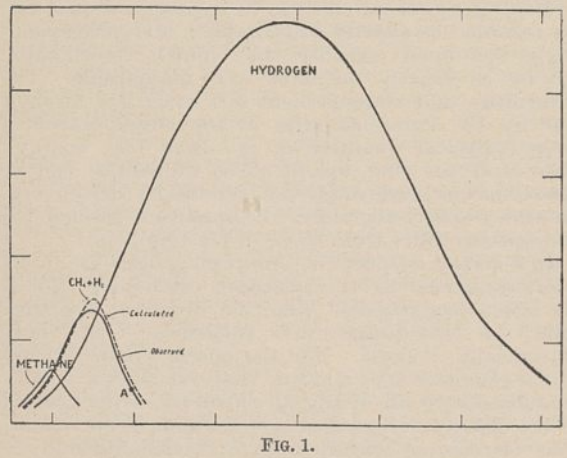


FIG. 1.

more air. Owing to the steepness of the speed-composition curves towards the limits of inflammability, a small difference in the composition scale is magnified considerably on the speed curve. We reproduce, in illustration of this, a set of speed-composition curves embodying the results of series of determinations with mixtures with air of hydrogen, methane, and equimolecular mixtures of these two gases (Fig. 1), from which the full extent and the general nature of the divergencies from the law can be judged. The two mixtures chosen by Prof. Bone to test the law contained 11·05 per cent. methane in air and 71·9 per cent. hydrogen in air. The result obtained with a blend of these two mixtures such as would give an equimolecular mixture of methane and hydrogen would fall near point A on our diagram.

Other examples of the application of the law to the uniform movement of flame, showing the extent of the divergencies, will be found in the *Journal of the Chemical Society* (115, 1454, 1919; 117, 48, 1920). We have recently (*Journal of the Chemical Society*, February 1927) dealt with the application of the law of speeds to a condition of flame propagation other than the 'uniform movement,' namely, propagation within a closed sphere, using mixtures of hydrogen and carbon monoxide with air. The results were in accordance with the law.

W. PAYMAN.
R. V. WHEELER.
Safety in Mines Research Board Laboratories,
Sheffield, April 26.

The Spectrohelioscope and Direct Telescopic View of Solar Prominences.

IT is rather hesitatingly I venture to discuss one or two remarks by Prof. Hale in his interesting contribution entitled "The Fields of Force in the Atmosphere of the Sun," in NATURE of May 14, p. 708.

The instances in which I have observed, with perfect ease, intensely black (and bright) hydrogen flocculi, often of stupendous magnitude, suddenly develop near active spots, and even where no conspicuous spots were visible at all at the moment, can be counted by the hundred in my observational notes. I have frequently taken occasion to describe such observations in scientific journals, as well as alluded to them in my annual report to the *Monthly Notices of the Royal Astronomical Society*, which circumstance I wish to mention particularly, because Prof. Hale seems to attribute this kind of observations exclusively to the capabilities of the spectrohelioscope, whereas a good solar grating spectroscope has shown me practically all the phenomena he describes, on many occasions. Had I at my station the superior apparatus of Mt. Wilson, or Pasadena, at disposal, and above all the incomparably more numerous and favourable observing opportunities afforded by Californian skies, I should of course be able not only vastly to increase the number of my observations, but also to enjoy better access to the finer detail only seen here when the air conditions are best.

I have also pointed out the drawback of the second slit of the spectroheliograph, which obscures deflexion effects beyond the amount permitted by the width of the second slit, such effects showing perfectly satisfactory with the single slit solar spectroscope. If enhanced seeing is desired, the introduction of a second adjustable, and laterally movable, slit in the focal plane of the ocular of the view-telescope helps to exclude unwanted light from the field of view. Of course, if the second slit is set too narrow, the same difficulty just mentioned in connexion with the second slit of the spectroheliograph is introduced, wherefore in the case of displacement observations, the second slit in the ocular is opened out to the maximum amount of displacement seen through the first slit. Good vision of such evolutions is further enhanced by the use of an eye-cup attached to the ocular of the view telescope.

In spite of the many observations (also shared by myself), which have caused other writers to state that the dark flocculus was sucked through the spot cavity into the interior of the sun, this contention cannot be correct for purely physical and mechanical reasons attending spot evolution. The flocculus may be seen drawn towards the spot vortex, from above and from aside the latter, but on nearing the general upper levels of the spot-umbra, this indrawing action becomes arrested and the gases of the flocculus start to partake of the radial outflow of the gases coming up the spot-cavity from the interior. Where the flocculus encounters these, it becomes heated up temporarily into brightness before being scattered sideways into the penumbral regions.

On May 7, 1927, at 1.45 Greenwich Summer Time, I had the good fortune to witness an exceptionally brilliant eruptive prominence shoot out near Position Angle 85°. The display was for a few minutes of such intensity that the whole length of the spectrum showed indication of being traversed by a ribbon of continuous light. Leaving the slit tangential to the same Position Angle, but using the direct reflecting position of the grating, I had no difficulty in discerning the clear-cut, pale-white form of this prominence. Its brilliance in the first order of the spectrum

induced a reasonable expectation of this direct view, and I feel positive that such a prominence would be readily visible at sunrise, or sunset, with the sun's limb just registering with the horizon.

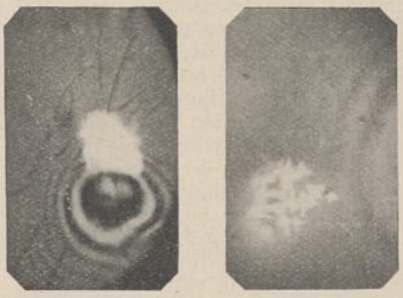
ALBERT ALFRED BUSS.

Chorlton-cum-Hardy,
Manchester,
May 16.

White Spot with Newton's Moving Water Rings.

LAYERS of moisture, grease, etc., condensed on solid surfaces play an important part in many phenomena, hence it may be of interest to recall an observation made by Newton, which, so far as I know, is never referred to in modern text-books. Observation XI. in "The Second Book of Opticks," Part I. (1704), is one of Newton's many careful observations of the coloured rings seen between convex and plane surfaces of glass, and is as follows: "When the water was between the Glasses, if I pressed the upper Glass variously at its edges to make the Rings move nimbly from one place to another, a little white Spot would immediately follow the centre of them, which upon creeping in of the ambient water into that place would presently vanish. Its appearance was such as interjacent Air would have caused, and it exhibited the same Colours. But it was not Air, for where any bubbles of Air were in the water they would not vanish. The reflexion must have rather been caused by a subtiler medium, which could recede through the Glasses at the creeping in of the water."

I have taken rough 'snapshots' of this phenomenon, two of which are here reproduced (Fig. 1),



a *b*

FIG. 1.

but owing to photographic exposure difficulty they do not show the brilliant coloured rings which extend across the white spot. Fig. 1*a* shows the formation of the white spot sharply at the edge of the dark centre of Newton's rings, indicating that contact (whatever contact may mean) between the glass surfaces extends over the central black spot. Fig. 1*b* shows the white spot beginning to disappear into the glass or into the water or simply contracting due to increase in pressure. At the rear of the moving Newton's rings pressure will be greatly reduced, so the white spot is probably mainly water vapour at low pressure. That the spot contains gases, however, can be shown by giving the top plate a jerk, when instead of the whole white spot disappearing "at the creeping in of the water," a tiny white bubble of gas may be seen remaining for a long time in the water between the glasses. The white spot can be observed perhaps better because with slower motion, if a viscous liquid such as strong sulphuric acid or vacuum pump oil be used instead of water, or even with a plastic solid like soft soap between the glasses.

JAMES MUIR.

The Royal Technical College,
Glasgow, April 27.

An Arctic Peat in Ireland.

IT has often been stated, and is very generally believed, that no deposits analogous to the Arctic peats of Scotland occur in Ireland. The proximity of the two countries is so great, however, that climatic conditions which affected Scotland must have affected at least the northern portions of Ireland in a similar degree, and it is not surprising, therefore, that an Irish Arctic peat, or something approaching one, has at last been discovered. This peat bed in question is situated on the boundary between the counties Dublin and Wicklow, on the eastern slopes of the Dublin mountains. Locally the place is known as Ballybetagh and Mulligan's Bogs, the former lying in Dublin, the latter in Wicklow. Both bogs have long been famous for the vast quantity of remains of the so-called Irish elk, which has been found beneath them.

The site of the bogs is an oval depression about half a mile long (north to south) by a quarter of a mile in width, and was occupied in late glacial and early post-glacial times by a (?) shallow lake, now entirely filled up by deposits of various kinds. The first post-glacial stratum to be laid down in the lake was a fine bluish-grey clay, sometimes containing chips of stone or gravelly layers, derived by subaerial denudation from the moraines surrounding the site. Resting on this clay, and often bedded into it, lie the scattered bones of the great deer; while in turn these are covered by a flaky peat—locally known as "elk deposit"—which, besides numerous seeds, roots, etc., contains many leaves of *Salix herbacea*. At present my claim that this is an Arctic peat rests solely on the evidence afforded by this willow, though I have just heard from Dr. G. Erdtman, of Stockholm, that a hurried and superficial examination of a sample of the peat from Mulligan's Bog has convinced him that it "is sub-Arctic, if not Arctic."

I have to thank Dr. Henry Stokes, of this city, for permission to examine numerous sections at Mulligan's Bog in August 1926, when he was digging for remains of the Irish elk. I have also to thank Miss M. C. Knowles, of the National Herbarium, for confirming my identification of the leaves of *Salix herbacea*. I may add that the leaves from Mulligan's Bog differ greatly from those of the same willow now growing in the Wicklow Mountains at altitudes of from 2000 ft. to 3000 ft., and resemble the leaves of prostrate specimens of the plant in the National Herbarium from Arctic Europe and Labrador. The present lowest limit of *Salix herbacea* in Wicklow is a little more than 2000 feet altitude, thus suggesting a considerable lowering of the snow-line during the period in which the peat was deposited, Mulligan's Bog being only about 750 feet above present sea-level.

There is at present no proof, but I suggest that the Irish elk may have lived during a comparatively mild period, and that the peat containing the leaves of *Salix herbacea* may be contemporaneous with one of the re-advances of the ice—when the Scottish ice sheet was forming its terminal moraines along the north-east coasts of Ireland, on the Isle of Man, Cumberland, and in south-west Scotland. For evidence connected with these moraines see "The Re-advance, marginal kame-moraine of the South of Scotland, and some later stages of retreat," by Dr. J. K. Charlesworth (*Trans. Roy. Soc. Edin.*, 1926), and also A. R. Dwerryhouse in *Quar. Jour. Geol. Soc.*, 79, 352; 1923.

A. W. STELFOX.

National Museum,
Dublin.

Audibility of Gunfire.

IN an article published in NATURE last August the suggestion was made that it might be possible to utilise gunfire for accurate measurement of the time of passage of sound over long distances, and in a postscript to the article I was able to record my success in listening at Grantham for the sound of guns discharged at Shoeburyness. On that occasion the interval between the firing of the gun and the arrival of the sound at Grantham varied between 10¾ and 11¼ minutes.

It is now agreed that 'abnormal' audibility at great distances is due to the refraction of the sound waves in a region at a height of 40 kilometres or more where the temperature of the air is comparatively high. More observations are required to elucidate various problems concerning this region. It is therefore gratifying that the War Office has given approval to the proposal to broadcast the times of firing of one of the guns at Shoeburyness and that the British Broadcasting Corporation is making the necessary arrangements. Full particulars will be announced shortly.

To take full advantage of the opportunity it will be necessary to supplement the aural observations by instrumental records of the aerial disturbance. I am therefore anxious to get into touch with any persons who are provided with apparatus suitable for the purpose. I believe that sets of sound-ranging equipment exist at certain universities and technical colleges. The co-operation of observers who had experience with such apparatus during the War and would be able to utilise it would be especially valuable; it would probably be possible to provide sets for them. It is anticipated that the best distance for successful observations will be at about 120 miles from Shoeburyness, but it will be worth while to attempt observations at rather greater distances, at such places as Nottingham, Birmingham, and Bristol. Records from comparatively near stations, which will be in the region of normal audibility reached by sound waves passing only through the lower atmosphere, are also desirable.

The experimental work on this subject has been done hitherto on the Continent. The trial which we are undertaking offers greater difficulties, as the explosion from which the sound is to originate will be so much smaller. Previous experience shows that as a general rule the zones of audibility are unsymmetrical, so that it is impossible to forecast where the sounds will be perceived. There is, however, reason to believe that in summer the region of abnormal audibility is likely to be to the north and west of the source of sound, so that our trial will be conducted in the most favourable circumstances.

I hope that those who may be able to co-operate in procuring instrumental records will kindly communicate with me at once. Others who are interested and will be able to make aural observations are asked not to write at present. Full details of the trials will be published as soon as possible.

F. J. W. WHIPPLE.

Kew Observatory, Richmond,
Surrey, May 17.

Phytophagic or Biological Races in Insects.

I HAD no desire to enter into any controversial discussion with Dr. Heslop Harrison (whose letter in NATURE of April 16, p. 562, I regret not to have seen earlier), either in regard to his experiments or the conclusions he draws from them; I sought only to obtain some explanation of an alleged 'new principle in evolution,' since anything that deserved such a title would probably be serviceable to me in my studies. I was fully acquainted with the previous paper to which Dr. Harrison refers, as I had particular occasion to consider it at its first appearance. This earlier paper related to the fixing of certain qualities of colour, etc., under chemical influences in food, and I could readily accept it; the second described the fixing of hereditary habits by slight changes of food plants in three generations, and was much less easy of digestion. Yet on the strength of this latter case only (for the former does not touch the real point, and is only connected with the latter by an assumption of a common explanation, a conjectural modification of a wholly supposititious germ-plasm) Dr. Harrison proceeded to specify a number of actual instances of pairs of allied species, particularly stated to be 'in Britain,' and well known to me, and to suggest that this case explained their origin. If he did not mean that they originated in Britain, why describe their British association? It is no evidence that they are similarly associated in Siberia.

I do not deny that food produces differences in species; on the contrary, I know it produces differences. I do not know that it produces specific differences, nor, I think, does any one else. But I cannot believe that in any single instance pairs of allied species come into existence as Dr. Harrison describes; he excludes the essential factor of isolation (either in space or time), without which it would be impossible to keep the two stocks distinct until they were fixed. My case is that many of the most obviously close pairs of species feed not on allied but on the very same species of plants in the same way (I will instance *Tischeria complanella* and *T. dodonæa* on oak, *Heliozela sericiella* and *H. stanneella* on oak, *Antispila pfeifferella* and *A. treitschkiella* on Cornus, all exceedingly close pairs), and that the law of averages renders it unlikely that the direct chemical influence of the food plant is often more effective in other categories than in these, where it is nil.

I should like to add, in relation to Mr. W. H. Thorpe's letter (April 23, p. 602), that the genus Hyponomeuta, on which he is working, does, in my opinion, offer the most suitable material known to me for investigations on the direct effect of food plants, and I trust he will obtain valuable results.

EDWARD MEYRICK.

Thornhanger, Marlborough,
May 7.

The Chemistry of the Adrenal Cortex.

IN a previous paper (*Biochem. Z.*, 181, 433; 1927) it was shown that extracts of the adrenal cortex strongly reduce silver nitrate and iodine. This reduction could not be accounted for either by adrenalin or glutathione, and seemed to be specific to the interrenal tissue. To exclude any anticipation of function and chemical structure, the substance giving this reduction was named by its protocoll-number "C_{xii}," being the twelfth substance prepared and examined in my work on tissue oxidation and the function of the adrenal cortex. Having been enabled to resume this work at the Biochemical Laboratory, Cambridge, the substance has been further investigated and finally isolated in crystals, which on recrystallisation showed a constant melting-point.

That C_{xii} is definitely confined to the adrenal cortex can be easily demonstrated by the direct application of silver nitrate to the fresh-cut surface of the gland. If a cross-section is made through the (cow's) gland and the pieces immersed into a dilute

(0·2 per cent.) silver nitrate solution, the cut surface of the cortex will be seen to turn almost black within a short time, while the medulla, like other organs, remains practically uncoloured.

The purification of C_{XII} was based on the following properties: it is readily extracted by methyl alcohol and precitated almost quantitatively from its alcoholic (not from watery) solution by lead acetate. It shows a different solubility in organic solvents at acid or alkaline reaction. At an alkaline reaction it is readily soluble in water, methyl alcohol, sparingly in acetone, insoluble in ether and other more hydrophobe solvents, and is precipitated by these latter from its strong alcoholic solution. At acid reaction it is readily soluble in water, alcohol, and acetone, is not precipitated from alcohol by ether, but is carried down by this latter from an acetone solution. The substance does not form a precipitate with any of the great number of other precipitating agents applied. No colour reaction could be found. (The brown coloration on application of acid iodate, mentioned in the first paper, is caused by the liberation of iodine. My first impression that the substance was a thiophenol has been disproved, as no sulphur is found on analysis.) The substance has been crystallised in fine colourless needles from a hydrochloric acid solution, the crystals showing a constant melting-point of 175° C.

