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School and Sex.[1]

IN 1920 the Consultative Committee of the Board of Education was reconstituted by Order in Council, and two urgent problems, of scientific character and far-reaching importance, were referred to it almost immediately for inquiry and advice: namely, first, what degree of differentiation is desirable, for boys and girls respectively, in the teaching of secondary schools; and, secondly, what use can be made, in the public system of education, of psychological tests. On the subject of the former reference the committee has received a vast body of evidence from a long list of witnesses—from medical men and psychologists, from teachers and examiners, from employers and business men; and the results of its inquiries have now been brought together in the pages of the report before us.

The first chapter, largely the work of the committee's secretary, Mr. R. F. Young, provides an admirable history of the curriculum in secondary schools for boys and girls; and this brief chronological survey is followed by a descriptive account of the present system of secondary education, so far as it bears upon the terms of the committee's reference. The education of what was once considered to be the weaker or the gentler sex has passed through two opposite phases, and is entering upon a third. The first was a phase of emphasised sex-difference based upon a supposed sex-inequality. It was the stage of feminine accomplishments and nothing more; it was also, therefore, a stage of educational inefficiency. During the second period—a period of reaction—education was based upon an assumed equality of the sexes; and reformers claimed, and endeavoured to secure, an identity of education for boys and girls, regardless of sex-difference. This, too, has not been entirely successful. The committee now discovers signs of a third stage—a stage which its own report will undoubtedly strengthen and reinforce—which recognises that equality does not demand identity, and would allow the widest possible freedom for all individuals, no matter which their sex might be, to develop their special talents, and to prepare themselves for their future duties, according to the peculiar tastes and capacities of each.

It is, however, the central section of the report which will command the greatest scientific interest. Here the committee has collected together all the available evidence dealing with the physical and mental differences between boys and girls during the critical years of development.

The known facts regarding the anatomical and

[1] Board of Education: Report of the Consultative Committee on Differentiation of the Curriculum for Boys and Girls respectively in Secondary Schools. Pp. xvi+193. (London: H.M. Stationery Office. 1923.) 2s. 9d. net.

physiological differences between the sexes are concisely summarised in a special appendix by Dr. J. G. Adami. The point of chief significance is the peculiarly rapid growth of the girls during the earlier phases of puberty. It is remarked that, as a consequence, the girl is almost adult while the boy is still adolescent. The memorandum ends by noticing that some of the most significant physiological differences are to be found in the activities of the glands of internal secretion; and, since recent research shows that these glands are intimately connected with emotional activity, this subtle physical difference is not without a deep psychological bearing.

As regards psychological differences generally, the committee has found that two opposing views appear to be entertained by various persons who have expressed opinions upon the subject. The first view maintains that "the higher the level reached in the development both of species and of individuals, the greater is the sex divergence"; and concludes that "educationally the first and safest classification is that which is based upon sex." The second view insists that "sex is the cause of only a small fraction of the mental differences between individuals," the divergences of man from man, and of woman from woman, being far greater than those between one sex and the other.

The committee has reviewed the few scientific investigations carried out upon this problem both in England and in America, and has manifestly decided that the weight of the evidence is upon the side of the second of these alternative beliefs. It has been stated, upon statistical grounds, that the largest sex-differences are physical differences—differences in height, in weight, and in bodily strength. Intellectual differences are far smaller; and here again the wider divergences are discovered not upon the higher but upon the lower levels of the mind, namely, in processes involving simple sensory or motor activity, in sensation and in movement; in the higher and more complex processes—in general intelligence and in ability to reason—the differences during the school period are extremely small. In memory and retentiveness, it is true, girls seem to surpass boys, and women to surpass men; nor is this without an obvious educational bearing. But of all psychological differences the most significant are those that relate to temperament and character. It is the quality of her emotions which, in the mental sphere, chiefly distinguishes the woman from the man.

Thus, inborn sex-differences in mentality are far slighter than has been popularly assumed. On the other hand, the cumulative result of the emotional divergence, and still more of the difference in social functions, has resulted in wide separation of interest and outlook, which is only in a small degree innate and ineradicable, and is chiefly due to tradition, and to the varying play of educational influences, whether conscious or unconscious.

In actual educational attainments, the differences vary considerably according to the circumstances of teaching. Where boys and girls have been taught together in mixed schools, the differences may be barely discernible; but where they have been taught in distinct departments, there the divergence is wider. Such differences can be measured easily by means of standardised scholastic tests.

The chief ascertainable differences appear to be the following: boys are better at arithmetic, mathematics, physical sciences, classical languages, geography, and drawing; girls are better at reading, spelling, handwriting, English composition, English literature, and possibly history, modern languages, and biological sciences. Here very plainly the effects of interest and tradition are at work quite as much as constitutional differences of intellectual capacity. The part played by the two factors, however, can only be disengaged by further inquiry.

Indeed, the most suggestive paragraphs of the whole report are those in which the committee emphasises the need for further research. It is pointed out that the provisional conclusions arrived at rest mainly upon the casual impressions and subjective opinions of schoolmasters—men of considerable practical experience, but of little or no psychological training; and it is urged that there is both room and need for a widespread co-operative inquiry, in which strict scientific methods shall be employed, and in which teachers, psychologists, and medical men shall all take part.

Science and Superstition of Primitive Mankind.

The Golden Bough: a Study in Magic and Religion. By Sir James George Frazer. Abridged Edition. Pp. xiv+756. (Macmillan and Co., Ltd., London, 1922.) 18*s.* net.

SIR JAMES FRAZER'S "Golden Bough" is in many respects the greatest achievement of anthropology—a science the short life-history of which allows still of a rapid survey and a correct apportionment of values. The book, like no other work, expresses the spirit of modern humanism—the union of classical scholarship with folk-lore and anthropology. The marble forms of antique legend and myth are made to lend their beauty to the crude and queer customs of the savage and the uncouth usages of the peasant, while the Gods and Heroes of Olympus receive in exchange the vitalising breath of life and reality from their humbler yet more animate counterparts.

It is difficult to review a new version of the work in

the ordinary manner. It would be as presumptuous to assess the value of a universally acknowledged masterpiece of literary art and a classic of scholarship as it would be unnecessary to indicate the scope of a work known to every cultured man, a work which has exercised paramount influence over several branches of learning and has created new lines of scientific research. But though it is superfluous to praise the book or to explain it, the appearance of the abridged edition seems an opportune occasion for us anthropologists to undertake a little examination of conscience with regard to this classic. We all admit that we owe an immense debt to the author of the Golden Bough and to his work, but have we acquitted ourselves well of an obligation, have we given him his due in return? By this I mean, have we taken all that has been offered to us and made the most of it? Have we followed his lead to the end of the road, have we searched everywhere where the light of the Golden Bough has shone?

For this is the difference between the economic and the spiritual order of things: that in the former it is good to receive material benefits, and, speaking without cant, painful to give them; while in matters of the mind it is a joy to bestow but a burden to take, since this has to be done in an unselfish submission of the spirit, and requires obedience, discipline, and patience.

Surveying the immense influence exercised by this and Frazer's other works on contemporary humanistic literature, it might appear as if this quarry of inspiration and fact, however rich, must have by now become nearly exhausted. Literally half the subjects of modern anthropological argument and controversy have been submitted by Frazer for discussion: totemism, problems of the taboo, origins of kinship and chieftainship, primitive conceptions of the soul and spiritual life—the list could be drawn out indefinitely by going into more detail. In Great Britain, in France, in Germany and the United States, whole schools of anthropological science have flourished or grown rankly, respectively, on the ground broken and first cultivated by Frazer. It is enough to mention the names of Crawley, Marett, Durkheim, Hubert and Mauss, Van Gennep, Wundt, Freud and his school (in their anthropological studies), who in their work, some of it of the very first rank, are more or less dependent on Frazer and his initiative. Yet it would be easy to show that even this immense and most valuable Frazerian literature has left enormous areas within the enclosure of the Golden Bough ready for further cultivation.

It is not from the side of theory, however, that I wish to approach this great work, but, as a field-worker, from the point of view of actual research among savage races. The test of a scientific achievement lies in its power of anticipation and of prophecy: a sound theory must be the forerunner of empirical discoveries, it must allow us to foreshadow new facts not yet ascertained by observation. It is not when a man talks to us about things we have seen already, but when, from his study, he can foretell unsuspected events, can direct us towards unforseen treasures of fact, and guide our researches in unexplored countries, it is only then that the value of his theories is put beyond doubt or cavil. This is well known in natural science, where the value of a theory is always gauged by its lead in the laboratory or in the field. In humanistic and historical science the honour of a prophetic voice has been reserved to its youngest off-shoot, anthropology. For though "history never repeats itself" when we watch it over a relatively brief span, interested in its detailed course of accidental happenings, yet the evolution of culture, taken as a whole, is submitted to definite rules and regularities, and human nature, broadly viewed, as it breaks through the media of various civilisations and stages of development, remains the same, and, being subject to laws, is thus capable of prediction.

The Golden Bough has had a triumphant career in this respect. One after the other the main supports of the lofty edifice, which at first might have appeared entirely carved out of the author's creative imagination, were traced to the solid bedrock of fact by subsequent discoveries among the backward races. The most fantastic feature in the ritual of Aricia, the succession by murder, led the author to the theory of the killing of divine kings, carried out by certain savages, in order to prevent their end by disease or senile decay. This theory, when first emitted, had only partial and meagre evidence in recorded fact. But the brilliant discoveries of Dr. and Mrs. Seligman about the divine kings of the Shilluk, about their violent end, regularly inflicted after a term of reigning, and about the spiritual succession by the transmission of the soul, confirmed Sir James Frazer's theoretical assumptions in every detail. Following this, field-work has brought, and is still bringing, fresh evidence, enough to prove that Frazer's researches have revealed an institution of the greatest importance among backward races.

Sir James Frazer was the first to express the view that before humanity had begun to worship spiritual beings there was a stage of belief and ritual, essentially magical, in which man assumed a fixed order of Nature, subject to the power of specific incantations and rites. Modern research among savages, in the measure as it penetrates more deeply into the comprehension of native ideas, tends to establish the correctness, not only of the general assumption of the magical stage in evolution, but also of Sir James's detailed theories of the psychology

of magic. The nature of primitive kingship and power; the paramount rôle played by the taboo and its psychology; the importance of harvest ritual and ceremonies among savages—in all this it would be easy to show what copious results recent field-work has produced by following the suggestions and inspirations of the Golden Bough.

An irrefutable though somewhat external proof of this is to be found in the ever-increasing bulk of the book as it passes through successive editions, a score of new instances appearing to testify to the truth of some of Frazer's fundamental propositions, where previous evidence was able only to supply a few.

To mention only the other masterpiece of Sir James Frazer, "Totemism and Exogamy," we find again, after some thirty years, a small volume expanded into four large ones by the rich harvest of facts which followed the theoretical forecasts of the author. The ignorance of paternity, at first observed by Spencer and Gillen among one tribe only, was at once recognised by Frazer as of extreme importance for the early forms of totemic belief and organisation and kinship. Here again this forecast was confirmed, not only by further researches of Sir Baldwin Spencer in the north of Australia, but also by the discoveries of Dr. Rivers in the New Hebrides, and by the findings of the present reviewer among a number of Papuo-Melanesian tribes of Eastern New Guinea. There this ignorance is of extreme importance in shaping the matrilineal ideas and institutions of the natives, and is also closely connected with their totemism.