The C_{XII} content of the adrenal gland (cow) is approximately 0·1 per cent. Preliminary experiments tend to show that the substance is not devoid of biological activity. My earlier experiments, showing that C_{XII} is not the hormone of the adrenal cortex, seem in the light of Banting's and Rogoff and Stewart's recent work to be inadequate. Analysis of the biological significance and chemical constitution has been started. A full account of the methods of preparation will be given in another place.

A. v. SZENT-GYÖRGYI.

Biochemical Laboratory,
Cambridge University,
April 30.

Behind the Divining Rod.

RECENT correspondents have not referred to the views that place the use of the divining rod in the category of 'psychological automatisms' like the use of planchette or divination by a ring suspended in a tumbler. A simple experiment will demonstrate such an automatism. An unsuspecting subject is directed to sit leaning forward with his elbows resting upon his knees and with his hands placed just below the level of his eyes. The end of a watch-chain is placed in his hands with the watch dangling between his separated knees, and he is now assured that the watch will swing from knee to knee. Any plausible explanation may be given—bodily magnetism, or the inner movements of the watch—and, unless the subject be critically disposed, the watch as he gazes upon it will swing with increasing amplitude in the direction named. In an experiment with a fresh subject the watch, by suitable assurance, may be made to swing at right angles to its path in the first case.

The movement is produced unwittingly by the muscular action of the subject. The divining rod, as I have seen it used, provides a delicate mechanism by which muscular action can produce movements that the subject apparently, and in his own belief, is trying to resist. I have described the method in "Spiritualism and the New Psychology" (Edward Arnold, 1920).

Testimony as to the honesty of the dowser adds to the pathological interest of the phenomenon; conscious fraud is less pathological than a mild dissociation of personality. Prof. Sollas rightly insists that in tests of ability to 'dowse' coins the investigator himself should not know what they are, but there is no need to invoke telepathy. There is a super-acuity of the senses, in the presence of a mental dissociation, that enables the 'dissociated' subject to pick up the slightest indications from bystanders or otherwise.

The divining rod has had many uses: to find water, coal, ore, hidden treasure, criminals, and witches. Mechanically and psychologically it belongs to the same category as planchette. Pierre Janet dealt fully with this and other psycho-pathological manifestations in "L'Automatisme psychologique" (Paris: F. Alcan, 1889) and remarked (p. 368): "Il est probable que, dans quelques campagnes, subsiste encore la croyance aux révélations de la baguette divinatoire."

MILLAIS CULPIN.

1 Queen Anne St.,
London, W.1.

Gallium in Flue Dust.

MR. W. KIRBY'S observation of the occurrence of the element mercury in coal-tar, recorded by Dr. Aston in NATURE of April 2, p. 489, is another instance of the wide distribution of an element in minute quantity. Employing the method of spectrum analysis by oxy-hydrogen or oxy-coal gas flames (Hartley and Ramage, *Trans. Chem. Soc.*, 71, 533, 1897, etc.) in a search for sources of potassium in flue dusts during the War, certain samples were found to contain notable quantities of gallium. Experiments have been made as occasion permitted to perfect a method for extracting that rare metal from Norwich Gas Works' flue dust, derived from South Yorkshire coal, and in the course of the work the presence of the following elements has been noted: lithium, sodium, potassium, rubidium, cæsium, copper, silver, calcium, strontium, zinc, aluminium, gallium, indium, thallium, carbon, titanium, silicon, lead, vanadium, phosphorus, arsenic, antimony, bismuth, oxygen, chromium, molybdenum, sulphur, manganese, chlorine, iron, and nickel. Circumstances have not permitted a complete analysis to be made, and one substance, at least, awaits final purification and identification. Certain selected pieces of dust, partially fritted, apparently contain about 2 per cent. of gallium, and the proportions of zinc and vanadium are probably higher still.

HUGH RAMAGE.

Municipal Technical Institute,
Norwich.

Distinctive Colour Senses of Artists.

THE article in NATURE of May 14 on the exhibition of the Royal Academy reminds me of a discussion I once had with a brother of Sir Charles Walston, who was a medical man interested in art. He was looking out for a method to determine the average colour of a picture, which he thought was characteristic of the painter, and might serve to identify him as certainly as finger-prints identify persons. I could only refer him to the method tried by the third Lord Rayleigh, when instead of spinning colour discs he looked at the stationary discs after reflexion from a surface that could be set into rotation. Applied to a painting, this would then give the average colour for concentric circles round the centre of rotation.

While I am writing, I am looking at portraits of two ladies made by the same artist. The dress of one is bright yellow, that of the other dark blue, and their average colour is not balanced by the colour of the background. The conclusion to be drawn is, that it is dangerous to mix science and art, though we may apply one to the other.

ARTHUR SCHUSTER.

Yeldall, Twyford, Berks,
May 18.

The Essential Oils of the Eucalypts.

By Prof. JOHN READ, University of St. Andrews.

THE timbers and the resinous exudations, or 'gums,' of the eucalypts have deservedly attracted much attention; but chemically, if not economically, the greatest interest of this leading genus of Australia centres around the eucalyptus oils. These 'essential' oils are produced abundantly in the minute leaf-glands of the eucalypts, and sometimes they may also be distilled from the bark and timber. Essential oils, as the name indicates, possess fragrant odours; they are more mobile and more volatile than the 'fixed' plant oils, with which they must not be confused; further, unlike the fixed oils, they are unassimilable, being in no way related to the fats.

The early settlers in Australia were quick to notice the value of the eucalypts as sources of essential oils. Dr. John White, surgeon-general to the first settlement, attracted by the strong peppermint odour of a common species growing around Port Jackson, was led to make the first distillation of a eucalyptus oil in 1788. In his "Journal of a Voyage to New South Wales" (1790, p. 227) it is recorded that "the name Peppermint Tree has been given to this plant by Mr. White on account of the very great resemblance between the essential oil drawn from its leaves and that obtained from the Peppermint (*Mentha piperita*) which grows in England. This oil was found by Mr. White to be much more efficacious in removing all cholicky complaints than that of the English Peppermint, which he attributes to its being less pungent and more aromatic." The species of eucalypt which furnished this oil is now known as *Eucalyptus piperita*, and it is common in the Sydney district and the Blue Mountain Ranges of New South Wales. It was sixty-six years later that the first eucalyptus oil factory was established in Australia by Bosisto, while the first chemical investigation was made by the French chemist, Cloëz, in 1870, upon an oil yielded by specimens of *E. globulus* grown in France. Such were the modest beginnings of the utilisation and scientific examination of eucalyptus oils.

Every Australian knows that a eucalyptus leaf, when crushed, often emits an agreeable odour; many know that these odours may vary considerably, from tree to tree, throughout a stretch of bush; and some are able to effect a rough classification of these trees, based upon such observations. Few, however, are able to proceed beyond this point, and it is remarkable that so little exact knowledge should exist, in the popular mind, of a genus which is rightly held in such esteem as an emblem of Australia. In remote parts of Tasmania 'bush-whackers' born and bred among the eucalypts have been known to assert that there are five kinds of 'gums'; but Australian men of science who have devoted their lives to a study of this wonderful genus have distinguished some two hundred and fifty species, and the tale is even yet incomplete. So interwoven are the relationships, so refined the distinctions, that in some instances discrimination between closely related species has been rendered possible only through the combined efforts of the botanist and the organic chemist. Investigations of this nature, which were prosecuted with unflagging zeal through a period of more than thirty years by R. T. Baker and H. G. Smith, of the Sydney Technological Museum, have demonstrated the remarkable constancy of composition of the leaf-oil derived from any particular species of eucalypt, and have rendered possible a chemico-botanical classification of the various species, through the elucidation of certain remarkable relationships between chemical and botanical characteristics in the genus.

It is usually taken for granted that 'eucalyptus oil' consists mainly, or wholly, of the familiar eucalyptole, or cineole, the smell of which is so familiar during epidemics of colds and influenza. In point of fact, however, cineole is merely one out of about forty chemical components which have been discovered in the oils of this genus since 1870. According to the interesting evolutionary theory of Baker and Smith, the original eucalypts were evolved in north-western Australia from the still older genus Angophora, and such species still predominate in this region; the leaves in this group, of which the well-known Bloodwood (*E. corymbosa*) is an example, possess a 'feather' venation and are very poor in oil, of which the main component is the turpentine hydrocarbon, pinene. At the other end of the evolutionary scale, the most recently evolved species occur mainly in the south-eastern portion of the continent; the leaves have a 'butterfly-wing' venation and are thickly studded with oil-glands, so that the yield of oil may exceed four per cent. of the weight of the leaves and twigs. The Broad-leaved Peppermint (*E. dives*), a widely distributed member of this group, furnishes an oil consisting largely of phellandrene, in association with an interesting peppermint ketone, called piperitone, which promises to assume considerable importance as a commercial source of synthetic menthol and thymol. Certain oils in this group are used also in the flotation process for the separation of metallic sulphides from their ores. Cineole is the chief component of the oils from an intermediate group of eucalypts; it occurs as a rule in association with pinene, in such species as *E. globulus*, *E. Smithii*, *E. Australiana*, and many others. Oils of this type are used largely in pharmacy, and they are sometimes so rich in cineole that the crude 'first-hour oil' readily deposits a solid glacial mass of this substance when placed in a freezing chamber.

Chemically, therefore, it is possible to discern three main groups of eucalyptus oils; but in addition there are many exceptional species the leaf-oils of which contain such valuable components as geraniol (*E. Macarthuri*), citronellal (the Citron-scented Gum, *E. citriodora*) and citral (the Lemon-scented Ironbark, *E. Staigeriana*). As a rule, each chemical constituent is found to increase through a range of species until it reaches a maximum value in the final member. In exceptional

cases, such as that of *E. Macarthuri*, the end species alone appears to have survived. In spite of the intricate relationships in the genus, ability to discriminate between the main types is not particularly difficult to acquire. As a practical aid in such studies, an interesting record of the character of the leaf-venation and the disposition of the oil-glands may be obtained by making direct sun-prints of the leaves on sensitised paper. The identification of indigenous species in any particular area is helped by the fact that the chemical fastidiousness of the eucalypt is accompanied by an equally marked susceptibility to environment, so that changes in such factors as geological formation, rainfall, and altitude are reflected in the character of such species.

In harvesting eucalyptus leaves for distillation the trees may either be lopped or felled, and although the latter method may appear extravagant, yet experienced distillers often favour it. The phœnix-like eucalypt conforms to the general motto of the Australian flora, which is 'Resurgam!' It combines amazing vitality with unusual rapidity of growth; and so, after the lapse of a few years, the decapitated stump may have surpassed the ideal of Dean Swift by producing not merely two, but three, or even four, sturdy trunks where only one grew before. To that bizarre list of alleged Australian paradoxes which circulates so freely outside Australia, to the mingled amusement and annoyance of good Australians, may thus be added the less familiar but more truthful statement that a lopped or felled eucalyptus tree, rising on the stepping-stone of its dead self, may in a few years develop more foliage than it originally possessed.

The mallee scrub in the Wyalong district of New South Wales is treated in a still more drastic manner. The mallee, a type of eucalypt embracing many species, is a dwarfed form, having a number of small stems instead of the usual single trunk. In the western part of New South Wales, as also in South Australia and other regions, mallee eucalypts cover vast areas, and the essential oil of the Blue Mallee (*E. polybractea*), the dominant species in the Wyalong district, is worked extensively for cineole. A second species, *E. oleosa*, or Water Mallee, secretes water in its roots, a fact which was fully appreciated by the aboriginal inhabitants of Australia. Other important mallees are *E. odorata* and *E. cneorifolia*, from which the bulk of the South Australian eucalyptus oil is extracted; the last-named species occurs only on Kangaroo Island. In dealing with the Blue Mallee, the oil distiller flattens and partly uproots the mallee scrub by driving a heavy roller over it; and after the hardly used vegetation has dried in the sun he completes its apparent destruction by burning it off. The bare waste which repels the eye at this juncture seems to be devoid of any germ of life. In a short time, however, the irrepressible eucalypt reappears; a pleasing dull blue mantle of *E. polybractea* covers the landscape; and after the interval of a year the oil distiller is gladdened by the sight of a luxuriant growth of mallee rising to the height of his waist.

The harvesting of eucalyptus leaves from the mallee forms is simpler than from the trees, but the subsequent operations are the same for material from either source. In order to liberate the oil, the leaves are brought into contact with steam, which ruptures the oil-glands and causes a slow vaporisation of their contents. The primitive form of bush-still consists of the cubical iron tank so familiar to Australians; this contains the tightly packed leaves resting upon a grating, below which water is boiled by means of a wood fire underneath the tank. As the steam forces its way up through the mass of leaves it becomes charged with the vaporised oil, and the mixed vapours are condensed during their passage through an exit tube cooled by immersion in a creek, or in some more refined manner. The resulting mixture of water and oil runs down the tube and is collected in a receiving vessel, which is so constructed as to allow the relatively small layer of oil to be drawn away from the water upon which it floats. Other types of plant possess an independent boiler which supplies steam under pressure to a series of digesters, these latter being sometimes sunk into the ground to facilitate the handling of the fresh and the spent leaves.

The prices realised by eucalyptus oils range over a wide scale. The value of the oil depends upon its chemical composition, which, although sensibly constant for any particular species, varies enormously from one species to another. The Blue Mallee, for example, yields a cineole oil having a market value of somewhat more than a shilling a pound to the distiller, while the citronellal oil of the Citron-scented Gum of Queensland brought in as much as six shillings per pound during the War. The reputation of the cineole oils has suffered in the past, owing to the multiplicity of species yielding such oils and to the confusion which has existed between these species in the field. A vernacular name, such as Messmate, may easily be interpreted in half a dozen different ways, according to the tastes of the individuals concerned. It is therefore a satisfaction to find reputable oil distillers adopting the systematic Latinised names; and although the use of scientific nomenclature in the Australian bush may occasion some degree of surprise, yet—as a 'bushwhacker' once remarked in different words—there is nothing inherently difficult in the pronunciation of 'Eucalyptus Macarthuri,' and the name is decidedly more euphonious than the synonymic Camden Woolly Butt or Paddy's River Box. Fortunately, neither *E. Luehmanniana* nor *E. macrorhynca* is worked for oil!

As his readiness to use these strange names shows, the oil distiller is eminently adaptable; he has been known to write his letters with home-made charcoal ink by the light of a lamp burning the oil of *E. Macarthuri*. He is, indeed, a virile and picturesque Australian type, full of the lore of the bush. Let us hope that some day an Australian master will arise to do by him as Thomas Hardy has done by the tranter and the reddleman of Wessex.

Evolutionary Advance: Emergent and Resultant.[1]

By Prof. C. LLOYD MORGAN, F.R.S.

THERE seems to be not a little misapprehension as to the position which those who advocate emergent evolution are concerned to defend. Some critics seem to suppose that the contention is: All evolution is by discrete steps, each of which introduces something new; therefore no evolution is by continuous advance with resultant outcome. That is not so. At any rate, I, for one, disclaim intention of saying anything of the sort. It has been my aim to emphasise the claim that what is genuinely new in evolutionary advance is of the emergent type, as distinguished from the resultant type. My claim is: Some evolution is by discrete steps, each of which introduces something new. But stress on emergent factors in evolution does not imply denial of resultant effects.

When we consider organic evolution this must be borne in mind. If the biologist adduces thousands of examples of changes in living organisms which are interpretable mechanically as strictly resultant, that is no argument which serves to disprove the occurrence of changes which, as we think, must be interpreted as strictly emergent. If both types of change are in evidence, our aim should be to distinguish the one type from the other.

The emergent claim is (1) that there are certain characterising features of the living that cannot be deduced from our knowledge of what happens on the lower platform of the not-living. But the further contention is that this holds good, not only for the living and the not-living, but also at many stadia of evolutionary advance; so that, on like empirical grounds, we may say, for example (2), that there are certain characterising features of the molecule that cannot be deduced from our knowledge of what happens on the lower platform of the atom.

It is with the former claim that we are here concerned. Then the trouble is that one who advocates emergent evolution is sometimes supposed to deny resultant evolution. He is supposed to say in effect: *Not* resultant advance, *but* emergent advance.

Let us consider the attitude of those who do nothing of the sort. In resultant advance the conditions are such that there is homogeneous continuity. Hence deductive conclusions are relevant all along the line of advance. With adequate knowledge of the law of such advance, predictions as to the exact nature of any later phase could be made on the basis of adequate and sufficient knowledge of any earlier phase. Hence the unlimited range of astronomical predictions in so far as they are based on the principles of resultant mechanics.

Now what is the bearing of this on the vexed biological issue? The 'mechanist' says in effect that all processes and products from first to last—from the not-living to the living organism—are susceptible of resultant interpretation. They are all on one continuous plane of resultant advance. And he points with justifiable pride, which others may share, to the outcome of such treatment. There are, no doubt, as he frankly admits, sundry physiological processes which still present difficulties. What of that? Further research on this method of interpretation will resolve them in due time.

What, then, say those who have been led to accept emergent advance? Do they deny any one of the successful achievements based on resultant treatment? They do not. What they do submit is that there are modes of 'behaviour' in the clustering of events within the living organism that are of such a nature as not to be deducible from that which obtains in the not-living. They submit, in further detail, that there are *some* physiological processes which elude the meshes of the resultant net, which are on a different level of emergence, which could not be predicted from the not-living platform.

It may be asserted that with further knowledge it will be shown that there are *no* physiological processes that elude the resultant net. We are, however, dealing with matters as they now are; and our attitude is: Resultant advance in plenty; as much as can be proved; but not a few residual matters which bear witness to emergent advance. If this be so, is not the present position of affairs this: The living organism in physiological regard is such as to exemplify evolutionary advance, not resultant only, not emergent only, but both resultant and emergent?

Should not this be our attitude in broader biological regard? Now that the concept of emergence has been admitted into the field of serious discussion, there is grave danger of its being used wildly and without discrimination as a popular catchword. People talk of the emergence of the elephant or the mongoose; the emergence of the social Hymenoptera, of polymorphism in ants; perhaps the emergence of mimicry or of display in courtship.

It may, however, be said: We thought that evolutionary advance is what you stand for. But now it seems that you propose to introduce sundry rather puzzling reservations. If polymorphism in ants—to select one of your examples—if, in other words, the differences of structure and diversities of behaviour that characterise the constituent members within some social community of ants, be not the outcome of evolutionary process, of what natural process is all this the outcome?

I do not suggest that all this is not the outcome of, or does not afford an instance of, *evolutionary* advance. My aim is to distinguish, within this advance, (1) that which is deducible on the method of resultant treatment, from (2) that which is not deducible on this method. The former I speak of as resultant advance; the latter as emergent advance. I submit that, on the evidence, we find

[1] From a paper read at a meeting of the Aristotelian Society on Feb. 14.

in the field of biological inquiry both emergent and resultant advance. My plea is for careful analysis.

There are a good many critics who seem not yet to have grasped just where the concept of emergent evolution is applicable. They seek to apply it where I, for one, hold it to be inapplicable. They may then ask: What bearing has this concept of emergence on the theory of natural selection? It may savour of extravagance if I express the opinion that on this theory, as such, it has little or no bearing.

To make my meaning clear, I must ask: Are we, under natural selection, dealing with the survival of variants or with the origin and transmission of variations? In the opinion I express I assume that the theory of natural selection *as such* deals with variants, and that the origin and transmission of variations fall for discussion under a different theory—that of genetics. If this be so, the issue for natural selection is a plain issue. Are some variants weeded out in 'the struggle for existence' or are they not? If some are weeded out, leaving others to survive, I regard such elimination as a resultant effect.

That leaves the origin of variations (or of mutations) to be discussed as a separate issue under genetics. It opens up a wide field of inquiry, including Mendelian research. Here the question does arise: Is this or that variant the outcome of resultant, or emergent, advance; or is it a joint product of both? If both are given in the evidence, the emergent factors should be distinguished.

My plea is: If the concept of emergence be accepted, let us make quite clear just where this concept is applicable. When I express the opinion that it is not applicable to natural selection, as such, it should be obvious that this does not preclude the survival of those variants which have genetic characters that can be shown, under searching analysis, to be emergent in origin. Biological inquiry includes both natural selection and genetics; and genetics discloses, as I think, both emergents and resultants. Is there not pressing need for the exercise of distinguishing analysis?

Fat-soluble Vitamins.

BARELY two decades have elapsed since the concept of 'vitamins' first began seriously to attract the attention of investigators. Scurvy had been recognised as a clinical entity for a couple of centuries, and the treatment of it, by means of fresh vegetables and fruit juices, was well known. But the idea that disease might be caused by the *deficiency* of some factor in the diet was, for many, too novel to be accepted without question, and much work was necessary before the reality of the accessory food factors or vitamins was generally admitted. Recognised at first solely by the effects produced on experimental animals when absent from their carefully purified diets, it was not long before chemical investigations began to define their properties, from which tentative conclusions as to their chemical nature might be drawn. With the discovery that ultra-violet light could cure rickets, and was also capable of making a diet, previously inactive, protective against this disease, a new key was provided for the unlocking of the door which led to the chemical constitution of the anti-rachitic vitamin, or vitamin D, as it is also called. At this stage the work came into contact with other investigations on a group of compounds of widespread distribution in Nature, but of almost unknown biological significance, the sterols. At the present time it is certain that vitamin D, if not actually a member of this group, is closely related to one, and it is extremely probable that vitamin A, or the fat-soluble growth-promoting vitamin, is also of a similar nature.

Following the discovery that exposure to ultra-violet light could render a deficient diet anti-rachitic, it was soon found that the unsaponifiable fraction of the fat of the diet was responsible for this effect. O. Rosenheim and T. A. Webster, working at the National Institute for Medical Research, and Steenbock and Hess and their collaborators in America, then discovered independently that 'chemically pure' cholesterol was rendered anti-rachitic by this exposure. Further work by these and other investigators has now sufficed to determine more definitely the properties and nature of the compound which undergoes this change, although the actual nature of the change itself is undetermined.

Rosenheim and Webster (*Biochem. Jour.*, 1926, vol. 20, p. 537; *Lancet*, 1927, vol. 1, p. 306) were unable to convert more than 0·1 per cent. of cholesterol into vitamin D under the influence of ultra-violet light. They also showed that the presence of the unsaturated linkage and of the secondary alcohol group of the sterol was essential for the reaction to take place, and that the vitamin was not precipitable by digitonin. The fact that only a minute amount of the cholesterol could be 'activated' raised a doubt as to whether this substance was the true precursor of vitamin D, and the doubt became a certainty when it was found that cholesterol purified by way of the dibromide could not be activated and, moreover, no longer possessed the characteristic absorption spectrum in the ultra-violet region. These experiments proved that the vitamin precursor is not cholesterol itself, but some substance which is closely associated with it when obtained from all natural sources.

Further work showed that the precursor was easily oxidised and could also be precipitated by digitonin, unlike the vitamin obtained from it. Attempts to separate it from cholesterol by making use of the latter property, or by fractional crystallisation (Heilbron, Kamm, and Morton, *Jour. Soc. Chem. Ind.*, 1926, vol. 45, p. 932) or by fractional distillation in a high vacuum (Windaus), resulted in a considerable concentration of the precursor, but it was not obtained in a pure state.

The authors therefore selected another sterol, ergosterol, which they had previously shown could be rendered anti-rachitic by ultra-violet light, for further examination, since it possesses some of the properties of the vitamin precursor: thus, it cannot be recovered unchanged from its bromide (Windaus), it is extremely sensitive to light and oxidation, forms an insoluble digitonide, and possesses three unsaturated linkages. It was found that this sterol exhibited a very pronounced absorption in the ultra-violet region of the spectrum, which disappeared on irradiation; at the same time the product lost the property of being precipitated by digitonin. Experiments on rats suggested that the limit of anti-rachitic activity will be in the region of a daily dose of $\frac{1}{1000}$ mgm. or less.

It is therefore probable that the vitamin precursor is really ergosterol: similar or identical sterols have been found widely distributed throughout the lower plants. Thence they must find their way into animals, thus enabling the latter to develop their own anti-rachitic vitamin on exposure to light. The anti-rachitic power developed by cholesterol on irradiation, then, is due to contamination of this compound with ergosterol; from the intensity of the ultra-violet absorption spectrum it appears that this contamination occurs to the extent of about 0·05 per cent.: this assumption also explains the impossibility of making anti-rachitic more than a small amount of the "cholesterol."

Less is known at the moment about the nature of the fat-soluble vitamin A. Like vitamin D, which has only recently been definitely differentiated from it, it occurs in the unsaponifiable fraction of the fats and oils (notably codliver oil) in which it is present. Following the work of Drummond, Takahashi, and other investigators, certain of its properties have become established (see NATURE, 1926, vol. 117, p. 522, and J. C. Drummond, H. J. Channon, and K. H. Coward, *Biochem. Jour.*, 1925, vol. 119, p. 1047). Thus the vitamin A present in the cholesterol-free oil obtained from the unsaponifiable matter of codliver oil can be distilled at low pressure at a temperature of about 180°-220° C.: only small amounts are obtained, the greater part of the purified oil consisting of unsaturated alcohols together with a certain amount of squalene. Even the product obtained in this manner is impure, so that Drummond was unable to agree with Takahashi with reference to the claim advanced by the latter that he had isolated the vitamin in a pure state. Drummond noticed that the growth-promoting activity was retained after destruction of the hydroxyl group of the alcohols present, but was always destroyed by exposure to reagents which affected the unsaturated linkages. More recently Rosenheim (*Med. Res. Council Rep.*, 1925–6, p. 30) has found that partial oxidation of cholesterol produces a substance which gives the colour reaction characteristic of vitamin A (and a few other substances). It is therefore possible that vitamin A may also be found to be a derivative of one of the sterols.

The story of the work on the fat-soluble vitamins A and D shows how two entirely different lines of research may suddenly converge, and how a purely academic investigation may suddenly assume a definite practical importance. Without the knowledge obtained from the work of previous investigators on the sterols, the biological importance of which was not at the time obvious, it is possible that the isolation of these two vitamins would have taken much longer than it now seems probable will be the case.

The practical application of these researches in the prevention and cure of rickets is obvious: but this is not a very common disease, so that it is worth inquiring if deficiency of these vitamins may play a part in other diseases or states of ill-health. Drawing an analogy from the symptoms shown by rats suffering from deficiency of vitamin A, it is probable that this vitamin plays a part in maintaining the various mucous membranes of the body in a healthy state, quite apart from any effect it has on proper growth: in fact, deficiency of this vitamin has led to the appearance of xerophthalmia in human beings just as in experimental animals.

At the same time, increasing light is being thrown on the relationship between vitamin D and the formation and decay of the teeth, a subject of very great importance. Mrs. Mellanby first demonstrated this relationship in the case of animals, but the application to human beings was not immediately obvious, since dental decay occurs frequently in apparently perfectly formed teeth. Mrs. Mellanby has, however, found (*Med. Res. Council Rep.*, 1925–6, pp. 18 and 74) that teeth, normal to naked-eye examination, may show defects of structure of both the enamel and dentine when examined microscopically. Decay was almost general in these teeth, whilst only one-quarter of the well-formed teeth were affected.

With C. L. Pattison, Mrs. Mellanby has investigated the extension of caries in children on different diets, and has found that increasing the vitamin D and decreasing the oatmeal has reduced the extension, when compared with less satisfactorily constructed diets.

The fact that apparently well-nourished people give signs, in the structure of their teeth, of a specific vitamin deficiency in their diet, is of great interest. It suggests that the supply of vitamin has been inadequate, and that in the competition for the amount provided in the diet, the teeth fail to obtain their due share. This work brings the problem of dental decay within the sphere of nutrition, and points the way to effective prevention: either the diet must be improved by the increased use of natural foodstuffs containing the vitamin, or a palatable and cheap source of the vitamin must be available. The work on the irradiation of ergosterol gives grounds for suggesting that it may be possible to provide, in the near future, vitamin D in a highly concentrated form, to be used either by itself as a medicament or for the enrichment of suitable articles of diet.

Obituary.

DR. W. COLLINGRIDGE.

DR. WILLIAM COLLINGRIDGE, who died on April 29 at seventy-three years of age, went up to Cambridge as a young man, and while there his medical studies were interrupted by the circumstance that he volunteered surgical services to the Serbian Forces during the Turko-Serbian War. On his return to England he resumed his studies at the University and graduated in medicine. After two years of private practice he was appointed (1880) Medical Officer of Health of the Port of London, and during his twenty years' tenure of this post he contributed materially to the advances made in port sanitary work. The period was an eventful one; for two continental epidemics of cholera seriously threatened Great Britain, and the measures he devised and conducted were of great assistance in securing the immunity from infection which London, and the country generally, enjoyed. In no small measure are we indebted to Collingridge for the comparative composure with which we should face such risks at the present day.

Collingridge's special knowledge and experience led him to become a great opponent of the old practice of 'quarantine'; and this was the subject which he discussed, most ably, in his Milroy Lectures to the Royal College of Physicians (1897). He maintained that no attempt should be made to enforce quarantine in a commercial country, now that other more satisfactory measures of safety were available; and he gave opinions supported by facts that such measures had certainly been evolved. Quarantine was expensive; it often failed, and thus gave a false sense of security; and it involved serious danger to those detained on the ships. Sanitation, the medical inspection of passengers and crew at some suitable mooring station, the hospital isolation of infected persons and the temporary detention of suspects, constituted a scheme which presented many advantages. These views have now met with a very wide acceptance. It was also during these years that he became a warm advocate of improved sanitary conditions in the mercantile marine; and he was a pioneer in securing such improvements, although the existing conditions still leave much to be desired.

In 1901, Collingridge was appointed Medical Officer of Health for the City of London—a post which he retained until 1913. It was inevitable that in this sphere of work also he would leave a deep impress of progress in measures to promote the public health. He recognised the danger from oysters bred in waters polluted with human sewage, and his persistent advocacy of the adoption of protective measures led to useful progress towards safety. He extended these operations to what he styled "the poor man's oyster"—the cockle—to the consumption of which he attributed, with good cause, much preventable illness. He always impressed the public health need for cleaner milk and did much to secure this in the City of London.

After his retirement from public health official work, Collingridge still remained deeply interested in public health matters. Throughout the War he was in charge of Auxiliary Military Hospital No. 112 in Kent. He maintained to the end his connexion with the Royal Sanitary Institute, of which he had been a member of Council and with which he was connected for nearly fifty years.

PROF. D. A. GILCHRIST.

BY the sudden death of Prof. Douglas Alston Gilchrist, professor of agriculture, University of Durham, Armstrong College, Newcastle-on-Tyne, on April 4, agricultural education and the agricultural industry of Great Britain have suffered a great loss. Prof. Gilchrist was the son of a west of Scotland farmer, and after leaving school, spent twelve years in practical farming, in which period he secured a thorough knowledge of the practical work and problems of farming. Afterwards he commenced to attend agricultural and science classes at the Glasgow and West of Scotland Technical College, and later made his way to Edinburgh, where he graduated B.Sc. (in agriculture) in 1889. In addition he obtained the senior certificate of the Royal Agricultural Society of England, and the diploma in agriculture of the Highland Agricultural Society of Scotland. In 1903 he was granted, by vote of Convocation, the degree of master of science in the University of Durham.

Bangor (North Wales), Reading (south of England), and Newcastle-on-Tyne were the three centres of Prof. Gilchrist's life work. He also visited France, Holland, Italy, Germany, and Canada, with the object of knowing something of agricultural education, research, and the practice of agriculture in these countries. In 1902 he was appointed to the chair of agriculture at Armstrong College and scientific director of the Northumberland County Experimental Station at Cockle Park. The abundant labours of the past twenty-five years are known and appreciated by a vast number of agriculturists, not only in Great Britain, but also all over the world. He was best known for his research in connexion with grass and clover seeds mixtures, and the improvement of permanent grassland by means of economic dressings of phosphatic manures.

When Prof. Gilchrist came to Newcastle there were six academic members on the staff of the Agricultural Department of Armstrong College. There are now sixteen such members, six of whom are advisers, the College being the northern provincial centre of higher agricultural education of the Ministry of Agriculture. By his writings and lectures delivered in various parts of the country Prof. Gilchrist was well known all over England. The experiments and demonstrations he organised at Cockle Park have had a marked effect upon farming in the north of England as well as in other parts of the country. He was much beloved by his colleagues on the staff of the Agricultural Department and his many students.

News and Views.

AT the recent monthly meeting of the Zoological Society, the Duke of Bedford presented the bronze medal of the Society to Keeper E. Bowman for the successful rearing of the young male hippopotamus which was born in the Society's Gardens at Regent's Park last August. A similar award has not been made since the year 1872, when the last baby hippopotamus was reared by Michael Prescott and Arthur Thomson. This animal was "Guy Fawkes," who afterwards lived for thirty-six years at the Zoo. In nine months the present youngster has trebled his birth-weight, which was in the region of a hundredweight, and now seems to be well on the way towards equalling the record set up by his famous predecessor. Some interesting facts were recorded at his birth and during the time which followed. From the Keeper's own observations in this case and previous records made by A. D. Bartlett in 1871 and 1872, the period of gestation for the hippopotamus has been fixed at 240 days. The mother's behaviour immediately before parturition indicated that in Nature birth probably takes place in very shallow water or in a bed of reeds at the water's edge. Although unable to stand or walk properly, the young one shuffled along on his knees into the water a few hours after birth and swam round the pond with his mother. After a time the mother submerged her body entirely and turned on her side. The young one immediately began to suckle under water, coming up to breathe at intervals varying from twenty to forty seconds. This he has continued to do up to the present time, although he has now cut a good set of milk teeth and is able to eat a certain amount of solid food. He has occasionally been observed to remain under water for so long as three minutes while suckling. The average time for an adult hippopotamus to stay submerged is four minutes.