There seems to be some need of emphasising this empirical fecundity of the book—that is, its essentially scientific value. The great admiration which this work has inspired as a literary masterpiece and as a classic of comparative history, folk-lore, and archæology, seems to have overshadowed the merits of the book as an organiser and director of field-work. These merits are due, not only to the learning and to the constructive craft of Sir James, but also mainly to his genius in understanding the fundamentals of human nature, especially of the nature of primitive man, such as we see him represented by the peasant and the savage. In no other work can we find the same intimate understanding of savage modes of thought and behaviour, the same unfailing capacity to interpret the savage's customs, ideas, and traditions from his own point of view, the same prophetic intuition of what is really important with the native and what is secondary. It is because of that that no other work of anthropological theory has received such brilliant confirmation from later researches in the field, nor is any one of them likely to stimulate future research to the same degree as the Golden Bough.

To substantiate this last forecast I should like to indicate, on one more point, this suggestive quality of Frazer's theories. I mean the very *Leitmotiv* of the book, the importance of vegetable cults for primitive magic and religion, the enormous concern of primitive mankind for the soil's fertility and for its conditions, the sun, the rain, and the weather. Over and over again, in the course of the long and devious explanations of the ritual of Nemi, we meet with the magic of the skies and of the soil, with the worship of trees, with the belief in the influence of sex on vegetable fertility, with harvesting customs and superstitions, with Gods and Goddesses of the teeming forces of Nature.

The reader remains under the impression that the interest in the vegetable world has exercised an overwhelming influence over the formation of magical and religious belief and ritual; that these, like the luxuriant mantle of green which covers our earth, have grown out of the union of the skies with the earth's fertility.

This view, indeed, is not expressed by the author, who even, in the preface to this new, abridged edition, repudiates an extreme form in which this opinion has been imputed to him, the view, namely, that all religion starts from tree worship. "I am so far from regarding the reverence for trees as of supreme importance for the evolution of religion, that I consider it to have been altogether subordinate to other factors." This, of course, is quite true, but if, instead of tree worship, we take the wider complex of religious phenomena, the cult of vegetation, or rather of vegetable fertility and its conditions, I for one would fully endorse the view that here we have one of the very taproots of religious growth. I perceive, moreover, that this aspect of the Frazerian theories opens up new lines of empirical research of the greatest promise and importance.

The Golden Bough, in this regard, shows us primitive man as he really is, not an idle onlooker on the vast and varied spectacle of Nature, evolving by reflection a sort of speculative philosophy as to its meaning and origins, but an eager actor, playing his part for his own benefit, trying to use all the means in his power towards the attainment of his various needs and desires: supply of food, shelter, and covering; satisfaction of social ambitions and of sexual passions; satisfaction of some æsthetic impulses and of sportive and playful necessities. He is interested in all things which subserve these ends and are thus immediately useful. Round these he develops not only his material technique, his implements, weapons, and methods of economic pursuit, but also his myths, incantations, rites, and ceremonies, the whole apparatus of primitive science and superstition.

Among all forces of Nature useful to man, the earth's fertility occupies quite a privileged and special position in the mind of the savage. Vegetable life—in its

perennial periodicity of active exuberance and relative rest in the tropics; of life and death in the cold and temperate zones; of barrenness and fertility in certain periodically irrigated deserts—exhibits a regularity and system, a dependence on causes and motives, which seem to be almost within the control of man, yet from time to time so baffling to all his endeavours as to keep his interests, hopes, and fears constantly alive. On this borderland, where man's self-sufficiency utterly fails him, yet where he perceives a clear order; on this ground, so vital to himself and so clearly subject to the play of some extraneous regularities or wills, here the ideas of magic and religion, always a cross-breed of reflection and emotion, flourish most abundantly. Especially where man begins actively to shape the forces of Nature in agriculture, magic ranges itself side by side with technical efforts and becomes a controlling factor of immense importance.

It would be natural to expect, therefore, that among savages there exists public magic of fertility, and that, on the sociological side, this leads to the early forms of chieftainship and kingship, while on the side of belief it leads to important developments of ritual and cult.

Here we touch on the sociological aspect of Frazer's theories of early magic. He clearly recognises the existence of a special class, who, by their magical knowledge, can acquire social importance: "the public magician occupies a position of great influence, from which, if he is a prudent and able man, he may advance step by step to the rank of a chief or king." The author further proceeds to show how very important these specialised magicians are, both in that they perform their services for the whole community, thus forming an integrating power, and also in that they are the first examples in the evolution of mankind of specialists freed from the ordinary burdens and occupations of their fellow-tribesmen, and able to devote themselves to one pursuit. The evidence which Sir James is able to adduce in support of his theory of public magic and of its sociological importance is great, but not quite adequate to substantiate all his theories. Thus, among the forms of public magic, Sir James can find examples only by referring to sunshine, rain, and weather. Even this material does not allow him to demonstrate in detail how political power and social influence arise from the exercise of the magical functions. We are led to inquire: If vegetable and fertility rites are so important, how is it that there are no departmental magicians of agriculture on record? Why does the public magician only control the conditions of fertility and not fertility itself? How can magical influence grow into political power? These questions seem at first sight to qualify and invalidate Frazer's theories of early kingship and magic. Yet here again, recent results of field-work among primitive people allow us to settle these doubts and cavils in a manner once more triumphant for the book, which shows itself to have been ahead of the material at the author's disposal.

In ethnographical researches done among some Papuo-Melanesian tribes of Eastern New Guinea, I found myself at once in the thick of a social and psychological situation such as is postulated by the Golden Bough. The office of the chief coincides there with that of the public magician. To the control of rain and sunshine the chief owes an enormous proportion of his executive power, which he uses to strengthen his position and to enforce his general will. A faithful disciple of the Golden Bough, I turned my attention to the institutions associated with agriculture. Then gradually I began to see that Frazer's theories of the sociologies of magic, of the rôle of the public magician, of the departmental control of natural forces, rested on much more solid foundations than he himself had been able to realise with the material in hand, and that this can be demonstrated on the book's own territory, that of vegetable cults. For not only do there exist in these tribes departmental magical rites of fertility, not only are they the most important ones, ranking even before the weather rites and always carried out by the chief, but also we can study there the sociological mechanism by which the garden magician obtains his political power.

In each community we find a garden magician, who performs his ritual for public benefit. These functions are always vested in the headman of the community. In villages which are capitals of a district and governed by a chief, he himself carries out the magic of vegetation. In this rôle, the headman or chief commands not only a high respect, as the man who has in his hands the forces of fertility and who knows how to tap them, but he also takes an actual lead in the practical pursuits accompanied by the magic. For the magical ritual is intimately bound up with the technical activities. It imposes a regularity in time, and compels people to work in order and in organised groups. This refers to several forms of public magic, such as canoe-building, fishing, and overseas expeditions, but most conspicuously to garden magic. In this, the magician controls the work of the whole community during the course of the year, gives the initiative to the various stages, has the right of reprimand and punishment, is regarded as the man responsible for success and failure, and receives tributes from his fellow-villagers.

Here again we see that, starting from one of those theories of the Golden Bough which go far ahead of the available evidence, field-work reaches interesting and important discoveries. In this case it leads to the study of primitive economics, a chapter very much

neglected by the traveller and amateur ethnographer, and even by the specialist, which promises, however, to yield results of some importance. For I have no doubt that my confirmation of Sir James's theories from a limited ethnographical area will be followed by other more important discoveries all the world over.

Thus the Golden Bough, far from being a classic in the sense of having attained the fulness of its glory and deserving honourable rest, is a book which still has some hard service in the field before it, a book which should be n the kitbag of every ethnographic explorer. A modern ethnographer, in his researches among savages, must, while making his observations, remain still in contact with theoretical literature in order to receive from it constant inspiration and guidance, especially if he is bent on doing intensive field-work, if he is willing and able to remain for months and years among the same tribe and study it by means of their own language and by personally taking part in the tribal life. In such study I derived constant inspiration and benefit from the works of Westermarck, Karl Bücher, Ratzel, Marett, Hubert and Mauss, Crawley and Rivers, some of which I actually have re-read while in the field, others again in the intervals between my expeditions. Alas! at that time the twelve volumes of the Golden Bough were too heavy and costly a burden to carry across sago swamps, to paddle over lagoons in an outrigger always ready to capsize, or to keep in a tent or thatched hut by no means rain- and insect-proof. Now the more fortunate field-worker can easily take with him, handle, and constantly refer to the new, one-volume, abridged edition.

To the student in his library, this abridged edition will no doubt only serve as a handy guide, as a sort of explicit digest, or to the beginner as a preliminary introduction. The full version is indispensable to the student, and it is also the most fascinating and instructive reading to the layman. But no doubt many a one who was at first shy of tackling directly the Golden Bough will, in the short edition, find a bridge to the full work, which is not only the most important achievement of Sir James Frazer, but also the last word of modern anthropological scholarship.

B. MALINOWSKI.

Modern Cosmogony.

The Nebular Hypothesis and Modern Cosmogony: being the Halley Lecture delivered on May 23, 1922. By J. H. Jeans. Pp. 31+4 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1923.) 2*s.* 6*d.* net.

DR. JEANS'S analysis of the modes of rupture of fluid masses under the influence of excessive rotation or of the gravitation of other bodies, earned him the Adams prize of the University of Cambridge in 1917 and the gold medal of the Royal Astronomical Society in 1921. The results appeared in his "Problems of Cosmogony and Stellar Dynamics," published in 1919. The relation between his book and the pamphlet under review is that while the book was a theoretical work with an observational commentary, the Halley lecture is an account of observations with a theoretical commentary.

The Laplace-Roche theory of the development of a rotating and condensing gaseous mass showed that it would be flattened at the poles, and, if strongly condensed towards the centre, it would ultimately become lenticular, with a sharp edge. The next stage was believed to be that this edge would open all round, and the matter would pour out to form a ring. The rings of Saturn were claimed as an example of this process, but it is now known that they could never have passed from the gaseous to the solid state if they had been first produced in this way at their actual distance from the planet. The heavens have been searched for other bodies showing rings of Laplacian type, but none has been found.

Numerous nebulæ, however, show the flattened and lenticular forms indicated by the early stages of the theory, and Jeans considers that they are true examples of it. Other nebulæ show lenticular centres, with definite indications of detached matter around the equatorial sharp edge, and the more of this matter there is, the clearer does it become that it is not in the form of a ring or series of rings, but of spiral arms. In fact, known nebulæ afford examples of every intermediate stage, from the flattened symmetrical mass, through the lenticular form, to the typical spiral nebula, and it is difficult to resist the conclusion that this gradation corresponds to an actual course of evolution. This evidence is beautifully presented in the published lecture.