DR. A. C. D. CROMMELIN, who retired from the Royal Observatory, Greenwich, on May 11, after thirty-six years' service, was educated at Marlborough and Trinity College, Cambridge. After a short time as assistant master at Lancing, he obtained by competitive examination a post as junior assistant at Greenwich in 1891. Dr. Crommelin was a regular observer with the transit circle, altazimuth, and Sheepshanks' equatorial. He had a wide general knowledge of astronomy and became an authority on questions connected with comets, minor planets, dates and times of eclipses, etc. His frequent notes on comets and his annual reviews on minor planets, as well as the physical ephemerides which he calculated for objects in both these groups, have been of great service. It was Dr. Crommelin who suggested to Dr. Cowell that they should calculate the 1910 return of Halley's Comet, and by the elegant method devised by Cowell, they predicted the return correctly to two days. For this they received a prize offered by the Astronomische Gesellschaft and the degree of D.Sc. from the University of Oxford. Dr. Crommelin went to the eclipses of 1896, 1900, and 1905, and had the good fortune to take part in the observations in 1919 which verified the bending of light predicted by Einstein. He has served on the Council of the Royal Astronomical Society since 1906 and was secretary from 1917 until 1923. He has also been on the council of the British Astronomical Association since 1896 and was president 1904–1906. Dr. Crommelin is such an enthusiastic astronomer that his work will not cease with his retirement from Greenwich. He has for several years been the chief contributor of notes in our Astronomical Column, and we hope to continue to have the advantage of his valuable co-operation.

ACCORDING to an announcement circulated by Science Service, of Washington, Dr. H. Fairfield Osborn has reported to the American Philosophical Society the discovery of fossil bone implements in Nebraska of Pliocene age. More than three hundred implements of forty different types have been found. They are made of the fossilised bones of extinct animals—camels, horses, deer, elephants, and mastodon. The exact locality of the discovery is not disclosed, beyond that it is in western Nebraska, in order to protect the site. The first find was made two years ago, and since then machinery has been used in excavating the area. Two localities about 75 yards apart have produced most of the finds. Dr. Osborn regards the implements as of undoubted human origin. Among them are skin dressers, awl-like implements, neck ornaments of strung bones, and a comb-like form that may be a tatooing implement. Eighteen of the types have been matched with counterparts from the ruins of cliff-dwellers of the south-west, and one can be nearly duplicated by a much more recent implement from a shell-mound in eastern America. Pending further information as to the geological evidence upon which the date of these implements has been determined, judgment must remain in suspense, although the opinion of Dr. Osborn must be given full weight. The comparison with the implements from the cliff dwellings is not necessarily reassuring until we know the types which present these similarities and have indubitable evidence of their high antiquity. Should this be established, the discovery will give strong support to those who have favoured the human character of the tooth discovered in the Pliocene of Nebraska a few years ago.

FARADAY'S lecture theatre at the Royal Institution was on May 18 the scene of a meeting of the Chemical Society and its distinguished guests, amongst whom was Lord Balfour, to hear the Faraday Lecture delivered by Prof. Richard Willstätter, whose discourse was devoted to a consideration of problems and methods in enzyme research. Taking Faraday's experiments "on the power of metals and other solids to induce combination of gaseous bodies" as the

starting-point in his discussion of organic catalysts, Prof. Willstätter said that the catalyst may function in degrees of association with the substrate varying from fixation to approach, the continuous distribution of electrical charges of the catalyst and the substrate mutually influencing one another. Platinum is capable of transferring hydrogen catalytically only in the presence of oxygen, hence the oxygenated platinum may be regarded as comparable with the enzyme-activator complexes. No single hypothesis is adequate to explain all the phenomena, but in enzyme chemistry no theory is so fruitful or so satisfactory as that assuming the existence of intermediate compounds between catalyst and substrate. The enhanced effects produced by mixed inorganic catalysts are closely analogous to the differences in potency and specificity exhibited by such enzyme systems as trypsin and trypsin-kinase or papain and papain-hydrogen cyanide. These catalytically active mixtures may be of the nature of new chemical compounds; the assumption that the admixture to the simple catalysts merely increases the frequency with which the catalytically active atoms stick out from the lattice is inadequate.

PROF. WILLSTÄTTER dealt also with the problem of the isolation of the enzymes in a state of purity, a problem which is in process of solution by taking advantage of absorption effects of alumina, kaolin, lead phosphate, etc., followed by elution with very gentle chemical reagents. No less should the method of preparation of an inorganic catalyst aim at increasing as much as possible the efficiency of unit weight of the material. Prof. Willstätter gave examples of the use of the process of purification by adsorption in determining whether or not certain elements such as iron or phosphorus are essential constituents of the enzymes. There is, however, no certain method of freeing the enzymes from protein derivatives. The tenacity with which proteins cling to enzymes threatens again and again to impose the conclusion that the enzymes are of a protein character. Invertase can, however, be freed almost completely from various chemically recognisable substances of high molecular weight without loss of activity or stability. The highest degrees of enzymic purity hitherto obtained have been achieved by a process of fractional adsorption on a finely divided precipitate, whereby an enzyme can be separated even from the products of its inactivation. In many cases there are indications as to which atomic groups of an enzyme are responsible for its union to an adsorbent, and delicate gradations in adsorptive power are determined by differences in the constitution of the particular gel employed. The only property of enzymes which is independent of their varying degree of purity is, apparently, their qualitative specificity. It is even possible, in certain cases, to ascertain the particular atomic group of the substrate molecule towards which the enzymic activity is directed.

IN addition to the official welcome given to Prof. Willstätter by the Chemical Society, a number of members of the Athenæum, representing many branches of biological and chemical science, entertained him at dinner at that Club on May 17. Prof. H. E. Armstrong was in the chair, and by the kindness of the director of the Royal Botanic Gardens, Kew, the table was decorated with some of the flowers of which the pigments have been investigated by the guest of the evening. When, in 1913, Willstätter and Everest described their work on the pigment of the blue cornflower, which they called cyanin, they laid the foundation of the fuller investigation of the anthocyan pigments that has been developed so successfully since that date, with the result that the colouring matters of the rose, pelargonium, viola, peony, hollyhock, cherry, and many other flowers are now known. Prof. Armstrong made a felicitous reference to an extract from Walt Whitman's "Leaves of Grass" in proposing the toast of Prof. Willstätter at the dinner:

"A Child said, 'What is Grass?' fetching it to me
with full hands.
How could I answer the child?
I do not know what it is any more than he.
I guess it must be the flag of my disposition, out of
hopeful green stuff woven."

Prof. Willstätter was welcomed as the man who had so greatly helped to draft what must finally be the answer to the child's question, at least in respect to the mingled greens and yellows which make up the beauty of plant colours; and Prof. Armstrong expressed the hope that he would return to this field of inquiry and discover new secrets in it.

IN a report from Cairo, Dr. Reisner states that at the moment of closing down operations for the season, the Harvard-Boston Expedition has made another discovery of no little importance at Giza. While excavating the burial chamber of Queen Hetepheres discovered two years ago, the clearing of the Royal Necropolis eastward of the Great Pyramid has proceeded simultaneously, and here, on what was intended to be the last day of the season's work, a doorway in the rock was disclosed which proved to be the entrance to the tomb of Meresankh, a granddaughter of Khufu (Cheops) and great-granddaughter of Queen Hetepheres, wife of Seneferu. It appears that three halls of the funerary chapel have been discovered. Statues and statuettes stand in niches in the walls; but the special feature of the tomb is the decorations in relief and colour. Some of these were added after the original decoration, one being of a son of Neweserraankh, a king of the Fifth Dynasty who claimed royal descent from Queen Meresankh, possibly being her grandson. This gives six generations descended from Queen Hetepheres represented here, extending from the Third to the Fifth Dynasty. According to the account given in the *Times* of May 19, all the figures show the characteristic physique of the family of Cheops, a receding chin, stumpy build, and obesity. One outstanding feature of the report is that a representation in relief of Hetepheres, daughter of Khufu and mother of

Meresankh, has short yellow or red hair. This is the earliest representation of that variant of pigmentation among the dark-haired Egyptians, and opens up an interesting field of speculation as to racial admixture at this early date.

A MEMORANDUM on the inscription of Darius I. recently discovered at Hamadan has been submitted by Prof. E. Herzfeld to the Indian Archæological Department. The record, which was engraved in three languages, old Persian, Elamite, and Babylonian, on each of two tablets of gold and silver, fixes the limits of Darius's empire "from the Saka, who are beyond the Sugd as far as the Kush, from the Hindu as far as Sparda." According to an account in the *Times* of May 19, Prof. Herzfeld concludes that Darius added Hindu to his conquests in 516 B.C. More important than his determination of the date, however, is his identification of Hindu with the third Indian sculptured figure of Darius's tomb, the other two being Gandara and Thatagush. The location of the last named had not hitherto been determined, but it is now suggested that the specific mention of Hindu, that is, Sind (Persian H = Indian S), and Gandara occupying the Kabul River Valley, Swat and the country around Tazila, fixes Thatagush (Persian Satagus, Indian Satagav—"having a hundred head of cattle") as having inhabited the Punjab. The inscription has a further significance in its bearing upon early racial distributions, for in giving the location of Saka as beyond the Sugd, Prof. Herzfeld holds that it throws light on the home of the kindred tribes which occupied the country between the Danube and central India and founded the empire which extended from Seistan to Malwa in central India.

AT an extraordinary meeting of the Council of the National Union of Scientific Workers, held at Caxton Hall, Westminster, on May 21, it was decided to change the name of the society to "The Association of Scientific Workers" in accordance with the votes cast by members and potential members for each of three titles, "The Association of Scientific Workers," "The Association of Scientists," "The Institute of Scientists." It was also decided, in order to give every qualified scientific worker in Great Britain the opportunity of becoming a member of the society, to make the subscription rate, as from Jan. 1, 1928, a minimum of ten shillings, leaving it to members to increase this amount according to their means. In view of the attitude of the Government towards professional organisations, as outlined by Mr. Ronald McNeill, the following resolution was put and passed unanimously: "That this Council Meeting of the Association of Scientific Workers calls on H.M. Government to amend Clause 5 of the Trade Disputes and Trade Union Bill in order to make it clear that civil servants in professional and technical grades are not deprived of the right to organise in their respective professional organisations, which have for their principal objects the maintenance of a high standard of professional attainment and the general improvement of status and conditions of service among their members, by whatever authority employed, as well as the spread of scientific knowledge and the increase of public support for scientific work. It reminds H.M. Government that H.M. Government has adopted the policy laid down in the Report of the Committee on State Servants that the professional man in the Civil Service, unlike any member of the administrative or fighting services, should relate his pay and position with those of his professional brethren in the outside world, which implies that the professional civil servant should be organised with his brethren in outside occupations."

DURING the past few days, long-distance flights by aeroplane have been well to the fore. Nungesser and Coli set out on May 8 from Le Bourget, near Paris, to cross the Atlantic, but at the time of writing, no news has been received of them. On May 20, two long-distance journeys commenced. Capt. Charles Lindbergh took off from Roosevelt Field, Long Island, New York, at 7·50 A.M. with the intention of making a non-stop flight to Paris; and Flight-Lieutenants C. R. Carr and L. E. M. Gillmans started at 10·42 A.M. from Cranwell Aerodrome, Lincolnshire, on a non-stop flight to India. Capt. Lindbergh landed at Le Bourget at 10·30 P.M. on May 22, having flown some 3500 miles in 33½ hours. His machine was a Ryan monoplane fitted with a 220 h.p. Wright "Whirlwind" engine and he carried 448 gallons of petrol. His course was along the American and Canadian coast to Newfoundland, across the Atlantic by a northerly route, along the south coast of Ireland, to Cornwall, Cherbourg, and Paris. Capt. Lindbergh was alone, and his feat was a noteworthy achievement of skill and endurance. Only once before has the Atlantic been crossed in one stage of flying and that was in 1919, when Alcock and Brown, flying a Vickers-Vimy machine, left the coast of Newfoundland at 4·28 G.M.T. on June 14 and landed at Clifden, Ireland, at 8.40 G.M.T. on June 15, having flown nearly 1900 miles. Lieuts. Carr and Gillman, on their attempt to reach India, flew a Hawker Horsley day bomber fitted with a 650-700 h.p. Rolls-Royce "Condor" engine, and carrying 1100 gallons of petrol. The total weight of the loaded machine was 14,200 lb., as against the 4750 lb. of Capt. Lindbergh's monoplane, which was of course specially designed for the Atlantic flight. Lieuts. Carr and Gillman came down in the Persian Gulf 45 miles south-east of Bandar Abbas at 8.15 P.M. on May 22. Both airmen were picked up by a passing vessel, but their machine was lost. They appear to have covered about 3500 miles in 30-32 hours.

ON May 4 occurred the centenary of the death of Mark Beaufoy, F.R.S., who assisted to found the Society for the Improvement of Naval Architecture of 1791 and to whom we are indebted for a long series of experiments on the resistance of bodies moving through water. Beaufoy's experiments, described in his "Nautical Experiments," were carried out in the old Greenland Dock and extended over

the years 1793–1798. It is said the experiments cost between £20,000 and £30,000 and that most of this was found by Beaufoy himself. The history of the Society and Beaufoy's work was the subject of a paper to the Institution of Naval Architects by Mr. A. W. Johns in 1910. Beaufoy was born in 1764, and was the son of a brewer. When twenty-three years of age he visited Switzerland and was the first Englishman to climb Mont Blanc, reaching the summit on Aug. 9, 1787, six days later than Saussure. In later life he turned his attention to magnetism and astronomy, and was one of the earliest members of the Royal Astronomical Society, to which his son afterwards presented his instruments.

THE *Proceedings of the Cambridge Philosophical Society, Biological Sciences*, has changed its scope and, under the title of *Biological Reviews and Biological Proceedings of the Cambridge Philosophical Society*, will take the form of critical summaries of recent work in special branches of biological science. The contents of vol. 2, No. 2, give an excellent idea of the aims of the publication in its new guise. It contains three articles, the first of which, by M. Abeloos, deals with the theories of polarity in the phenomena of regeneration. After a review of recent work in this field, M. Abeloos concludes that Loeb's theory of formative substances, if apparently providing a satisfactory interpretation of the facts of regeneration in plants, is insufficient when applied to the animal kingdom. He is of the opinion that the theories of Child alone provide any approach to a complete explanation of the quantitative, qualitative, and physiological aspects of polarity. Dr. F. H. A. Marshall discusses the conditions governing parturition and recent investigations which seem to throw light upon the problem. He shows that parturition is not the result of one or two factors but of a combination of conditions all contributing to the end in question. These conditions are analysed in the light of recent research. In a brilliant review of the mechanics of vertebrate development, Dr. G. R. de Beer summarises the work which has been done and the results achieved in the experimental study of the early development of vertebrates. If this number can be taken as indicative of the aims and scope of the journal for the future, it can be stated at once that it will meet a long-felt want. The articles are comprehensive in character, critical in outlook, and masterly in treatment. Biological workers will welcome such authoritative summaries of current work, and university teachers, in particular, will be grateful for such valuable help in their struggles, often under the most adverse conditions, to keep pace with the bewildering multiplicity of developments in biology and the ever-increasing scope of the science. *Biological Reviews* deserves the support of all workers in this branch of science.

THE annual report of the Institute of Physics for the year 1926, which was received and adopted at the annual general meeting held on May 16, refers to the changes which have been made in the honorary secretaryship and secretaryship of the Institute, already announced in our columns, consequent upon the resignation of Prof. A. W. Porter and the death of Mr. F. S. Spiers. The report shows a steady increase in the membership of the Institute, and refers to revised regulations for the admission of students which are intended to make the student membership more attractive to those who are not yet in a position to apply for corporate membership. Particulars are also given of the arrangements which are being made at the new offices of the Institute at 1 Lowther Gardens, Exhibition Road, South Kensington, London, S.W.7, whereby the Institute will undertake at the new offices, on behalf of the Physical and Optical Societies, routine work such as correspondence in relation to membership and subscriptions, and the control of stocks and sales of publications. The annual exhibition of the Physical and Optical Societies is included in this arrangement, and the exhibition will in future be organised from 1 Lowther Gardens, and controlled by a committee of representatives of the two societies, to which the secretary of the Institute will act as secretary. A fund for the furnishing and equipment of the offices has been raised largely on the initiative of Mr. Robert W. Paul, chairman of the Finance Committee, and generous contributions to this fund have been made by members of the Institute and by a number of firms. The editor of the *Journal of Scientific Instruments* reports the satisfactory progress of this publication, and announces that under the new editorial arrangements it is hoped to extend the manufacturing sections of the Journal.

THE second of the conversaziones of the Royal Society this year will be held on June 22.

THE Safety in Mines Research Station at Harpur Hill, Buxton, will be opened by Viscount Chelmsford, chairman of the Miners' Welfare Committee, on June 14.

DR. MAX WEBER, emeritus professor of zoology in the University of Amsterdam, who is an authority on marine mammals and fish, and has for many years engaged in oceanographic work, has been awarded the Agassiz Medal by the U.S. National Academy of Sciences.

THE following have been elected honorary members of the Russian Academy of Sciences: Prof. Albert Einstein (Berlin), Mme. Curie (Paris), Prof. W. Nernst (Berlin), Prof. A. A. Michelson (Chicago), and Prof. M. G. Mittag-Leffler (Djursholm, Sweden).

THE tenth Silvanus Thompson memorial lecture of the Röntgen Society will be given at 8.30 on Tuesday, June 14, in the Barnes Hall of the Royal Society of Medicine, 1 Wimpole Street, W., by Sir J. J. Thomson. The subject will be "The Structure of the Atom and Radiation."

DR. E. H. RAYNER will deliver a lecture, to be followed by a discussion, on the solar eclipse of June 29 at a special meeting of the Physical Society, to be held on June 3 at 5 P.M., at the Imperial College of Science and Technology, South Kensington. Fellows of the Society are invited to take friends to the meeting.

AT the annual general meeting of the Manchester Literary and Philosophical Society, the following officers were elected: *President*, Prof. W. L. Bragg; *Vice-Presidents*, Dr. G. H. Carpenter, Dr. O. T. Jones, Dr. H. Levinstein, Dr. R. S. Willows; *Secretaries*, Mr. John Allan, Prof. E. A. Milne; *Treasurer*, Mr. R. H. Clayton; *Librarians*, Mr. C. L. Barnes, Dr. J. C. Withers; *Curator*, Mr. W. W. Haldane Gee.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant lecturer in agricultural chemistry at the East Anglian Institute of Agriculture, Chelmsford—The Clerk of the Essex County Council, Shire Hall, Chelmsford (June 4). A demonstrator in the department of organic chemistry of Bedford College for Women—The Secretary (June 8). A senior and a junior lecturer in comparative anatomy and embryology in the Natural History Department of the University of Edinburgh—The Secretary, The University, Edinburgh (June 10). A lecturer in chemistry in the University of Reading, preferably with physical chemistry qualifications—The Registrar (June 10). An assistant lecturer and tutor in social science at the London School of Economics and Political Science—The Secretary, London School of Economics and Political Science, Houghton Street, W.C.2 (June 15). An assistant lecturer in applied electricity at the University College of North Wales, Bangor—The Secretary and Registrar, University College of North Wales, Bangor (June 15). An assistant lecturer in mathematics in the University of Sheffield—The Registrar (June 15). A professor of pathology at St. Bartholomew's Hospital Medical College—The Academic Registrar, University of London, South Kensington, S.W.7 (June 20). A professor of agriculture and a lecturer in entomology and zoology at the Imperial College of Tropical Agriculture, St. Augustine, Trinidad—The Secretary, Imperial College of Tropical Agriculture, 14 Trinity Square, E.C.3 (June 29). A temporary research officer under the Foot-and-Mouth Disease Research Committee of the Ministry of Agriculture and Fisheries—The Secretary of the Committee, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1. A Secretary and bursar of the South-Eastern Agricultural College, Wye, Kent—The Principal. A research assistant at the Government Laboratory, Porton—The Commandant, Experimental Station, Porton, near Salisbury. Chemists in the establishment of the War Department Chemist, Woolwich—The Permanent Under-Secretary of State, War Office (F.6), London, S.W.1.

Our Astronomical Column.

THE COMING TOTAL SOLAR ECLIPSE.—As an example of the general interest in astronomy that is being awakened by the approaching eclipse, we may mention a pamphlet by Mr. A. J. Hawkes, Borough Librarian at Wigan, in which he gives a list of the astronomical books in that Library, together with particulars and a map of the eclipse track. The map seems to place Wigan too far from the zone of totality; it is placed five miles outside, but the map issued by the Ordnance Survey places it considerably closer. The author seems to be in error in saying that the eclipse of August 1999 will not be total in Cornwall; it is true that calculations have not yet been made using Brown's tables of the moon, but fairly trustworthy calculations indicate that the Lizard and several miles to the north of it will enjoy total eclipse.

The list of books on astronomy is grouped under 23 different headings and occupies 8 pages. It is to be hoped that it may lead to a revival of popular interest in astronomy, such as was awakened by the Norwegian totality of 1896.

NEW DETERMINATIONS OF THE VELOCITY OF LIGHT.—The velocity of light *in vacuo* is a constant of fundamental importance in modern science, and it is necessary that the utmost attainable accuracy should be aimed at in determining its value. Great interest, therefore, lies in the experiments started in 1924 by Dr. A. A. Michelson at Mt. Wilson, with the object of re-determining this important quantity. The method originally employed was to send a beam of light from an octagonal mirror at Mt. Wilson to a station 22 miles distant, whence it was reflected back (by a fixed mirror) to the first mirror, and finally into a micrometer eyepiece. The octagonal mirror was rotated at such a speed that it moved one-eighth of a turn during the journey of the beam of light to the distant station and back (44 miles). The returning beam was thus received on the succeeding facet of the rotating mirror at the same angle as if the latter were at rest. The velocity of rotation required gave, by a simple calculation, the velocity of light in air. This apparatus has been slightly modified and improved in the later series of observations made by Dr. Michelson. Rotating mirrors of various types are used, some of steel, others of glass, with eight, twelve, and sixteen facets; the results from the different mirrors being in excellent agreement. These latest experiments are described in the *Astrophysical Journal*, vol. 65, p. 1, in which the final value of the velocity of light *in vacuo* is given as 299,796 km./sec. The success so far attained has led to the consideration of an extended base line, and it is hoped to continue the work with a distant mirror on Mt. San Jacinto, 82 miles from Mt. Wilson.

ROYAL ASTRONOMICAL SOCIETY'S ANNUAL REPORT.—The annual report of the Council of the Royal Astronomical Society (*Monthly Notices*, Feb. 1927) contains the usual valuable summary of astronomical progress during the year. In particular a lengthy section by "H. D." on variable stars may be mentioned, which summarises all the important papers published on this subject during the year, and gives copious references. The fact that more than a third of this article is devoted to Cepheid Variables shows that the recent revival of interest in these objects is still being maintained. A valuable innovation has been introduced by "J. A. C." in the sections on solar research and stellar spectroscopy. This consists in a classified bibliography at the end of each section giving references to all relevant papers published during the year, including those not specifically mentioned in the text. This will be appreciated by those specially interested in solar and stellar physics, and is a procedure which might advantageously be extended to the other sections. In addition to the notes on astronomical progress, this issue contains obituary notices of deceased fellows, annual reports of observatories, and the presidential address of Dr. Jeans on the occasion of the award of the Society's Gold Medal to Prof. Schlesinger.

Research Items.

MAORI GAMES.—A valuable monograph by Mr. Elsdon Best on the games and pastimes of the Maori has been published under the direction of the Board of Ethnological Research of the Dominion Museum, N.Z., as Bulletin No. 8. Not only is the account of Maori games given by early travellers meagre, but, owing to the disapproval of these games by the missionaries, notwithstanding their harmless character, few of them survived until the beginning of the present century. Like other features of Maori life, the arts of amusement were attributed to a mythical originator. The practice of the arts of Ruhanui followed the rising of Whanui (the star Vega) when the main crops were lifted. The indulgence in games thus depended to some extent on the leisure afforded by seasonal occupations, but they were also played at night. The recreations may be classified into (1) children's games played at all times; (2) games played at night or at free times when members of two or more families met in a house or on the village plaza; (3) at large meetings such as ceremonial feasts, harvest festivals, etc., when members of one or more sub-tribes gathered together, contests of skill or strength forming a special feature of the occasion; or (4) specially arranged contests between members of different village communities, in wrestling, canoe rowing, dart throwing, posture dancing, and the like. Kite-flying contests were also held. Certain of the games, such as the duels and combats in the school for arms for men, and the posture dances for women, were looked upon not merely as recreation but also as a training for the arts of life, the grace of action, for example, to be acquired through the dance being regarded as an essential in a girl's deportment. The monograph includes in its scope a careful and detailed study of the songs and musical instruments. The Maori did not use stringed instruments, but only wind and percussion.

SUGAR BEET IN ENGLAND.—Mr. G. Turville Brown, in Paper No. 507 of the Surveyors' Institution, gives a full account of the British sugar beet industry. Beginning with a general history of the sugar industry, he shows that the introduction and development of beet sugar in Europe can be traced largely to political conditions, and that the chief reasons why it was not possible to establish its cultivation in England earlier were the facts that the bulk of the beet sugar exported from the Continent, a practice encouraged by European governments with bounties, came to Great Britain, and that British interests were largely vested in the production of cane sugar in the British Empire. The first attempt to introduce the cultivation of sugar beet into England in 1870 was unsuccessful, and even in 1921 the revived industry suffered heavy loss in spite of Government aid. The passing of the Beet Sugar Subsidy Act in 1925, however, details of which are appended to the paper, has resulted in the industry attaining national importance, and in the first year five of the ten factories showed a profit. Although in comparison with countries where the growers are experienced the tonnage obtained is low, the quality and sugar content have been high, and when the farmer has learnt to make the best use of the by-products, namely, the fodder portion of the crop, there is good augury for the success of the industry in Great Britain. With regard to the return which the farmer receives, an average figure based on the prices for 1925 and 1926 shows a £10 profit on a 10-ton crop, without including the feeding value of the residual tops and leaves. Further, any increase in the cultivation of a profitable root crop would help to check the modern tendency of putting arable land down to grass. As regards climate, England and the lowlands of Scotland are quite suitable for sugar beet, and indeed Great Britain, in being less liable to late frosts, has a distinct advantage over northern Europe. The importance of this is manifest, since much seed-selection work is being carried out in Holland with the view of securing a variety able to withstand late frost without going to seed. Some points with regard to the choice of suitable factory sites, and the methods of working which will secure the greatest possible economy, are included, matters which will prove themselves all the more important to the life of the industry as the subsidy decreases.

AGE AND AREA.—In an article in the *Quarterly Review of Biology* (vol. 1, No. 4) Dr. J. C. Willis replies in part to various criticisms of the age and area hypothesis, and particularly to those of Prof. Fernald in the same journal (vol. 1, No. 2). Many points of difference are involved, some of which cannot at present be settled. For example, as regards rate of distribution, Willis estimates that the wing-fruited Dipterocarp trees of Malaya and the Philippines would be dispersed at the rate of 100 miles in 60,000 years, while Fernald points out that nearly the whole of Canada must have been forested from farther south since the retreat of the ice not more than 25,000 years ago. Notwithstanding the rapid dispersal of weeds, Willis concludes that generally whole associations of plants must advance together but with extreme slowness. Again, the need is recognised for distinguishing between local endemics and epibiotics or survivors from a larger area; and the fossil history, which often cannot be traced, must also be considered. Again, it appears that, *e.g.* in the Ericas of South Africa, a wide-ranging northern form has quickly produced a whole series of new local types after reaching what must be regarded as favourable conditions for the genus. Willis insists upon the necessity of treating his results statistically, but it appears unnecessary to make the improbable assumption that new species have generally arisen as the result of a single mutation. His work has brought fresh interest to the old problems of distribution; and further investigations should show in how far time, which no one denies is a factor in dispersal, can be disentangled statistically from the many other factors such as barriers, the rate and conditions of variation, etc., which will play a part in determining the area occupied by a particular species or group of species at a particular time.

TORTOISESHELL CATS.—The tortoiseshell cat remains a genetic anomaly, although the work of Mrs. Bisbee and Miss Catherine Herdman (*Jour. Genetics*, vol. 18, No. 1) sheds further light on the subject. Normally tortoiseshells are females derived from a cross between yellow and black, but in rare cases a male tortoiseshell may occur. Numerous theories have been put forward to explain these and related facts. It appears that either there is a difference in the dominance of black and yellow in the two sexes or both colours are sex-linked. The authors favour the latter view, having found that all yellow cats of either sex have a few scattered black hairs. In the breeding experiments an anomalous yellow female appeared, which showed and transmitted a very small amount of black spotting. This is accounted for by a theory of fractionation of a factor—yellow; the

'anomalous yellow' and black being regarded as a series of multiple allelomorphs.

NEW COTTON SPECIES.—Five new species of cotton have recently been described by Messrs. O. F. Cook and J. W. Hubbard, who give a general account of these primitive cottons in *Jour. of Heredity*, vol. 17, No. 12. They were found among desert vegetation or in door-yards and along roadsides in the provinces of Sonora and Sinaloa in north-western Mexico. One species, *Gossypium Morrilli*, found growing in natural undisturbed conditions in the Yaqui Valley, produces great numbers of bolls and has commercial possibilities. *G. contextum* has the interesting peculiarity that numerous additional fibres form a lining to the inner walls of the carpels, but it is not yet certain that they are actually attached to the wall. Another desert species, *G. davidsoni*, has no lint, but only a short brown fuzz on the seeds. The different types are well illustrated by photographs, and some of them will be useful for crossing with the cottons in cultivation.

AGRICULTURE IN NIGERIA.—The fifth annual bulletin (1926) of the Nigerian Department of Agriculture contains the reports of the various agricultural stations for the previous year, together with a number of papers dealing in detail with some of the investigations in progress at the different centres. A scheme is proposed, which of necessity will extend over a long term of years, the object of which is to increase the production of palm fruit, but social and administrative considerations, arising largely from the manner of ownership of the groves, tend to increase the difficulties entailed in carrying out any improvements. The ground-nut trade is another important industry, but possesses many problems, which if solved would greatly enhance the value of the product. The best time for lifting the crop, and suitable preparation for export, such as efficient decorticating, grading, and packing, are some of the principal subjects under present consideration. An improved method for the extraction of palm oil by natives, the Cooker-Press process, is described and its advantages over the current methods pointed out. Research as to the most suitable preparation of palm nuts before cracking and the subsequent treatment of the nuts and kernels affords another example of investigations which are likely to prove of immense help to the native industries. Variety trials, cultivation and manurial experiments of all kinds, are reported from the various agricultural stations, and fungoid diseases of cotton and, to a less extent, the control of insect pests such as the yam beetle, are being investigated.

WATER AND INDUSTRIAL DEVELOPMENT.—The relation between the quality of the water and manufacturing activity in the United States is discussed by Mr. W. D. Collins in Water Supply Paper 559 (United States Geological Survey). The supply of water is a factor of equal importance with raw materials, power, labour, and transport, in deciding the location and growth of manufactures, and though water can be artificially improved, the cost of so doing is generally too great in manufactures that require large quantities of water of definite quality. A comparison between the location of industries fifty years ago and the present time appears to show that soft water was then more important than it is now, since manufacturing activity has increased most rapidly in States which have hard water. However, Mr. Collins shows that the growth of industry in hard water regions is mainly of two kinds: first, industries that do not depend on the quality of the water, such as metal and wood industries, canning and preserving, glass and rubber works; and secondly, industries in which numbers of population are more important than any other factor, as flour mills, confectionery, printing, gas-making, etc. The industries dependent on the quality of water, which include chemical, textiles, leather and paper, within the last fifty years have grown almost entirely in those States where the water is soft or only slightly hard, and they do not show any tendency to shift from those regions. The whole subject is treated statistically and illustrated with distribution maps.

IRON ORE IN WESTERN CANADA.—Messrs. G. A. Young and W. L. Uglow have provided an account of the iron ores in the western part of Canada in a recent memoir (Canada. Department of Mines; Geological Survey. Economic Geology Series No. 3: Vol. 1: British Columbia and Yukon. (No. 2093.) 40 cents. Ottawa: F. A. Acland.) It must be admitted that from the economic point of view the report is not particularly hopeful. There are 24 deposits listed believed to contain upwards of 25,000 tons of iron ore; the amount of ore considered to be almost certainly present is only 137,000 tons; the amount of ore probably present is estimated at 1,200,000 tons and the total possible ore contents only 5,000,000 tons; these figures refer to magnetite deposits, of which the greater part of the iron ore deposits in the area discussed consist; with a couple of exceptions of deposits rich in apatite, all the known magnetite deposits are of Bessemer quality. There are also a few deposits of limonite, but these do not appear to be of any great importance. Furthermore, the difficulties of transport in several cases are at present very serious. The report considers that the magnetite deposits of the coast districts must be looked upon as the primary sources of native iron ore that might support an iron-making industry in British Columbia, but evidently the prospects of such an industry being formed on an economic basis do not at present appear to be very promising.

THE ORIGIN OF METEORITES.—In *Gerlands Beiträge z. Geophysik* (1927, pp. 195-222), R. Schwinner discusses the origin of meteorites in greater detail than has hitherto been attempted. He suggests that meteorites cannot be descendants from any part of our solar system, but that they form a cosmic cloud which the solar system entered for the first time in early Quaternary time. This deduction is based partly on the orbits of meteorites and partly on the remarkable fact that no meteorites from beds of Tertiary or older formations have ever been discovered. The origin of the cosmic cloud is ascribed to a collision between two small stars which is estimated to have occurred between 10^{10} and 10^{11} years ago. It is claimed that the structure of meteorites supports the view that they were formed like explosive tuffs and that some parts of them cooled rapidly in a weak gravity field. Though meteorites as a whole may provide a kind of cross-section through a formerly existing heavenly body, the supposition that they provide any information as to the interior of the earth must be regarded with extreme caution. As to the origin of tektites, the author is unable to decide whether or not they are of meteoric origin.

FRACTIONAL PRECIPITATION OF BARIUM AND RADIUM CHROMATES.—Several methods are available for the separation of radium and barium by fractional precipitation. In the *Journal of the American Chemical Society* for March, Henderson and

Kracek describe a method of separation by means of the chromates which compares very favourably with the best of those previously employed. In general, the radium-barium solutions were treated with hydrochloric acid followed by definite quantities of potassium chromate solution. Partial separation follows from the fact that barium chromate is appreciably more soluble than the corresponding radium salt. This method may be used with advantage when the radium content of such mixtures is too small to be treated by the chloride method.