Although the astronomical evidence for such a phenomenon is strong, it calls for a dynamical explanation. We need to know why the matter is ejected almost entirely at two opposite points and not uniformly all around the equator. Jeans suggests, with much plausibility, that the equator would be distorted by the gravitation of surrounding bodies, and that, however small the distortion was, it would suffice to localise the ejection at two opposite points, and hence two arms would be formed instead of a ring.

Van Maanen, at Mount Wilson, has measured the motions of identifiable parts of spiral nebulæ. The motion is curious. The arms are approximately equiangular spirals, and the matter constituting them is moving outwards along the arms, its velocity increasing the farther it recedes from the nucleus. The

nucleus is rotating with the arms. Now, this motion is just what Jeans deduced from theoretical considerations, taking into account the viscosity of the mass. The time of rotation of the nebula, and the velocities found spectroscopically, together give an estimate of the distance of the nebula M. 33 as 2000 parsecs, and of its diameter as 30 parsecs. The mass of the whole is about 100,000 times that of the sun. The nebula in Andromeda probably has a mass 20,000,000 times that of the sun.

The velocity of the arms of M. 33 is such that the whole of the visible matter must have been within the nucleus 200,000 years ago; and as we must suppose that the nebula is older than this, matter must be continually ejected. Jeans gives strong ground for believing that it condenses to form stars of mass comparable with the sun.

The method of rupture of much denser and smaller masses is next considered. Jeans has already shown that a star will break up into two fragments comparable in mass if it rotates sufficiently rapidly. Some double stars show such light variations and velocities in the line of sight as indicate that they are in close contact, agreeing with the hypothesis that they have just been formed by the fission of a single star through excessive rotation. Their periods of revolution and their spectral type (B) agree with further predictions of the theory. In some cases a stationary calcium atmosphere surrounds both components; this is readily explicable as the original atmosphere of the star, which has not yet attached itself to either component, but will divide into two when the components get far enough apart.

The last few pages give a short summary of the tidal theory of the origin of the solar system. The disruption of the sun by the tidal action of a passing star is supposed to have led to the formation of the planets. Jeans considers that such an event may have happened to some other stars, but that these constitute only a small fraction of the stars we know. The majority of the stars are probably unattended by planets, and perhaps the earth is the only body in the universe capable of supporting life.

HAROLD JEFFREYS.

Military Mining.

The Work of the Royal Engineers in the European War, 1914–19. Military Mining. (Published by the Secretary, Institution of Royal Engineers, Chatham.) Pp. x+148+61 plates. (Chatham: W. and J. Mackay and Co., Ltd., 1922.) 12*s.* 6*d.* (7*s.* 6*d.* to members of the I.R.E.)

THE volume before us describes a most arduous branch of the work that the Royal Engineers were called upon to carry out in the War—a branch, the final success of which was largely due to the technical skill of civilian coal-miners from Great Britain working under mining engineers from the Colonies and abroad.

The book is divided into three sections dealing with (1) the history of mining during the major operations of the campaign, (2) mine rescue work, and (3) technical considerations.

At the end of the first battle of Ypres "the study and practice of military mining were suddenly revived by the discovery that stationary trench systems brought back all the old features of fortress warfare." Before the end of 1914 at least two mines were exploded by the enemy under our trenches. This caused a demand for special mining units, and in February 1915 the first party of British miners arrived in France. By the end of June 1916, operations had extended so much that a total force of 25,000 men was employed in this work, and during that month no less than 227 mines were blown on the British front, 101 by us and 126 by the Germans.

The greatest of many successful mining achievements during the war was the deep-level attack at Messines on June 7, 1917, when on a narrow front and in the space of 30 seconds mines were fired containing nearly 1,000,000 lbs. of high explosive. "The moral effect of these explosions was simply staggering," writes General Ludendorff in his Memoirs, and he attributes to them the success of our attack. This scheme was remarkable also for the long period of preparation (it was begun in the previous summer) and the consequent anxiety lest its extent should become known to the enemy. A month before the attack they were clearly heard in deep workings at Hill 60, but it was correctly calculated that their gallery would just pass clear over ours, and they were allowed to go on working.

In addition to offensive mining an immense amount of work was done by tunnelling companies in the construction of dug-outs, communication tunnels, and road repair, and during the summer of 1918 in the removal of mines and traps left by the enemy as they retired.

Owing to the number of casualties in the early days of mining, chiefly caused by carbon monoxide from the detonation of high explosives, rescue work became of great importance, and was effectively organised under Lieut.-Col. D. Dale Logan. The next step was the formation in 1916 of a special medical service for tunnelling companies, all the officers of which had been for years in mining practice. A well-deserved tribute is paid to the work of these officers and of the rescue men, whom it was found necessary to select with the greatest care owing to the very trying nature of their work.

The apparatus and methods used are described at some length. It is worthy of note that "with small exceptions there appeared to be a total absence of any regular mine-rescue organisation along the whole German front."

In the technical section of the book a large amount of information is given on such subjects as disposal of spoil, listening instruments, and the work of the mine schools. It also discusses the main principles which gradually became evident as underground warfare developed, the most important of which may be summed up in the statement that "the best form of defence is attack." By a strenuous application of this idea "the enemy was reduced underground by the autumn of 1917 to a state of absolute passivity on the entire front."

Our Bookshelf.

Encyclopædia of Veterinary Medicine, Surgery, and Obstetrics. Edited by Prof. George H. Wooldridge. In 2 vols. Vol. 1: *Veterinary Medicine.* Pp. xiv+546+xxiii. Vol. 2: *Surgery and Obstetrics.* Pp. viii+547-1106+xxx. (London: H. Frowde and Hodder and Stoughton, 1923.) 2 vols., 6*l.* 6*s.* net.

To describe this work as an encyclopædia is a little misleading. It comprises two volumes, the first of which deals with veterinary medicine and the second with veterinary surgery and obstetrics, but they are distinguished from what are commonly called text-books on the same subjects only by the fact that a large number of authors have collaborated in their production. The preface expresses the hope that the work will be found useful to veterinary students, owners of animals, and members of the medical profession, as well as to the general veterinary practitioner; but it is obvious that the guiding consideration in the production of the work has, quite rightly, been the requirements of the practising veterinary surgeon.

No veterinary work on exactly the same plan has previously been published in Great Britain, but it may safely be said that as a practical and scientific treatise it is superior to any of the previous English text-books on the same subjects. In a work to which more than thirty authors have contributed, absolute uniformity in style and other qualities of the different sections is not to be expected, but for the most part the language is clear and concise, and the information is up-to-date. A notable defect, especially marked in the first volume, is that the amount of space devoted to different diseases appears to bear no close relationship to the importance of the subject. It seems impossible to imagine any good reason for allowing seventeen pages to horse-sickness, which is a purely African disease, and six pages to snake-bite, while tuberculosis is only allowed ten pages, and glanders, epizootic abortion, foot-and-mouth disease, and rabies together occupy only sixteen pages. The value of many of the articles is enhanced by good illustrations, and the publishers' share of the work has been well done.

Archives de morphologie générale et expérimentale. Fascicule 14 (*Morphologie expérimentale*): *Le Déterminisme et l'adaptation morphologiques en biologie animale.* Par Prof. R. Anthony. Première partie: *Déterminisme morphologique et morphogénie.* Pp. 374. (Paris: Gaston Doin, 1922.) 28 francs.

THIS work is an attempt to describe the form and structure of animals in so far as they can be shown to be determined by morphogenetic factors in the environment. The author begins with generalities about life, evolution, and variation, sketches the history from the earliest times of a rational explanation of morphology, upholds the Lamarckian doctrine with the usual inconclusive arguments, and incidentally places the Emperor Julian as a precursor of Lamarck. Thence he passes to the description of observations and experiments on the effect of external factors on structure, more especially in molluscs and vertebrates.

Although there appears to be little in this account which is actually new, yet Prof. Anthony has brought together a number of interesting facts showing how closely structure is correlated with function—how, for example, the shape and size of muscles and the relative lengths of muscle fibres and tendons are regulated according to the motions to be executed, also the shape and internal structure of bones. It follows that in many cases they can be altered experimentally.

These observations, however, seem to us to prove, not that the Lamarckian theory of evolution is correct, but that organisms are the products of the interaction of the physical basis of heredity with the environment in which they develop. This fundamental conception, long ago appreciated by the botanist with regard to plants, is still but imperfectly understood by the zoologist.

Department of Scientific and Industrial Research. Memoirs of the Geological Survey. Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for 1921, *with Report of the Geological Survey Board and Report of the Director.* Pp. iv+189. (Southampton: Ordnance Survey Office; London: E. Stanford, Ltd., 1922.) 5*s.* net.

FOR many years past, geologists who wish to keep pace with research in the stratigraphy or petrology of our islands have found that they must not overlook the annual volumes modestly entitled "Summary of Progress of the Geological Survey." The issue for 1921 contains a paper by E. E. L. Dixon on "The Retreat of the Lake District Ice-Cap," and the formation of fluctuating lakes held up by glacier-dams. The relations of kames and outwash-mounds of various kinds are considered, and the protruded products of sub-glacial melting, where clearly connected with a "feeding esker," are well styled "esker deltas." Foreign geologists may be puzzled at the frequent occurrence of the name of Lamplugh in a glacial paper as that of a village at the foot of Owsen Fell. On p. 129, Dr. R. Kidston provides a new example of how the determination of the species of Carboniferous plants enables the "practical man" to determine the horizons of his coal-seams. The lists of species from the beds now shown to be Westphalian in the Durham

and Northumberland Coalfield contain some revisions of genera, and several new forms are mentioned. May we suggest that the printing of the titles of such papers on the cover of the "Summary of Progress" would do much to bring the publication into line with the convenient bulletins of the United States Geological Survey? G. A. J. C.

Comparative Ethnographical Studies, 5: Deductions suggested by the Geographical Distribution of some Post-Columbian Words used by the Indians of S. America. By Erland Nordenskiold. Pp. xiv+176. (London: Oxford University Press, 1922.) 18*s.* 6*d.* net.

THE fifth volume of Baron Nordenskiold's valuable series of Comparative Ethnographical Studies deals with the distribution of words used by the Indians for certain post-Columbian elements in their culture—the domestic fowl, horses and cattle, the banana, iron, firearms, scissors—and certain partly post-Columbian elements—European knives, needles, and fish-hooks. Of these words some are of Spanish or Portuguese derivation, others are of native invention and are onomatopœic, as sometimes for the fowl, or purely descriptive.

The author's main interest lies in the historical deductions to be drawn from the distribution of these words. It affords clear evidence, not only of the course of the diffusion of culture, but also of trade routes and of tribal migrations. In many instances, confirmation is afforded by comparison with the accounts of the early chroniclers. It is interesting to note that European culture elements had reached the Aymara and Quichua from the East before Pizarro came into contact with them from the West. This valuable contribution to the history of the Indians of South America in post-Columbian times will cause students of South American civilisation to look forward with eager anticipation to the author's promised study of pre-Columbian culture on similar lines.