CHEMICAL TREATMENT OF FLOUR.—We have received a copy of the Report of the Departmental Committee which has been considering the treatment of flour with chemical substances, published by H.M. Stationery Office (6*d*. net). Chemical substances are introduced into flour in the first case as bleaching agents, and secondly as improvers, which are said to enhance the natural baking qualities of the flour, which may be deficient in one or more respects. Among these substances are calcium and ammonium acid phosphates, persulphates, chlorine, nitrogen trichloride, nitrogen peroxide, nitrites, and benzoyl peroxide. The Report recommends that when bleaching and improving are necessary the use of chlorine, nitrogen trichloride, and benzoyl peroxide should be avoided. An alternative method of improving by physical means is suggested. By heating wheat or flour at a given temperature for some time, the baking properties are considerably improved, and under certain conditions this flour itself may be used as an improver. At least one mill has discontinued the use of chemical improvers in favour of the physical method.

THERMAL DISSOCIATION OF IODINE AND BROMINE.—The method usually employed for the measurement of the dissociation of iodine and bromine, namely, by measuring the pressure produced by a known amount of halogen sealed in a quartz bulb of known capacity in the presence of an inert gas, has yielded values which are in poor agreement with those predicted by theory. In order to establish with greater certainty the values of the thermal quantities involved, Devries and Rodebush have adapted the method of Knudsen for the determination of vapour pressure by the measurement of the rate of diffusion through a small orifice. Their work is described in detail in the *Journal of the American Chemical Society* for Mar. 1927. The previously accepted value for the entropy of monatomic iodine at 298° K. and 1 atmosphere is 42·6, while the calculated entropy is 40·4. Although the newly determined number is 40·5, Devries and Rodebush consider that the true value of the entropy lies between 42·6 and 40·5, since spectroscopic data indicate that the iodine molecule should possess a magnetic moment and consequently a higher entropy. The calculated entropy of monatomic bromine is 39·0, but this is only approximate, and for this reason no significance can be attached to the agreement of this value with that of 38·2 determined experimentally.

ATOMIC PHYSICS.—The issue of the *Physikalische Zeitschrift* for Mar. 15 contains an address on the present position of atomic physics, delivered by Prof. A. Sommerfeld before the Faculty of Science at Hamburg. One of its objects was to counteract the pessimistic opinion held by many, of the inability of the quantum theories to give a comprehensive view of the physics of matter capable of replacing entirely the electromagnetic theory of thirty years ago. While Heisenberg introduces into his specifications of atomic systems only such quantities as can be directly observed, Schrödinger and de Broglie in their wave mechanics go behind observed phenomena, and their method has led to great developments in the mathematical treatment of atomic problems. Unfortunately, the new mechanics destroys the sharpness of the picture of the planetary atom to which we have grown accustomed, but the gain in mathematical simplicity is of much greater importance than this loss, and there can be no suggestion of entirely giving up the Bohr theory of the atom.

COMPRESSIBILITY OF HYDROGEN AND NITROGEN.—In view of the number of processes now in use for the production of ammonia from mixtures of hydrogen and nitrogen at pressures from 100 to 1000 atmospheres, data concerning the properties of the compressed gases are of great value. The compressibility isotherms of hydrogen and nitrogen and mixtures of these gases at 0° and pressures up to 1000 atmospheres have been determined at the Fixed Nitrogen Research Laboratory of the American Bureau of Soils by E. P. Bartlett. A quantity of gas at a given pressure and temperature, confined in a heavy steel pipette of known volume, is allowed to expand into a gas burette, and the amount of gas determined by measurement of a fixed volume at a known pressure differing but slightly from atmospheric. Details and the results of this work are given in the *Journal of the American Chemical Society*, Mar. 1927. The compressibility factor of a mixture cannot be calculated from those of the separate gases, since the compressibilities are not linear functions of the composition, but certain empirical equations have been derived connecting these two quantities.

AN ALUMINIUM FILM FILTER IN TELEPHONY.—In a modern telephone system there is a battery of accumulators at the central office which serves as a common reservoir of energy for talking and signalling. It is necessary to charge this battery while it is connected to the system. The alternating components of voice frequency in the output of the charging generator appear as objectionable noise currents in the telephone lines, and therefore great pains are taken to design the direct current generator so as to eliminate all ripples from the voltage wave. This more than doubles the cost of the machines, reduces their efficiency and increases the maintenance cost. In the *Bell Laboratories Record* for April, Mr. Siegmund describes a filtering device which prevents the disturbing ripples from entering the talking circuit even when only a cheap commercial dynamo is used for charging. As condensers having capacities of several thousand microfarads have to be employed, the device would not be economical were it not for the high capacities and the little space occupied by aluminium electrolytic condensers. When an aluminium rod is maintained positive to a suitable electrolyte, a very thin non-conducting film is formed on it which forms the dielectric of the condenser. The electrolytic condenser resembles a single-cell storage battery. The anode plate is corrugated and the cathode plate is flat. They are fastened to the porcelain cover of the jar. For 24-volt operation one jar has a capacity of about 1000 microfarads. They require no routine maintenance. The oscillograph records shown by Mr. Siegmund prove the utility of the device. The properties of the aluminium film have been already used in chemical rectifiers, in lightning arresters and in condensers for power work. Their application in telephony, however, is of particular value at the present time, when the power required for machine switching in automatic systems is growing so rapidly.

What Determines the Resistance and the Tilt of an Aeroplane?[1]

By Sir JOSEPH LARMOR, F.R.S.

ONE used to recognise that the exigencies of flight in the tenuous air prescribed a limit to the bulk of a bird, as compared for example with a whale. Yet nowadays every day loads of twenty tons of stuff or possibly far more are carried over long journeys, owing to the power available, solely on wings. How does the attenuated aerial medium find means of supporting such an astonishing mass? To experts the fact is familiar, and so scarcely demands explanation. Indeed, the source of the support in plain terms is just as wonderful as the fact itself. The load is held up solely by the swirl that it produces and leaves behind, and this vertical support must be the only dynamical effect of the swirl when the speed is steady: there remains the question how precisely this result is adjusted. Unfortunately the wakes from screw and wings can scarcely be additive without some mutual interference, though momenta are additive always. For example the spread of the wings is adapted readily to counteract the rotational grip of the screw. Stability is theoretically (G. H. Bryan) another affair.

Whether the supporting medium is air, or water, or even pitch, provided only it is of uniform density everywhere, the momentum, with which the flight is concerned, proves to be expressible at each instant in terms of the distribution of swirl or vorticity alone. Force is experienced by the travelling system equal and opposite to the rate at which momentum is shed away into the wake of its motion. The nature of the swirl passing into the wake thus determines all. In the ideal perfect fluid of abstract hydrodynamics there would be no wake, and therefore no force affecting the translatory motion, though the mass may twirl in permanent precessional spin. If this train of ideas is right it is impossible for a circulation round the wings of an aeroplane to sustain it, except in so far as it has to be associated with a vortical wake.

The formula for the momentum associated with each element of whirl in the ambient medium, of whatever kind it be and however complex its internal friction, provided only it is *of uniform density*, turns out to be unexpectedly simple. There is translational momentum equal, as applied at any chosen origin, to the vector moment of the mass-vorticity of the element (mass multiplied by spin), combined with rotational momentum around that origin equal to this mass-vorticity multiplied by the square of the distance with sign reversed. Now vorticity has the advantage of being a quality of considerable persistence, unless the internal friction is high: if then this field of spin could be sufficiently explored by observation, it would only be necessary, in order to obtain the forces operating, to trace out the rate at which the derived system of momentum thus associated with the travelling machine is changing. Many special illustrations present themselves. For example, a travelling aeroplane adjusts its presentation so that this moment of momentum, with regard to the point where the pull of the screw intersects the line of weight, is not subject to loss into the wake: such automatic adjustment would tend to nip together the two boundary sheets of the vortical trail, which thus would open out only at the ends of the wings. Again, a windmill parachute appears to be more effective than the simple umbrella type: if so, the cause doubtless declares itself in a wind-channel by the contrasted types of whirl in the wakes they leave behind. And generally, the performance of any propelling screw wholly submerged would be determinable in terms of the whirl in its wake alone, if only that could be explored.

[1] Abstracted, with additions, from *Proc. Cambridge Phil. Soc.*, Feb. 1, 1927, pp. 617-630.

The Wren-Ashmole-Plot Memorial Windows at Oxford.

THE public unveiling of the memorial windows to Sir Christopher Wren, Ashmole, and Dr. Plot by the Chancellor of the University, Lord Cave, took place at Oxford on May 17 in ideal circumstances of weather, after the ceremony of the presentation of honorary degrees to MM. Doumergue and Briand. Speeches were delivered in the Divinity School by the representatives of the bodies who have given the windows. Mr. Madan, on behalf of Brasenose College, spoke on Ashmole as the founder of the oldest museum of natural history; Mr. Guy Dawber, president of the Royal Institute of British Architects, pronounced an éloge on Wren; and the Public Orator, Mr. Poynton, representing University, Magdalen, and Hertford Colleges, made a witty speech on Dr. Plot. The windows are a notable addition to the beauty of the staircase of the Old Ashmolean Museum, and will recall to generations of visitors the great pioneer work of this interesting group of men of science of the seventeenth century, some of whose work is illustrated in the Lewis Evans Collection on the upper floor of the building. The Chancellor expressed the grateful thanks of the University to the respective donors. He also paid a well-deserved tribute to Dr. R. T. Gunther, the Curator of the Lewis Evans Collection of Scientific Instruments, to whose zeal and energy are to be attributed the excellent arrangement and appropriate housing of the Lewis Evans Collection, and at whose instigation the donors of the memorial windows were moved to undertake these admirable additions to the interest of the historic building that contains them.

The new windows in the Old Ashmolean Building commemorate the work of Ashmole and his three friends, whose collective scientific achievements during the second half of the seventeenth century have proved second to none even in that fertile period of English science. The word collective is used designedly, for it is extremely probable that the labour or good intention of any one member of the group would have been of no avail without the faithful co-operation of the others. They have one and all in their several ways participated in the establishment in Oxford of the first public museum of natural history in Britain. It is meet that so great a public service should be recognised in the building, which fortunately is still standing, a monument to their great work.

The oldest member of the group, John Tradescant, was a great collector, a scientific traveller, a pioneer who introduced new plants into Europe, and followed his father as the owner of the first London museum, at Lambeth. To him succeeded Elias Ashmole, a great transmitter. He realised the supreme educational value of the collection, and on the death of Tradescant, saved it from being scattered by his widow. His social prestige assured its appreciative acceptance by the University, which received the gift with royalty and a banquet, after the expending of a great sum on a building which is not only the finest classical building

in Oxford, but preserves to us Wren's plan for a scientific institution.

With singular appropriateness Oxford is therefore able to accept this memorial window to one of her most distinguished sons of science from the Royal Institute of British Architects. For long before the chance of rebuilding London definitely turned the scientific worker into the architect, Wren had filled the highest scientific post in the University with laudable distinction, and when the Ashmolean Museum was in building he occupied the presidential chair of the Royal Society.

The Tradescant window was presented by the Garden Clubs of Virginia in memory of his great prestige as a gardener and of his fruitful visits to their colony. It was unveiled by Lord Fairfax of Cameron in November last. The Ashmole window is given by the principal and fellows of Brasenose College, of which Ashmole was a member during his sojourn in Oxford. The badge and supporters to the coat of arms, the head of Mercury and the figures of the constellation of the Twins, are emblematic of Ashmole's double interest in astrology and alchemy, with especial regard to Mercury, planet and chemical element. The design has been taken from one of his most treasured books now in the Bodleian Library.

The inscription runs :

ELIAE ASHMOLE
HUIUS MUSEI FUNDATORI
COLL. AEN. NAS. PRINCIPALIS ET SOCII
ALUMNO SUO HANC FENESTRAM DEDICAVERUNT
MCMXXV.

The right-hand upper light records the distinguished service of Ashmole's first Keeper of the Museum, Dr. Robert Plot, one of the most remarkable of the Oxford celebrities of his time. He received his early education at University College, whence he proceeded to Magdalen Hall, and when thirty-seven years of age published his "Natural History of Oxfordshire," the work which not only made him famous but also probably suggested Oxford as the best destination for the Tradescant-Ashmole collections. His "Natural History" certainly was the first of its kind, and became the model for many later works. On the strength of a testimonial from John Evelyn, Ashmole in 1683 appointed Plot as his first Keeper of the Museum, a position that he filled for seven years, combining the duties with those of professor of chemistry and of secretary to the Philosophical Society of Oxford.

Towards the end of his life, Plot, elected to the office of Mowbray Herald, seems to have adopted the coat of arms in the new window. The surrounding wreath is of two Oxfordshire flowers which Plot was the first to recognise as new to the British flora. They are the marsh violet (*Viola palustris*) and the "Greatest Dove's foot Crane's-bill with dissected leaves" (*Geranium dissectum*). The happy dedicatory inscription runs :

ROBERTUS PLOT R.S.S.
HUNC CELEBRANT COLLEGIA NOMEN ET ARTEM
TRADITA MUSEI EST PRIMO CUSTODIA PRIMI.

In the right-hand lower light are emblazoned the arms and crest of Sir Christopher Wren, with two swags of foliage and contemporary scientific instruments familiar to astronomers and navigators at the time when, as Savilian professor of astronomy, Wren doubtless taught their theory to his pupils. The instruments comprise the mariner's astrolabe, cross-staff, backstaff, astronomical ring dial, and nocturnal, all very carefully studied and drawn upon the glass. Of special interest is the drawing of Wren's own pair of compasses, now in the possession of the Royal Society, and the only example of his many instruments that has come down to us. A cartouche below contains the dedicatory inscription recording the circumstances of the presentation of this window by the Royal Institute of British Architects.

CHRISTOPHERUM WREN
ASTRONOMIAE PROFESSOREM SAVILIANUM
COELESTIBUS EXSTRUCTIONIBUS NOBILEM COMMEMORAVIT
REGALIS SOCIETAS ARCHITECTORUM BRITANNICORUM
MCMXXVII

In a letter to the *Times* for May 23, the anniversary of Ashmole's birthday, Mr. E. B. Knobel expresses the hope that these armorial windows may be supplemented by one to Dr. Lewis Evans, whose gift has led to the revival of the Old Ashmolean.

University and Educational Intelligence.

CAMBRIDGE.—Dr. G. F. C. Searle, Peterhouse, has been reappointed University lecturer in experimental physics, and Mr. C. Warburton, Christ's College, has been reappointed demonstrator in medical entomology.

LONDON.—At a meeting of the Senate on May 18, the Vice-Chancellor stated that with reference to the anonymous offer, already announced, of £10,000 towards the establishment of a chair of dietetics, Messrs. A. Wander, Ltd., had now intimated their desire to contribute a similar sum to the same object.

It was announced that a donor who desires to remain anonymous has offered £250 as a contribution towards any preliminary expenses involved in the preparation of a comprehensive plan for the development of the Bloomsbury site.

Mr. D. MacC. Blair, lecturer in regional anatomy in the University of Glasgow, has been appointed as from Aug. 1 to the University chair of anatomy tenable at King's College.

Dr. G. S. Wilson has been appointed as from Oct. 1 to the University readership in bacteriology and immunology tenable at the London School of Hygiene and Tropical Medicine. Dr. Wilson was educated at Epsom College, King's College, London, and Charing Cross Hospital. In 1919 he was appointed specialist in bacteriology at the Royal Army Medical College; in 1921 he became assistant in bacteriology under the Medical Research Council. In 1923 was appointed lecturer in bacteriology in the University of Manchester, and since 1925 he has been assistant director of the Public Health Laboratory, Manchester.

The following doctorates were conferred : D.Sc. in Botany on Mr. P. Sarbadhikari (Imperial College—Royal College of Science) for a thesis entitled "Cytology of Osmunda and Doodia—On the Gametophyte and Post-meiotic Mitoses of the Gametophytic Tissue of Doodia;" and D.Sc. (Economics) on Mr. G. C. W. C. Wheeler (London School of Economics) for a thesis entitled "Mono-Alu Folklore."

The Dunn Exhibitions in anatomy and physiology were awarded to Mr. K. M. Robertson, of St. Thomas's Hospital Medical School.

THE Society for the Advancement of the Training of Mechanics, Leyden, announces vacation courses for mechanics and glassblowers in August next at the Physical (Cryogenic) Laboratory of the University of Leyden. Full particulars can be obtained from Dr. C. A. Crommelin, the Physical Laboratory, Leyden, Holland.

BY the will of Lady (Charles) Henry, of Carlton Gardens, London, S.W., a large sum of money will become available for the foundation of scholarships

at Oxford and Cambridge for American students and at Harvard and Yale for British students. The scholarships will be open to both sexes and are to be available for undergraduate as well as post-graduate courses. The Charles and Julia Henry Fund, as it will be termed, is to be administered by twelve trustees, three each being appointed by the four universities concerned, who will have wide discretionary powers. The whole of the residuary estate, estimated at £300,000, goes to the fund.