The Industrial Applications of X-rays. By P. H. S. Kempton. (Pitman's Technical Primers.) Pp. xiii +112. (London: Sir Isaac Pitman and Sons, Ltd., 1922.) 2*s.* 6*d.* net.

MR. KEMPTON'S little book gives a good introduction to "radiomateriology," that is, to the examination of materials by means of X-rays. The art has made great strides since the War, and, by means of the powerful high voltage apparatus now employed, steel forgings and castings several inches thick can be satisfactorily tested. Examination by X-rays is of particular value for detecting flaws in metallic products and for examining welds and joints made by brazing or soldering. It is also specially useful for examining timber, reinforced concrete, electrical insulating materials, and precious stones. The author describes the apparatus used in industrial radiology and gives interesting radiographs. Complete installations for the X-ray examination of materials are described, and due stress is laid on the importance of protective screens and safety devices. In the table of spark-gap voltages given, it is interesting to note that for a given spark-gap the disruptive voltage increases with the size of the spherical electrodes up to a certain value and then diminishes for larger electrodes. This is in accordance with theory.

Inca Land: Explorations in the Highlands of Peru. By Hiram Bingham. Pp. xvi+365+45 plates. (London: Constable and Co., Ltd., 1922.) 24*s.* net.

IN this volume Prof. Bingham describes a part of the work accomplished by the four expeditions of Yale University and the National Geographical Society to Peru between the years 1909 and 1915. Where so much is new and of absorbing interest it is difficult to select any one discovery as outstanding; although in archæology most will, no doubt, agree that the exploration of the ruins of Machu Picchu has been the most important in its results. This site, with its magnificent and, in some respects, unique architectural remains, is held by the author to be probably the Tampu Tocco to which the pre-Inca people, the Amautas, retired when the country was invaded from the south about A.D. 800, and from which the first Inca, Manco Ccapac, began to extend his Empire about A.D. 1300. Fascinating, too, is the story of the search for Uiticos, the lost stronghold of Tupac Amaru, the last of the Incas, defeated and killed by the Spaniards in 1572, and for the "white rock over a spring of water," the site of the Temple of the Sun burnt by two zealous Spanish friars in 1568. The results obtained by these expeditions were little short of remarkable, and have added enormously to our knowledge of the geography, archæology, and natural history of the country.

Laboratory Manual of Physical Chemistry. By Prof. Albert W. Davison and Prof. Henry S. van Klooster. Pp. viii+182+32 pages of sectional paper. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1923.) 10*s.* net.

THIS "Laboratory Manual of Physical Chemistry" covers only twenty-four experiments, but these are set out in detail with full references to the literature. An ample supply of blank pages is provided, together with ruled spaces for filling in experimental data; tables of atomic weights, densities, vapour-pressures, and refractive indices are also given, with logarithm-tables and a sufficient supply of squared and triangulated paper to provide for the whole of the experiments suggested. The manual, therefore, becomes the student's note-book as well as his text-book, and will enable him to place his own results on his bookshelf in a more orderly manner than is usual.

Causes and Consequences. By Sir Bampfylde Fuller. Pp. x+291. (London: J. Murray, 1923.) 12*s.* net.

THE author of this book discourses on many things, indeed, on all things which concern science and philosophy, with an easy-flowing style and irresponsible dogmatism. His description of insects as "brainless animals" has already evoked a lengthy correspondence in the Press, and he might easily be called to account for a hundred other equally confident and artlessly simple-minded statements. Thus, for example, he tells us "it seems clear that some of the theories connected with the name of Professor Einstein are based upon a confusion of time and space with rhythm."

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.*]

Adsorption and Hæmoglobin.

As I have in other places entered a plea for more consideration of the possibility that adsorption may play some part in the phenomena of the taking up of oxygen by hæmoglobin, a few remarks on the letter by Mr. N. K. Adam in NATURE of April 14 may be permitted me, chiefly with the object of making clear my attitude in the matter. It is briefly this. Nearly all, if not all, of the workers on the problem direct their attention only to the investigation and interpretation of these phenomena from the point of view of mass action in a homogeneous system. Now, while this may ultimately turn out to be the correct view, it must not be overlooked that hæmoglobin under most conditions exists in the form of colloidal aggregates. Thus, surface phenomena may intervene and should receive due consideration, even if only to be put on one side. This has not been attempted to any serious extent, since Wo. Ostwald showed that the data of the taking up of oxygen by hæmoglobin could be expressed by an adsorption formula. It is true that such a formula, as Mr. Adam says, contains two arbitrary constants, and fitting it to the experimental data does not prove anything as to the nature of the phenomena. But the same statements may be made with regard to the widely accepted Barcroft-Hill expression.

Any criticism that I venture to make is not to be understood as doubting the value of the data that are being obtained, but rather as directing attention to certain gaps in our knowledge which require to be filled up before further progress in the interpretation of the facts can profitably be made. There is, as it seems to me, some risk of building elaborate hypotheses on assumptions which are not clearly demonstrated. It appears sometimes that workers are so convinced that the mass action view is all that is necessary, that they are not interested in testing the truth of these assumptions. If it is found that an experimental result can be explained on the lines of mass action formulæ, however elaborate, it is taken as confirming the view; but other hypotheses might be found equally well to satisfy the case, if seriously examined. Compare, for example, Langmuir's formulæ for the adsorption of a gas by a crystal surface with the Hill-Barcroft formula. I am sometimes inclined to wish that it were possible for an investigator who knew nothing about previous theories to attack the problem as a new one.

But to be more precise—it is undoubtedly a very important fact that when hæmoglobin has taken up all the oxygen that it can, this oxygen is in the proportion of one molecule to each atom of iron in the molecule of hæmoglobin. It is natural to believe that the iron and oxygen are directly united. Mr. Adam's assumption that the oxygen is "locally attracted" rests on this belief. Are we quite certain that it is the case? And even if it were, we know too little about the forces which bring about adsorption to be able to exclude the possibility of local foci, as it were. On the view of chemical combination, in the strict sense, between oxygen and iron, is not the greater affinity of hæmoglobin for carbon monoxide than for oxygen rather puzzling? There is also the problem of methæmoglobin, another compound of hæmoglobin and oxygen, but one which does not give up its oxygen to a vacuum. I have not been able to find in the literature dissociation curves of oxyhæmoglobin continued beyond the saturation point in the presence of excess of salts or of carbon dioxide. On the purely chemical theory, with sufficient concentration of oxygen, the saturation point should still be in the same proportion of iron to oxygen. In connexion with the relations between hæmoglobin and carbon dioxide, no proof has yet been given that the union is of a different nature from that with oxygen. It is still uncertain whether the hæmoglobin that combines with carbon dioxide is a sodium salt.

To put the question in another way—does hæmoglobin free from sodium combine with carbon dioxide, or does it not? But if hæmoglobin, as worked with, is a sodium salt, osmotic pressure measurements give no direct information as to the molecular weight of hæmoglobin. It appears to be accepted by most of those working on the problems that oxyhæmoglobin is a much stronger acid than hæmoglobin itself. It is true that to explain the carriage of carbon dioxide by mass action formulæ, this is necessary. But is it impossible to put the question to more satisfactory experimental test than has yet been done? Again, the cause of the widely divergent results obtained by different investigators of the heat of combination between oxygen and hæmoglobin has not been adequately made out. While, therefore, the data which are being accumulated in so many places are of the greatest value in relation to the actual behaviour of hæmoglobin under certain conditions, I find it impossible to interpret them on the basis of any theory until the questions above mentioned are answered.

A subsidiary point, but one about which agreement is desirable, is the use of the name "polymerisation" in place of the more usual one, in relation to colloidal behaviour, of "aggregation." It would be of advantage if clear definition of these terms, together with that of "association," could be agreed upon.

It is perhaps to the point to recall those processes which obey the unimolecular law as deduced from mass action, at all events in a part of their time course, although we know that as a whole they are much more complex than simple chemical combinations.

Turning to Mr. Adam's criterion of adsorption, I agree that it is impossible to define it by the nature of the forces concerned. It seems to me, however, that it is only shown when a sufficient number of atoms are joined to form a surface. To adopt the criterion of the whole surface becoming uniformly covered when the concentration rises to a certain value, neglects, I think, those cases where two or more substances are adsorbed simultaneously. Mr. Adam appears to accept Langmuir's views. While these explain many cases, there are others where the range of the forces concerned extends beyond one molecule. According to Evans and George (Proc. R.S., A, 103, p. 192) the thickness of the layer of carbon dioxide on glass amounts to that of five or six molecules. Chemical forces in the ordinary sense seem to be excluded here. Moreover, accepting the probability of orientation on an inert surface, like that of charcoal, by affinity of certain groups for the water of the liquid phase, it is difficult to see how the increased concentration itself is initially brought about. But, after all, is it not rather an idle discussion to make definite distinctions between chemical and physical forces in the region of atomic properties? Does not the Braggs' crystal model indicate that the forces responsible for cohesion, chemical union, and electrical behaviour are one and the same? The recent

discovery that in the crystal of beryllium acetate an oxygen atom has four *equal* valencies suggests also a reconsideration of the doctrine of "residual valencies," as used by Langmuir in his theory.

W. M. BAYLISS.

April 30.

The Complex Anisotropic Molecule in Relation to the Theory of Dispersion and Scattering of Light in Gases and Liquids.

OBSERVATIONS by Cabannes,[1] the present Lord Rayleigh,[2] Gans,[3] and others have shown that the light scattered by various gases in a direction at right angles to the incident beam is not completely polarised. This is accounted for by Cabannes in terms of a *simple anisotropic molecule* of the type first used by Langevin [4] in 1910 to account for electric and magnetic double refraction. Such a molecule contains a single dispersion electron acted on by unequal quasi-elastic restoring forces along the principal directions and capable of vibrating with three different frequencies.

The present writer has extended the theory to gaseous and liquid media composed of *complex anisotropic molecules*, in which there are any number of dispersion charges the principal directions of which are not parallel. For an isotropic medium in which all molecular orientations are equally probable, a general dispersion formula of the Lorentz type is derived.

In *gaseous media*, owing to rapidly varying changes of position, each molecule contributes independently to the *intensity* of the scattered radiation. For unpolarised incident light of intensity I, the *depolarisation* is measured experimentally as the ratio of minimum to maximum intensity when the light scattered at right angles to the incident beam is examined by a Nicol prism, and as observed in gases is a quantity characteristic of the molecule. The intensity $I_s\theta$ scattered in a direction θ with the incident beam of wave-length λ, to a distance r from a volume $\bar{V}$ is given by the formula

$$\frac{r^2 I_s\theta}{\bar{V} I} = \frac{1}{2}\frac{\pi^2}{\lambda^4}\frac{(\mu^2-1)^2}{n}\cdot\frac{6(1+\rho)}{6-7\rho}\left\{1+\frac{1-\rho}{1+\rho}\cos^2\theta\right\}, \quad (1)$$

where μ is the refractive index corresponding to molecular density n.