PARTICULARS of vacation courses in England and Wales, 1927, are given in a pamphlet (London, H.M. Stationery Office. 6*d*.) issued by the Board of Education. Courses for teachers have been arranged: by the Board itself, to be held at Oxford, Cambridge, London, Durham, Birmingham, Nottingham, Bangor, Brighton, Eastbourne, and Studley; by the local education authorities of Brighton, Carmarthen, Cheshire, Glamorgan, Hertford, Kent, and Yorkshire (West Riding); and by five teacher-training institutions. Courses for foreigners are offered by the Universities of London and Cambridge. The University Extension summer meeting will be at Oxford, and there will be the usual university tutorial class summer schools in connexion with all the universities except Reading. Among the various courses offered at Bingley by the West Riding County Council is one by Mr. Stanley Jast on the library and the school. The National Museum of Wales is giving a course on methods of caring for exhibits. Some thirty courses in their special subjects are offered by various voluntary associations. Summer Schools of the League of Nations Union are to be held at Oxford (St. Hugh's College, July 27-Aug. 5) and Geneva (Geneva Institute of International Relations: elementary, July 30-Aug. 5; advanced, Aug. 6-Aug. 12). At Oxford, Lord Hugh Cecil will give the inaugural address, and there will be a preliminary conference of teachers on July 27-29, opened by the Right Hon. H. A. L. Fisher.

APPOINTMENTS made by the Committee of Award for the Commonwealth Fund Fellowships to the twenty Fellowships tenable by British graduates in American universities for the two years beginning in September 1927 include the following: Mr. J. M. Alston (Edinburgh), to Harvard University, in medicine; Mr. Maurice Black (Trinity College, Cambridge), to Princeton University, in geology; Mr. G. F. Brett (Leeds), to the University of Michigan, in physics; Mr. David Graham (Queen's University, Belfast), to the Massachusetts Institute of Technology, in electrical engineering; Mr. F. T. Hewer (Bristol), to Johns Hopkins University, in medicine; Mr. M. I. Hutton (Glasgow University and Balliol College, Oxford), to Yale University, in economics; Mr. Eric F. Nash (University College, Oxford), to Harvard University, in economics; Mr. R. A. C. Oliver (Edinburgh), to Stanford University, in education; Mr. A. Oppenheim (Balliol College, Oxford), to the University of Chicago, in mathematics; Mr. R. Robinson (Birmingham), to the University of Pennsylvania, in physical chemistry; Miss E. Simkins (Liverpool), to Clark University, in geography. This year the Commonwealth Fund has established three extra fellowships, primarily intended for candidates from British Dominions who have studied at British Universities. Nominations to these Fellowships include the following: Mr. H. I. Coombs (Adelaide University, Magdalen College, Oxford, and Trinity College, Cambridge), to the Rockefeller Institute, New York, in physiology; Mr. Reginald Jackson (University of South Africa and Trinity College, Oxford), to Harvard University, in philosophy.

Calendar of Discovery and Invention.

May 29, 1453.—From some points of view the fall of Constantinople, which took place on May 29, 1453, may be regarded as contributing directly to the birth of the modern age of scientific inquiry and discovery. When, after a siege of 53 days, Mahomet II. gained possession of the city, many Greeks fled into Europe, carrying with them the precious manuscripts of ancient Greek authors. Included in these were mathematical works which were translated and soon afterwards made available through the invention of the printing press.

May 29, 1624.—The first legislative enactment for regulating the granting of industrial monopolies was The Statute of Monopolies (21 Jac. I. c. 3) passed by the English Parliament on May 29, 1624. The Statute was not, as has often been assumed, the foundation of the English patent law; it merely gave parliamentary sanction to principles, already accepted at common law, which now form the basis of all patent laws throughout the world. Its purpose was to prevent the Crown from granting oppressive monopolies, but in the famous section 6 it exempted from the general prohibition the granting of patents for the encouragement of new inventions. This section is still in force.

May 31, 1836.—The introduction of screw propulsion was due to many pioneers, of whom, however, the foremost was Francis Pettit Smith. Smith's first patent was taken out on May 31, 1836, and he described his invention "to consist of a sort of screw or worm made to revolve rapidly under water, in a recess or open space formed in that part of the after part of the vessel, called the dead wood or dead wood of the run." His screw was tried successfully in the s.s. *Archimedes*, the first screw vessel to navigate the open seas.

May 31, 1919.—On the afternoon of May 31, 1919, the American seaplane NC4, piloted by Lieutenant-Commander A. C. Read, arrived in England, having since May 16 flown in three stages from New York to the Azores, thence to Lisbon and to Plymouth. She was the first machine to fly across the Atlantic.

June 1, 1785.—Cavendish in his study of the atmosphere used many methods, and some of these he described to the Royal Society in his paper, "Electric Discharges through Air," read on June 1, 1785.

June 1, 1894.—One of the landmarks in the early history of radio signalling was Sir Oliver Lodge's lecture at the Royal Institution on June 1, 1894, on "The Work of Hertz," when, with the aid of a Branly's coherer of filings, signals were detected at a distance from the transmitting apparatus.

June 1, 1906.—Five tunnels pierce the Alps—the Mont Cenis, the St. Gothard, the Arlburg, the Lotschberg, and the Simplon. Of these the Simplon is the longest and deepest, being 12¼ miles long and more than 7000 feet below the surface. Begun in 1898, it was opened on June 1, 1906. It was bored simultaneously from both ends, and when the two tunnels met, the error of alignment was only 3⅜ inches.

June 2, 1881.—The famous test of Pasteur's views on the efficacy of vaccination of animals for anthrax culminated on June 2, 1881, at the farmyard of Pouilly le Fort. Twenty-five vaccinated and twenty-five unvaccinated sheep had previously been inoculated with some very virulent cultures of the anthrax bacillus. On June 2, Pasteur and others visited the farm. "The carcases of twenty-two unvaccinated sheep were lying side by side; two others were breathing their last. . . . All the vaccinated sheep were in perfect health. . . . The one remaining unvaccinated sheep died that same night."

E. C. S.

Societies and Academies.

LONDON.

Royal Society, May 19.—Lord Rayleigh: Studies of the mercury band spectrum of long duration. The stream of vapour is excited by a current of less than a milliampere, using a hot cathode. It is then observed spectroscopically after leaving the region of discharge. As in previous investigations, the resonance line λ2537 is associated with the band spectrum, but the resonance line λ1850 is absent. The important divisions of the band spectrum are: (*a*) The band at λ2345, with attendant bands of shorter wave-length; (*b*) the resonance line λ2537, with bands within a few Ångströms of it; (*c*) the fainter maximum at λ2650, and a series of flutings which are made out with difficulty but seem to be associated with it; (*d*) the broad maximum at λ3300; (*e*) the broad visual maximum. When the vapour is examined *after excitation* all these features decay *pari passu*. The actual time taken to decay to half intensity under the conditions is $1{\cdot}82 \times 10^{-3}$ second. If the excited stream of vapour is passed through a tube locally heated to redness, the band (*e*) is extinguished, (*a*) and (*c*) are slightly weakened, but (*b*) and (*d*) are almost unaffected. As the vapour passes on to the cold part of the tube the visual light (*e*) reappears to some extent, and (*a*) and (*c*) tend to regain their intensities relative to (*b*) and (*d*).

A. Fowler and L. J. Freeman: The spectrum of ionised nitrogen (N II). Observations have been made over the range λ6836 to λ830. Of 340 lines recorded in this region, about one-half have now been classified, and of the remaining lines more than 100 are very faint. The spectrum is built up from triplet and singlet terms. The scheme of terms deduced from the Heisenberg-Hund theory of complex spectra has greatly facilitated the analysis of the spectrum. Of the 19 deepest terms predicted for transitions of a single electron, complex terms being counted as one, all but one have been identified. The term 1^3P_0 recently identified by Bowen from a multiplet at λ671 is probably the deepest, its value being 238850, corresponding to an ionisation potential of 29·5 volts. A few multiplets which appear in the spectrum are attributed to double electron transitions.

O. W. Richardson: The hydrogen band spectrum: new band systems in the violet. This paper describes the *Q* branches of some band systems which include much of the strength of the secondary hydrogen spectrum when this is excited by direct electron impact on the H_2 molecule and there are no additional complications. The final states of the bands appear to be the same as the initial states of the Lyman bands in the far ultra-violet (the *B* states of Dieke and Hopfield). All the bands are degraded towards the violet. The strongest band system, denoted by *A*, has its nucleus $(0 \rightarrow 0Q$ (1) line) at λ4633·95(9). The *Q* branch of the $1 \rightarrow 0$ band is the series 20 *Q* (*m*) of Richardson and Tanaka. There is a less strongly developed band system (*B*) with its nucleus at 3684·38(2) and a few *Q*(1) lines of a system (*C*) with its nucleus at 3368·47(0). *A*, *B*, and *C* all have the same set of final states. The terms are $2S = 33727{\cdot}12$, $3P = 12676{\cdot}47$, $4P = 7087{\cdot}66$, $5P = 4514{\cdot}14$. They are very close and similar to the corresponding terms of the principal series of He *singlets* but rather larger.

O. W. Richardson: Note on a connexion between the visible and ultra-violet bands of hydrogen. There is evidence in the visible secondary hydrogen spectrum of the existence of bands the final states of which are the same as the initial states of the bands found by Werner in the Lyman region. Some of the consequences of this are discussed, including a recalculation of the moment of inertia of the normal hydrogen molecule. The value found is $4{\cdot}5 \times 10^{-41}$ gm. cm.^{2}

C. N. Hinshelwood and P. J. Askey: Homogeneous reactions involving complex molecules. The kinetics of the decomposition of gaseous dimethyl ether. In the decomposition of dimethyl ether to form carbon monoxide and hydrogen the reaction is unimolecular at pressures above about 400 mm. At lower pressures it ceases to be independent of the initial pressure. The hydrogen seems to act only by maintaining the Maxwell distribution among the molecules of ether, when this would otherwise be disturbed by the chemical transformation of activated molecules; for it can only restore the rate of reaction to its normal limiting value and cannot increase it beyond this. Nitrogen, helium, carbon monoxide, and carbon dioxide do not have a similar influence.

W. G. Palmer: An experimental test of the dipole theory of adsorption. The electric coherer functions normally when the loose contact is immersed in liquids, and the cohering voltage increases regularly in the homologous series of primary alcohols, fatty acids, and their ethyl esters, according to the rule $E^2/l = \text{constant}$, where l is the length of the chain. This result indicates that the energy of desorption in a given series is proportional to the square of the electric moment of the adsorbed molecule, and supports the dipole theory of adsorption.

Sir Robert Hadfield: Thermal changes in iron-manganese alloys low in carbon. The temperature at which the final recovery of magnetism occurs on cooling, with its accompanying evolutions of heat, is progressively lowered with increasing manganese percentage. The transformation, however, becomes gradually weaker in intensity and finally vanishes while still at a temperature of about 100° C., and at a manganese percentage just short of that at which non-magnetic qualities are reached, namely, 16 per cent. Thus the explanation that the alloys exceeding this percentage owe their non-magnetic qualities to their critical change points being below atmospheric temperature, is not tenable. The present work gives further support to the belief that the suppression of the magnetic qualities of the iron may be due to its actual combination with the manganese.

K. S. Krishnan and C. V. Raman: The magnetic anisotropy of crystalline nitrates and carbonates: Crystals of sodium and potassium nitrates exhibit a marked diamagnetic anisotropy, the susceptibility perpendicular to the plane of the NO_3-ion being greater than for directions in the plane; the difference of susceptibility in the two directions is the same for the two crystals. Attributing this anisotropy to that of the NO_3-ion, its magnitude is exactly what we should expect from the known value of the magnetic birefringence (Cotton-Mouton effect) of nitric acid liquid. An explanation is suggested on the basis of its electronic structure; the CO_3-ion, which has essentially the same structure, gives almost the same anisotropy.

C. G. Darwin: The Zeeman effect and spherical harmonics. The problem of a spinning electrified sphere moving in a central orbit in a magnetic field is solved in spherical harmonics by the method of the wave mechanics. It leads to a set of simple arithmetical equations which give exactly all the features of the standard Zeeman effect in all strengths of field. Strictly the model only yields the odd multiplicities, but the same system of equations is just as competent to give the even.

D. Jack: The band spectrum of water vapour. Evidence on the nature of the emitter of the water vapour bands is in favour of the OH ion. The band

2608 is similar in structure to the others and leads to the same final moment of inertia as the bands 3064 and 2811. The scheme of bands suggested by Dieke has been extended, and verified by taking differences of the wave numbers of corresponding lines in the various bands.

L. S. Ornstein, H. C. Burger, J. Taylor, and W. Clarkson: The Brownian movement of a galvanometer coil and the influence of the temperature of the outer circuit. A particular form of theory suitable to the requirements for the more complicated case of a galvanometer having an external inductance L, of ohmic resistance r, at an absolute temperature T^0, is developed.

W. A. Bone and D. M. Newitt: Gaseous combustion at high pressures (Part vii.). A spectrographic investigation of the ultra-violet radiation from carbonic oxide—oxygen (or air) explosions. The resultant ultra-violet radiation from $2CO+O_2+4R$ explosions at corresponding high initial pressures, where R is a diatomic diluent, is much less when the latter is carbon monoxide or nitrogen than when it is oxygen; this result indicates that the former strongly absorbs the ultra-violet radiation emitted by the burning carbon monoxide in such circumstances. The marked nitric oxide formation which always occurs in a carbon monoxide excess-air explosion at an initial pressure of 25 atmospheres does not take place during the actual combustion, but after all the resulting radiation capable of effecting a sensitive photographic plate has been emitted. When nitric oxide is present during the actual combustion period in such an explosion, a definite absorption band spectrum is superposed upon the characteristic continuous ultra-violet spectrum of the burning carbon monoxide. The resultant ultra-violet radiation from a $2CO+O_2+4Ar$ explosion at an initial pressure of 14 atmospheres is very much stronger than that for a $2CO+O_2+4He$ explosion at the same pressure, although the maximum temperatures attained in the two cases differ by 130° C. only.

O. W. Richardson and M. Brotherton: Electron emission under the influence of chemical action at high gas pressures, and some photoelectric experiments with liquid alloys. The reaction investigated is that of $COCl_2$ at pressures not less than 0·001 mm. on drops of the liquid alloys of sodium and potassium. The electric currents are (1) proportional to the rate of drops (2) independent of the pressure of $COCl_2$ over a wide range. The distribution of velocity among the higher velocity electrons is Maxwellian; there is no sharp limit as in the photoelectric effect. The average energy is equivalent to a temperature of 2370° K. The chemical currents can be used to determine the contact potential between the drops and a second electrode. The results seem to agree with the hypothesis that the chemical action is propagated sideways at the edges of infected patches.

P. A. M. Dirac: The quantum theory of dispersion. One can consider a field of radiation to be a dynamical system whose canonically conjugate variables are the energies and phases of its Fourier components. One can then describe its interaction with an atom by a Hamiltonian function and obtain a satisfactory quantum theory of all radiative processes. The theory, when applied to the scattering of radiation by an atom, shows that two kinds of scattering processes can take place, namely, single processes for which a light-quantum simply changes its direction of motion, and double processes which are combinations of an absorption and emission. The sum of the two, when account is taken of their mutual interference, gives (excluding the case of resonance) just Kramers' and Heisenberg's dispersion formula. When the incident frequency coincides with that of an absorption line, practically the whole of the scattered radiation comes from transitions to the higher state and down, again governed by Einstein's laws.

Royal Microscopical Society[1] (Liverpool Conference), Mar. 30 and 31.—Eric Ponder: The diameter of the red cells of man before and after exercise. The red cells of man, or of any animal, may be measured without being brought into contact with any atmosphere other than one which is in equilibrium with the blood from which the cells are derived (technique of Dryerre, Millar, and Ponder). The preparations of cells, immersed in the plasma of the subject whose cells are to be measured, are made in a special chamber containing a gas mixture in equilibrium with the blood at rest or after exercise, as the case may be, the gaseous tensions of this blood being determined by preliminary analyses. These preparations are then photographed, and the diameter of the cells determined from the plates. There appears to be no difference in the mean diameter of the cells of the same individual before and after severe exercise.—W. Ramsden: Surface phenomena. Aqueous solutions of many organic solids of high molecular weight can be made to yield visible solid masses by treating them in such ways as will sweep up any particles present on their air-surfaces. The solutes used are solids which diminish the tension of a water-air surface, and the heaped-up surface-particles are termed 'massed adsorpta.' With the three proteins egg-albumin, fibrinogen, and edestin, the massed adsorpta undergo irrevisible coagulation and are insoluble in the mother liquids. With all other substances tested, including in these very many proteins, the massed adsorptum rapidly goes back into solution. The 'adsorptum-coated' surfaces are in some cases freely mobile (sodium oleate, bile-salts, quinine). In other cases (nearly all proteins, and saponin) sulphur grains or magnets floated on the surface are mobilised. All solutions capable of being blown into more than fugitive bubbles, or of forming stable emulsions with oils, contain solutes adsorbable at the interfaces concerned.—J. Ross-Mackenzie: The causes and correction of cloudiness in malt liquors. Brewing materials are extremely complex in composition, and the ever-changing character of nitrogenous substances produces cloudiness. The permanently soluble nitrogenous constituents are divided into two groups, 'assimilable nitrogen' and 'non-assimilable nitrogen.' The amount and type of assimilable nitrogen absorbed depends on the class of yeast used. A beer produced from British barley-malt and hops only would contain an excess of crude nitrogen; to overcome this excess the brewer is compelled to employ materials free from nitrogen as diluents. Composite yeasts are mainly used in breweries and 'wild yeasts,' in excess, are the main cause of cloudiness, abnormal flavours and odours, and general instability in beers.—A. C. Thaysen and H. J. Bunker: Some observations on the microscopical study of deteriorated fabric from early Egyptian tombs. Swabs were taken in the sepulchral chamber of Tut-ankh-amen's tomb immediately after opening and were tested for live bacteria and fungus spores. Though such were undoubtedly present when the tomb was sealed, no viable spores existed. Linen fabrics from this tomb and that of Queen Hetepheres, *circa* 3000 B.C., was examined to determine the cause of tendering. Probable fungus spores and fragments of mycelium were found in the Tut-ankh-amen material, but on swelling the fibres with sodium hydroxide, the appearance was typical of that produced when tendering is caused by

[1] Continued from p. 766.

chemical agencies. It seems that though microbiological activity occurred on the fibres to a limited extent and in localised areas, such action ceased comparatively soon after the sealing of the tomb and was superseded by a different type of deterioration, usually referred to as 'ageing.'