The corresponding formula for the coefficient of extinction by scattering is

$$K = \frac{8\pi^3}{3\lambda^4}\frac{(\mu^2-1)^2}{n}\cdot\frac{6+3\rho}{6-7\rho}. \quad . \quad . \quad . \quad (2)$$

A remarkable feature of these formulæ is their *invariance* with respect to such details of molecular structure as number and magnitude of dispersion charges and mutual orientation of principal directions.

In *liquids*, from the observations of Martin,[5] Lord Rayleigh, Kenrick,[6] Raman,[7] and others, it is now definitely established that dust-free liquids are able to scatter light. According to Smoluchowski [8] and Einstein,[9] the explanation of this phenomenon, first observed near the critical point of a liquid, lies in fluctuations of molecular density due to thermal agitation. Since a volume of linear dimensions small compared with a light-wave contains several million comparatively stationary molecules, it is necessary in dealing with liquid media to sum the components of the electric vector in the scattered light-wave from each molecule. In these circumstances, it may be shown that equally probable orientations of complex anisotropic molecules within this small volume would result in the scattered light being completely polarised, contrary to observation. It is concluded, therefore, that *liquids have an extremely fine-grained crystalline structure*, the crystalline aggregates being supposed to be incapable of withstanding stress owing to molecular vibrations, and to be continually breaking up and re-forming under the influence of these elastic waves, which according to Debye's [10] theory constitute the energy of thermal agitation. If we suppose the energy of one degree of freedom to be associated with the random pulsations of these crystalline aggregates, we derive instead of (1) the following formula for scattering,

$$\frac{r^2 I_s\theta}{\bar{V} I} = \frac{1}{2}\frac{\pi^2}{\lambda^4}(\mu^2-1)^2\frac{6(1+\rho)}{6-7\rho}\frac{RT\alpha}{N}\left\{1+\frac{1-\rho}{1+\rho}\cos^2\theta\right\}, \quad (3)$$

where, in addition to the symbols already defined, R is the gas-constant per gram molecule $=83{\cdot}2\times10^6$ C.G.S., N is Avogadro's constant $=6{\cdot}06\times10^{23}$, T is the absolute temperature, and α is the *adiabatic* compressibility.

As in the case of the preceding formulæ, (3) enjoys the property of invariance with respect to details of molecular structure, and it is derived on the hypothesis that the molecules in each crystalline aggregate are not greatly disturbed from perfect alignment by angular oscillations which result in a diminution of the depolarisation ρ as the critical point is approached, as has, in fact, been recently observed by Ramanathan [11] in the case of liquid ether.

For light scattered at right angles to the incident beam, Martin has shown that the inverse fourth power law holds good for benzene and water. For $\lambda=4358$ Å. and 20° C., we find for $r^2 I_s(\frac{1}{2}\pi)/(\bar{V} I)$ the following comparisons,

Benzene	$21{\cdot}5\times10^{-6}$ (calc.)	$26{\cdot}0\times10^{-6}$ (obs.).
Water	$1{\cdot}85\times10^{-6}$ (calc.)	$1{\cdot}77\times10^{-6}$ (obs.).

Formula (3) also accounts theoretically for the relative scattering of some twenty organic liquids studied by Martin.

This satisfactory agreement between theory and observation goes far to justify the hypothesis of the crystalline structure of liquids as just described. To this view strong support is lent by the observations of Debye,[12] Keesom,[13] and more recently of Hewlett,[14] on the scattering of a beam of X-rays by various liquids.

Although the results thus far have been based on a general type of "static" molecule, the theory is by no means opposed to the modern conceptions of the "dynamic" atom. For wave-lengths long compared with molecular dimensions, we may suppose those perturbations which contribute principally to dispersion to consist of forced oscillations of each atomic system of electrons with respect to the corresponding positive system.

LOUIS V. KING.

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The Adhesive Apparatus of the "Sucking-fish."

IT is regarded in text-books [1] as a well-established fact that the adhesive organ of the "sucking-fish" (Echeneis and Remora, etc.), and a somewhat similar structure in Pseudecheneis and certain other freshwater fish, functions as a "sucker"; in other words, it enables the fish to adhere by the creation of a vacuum, or at any rate a partial vacuum, between the ridges and the rim of which it is constituted. Observations on Pseudecheneis and its allies in natural conditions led both Dr. Annandale and myself to doubt whether this belief is well founded.

It is very significant that, as several observers have noted, Echeneis can be detached from its hold quite easily by either thrusting it forwards or sideways,[2] while the so-called rim of its adhesive apparatus is entirely absent as a raised ridge in fresh material or well-preserved specimens. The whole structure,[3] moreover, differs in almost every respect from the true sucking disc present on the lower surface of the fish Garra [4] (Discognathus) and of the tadpoles [5] of *Ranæ Formosæ*.

I have recently had an opportunity of conducting experiments on the living Pseudecheneis, and have also had the great advantage of being able to consult Prof. C. V. Raman on the physics of adhesion both in this genus and the true Echeneis. We are convinced that the apparatus of these species, unlike that of Garra and the tadpoles mentioned above, is not a true sucker but essentially an elaborate device for producing the maximum amount of friction. It is correlated in a very interesting way with the shape of the fish. The upper surface of Echeneis and the under surface of Pseudecheneis are flattened to increase frictional area, while the lower surface of the former and the upper surface of the latter have adopted such a form that an advantage is taken of the swift current, which, instead of dislodging the animal, presses it against the substratum. The pressure exerted by the current increases friction, for friction is proportional to two factors—the coefficient of friction and pressure. The coefficient of friction is increased by the presence of a large number of strong spines, all of which are directed backwards on the lamellæ of the pad of Echeneis, and by innumerable microscopic epidermal spines [6] found on the ridges of the adhesive discs of hill-stream fishes. The plates bearing the spines in Echeneis point posteriorly, with the result that the spines come into action against the opposing surface when the fish is pressed backwards by the current, but are released when the movement is in the opposite direction. The enormous difference in the frictional coefficient for forward and backward movement is easily noticed when a finger is passed over the pad of a preserved specimen of Echeneis. It is also possible that the ridges and grooves in these fishes assist in increasing friction much in the same way as the ridge- and groove-patterns to be found on the tyres of motor cars.

Echeneis can cling to smooth surfaces in the absence of currents.[7] The strong spines on the lamellæ are quite sufficient to render this possible, and the phenomenon is not at first sight so remarkable as the power of adhesion in opposition, as it seems, to a strong current.

This note is written chiefly with the object of bringing this new view of the mechanism of the so-called sucker to the notice of other workers, particularly of those who are in a position to make observations on living specimens of Echeneis, Remora, etc. I hope myself shortly to undertake fuller studies of the morphology and histology of the adhesive pad with the view of elucidating the subject further.

SUNDER LAL HORA.

Indian Museum, Calcutta, March 29.

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[5] Annandale and Hora, Rec. Ind. Mus. XXIV., pp. 505-509 (1922).
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Vertical Change of Wind and Tropical Cyclones.

IN his article on the birth and death of cyclones (London Meteorological Office, Geophysical Memoirs, No. 19, 1922) Sir Napier Shaw makes the interesting suggestion that the shearing of the head of a tropical cyclone with reference to its foot, by difference of velocity at different levels in the air which carries it, might cause its dissolution. If the hypothesis that the movement of a cyclone is due to its being embedded in a flowing current of air is correct, it will of course be admitted that if there is a considerable gradient of wind upwards, positive or negative, then there must be a continual shearing of the cyclone and the shearing must either be continually countered by the cyclone, or it must die. But the question is, whether there are occasions when a cyclone has to face such a strong vertical gradient of wind, and if there are, what vertical gradient a cyclone can stand and continue to live? With regard to the first point, from an examination of the symmetry of temperature and pressure Sir Napier Shaw remarks:

"If isobaric surfaces are also isothermal surfaces there is no change of wind velocity with height. In any case one would have to assume approximate uniformity of direction and speed for a thickness of several kilometres, in order to get a definite connected body of air in stable motion. Perhaps for the levels between four and eight kilometres there are enough occasions of little change of wind velocity between those levels to furnish convenient circumstances for the persistence of a sufficient number of cyclones or cyclonic depressions."

The atmospheric conditions in the region surrounding a cyclonic depression are so different from those of normal weather, that it is perhaps quite incorrect to assume that the vertical gradient of wind, which a cyclone has to encounter, is roughly of the same order as the gradient derived from the observations of the motion of pilot balloons under normal conditions. As pointed out by Sir Napier Shaw, it is also a matter for careful consideration, what is actually presented to us by the motion of a pilot balloon in a cyclonic depression. The irregularities due to local turbulence or the changes incidental to an inclined axis will appear in the results with as much weight as the examples of fundamental structure. Perhaps the altered condition of the atmosphere in which a fully developed cyclone finds itself does not permit of too much change of wind velocity with height, and then all our conjectures regarding the supposed effect of a vertical gradient of wind on a cyclonic system will appear futile.

If a cyclone is to be considered a stable dynamical system consisting of a vortex with a ring of maximum velocity, as Sir Napier Shaw considers it to be, and "protected from the ordinary vicissitudes of weather by the *enormous momentum* of a vortex with a high rate of spin," then as a vortex will generally, except perhaps for the fact that air is not a perfect fluid,

form a closed system or end on boundaries, we shall have to assume that in a cyclone the dynamical conditions extend from the ground surface to considerable heights. Perhaps also the entire length of the vortex and not simply the length where the sustaining energy is supplied is effective in offering resistance to extraneous forces, because the energy wherever it is supplied will distribute itself over the entire length. The high degree of permanence of the type of motion is also suggestive that its enormous momentum does offer considerable resistance to all forces of destruction. A small vertical gradient of wind, if there is such a gradient at all, will therefore probably not shear a cyclone out of existence. It will perhaps deform the cyclonic system or make its axis inclined to the vertical; but if the gradient is considerable and of long duration, and if the struggle to maintain its circulation and to remain reasonably erect proves too much for the cyclone, it will eventually die.

The possibility of the axis of a cyclone being inclined to the vertical has long been surmised, and Sir Napier Shaw himself has advanced arguments attempting to give definiteness to the meaning of this idea ("Manual of Meteorology," Part IV., p. 145). It should, however, be remarked that the axis of a cyclone being inclined to the vertical will have a definite meaning only if the whirl is supposed to extend to heights comparable to the diameter of the core and not simply to 3 or 4 km., that is, only a little beyond the levels where the sustaining energy is supplied, as suggested by some meteorologists, including Eliot and Dallas.

If, on the other hand, we do not consider the cyclonic system and the flowing current, if any, as two distinct systems, and seek for an explanation of the movement of cyclones in the mechanism of the cyclonic system itself, then the consideration of the shearing of a cyclone due to a vertical gradient of wind does not arise at all. Consider, for example, the storms which form in the Indian seas. The centrifugal force in these storms, especially at the outer margin, is not strong enough to keep the monsoon winds feeding into them revolving in a circular path, with the result that these winds after taking a small turn deviate from the circular path and carry the cloud ahead of the storms. The precipitation and the consequent latent heat set free in front of the storms reduce the pressure there, necessitating a readjustment and a shifting of the isobars. This will in general account for the movements of these storms. It is, of course, implied in this explanation that it is not the general drift of winds that makes a cyclone move, but that the movements of the cyclone involved in its mechanism make the outlying winds adjust themselves to the motion.

S. K. BANERJI.

The Observatory, Bombay, March 27.

A Levitated Magnet.

PRESUMABLY all interested in magnetism have tried to keep a magnet in suspension, by the repulsion of like poles balancing its weight. In common with others, I have always failed to do this with steels hitherto available. The experiment fails through inability of the small magnet to resist having its poles reversed, or diminished in strength, by the intense field necessary for levitation.

Recent research on magnetic steels has, however, produced steels having the necessary resistance against reversal of polarity and with the necessary strength of magnetic field.

I find that the experiment of flotation can be shown by using very simple apparatus. The best results have been obtained by using a solid rod of special steel, $2\frac{1}{2}$ inches by $\frac{3}{16}$, weighing about twelve grams. This rod is enclosed in a flat glass cell, slightly larger, giving clearance of about 1 mm. between the ends and sides, so that the rod may be able to move freely. This glass cell should be open at the top, and have a vertical height of about 3 inches. The bottom should also be made of thin glass—old photographic plates (quarter plates) answer very well for making this glass enclosure, adhesive tape being used for joining the glass plates, which may be separated by flat pieces of wood or glass slightly thicker than the steel bar, to give sufficient clearance. The magnetised rod should rest freely on the glass bottom (Fig. 1).

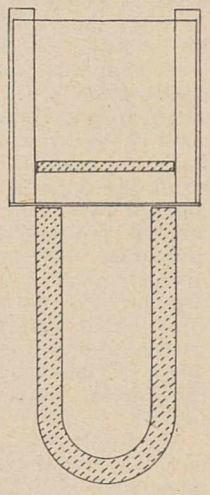

FIG. 1.

Holding the cell vertically, it is lowered slowly towards the poles of a horse-shoe magnet, held vertically. If the poles of the horse-shoe magnet are of the same sign as the opposing poles of the magnetic rod, the latter will rise and oscillate up and down in its enclosure. When properly adjusted in the field of a good magnet the rod will remain permanently poised about half an inch above the poles, which should be about the same distance apart as the poles of the levitated magnet.

Good bar magnets may be used, thus enabling the correct separation of the poles to be found experimentally.

A much greater distance of separation may be obtained by using an electro-magnet. In this case the cell must not be placed on the poles before turning on the current or the rod magnet will be reversed before it has time to rise and it will remain on the floor of the cell, being attracted. The same may happen if the cell is lowered awkwardly so that only one pole of the rod can rise: some reversal then takes place, necessitating remagnetisation of the bar. The particular steel used by me I owe to the kindness of Mr. W. H. Glaser, who tells me it contains 15 per cent cobalt and is known as "cobalt chrom" steel.

F. HARRISON GLEW.

156 Clapham Road, London.

Science and Economics.

F. S. M., the writer of the article "Labour and Science in Industry," in his rejoinder to my letter (NATURE, April 14, p. 498) does not seem to grasp my main point, that the present economic system has no sound *physical* foundation, and that it was an element of physical reality—for example, the laws of the creation of wealth as distinct from debt—that I wished introduced into the proceedings of the Economics section of the British Association. If the section has been proceeding on this road for a good many years now, as claimed, I apologise. But I am surprised at the slow progress it has made.

My "we," in the phrase "economic system under which we perish," was meant to be fairly catholic, and I have no objection to including the Russians and Chinese, though I think they may outlast us. My information about Russia is largely from schoolboys, who write to be told the latest about the atom; and about China, that the children work in mills

twelve and fourteen hours a day, much as we worked ours here at the same stage of the industrial system. But on the question whether *we*, the British, are perishing or not, the statistics obtained during the medical examinations for compulsory military service were, to say the least, disquieting.

In reply to your correspondent, Mr. W. W. Leisenring (April 28, p. 571), the object of the examination I advocated is to find out what the physical basis of economics is, because I think it is entirely the opposite of what the economists seem to believe. There is no question of altering it. The natural laws in connexion with energy and matter were not known or understood when the present system was formulated. The system is a reflection of certain passing conditions, —an *ad hoc* system, good enough perhaps fifty years back, but perilous to-day. It should now be possible to found broadly the physical basis, embodying modern knowledge of the laws of energy and matter and the two undeniable principles of the Physiocrats and Karl Marx to which I made allusion. That human nature is admittedly imperfect is no reason why physical nature should be distorted to suit it, even if that were possible. Because drivers are imperfect and of uncertain individuality we do not insist on imitating their idiosyncrasies in the cars they drive. Rather we try to make them "fool-proof."

Mr. Leisenring deduces from my letter that "the natural obvious truths of the nineteenth century as interpreted economically are, in this century, both unscientific and senseless." I accept the deduction, much as I would if the words "spring" and "autumn" were substituted for the contrasted centuries; but I am not clear why Mr. Leisenring should disagree with my statement that no one pretends to understand the present system. His eulogy of it, whether historically justifiable or not, was couched in the past tense, whereas my criticism of it was couched in the present tense. With regard to the present financial system, however, if there is one defect it does not suffer from, it surely is age. Such a system as the present has never even been attempted before. It is an absolute innovation; and to suggest that it has evolved through several centuries *pari passu* with science, and that its ultimate basis is character and ability, merely shows that it is not understood. Its ultimate basis is credulity, and, by the standards of the Codes of Laws and social formulæ of all great civilisations, it is counterfeit.

FREDERICK SODDY.

MR. W. WILSON LEISENRING'S interesting criticism of Prof. Soddy's economic views in his letter printed in NATURE of April 28, p. 571, appears to have overlooked some of the most important causes of the present confusion in the world of economics. Among these I would put first the well-known psychological process of *inversion*, whereby the *means* is mistaken for the *end*, as exemplified by the old mercantile system or fallacy of representing the accumulation of gold and silver as the ultimate goal of commerce, and as being the true basis of national prosperity. Thus "protection," "tariff reform" (and, indeed, most of the "labour" or trades union ideals) are no more than survivals of a belief that *money*, instead of being the mere instrument of exchange and a measure of market values, is of itself the end and purpose of all trade and labour activity.

A fruitful source of confusion is also ambiguous terminology. Attempts are often made to divorce the economic concept of *wealth* from private property. In their strictly economical signification "wealth" and "labour" are unmeaning apart from property and market values. The same ambiguity applies to "capital," hence all the absurdities associated with the phrase "capital levy."

I venture also to differ from Mr. Leisenring's statement that "the ultimate basis of credit in any age is character and ability." We have here another illustration of inversion. The true basis of credit is surely *reputation*, *authority*, and *familiarity*. These again depend upon systematic advertisement, or, to put it less invidiously, upon "practical instruction."

ST. GEORGE LANE FOX PITT.

Travellers' Club, Pall Mall, S.W.1,
April 30.

Spermatogenesis of the Lepidoptera.

IN a letter to NATURE of April 28, p. 568, Prof. J. Brontë Gatenby states his position as to the criticism, made independently by Dr. R. Bowen of Columbia University and myself, of his account of the formation of the macromitosome in the spermatogenesis of Lepidoptera. In doing so he makes a statement that, if I understand it correctly, is inaccurate and is certainly misleading.

The macromitosome is formed by the coalescence of the mitochondrial vesicles. On this point we are all agreed. The mitochondrial vesicles consist of an inner chromophobic or lightly staining material surrounded by an outer layer of chromophilic or deeply staining material. Now, Dr. Bowen and I consider that the coalescence of the mitochondrial vesicles results in "merely larger aggregates of chromophobic material, the chromophilic material running together to form more or less complete partitions between the chromophobic droplets" (Bowen, *Q.J.M.S.*, 66, p. 601). On the other hand, Prof. Gatenby considers that the coalescence consists of the flowing together of the vesicles forming first of all elongated structures and then loops of chromophilic substance which ultimately join up to form a "perfectly coiled spireme" in a mass of the chromophobic substance.

In his letter Prof. Gatenby uses the expression "whether the 'spireme' was formed of a flat ribbon, or a round string." This, presumably, indicates his conception of the difference between our views. If it does not, I have failed to grasp the necessity of this phrase. So far as I am aware, Dr. Bowen has never suggested that the mitosome is formed by the twisting of a ribbon, and I, certainly, have never used the word "ribbon" in this connexion. A mass of soap bubbles cannot be described as made up of a twisted ribbon of soap solution, whereas it can be described as a plate work, and that is the description continually given by Dr. Bowen.

I do not think that the difference between Prof. Gatenby's view and that of Dr. Bowen and myself is of as little consequence as Prof. Gatenby implies in the third paragraph of his letter. If his views as to the formation of the Lepidopteran mitosome are adopted, then the Lepidoptera are unique among all the insects in which spermatogenesis has been described. This is a view that one would hesitate to adopt, especially in view of the fact that practically all other recent workers on the spermatogeneses of all other insects agree more or less closely with the account of the plate-work mitosome of Dr. Bowen. For this reason it became important to confirm, if possible, Prof. Gatenby's description. Dr. Bowen carried out his work on the Lepidoptera especially for this purpose, and came to the conclusion that Prof. Gatenby's interpretation of the process was inaccurate. If, then, Dr. Bowen's account is accepted, the Lepidoptera are brought into line with other insects, and

this is certainly an important result. In view of this it seems very unfortunate that Prof. Gatenby has stated that, apart from Dr. Bowen's new interpretation of the sperm tail, "he adds nothing new to our knowledge of the spermatogenesis of the Lepidoptera." He considers the value of Dr. Bowen's work to lie in the fact that it confirms his own drawings of the appearance of the mitosome. After carefully comparing Dr. Bowen's paper with the original paper by Prof. Gatenby (*Q.J.M.S.*, 62, p. 407) I really cannot agree that there is any confirmation whatever. One figure by Dr. Bowen (Fig. 43) superficially resembles a corresponding one in Prof. Gatenby's paper (Fig. 14). Otherwise the figures of the mitosome are totally different in the two papers.

Prof. Gatenby has not answered the criticism that I have made of his original description of the formation of the mitosome. I cannot see how the chromophilic outer surface of a drop—which, of course, has an appreciable area—can, by fusion with another drop, or even by mere elongation, become transformed into a thread-like loop that has no appreciable area. He states merely that the mitochondrial vesicles flow together, "forming, at first, elongated structures, then loops, and finally filaments." I have pointed out (*Q.J.M.S.*, 66, p. 665) that I consider the figures that accompany this description inaccurate and misleading. Further, if such a process does take place, surely it would be possible to observe the intermediate stages, and would not these, in any case, be some sort of plate work? If Prof. Gatenby would enlarge upon his somewhat brief description it might help to clear up the differences between our views.