DUBLIN.

Royal Irish Academy, April 25.—E. J. **Sheehy**: The relative food values of brown (from entire wheat grain) and white (from endosperm of grain) wheaten flour, and their comparative potency for the prevention of xerophthalmia in guinea-pigs. Results of prolonged feeding experiments on guinea-pigs with restricted diets bear evidence of the superiority of brown over white flour as regards the content of vitamin A. Xerophthalmia appears earlier and more frequently in the group of animals fed on white flour and mangels than in the brown flour and mangel lot. The progress made by the group of animals fed on mangels, brown flour, and hydrogenated soya bean oil is similar to that made by those animals fed on mangels, white flour, and cod-liver oil.

Royal Dublin Society, April 26.—W. R. G. **Atkins**: The soluble silicate content of soils. The colorimetric method of Diénert and Wandenbulcke may be used to estimate the soluble silicate in an aqueous extract. Calculated on the weight of the air-dried soil the silicate, as SiO_2, was found to vary from 18 to 124 parts per million. No constant relation was observed between these figures and those for electrical conductivity or *p*H values, but the soils used had been stored.—M. **Grimes**, H. S. **Boyd Barrett**, and J. **Reilly**: Methylene blue (reductase test) in milk grading.

EDINBURGH.

Royal Society, May 9.—D. Noël **Paton**: Submergence and postural apnœa in the swan. An investigation of the apnœa in the swan in feeding, showing that it is postural and that both labyrinthine and neck reflexes are involved.—H. Graham **Cannon**: On the feeding mechanism of *Nebalia bipes*. Nebalia is a mud-living form feeding on food filtered from an antero-posterior food stream produced by the oscillatory movements of its trunk limbs. The latter are armed along their inner edges with four rows of setæ. The first and third rows are hooked and those of successive limbs interlock, forming a continuous filter wall. The fourth row are stiff setæ which comb the filtered food off the filter walls, and the second are brush setæ which sweep the food so gathered forwards to the mouth. The mouth parts both functionally and structurally resemble those of a mysid, and Nebalia probably arose from such a primitive form that took to mud-living habits, the foliaceous limbs having developed in correlation with this new habitat.—A. H. R. **Goldie**: The structure and movement of the atmosphere as affected by diurnal variations. The main processes are (*a*) gravitational mass convection, transferring heat upwards in accordance with Sandstrom's principle, which would in the long run lead to extreme stability in the vertical direction and great frequency of inversions were it not for the operation of (*b*), the waves and vortices due to discontinuous motions, however local, which operate to transfer heat downwards or horizontally at the cost of some of the energy of the general horizontal circulation and tend to obliterate the discontinuities. The final result is a stratification of the atmosphere with a fair degree of 'resilience' and in particular a semidiurnal variation; turbulence, initiated in the forenoon by such solar radiation as reaches ground level and initiated in the evening mainly by outgoing radiation from cloud masses or from air masses raised convectionally in the morning, leads at these times to a certain amount of mixing of layers with consequent retardation; on the other hand, in the late afternoon and the latter part of the night the laminarity of flow is improved.—A. W. **Greenwood** and F. A. E. **Crew**: On the quantitative relation of comb size and gonadic activity in the fowl. The law of 'all-nothing' formulated by Pezard does not hold in the case of comb volume. The degree of development of head furnishings is dependent not on the amount but on the degree of spermatogenic activity of the gonadic tissue.

ROME.

Royal National Academy of the Lincei, Mar. 6.—L. **Tonelli**: An approximation polynomial and the area of a surface.—C. **Somigliana**: Determination of geodic constants by means of measurements of gravity alone.—O. M. **Corbino**: Realisation of high positive and negative self-inductions by means of a three-electrode lamp and induction circuits.—A. **Lo Surdo**: The saturation current of thermionic valves. Experiments with various thermionic valves show that, in the phase of saturation, the current intensity is not constant but varies very nearly in proportion to the potential difference between the plate and the filament. Moreover, for any temperature of the filament of any one valve, the increases of the saturation current corresponding with definite increments of the anode voltage are, within wide limits, approximately constant fractions of the respective currents.—J. M. **Burgers**: Some investigations of Helmholtz and of Wien relating to the form of the waves at the surface of separation between two liquids.—L. **Fernandes** and F. **Palazzo**: Investigations on sulpho-salts (ii). Sulphoxypolymolybdates of ammonium and of guanidine. Treatment of the solution of a normal sulphomolybdate with even a relatively weak acid, such as acetic or formic acid, results in decomposition of the salt with evolution of hydrogen sulphide and precipitation of molybdenum sulphide. On the other hand, the sulphoxy-salts, although they are decomposed by strong mineral acids, undergo polymerisation similar to that experienced by the oxygenated salts under the action of weak acids in low concentration. A number of ammonium and guanidine sulphoxypolymolybdates have been prepared in this way.—Remo **de Fazi**: Alcoholic fermentation of glucose solutions exposed to the action of ultra-violet rays. When a glucose solution is exposed to the rays emitted by a quartz mercury vapour lamp, its optical rotation remains unchanged, but its subsequent fermentation by yeast is accelerated, often considerably, and the final liquid is appreciably more free from bacterial contamination than the untreated solution similarly fermented.—G. **Cotronei**: New observations on the influence of the nervous system in relation to nutrition with thyroid in the morphogenesis of the *Anura amphibia*.—P. **Pasquini**: Investigations on the experimental embryology of the echinoderms (i). Atypical segmentation and successive development of the egg of *Arbacia punctulata* (Grey) centrifuged after fertilisation. The resistance of the egg of Arbacia to centrifugal force is immediately modified by fertilisation, the plasma becoming more sensitive in some respects.—U. **D'Ancona**: Investigations on the increase in size of the eye of the eel in relation to sexual maturity, and considerations on its biological significance.—L. Volterra **D'Ancona**: Further as to the variability of the pelagic Daphnia of Lake Nemi.

Official Publications Received.

BRITISH.

Hull Museum Publications. No. 145: Record of Additions, No. 70. Edited by T. Sheppard. Pp. 47. No. 146: Hull's Art Treasures. By T. Sheppard. Pp. 56+15 plates. No. 147: Catalogue to the Hull Printing Trades Exhibition, held at the Museum of Commerce and Transport, High Street, Hull, from March 17th to April 9th, 1927. Pp. 40+xxxvi. (Hull.)

Canada. Department of Mines: Mines Branch. Helium in Canada. By R. T. Elworthy. (No. 679.) Pp. iv+64+2 plates. (Ottawa: F. A. Acland.) 20 cents.

Aeronautical Research Committee: Reports and Memoranda. No. 1055 (Ae. 238): Tests on Handley Page Aerofoil A.1. and R.A.F. 31. Communicated by Messrs. Handley Page, Ltd. (A.3.a. Aerofoils General, 159, 160, 161.—T. 2213-14-15.) Pp. 32+11 plates. 1s. 3d. net. No. 1058 (Ae. 240): D. M. Smith's Method for the Determination of the Transverse Frequencies of Vibration of Uniform Beams. By T. W. K. Clarke and V. M. Falkner. (D.1. Special Technical Questions, 180.—T. 2295.) Pp. 9+2 plates. 9d. net. No. 1067 (Ae. 249): On the Contraction of the Slipstream of an Airscrew. By H. Glauert. (A.3.d. Airscrews, 90.—T. 2237.) Pp. 11. 6d. net. (London: H.M. Stationery Office.)

University Grants Committee. Returns from Universities and University Colleges in Receipt of Treasury Grant 1925-1926. Pp. 24. (London: H.M. Stationery Office.) 3s. net.

Pharmaceutical Society of Great Britain: Pharmacological Laboratories. First Annual Report, 1926. Pp. 7. (London.)

Journal of the Royal Statistical Society. Vol. 90, Part 2. Pp. x+225-432. (London.) 7s. 6d.

The University of Leeds: Department of Coal Gas and Fuel Industries (with Metallurgy). Report of the Livesey Professor for the Sessions 1924-25 and 1925-26. Pp. 14. (Leeds.)

FOREIGN.

Proceedings of the Imperial Academy. Vol. 3, No. 2, February. Pp. iii-iv+45-114. (Uyeno Park, Tokyo.)

University of California Publications in American Archaeology and Ethnology. Vol. 23, No. 4: Arrow Release Distributions. By A. L. Kroeber. Pp. 283-296. (Berkeley, Calif.: University of California Press; London: Cambridge University Press.) 25 cents.

Columbia University. Bulletin of Information, Twenty-seventh Series, No. 19: Professional Courses in Optometry; Announcement 1927-1928. Pp. 30+3 plates. (New York City.)

United States Department of Agriculture. Department Bulletin No. 1472: Chemotropic Tests with the Screw-Worm Fly. By D. C. Parman, F. C. Bishopp, E. W. Laake, F. C. Cook and R. C. Roark. Pp. 32. (Washington, D.C.: Government Printing Office.)

Department of the Interior: U.S. Geological Survey. Water-Supply Paper 550: Surface Water Supply of the United States, 1922. Part 10: The Great Basin. Pp. v+192+2 plates. 10 cents. Bulletin 790-B: The 'Palouse Soil' Problem, with an Account of Elephant Remains in Wind-Borne Soil on the Columbia Plateau of Washington. By Kirk Bryan. (Contributions to the Geography of the United States, 1926.) Pp. ii+21-45+plates 4-7. (Washington, D.C.: Government Printing Office.)

Proceedings of the United States National Museum. Vol. 71, Art. 1: Description of a new Species of Fresh-water Copepod of the Genus Moraria from Canada. By Arthur Willey. (No. 2673.) Pp. 12. Vol. 70, Art. 4: Miscellaneous Descriptions of new Parasitic Hymenoptera, with some Synonymical Notes. By A. B. Gahan. (No. 2676.) Pp. 39+1 plate. Vol. 71, Art. 6: A new Genus and Two new Species of South American Fresh-water Mussels. By William B. Marshall. (No. 2678.) Pp. 4+2 plates. (Washington, D.C.: Government Printing Office.)

CATALOGUES.

The West Indies: being a Catalogue of Books, Maps and Engravings relating to British and Foreign Possessions in the West India Islands. (No. 495.) Pp. 42. (London: Francis Edwards.)

Catalogue of Secondary and Higher Text-Books. Pp. iv+208. (London: G. Bell and Sons, Ltd.)

Errata List No. 1. Pp. 8. Circular 251A: Laboratory Coats, Aprons and Short Jackets. Pp. 2. Circular 253A: Standard Volumetric Glassware. Pp. 2. Circular 255: The "Alltest" Multi-Range Portable Moving Coil Instrument. Pp. 2. Circular 256: New Electrical Apparatus for the Determination of Molecular Weights by Rast's Camphor Method. Pp. 1. Circular 262A: Monax Laboratory Glassware. Pp. 4. "Schola" Beakers and Flasks. Pp. 3. (London: A. Gallenkamp and Co., Ltd.)

Illustrated Price List of Apparatus for Radiology (Abridged). 1927 edition. Pp. 64. (London: Newton and Wright, Ltd.)

Rare and Valuable Books. (No. 17.) Pp. 126. (Newcastle-on-Tyne: William H. Robinson.)

Diary of Societies.

SATURDAY, MAY 28.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South Wales District Meeting) (at Town Hall, Newport), at 9.30 A.M.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates and Students Section) (at Neville Hall, Newcastle-upon-Tyne), at 3.—W. S. Armstrong: Variable Speed Gears and their Application for Colliery Purposes.—Paper open for further discussion: The Ventilation of a Pyrites Mine, with Special Reference to Fire-Fighting, Safety and Rescue-Work, R. White.

MONDAY, MAY 30.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Rev. Prof. R. D. Wilson: The Radical Criticism of the Psalter.

SURVEYORS' INSTITUTION (Annual General Meeting), at 5.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—T. Hastings: Devonshire House Buildings.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—W. F. P. Burton: Central Katanga.

TUESDAY, MAY 31.

ROYAL SOCIETY OF ARTS (Dominion and Colonial Meeting), at 4.30.—Dr. T. Baldasano: Spanish Morocco.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—E. A. Bierman: (*a*) The Development of Chloro-Bromide Papers; (*b*) The Exposure of Colour-Screen Plates.

WEDNESDAY, JUNE 1.

ROYAL SOCIETY OF MEDICINE (Surgery Section), at 5.—Sir James Berry, G. Turner, and others: Discussion on The Treatment of Cleft Palate by Operation.

ROYAL MICROSCOPICAL SOCIETY, 7.30 to 10.—Annual Pond Life and General Microscopical Exhibition.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.—Dr. H. Scott: Narrative of an Entomological Expedition in Central Abyssinia.

THURSDAY, JUNE 2.

GENETICAL SOCIETY (Annual General Meeting) (at Linnean Society), at 3.—Dr. R. A. Fisher: Light and Dark Lines in Pied Mice.—C. Diver: The Problem of Natural Selection in Relation to Helix (Cepæa).—Prof. R. R. Gates and Miss M. L. Sheffield: On Meiotic Arrangements in Oenothera and their Bearing on Segregation.—W. C. F. Newton: Sex in *Silene Otites* Agg.

ROYAL SOCIETY, at 4.30.—Prof. S. Chapman and A. E. Ludlam: A Theoretical Discussion of certain Elastic Constants of Calcite and Crystalline Sodium Nitrate.—R. W. Fenning and H. T. Tizard: The Dissociation of Carbon Dioxide at High Temperatures.—L. H. Callendar: The Influence of Boundary Films on Corrosive Action.—*To be read in title only*:—N. R. Sen: On Fresnel's Convection Coefficient in General Relativity.—C. F. Elam: Tensile Tests on Alloy Crystals.—A. J. Bradley and J. Thewlis: The Crystal Structure of α Manganese.

CHEMICAL SOCIETY, at 8.—U. R. Evans: The Passivity of Metals. Part I. The Isolation of the Protective Film.—Prof. T. M. Lowry and R. R. Goldstein: Studies of Valency. Part VIII. The Molecular Structure of Vernon's Dimethyltelluronium Salts.—E. Roberts and E. E. Turner: The Factors Controlling the Formation of Some Derivatives of Quinoline, and a New Aspect on the Problem of Substitution in the Quinoline Series.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Scottish Meeting) (at Dunfermline).

FRIDAY, JUNE 3.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—Dr. E. H. Rayner: The Forthcoming Eclipse of the Sun (Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. G. M. Trevelyan: Carlyle as an Historian.

ROYAL SOCIETY OF MEDICINE (Social Evening), at 9.30.—Dr. G. W. C. Kaye: X-rays, and some of their Uses.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Scottish Meeting) (at Dunfermline).

SATURDAY, JUNE 4.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Scottish Meeting) (at Dunfermline).

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South-Eastern District Meeting) (at Maidstone).

PUBLIC LECTURES.

SUNDAY, MAY 29.

GUILDHOUSE (Eccleston Square, S.W.), at 3.30.—Prof. J. Garstang: Recent Discoveries in Palestine.

TUESDAY, MAY 31.

CHELSEA PHYSIC GARDEN (Swan Walk, Chelsea Embankment), at 5.—B. Gerritzen: The Growing, Marketing, and Exporting of Fruit and Vegetables in the Netherlands (Chadwick Lecture).

THURSDAY, JUNE 2.

INSTITUTE OF PATHOLOGY AND RESEARCH, ST. MARY'S HOSPITAL, at 5.—Prof. C. A. Lovatt Evans: The Alkalinity of the Blood.

CONVENTIONS.

JUNE 6 TO 9.

CONVENTION OF CANADIAN CHEMISTS (at Quebec).

JUNE 6 TO 11.

PHOTOGRAPHIC CONVENTION OF THE UNITED KINGDOM (at Warwick).

Monday, June 6.—Afternoon.—Welcome by the Mayor of Warwick. Installation of President. Presidential Address. Annual General Meeting.

Tuesday, June 7.—Evening.—H. Baker: Lecture.

Wednesday, June 8.

Thursday, June 9.—Evening.—A. S. Newman: Lecture.

Friday, June 10.—Evening.—A. Keighley: Lecture.

Saturday, June 11.