With regard to the opinion of the late Prof. Doncaster on the formation of the mitosome I should like to add a few remarks. In 1919 I had the privilege of assisting Prof. Doncaster in working out the spermatogenesis of the louse *Pediculus corporis*. We divided the work into two, he dealing chiefly with the chromosome aspect, while I dealt mainly with the cytoplasmic inclusions. At first Prof. Doncaster was inclined to believe that the mitosome was formed in the manner described by Prof. Gatenby, and, in fact, in the original notes, which I now possess, there are rough drawings by Prof. Doncaster figuring the mitosome as a spireme. I could not accept this view, and explained my conception to him. Ultimately he agreed with me, and it was at this time—about May or June—that he paid the visit to Prof. Gatenby, and objected to the latter's description of the mitosome of Smerinthus. However, that he was quite prepared to accept Prof. Gatenby's description is shown by the fact that in his last book on cytology he gives Prof. Gatenby's account in full and does not, I think, refer to our own observations on Pediculus.

H. GRAHAM CANNON.

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The Rodier System of Rat Repression.

IN connexion with the article on "The Rat and its Repression," contributed by me to NATURE of May 20, 1922 (vol. 109, p. 659), I have been favoured with a letter from Mr. Wm. Rodier of Melbourne, in which he complains that my attitude to his system of rat repression is unsympathetic, or that, conversely, he is misunderstood.

I should esteem it a favour if you would allow me to say that I am not unsympathetic to any means of destroying the rat—an animal which I, at least, consider to be one of the greatest menaces of modern civilisation.

The attitude I take to the "Rodier Method" of rat destruction is that its principles are so thoroughly understood by all who have studied the rat problem that I am conscious of no unfairness when I suggest Mr. Rodier harms his cause when he asserts that those who do not immediately and unreservedly become his disciples are necessarily antagonistic, or stupid.

The difficulties Mr. Rodier has to overcome are such as are presented by the attitude of authorities towards putting rats back by rat-catchers who are paid to destroy their catches; the attitude of business houses when they pay for rat-clearing and find male rats turned back; and the plight of boroughs who make it their business to destroy female rats, when they find their polygamous males mated by females from contiguous boroughs where the "Rodier Method" is not in operation.

The whole question is one of education, and my immediate object is to convince the public that the rat is one of man's most dangerous foes, and one that is too expensive to maintain. As for the Rodier method, I have an open and sympathetic mind; and I would suggest that it would help Mr. Rodier's propaganda enormously if he could show us good results that could be scientifically checked, say in an island like Tristan da Cunha, or the Isle of Man. The authorities in the former island, where I am assured rats climb trees, would doubtless welcome assistance to overcome their terrible foes.

ALFRED E. MOORE.

The Incorporated Vermin Repression Society,
44 Bedford Row, London, W.C.1,
April 28.

Active Hydrogen by Electrolysis.

IN 1907 Fischer and Massenez (*Z. anorg. Chem.*, 52, 202, 1907) obtained a concentration of 17 per cent. by weight of ozone when they electrolysed a solution of sulphuric acid, using a very high current density. Since ozone can be produced by this method, it would seem probable that a high current density at the cathode might aid in producing the ozone form of hydrogen. When a solution of sulphuric acid is electrolysed, using the above principle, the hydrogen that escapes at the cathode contains an active constituent which combines with pure nitrogen to form ammonia. Some of the ammonia formed is collected in the absorption bulb, but quite a large portion of it remains dissolved in the sulphuric acid solution. This active constituent in the hydrogen that is evolved at the cathode is probably the ozone form, and is produced perhaps in a manner analogous to the ozone form of oxygen. The per cent. of the active gas formed varies with the current density and the concentration of the acid.

Likewise, if a solution of potassium hydroxide is electrolysed, using a high cathode current density, the escaping hydrogen contains the ozone form which combines with pure nitrogen to form ammonia.

In the electrolysis of the acid solution the escaping hydrogen contains a fog which persists after passing through the absorbing solution. This fog is similar to, but less dense than, the fog sometimes produced by ozone when it is bubbled through potassium iodide solution.

This work is a further verification of the theory of Dr. G. L. Wendt that tri-atomic hydrogen may be produced wherever atomic hydrogen is formed.

A. C. GRUBB.

Dept. of Chemistry,
University of Saskatchewan,
Saskatoon, Sask., Canada,
April 18.

The Low-power Aëroplane or Aviette.

By Prof. L. BAIRSTOW, F.R.S.

MUCH attention is being paid in the general and technical press of this and other countries to flight with low-powered engines. The addition of small engines follows quickly on the gliding successes of the past year, but no marked connexion is discernible between the new features of the two types of flying machine. The change from aeroplanes having two or three hundred horse-power, and carrying a single individual, to aeroplanes of five to ten horse-power is now so striking as to have stirred public imagination. Many of those now interested are probably unaware of the flights made by A. V. Roe more than ten years ago with a nine horse-power J.A.P. engine.

There is little in the new applications which would warrant the use of the word discovery, and the change is probably due in large measure to an emancipation from the fetters of war ideas. There is reason to suppose that aeroplanes designed for official use are subject to so many restrictions that development is difficult. The advent of the low-power aeroplane is therefore welcomed as a new outlet for ideas, one which gives scope to individual initiative, and one which it is hoped will make a popular appeal.

The unofficial character of the British development of the aviette is emphasised by the offering of a prize of 500*l.* by the Duke of Sutherland for a light aeroplane of British manufacture and design; for the Duke is Under Secretary of State for Air, though he is not acting in his official capacity. A separate prize of 1000*l.*, open to the world, is offered by the *Daily Mail*. The most striking conditions of the competition are: "The power unit must not exceed 750 cc. total cylinder capacity, and the prize will be awarded to the machine which flies the longest distance on one gallon of petrol, with a minimum distance of fifty miles to qualify."

Many other conditions apply which relate to ease of handling on the ground; there is also the usual vague reference to stability. It is in accordance with our present state of knowledge and application that, while the requirements for performance are always precise and well-defined, those for stability and control are valueless. In the competition rules for the low-power aeroplane there is neither definition nor means of checking aircraft as delivered in order to ensure a due measure of stability and control.

The French are, as is usual in matters relating to aviation, taking an active interest in the aviette, and in the *Times* of April 6 we find an article based on a flight by M. Barbot from Francazal to Toulouse in a seven horse-power aviette. The ideas of the flyer appear in the following quotation:

"M. Barbot, who is in Paris, expresses the belief that his aviette is the forerunner of the aero-taxi of the immediate future. He contemplates the production of a machine which will cost about five thousand francs (nominally 200*l.*), which can rise from almost anywhere and, furnished with a ten or fifteen horse-power motor, can land slowly within thirty yards of its objective and without any risk. . . . The cost will be only that of a gallon of petrol per hundred miles."

In the same issue of the *Times* is a reference to a British "power-driven glider":

"The test began yesterday at Ashton Park, Preston, of the first British auxiliary-engined glider, the Wren, designed and built by the English Electric Company at their Preston works. It is expected that the machine will provide valuable data on which to base the development of the economical aeroplane of the future. It has been constructed for the Air Ministry. It is remarkably light, being about 3 cwt., and the dimensions are: span 37 ft., length 23 ft., height 5 ft. The engine is a three horse-power A.B.C. motor-cycle engine, developed to seven horse-power, and gives a maximum speed to the aviette of forty-eight miles an hour. . . ."

These two extracts exhibit the features which define the low-power aeroplane, and in the remainder of this article it is proposed to analyse the projects and achievements in relation to the scientific knowledge involved. It will be found that the expectation of 100 miles per gallon of petrol in an aero-taxi carrying pilot and passenger is optimistic but not wildly in excess of what can be immediately foreseen, using arguments based on well-established data. On the other hand, risk is only incidentally reduced, and neither the extracts nor current technical literature show any attempt on the part of the designers of light aeroplanes to pay special attention to the fundamental problems of stability and control.

For the past eight or ten years it has been realised that all good aeroplane design tends to produce a result in which, for the most economical speed of flight, the weight carried is about nine times the resistance experienced. All high-power aeroplanes are able to exceed this most economical speed very greatly, with the result that at their maximum speed near the ground the resistance is more than one-quarter of the weight. If there be no great reserve of power, considerable height above the ground is unattainable, and the most economical speed is fixed by the design of the aeroplane, in particular by the magnitude of the load carried per unit area of wing surface. A common loading has been 7-8 lb. per sq. ft. corresponding with an economical speed of about 60 miles per hour; a reduction of loading to 2 lb. per sq. ft. would bring the best speed to about 30 m.p.h.

If the making of a specified journey be the basis of comparison, then speed in itself has no influence on petrol consumption per unit of weight carried, but the horse-power required is directly proportional to the speed. Indirectly, low speed is advantageous, since a smaller and light engine suffices for transport. Taking figures given in the Press as a basis, it appears that the aviette with a single occupant would weigh about 550 lb. all told, whereas the single-seater fighting craft weighs from three to four times this amount. The maximum speed claimed for the aviette is only about one-third of that achieved by the scout.

Further data lead to an estimation of a probable mileage per gallon of petrol. Many aero-engines exist in which the petrol consumption does not exceed 0·5 lb.

of petrol per brake horse-power per hour, and it is probable that an airscrew efficiency of 75 per cent. may be reached. With petrol weighing about 7 lb. to the gallon it will be found from those figures and a weight-resistance ratio of 9 that the number of miles possible per gallon of petrol consumed is roughly equal to thirty thousand divided by the weight of the aeroplane. To achieve 100 miles to the gallon, therefore, it would be necessary to improve on existing figures for performance, since a gross weight of 500 lb. yields only 60 miles per gallon. As an aero-taxi with pilot and passenger would weigh more than 500 lb. it would appear that M. Barbot's estimate is not to be easily achieved.

It will be noted, however, that the condition of a minimum of 50 miles per gallon in the competition rules for the Duke of Sutherland prize is reasonable. It will exclude seriously inefficient design without setting an impossible task.

In making the preceding calculations, no allowance was made for the use of energy obtained from the wind itself. As we all know, aeroplanes without engines, *i.e.* gliders, have maintained themselves in the air for several hours consecutively, utilising winds deflected upwards by a sloping hill-side. Up-currents of sufficient intensity for support are very local, and we are yet far from being able to use them for point-to-point journeys as distinct from tacking backwards and forwards in a chosen locality. The phenomenon of gliding, as we know it, does not modify the estimate of power already made, but does show how part of that power may be obtained from the wind. Langley contemplated the extraction of energy from the pulsations of the wind, quite apart from their direction, and this source of energy is probably very widely distributed. So far, however, little, if anything, has been attempted in practice in the extraction of this energy, and there is no clear lead as to the direction in which one might hopefully proceed.

For some time to come, it may be expected that the aviette will carry the main source of power for its support; economy of fuel may be obtained by utilising up-currents in the neighbourhood of flight and so using the engine in passing from hill crest to hill crest. The condition attached to the Duke of Sutherland prize that the competition is to take place over a triangular course of not less than 15 miles reduces the chances of obtaining substantial amounts of energy from the atmosphere.

Since a claim for reduction of risk has been made, it may be as well to state the view that the only contribution made to safety is in the sense that it is less dangerous to strike the ground at 30 m.p.h. than at 60 m.p.h. The inherent defects of the modern aeroplane which make for danger on stalling are quite untouched by the new application.

The low-power aeroplane can scarcely fail to react beneficially on scientific knowledge and its applications. At the moment, however, it would appear that the aviette has derived its being from knowledge obtained for other purposes and has not reached the stage of reciprocation.

[Since this article was written, a very definite advance in the practical use of the low-power aeroplane has been made by M. Barbot, who, as was recorded in our issue of May 12, p. 645, succeeded in completing the round trip from the French coast to Lympne in Kent and back again, covering about 80 miles, in a machine with a 15 h.p. engine. His time for the journey was about two hours and a quarter, including nearly half an hour's stay at Lympne, and it is stated that his petrol consumption was about two gallons.]

The Earth's Electric and Magnetic Fields.[1]

By Prof. W. F. G. SWANN, University of Minnesota.

II.

TWO of the most characteristic features of the earth's magnetism are the non-coincidence of the magnetic and geographic axis, and the secular variation. While a theory which is to claim any degree of completeness must account for these, one cannot resist the temptation of searching for any sort of phenomenon capable of giving a field of the order of magnitude of the earth's field in the hope that if such be found it may serve as a possible basis on which to build a more complete theory.

Attempts towards a theory of the earth's magnetism may be classed roughly in the following four groups:

(1) The earth is assumed to be made largely of iron, and to be a permanent magnet independently of its rotation, or to be magnetised inductively by an external field.

(2) The magnetic field is brought about by the rotation of an electrostatically charged system.

(3) The magnetic field arises from a state of magnetisation brought about by the rotation of the earth.

(4) The field is caused by electric currents circulating within the earth.

The high temperature of the earth's interior would be inconsistent with a state of permanent magnetisation unless the effect of high temperature is compensated in some way by that of high pressure. Induced magnetisation suffers from the same cause, and would, moreover, give a type of field totally unlike the earth's field.

As regards (2), a sphere of the earth's size, rotating with the earth's angular velocity, would have to possess such a surface charge as would give it a potential gradient a hundred million times the earth's potential gradient in order that the rotation of that surface charge would produce a magnetic field comparable with the earth's magnetic field. Even then, it turns out, as has been shown by Schuster and by the writer, that owing to the effect of the observer's motion with the earth's surface, a sign of charge which gave the right direction for the vertical component would give the wrong direction for the observed horizontal component.[2]

[1] Continued from p. 642.

[2] Inclusion of the effect due to the atmospheric positive charge annuls completely the magnetic field which would be observed by one moving with the earth.

The difficulties arising from the large electric field, and from the inconsistency in sign between the horizontal and vertical components may be avoided, at first sight, by supposing, with Sutherland, that the earth may be regarded as two superposed spheres of positive and negative electricity, the diameter of the negative sphere being greater than that of the positive. The electric field at external points would be zero, but the magnetic field would not be zero. The actual density of positive and negative electricity in the earth is so great that, if all the positive and negative electricity in a cubic centimetre could be concentrated at two points one centimetre apart, they would attract each other with a force of the order 10^{20} tons ; and, on account of this, it is only necessary for the radii of the two spheres of the size of the earth to differ by 2×10^{-8} cm. (the diameter of a single molecule), in order to ensure that the two, rotating together, would give rise to a field of the order of magnitude of the earth's field. Unfortunately, however, we find that the electrostatic forces opposing even this small separation are enormous, amounting to more than one thousand million volts per centimetre at the surface of the inner sphere.

Regarding forces which suggest themselves as possibly available for causing electrostatic separations of the above or allied kinds, we have, in the first place, gravity, tending to pull the free electrons towards the earth's centre, then centrifugal force tending to make them fly to the surface. Another possibility arises from an action analogous to the Thomson effect, by which the electronic density tends to decrease as we descend towards the earth's centre, on account of the increase of temperature. These effects have been submitted to calculation by the writer, and it appears that the first gives rise to a field only 10^{-21} of the earth's field, and in the wrong direction, the second to a field about 10^{-23} of the earth's field, but of a type widely different from that of the earth, and the third to a field in the right direction but amounting to only 10^{-17} of the earth's field.

As a general rule, we may say that it is practically hopeless to seek an explanation of the earth's magnetic field on the basis of the rotation of charges which have been separated against electrostatic attraction, since the mechanical forces necessary to produce the requisite separation must be, in all cases, enormous.

If the earth were made mainly of iron, its rotation would, by gyroscopic action, bring about a partial orientation of the molecular magnets ; and it has been experimentally demonstrated by S. J. Barnett that iron can be magnetised in this way. The effect in the case of the earth is, however, extremely small, and is only sufficient to account for a magnetic field 2×10^{-10} times that of the earth.

The suggestion has been made that the interior of the earth may be endowed with enormously high permeability, and that, in consequence, a very weak force would be sufficient to cause strong magnetisation therein. We must remember, however, that the very creation of a state of magnetisation within a sphere brings about an internal demagnetising field which is, as a matter of fact, equal to the external field at the equator. Hence any primary magnetising agent which is to be ultimately responsible for the earth's field must be of such intensity that it will produce, on the molecular magnets, forces at least equal to the forces which would be produced on them by a magnetic field equal in intensity to the earth's magnetic field at the equator.

Any theory attempting to account for the earth's magnetic field on the basis of currents circulating within the earth, calls for some explanation of the electromotive force wherewith to produce the currents. In this connexion it is of interest to recall a calculation by H. Lamb, to the effect that if currents were caused to circulate in a copper sphere of the earth's size, and the electromotive forces which caused them were removed, the currents would take ten million years to decay to one-third of their initial values. Attempts to account for the earth's field in this way have met criticism on the basis of the enormous currents which would be calculated by extrapolation back, even to epochs not more remote than those during which the earth's crust has been solid, so that, unless there is some reason for supposing that the conductivity is, or has been, in the past, even greater than copper, we are confronted with accounting for the enormous amounts of energy necessary to have produced the field initially.

The actual current density within the earth necessary to account for the earth's field is very small, being, for example, of the order 10^{-8} ampere per square centimetre on the surface at the equator for the case where the current density is proportional to the distance from the axis of rotation. If, taking a sphere of iron, we assume about 10^{23} free electrons per c.c., it is only necessary to suppose that the mean velocity of the electrons at the earth's surface, relative to the centre, differs from that of the periphery by one part in 7×10^{16} in order to account for this current. It is, perhaps, not too much to hope that a fuller knowledge of the mechanism of conduction in solids than we have at present may lead to an explanation of such a small difference as arising directly on account of the earth's rotation.

There is always the chance that the origin of the earth's field may have to be sought in some fundamental but small departure from the ordinary electrodynamic laws. In this connexion we may recall Lorentz's theory of gravitation, according to which gravitational forces may be accounted for by supposing that the attraction between two unlike units of charge is different from the repulsion between two like units. Paying due regard to the care necessary in defining electrical neutrality in this case, the theory may be shown to lead to the conclusion that, in order that the free electrons in a body shall be in equilibrium, the body must acquire a charge density to an extent not wholly determined by the weight of the electrons. Schuster has discussed the possibilities in this regard, but it would appear that, under the most favourable assumptions, the density would be insignificant as regards producing, by its rotation, a magnetic field comparable with the earth's field.

A greater measure of success is attained by making a somewhat similar assumption concerning the magnetic field produced by a moving charge. We first observe that a magnetic field is ultimately measured in terms of the force which it exerts on a moving electron ; for even a material magnet which may be used in the measurement derives its properties from electrons rotating within it. In analogy with the case of electro-

statics, where we have to deal with the forces produced by positive on positive, negative on negative, and positive on negative, we have, in addition, for moving electrons, the force due to the motion of a positive electron on a moving positive electron, the force due to the motion of a moving negative electron on a moving negative electron, the force due to the motion of a negative electron on a moving positive electron, and the force due to the motion of a positive electron on a moving negative electron. The first two of these four may be taken as the basis for defining the measures of the two types of magnetic fields produced by positive and negative electrons respectively. If, for similar motions, these four forces are all equal, a moving electron, or a magnet, would be entirely unaffected by the rotation of the earth as a whole.

If, however, the forces, due to motion, between unlike moving charges are suitably different from those between like charges in the same states of motion, it will immediately appear that the electrically neutral earth will, by its rotation, produce those forces on magnets and moving electrons which we associate with a magnet as ordinarily defined. By making the forces between electrons of like sign equal for both signs, the force due to the motion of a negative electron on a moving positive electron greater than, and the force due to the motion of a positive electron on a moving negative electron less than the forces between like electrons to the extent of about two parts in 10^{19}, we can account for the equivalent of a magnetic field of the order of magnitude of the earth's magnetic field. If we wish to combine these alterations with suitable alterations in the electrostatic forces, we can also include gravitation in the complete scheme.

The secular variation presents interesting problems for speculation. There is some evidence for the belief that the earth's magnetic axis rotates about the geographic axis once in about 500 years. This will result in induced currents, and the field we observe will be that due to these induced currents (the secondary field), and that due to the primary causes (the primary field). Taking an iron sphere of the earth's size for purposes of illustration, it works out that the flux of the secondary field through the sphere, which is, of course, related to that of the primary field, is of such magnitude as to annul almost completely the non-axial component of the primary flux, leaving only a small residual non-axial component, which lies, moreover, perpendicular to the primary non-axial component. Thus, in order that the resultant flux shall have an appreciable inclination to the geographic axis, it is necessary for the primary axis to lie very near to the equatorial plane, and yet for the primary flux to be so large that its axial component, which is small compared with it, represents the axial component which we observe. This example is given merely to illustrate the important rôle which might be played by the induced currents due to the secular variation in case the earth's interior had a conductivity comparable with that of iron.

The theory of the diurnal variation is in a better position than that of the earth's field as a whole. The suggestion of Balfour Stewart, developed in detail by Schuster, to the effect that the diurnal variations are caused by Foucault currents generated in the upper atmosphere by the tidal motion of the atmosphere across the earth's lines of force, seems well adapted to fit the facts, its chief difficulty being that it calls for a conductivity about 3×10^{11} times that found at the earth's surface. Various agencies have been invoked to account for this conductivity, namely, ultraviolet light, gamma rays, negative electrons, and alpha rays, from the sun, and finally charged atoms of gas, shot out from the sun by the pressure of light, and endowed thereby with velocities sufficient to give them the properties of low energy alpha particles. The corpuscular radiations have also been invoked to account for the phenomena associated with the aurora.

It is probable that ultraviolet light plays no important rôle, since it is capable of accounting for a conductivity less than one-millionth of the conductivity required. As regards the corpuscular radiations, the nature of the precipitation of corpuscles indicated by the aurora is of a type to correspond to a bending by the earth's magnetic field such as one would not readily associate with particles of mass as small as that of electrons. The mass of an electron increases with its velocity; but, so greatly has Birkeland found it necessary to draw upon this phenomenon in order to fit the facts, that, on the hypothesis of negative electrons, he is driven to assume velocities ranging from 400 metres per second less than the velocity of light to 4 metres per second less than that limit. Alpha particles have a mass and energy which would be better adapted to account for the aurora, as has been pointed out by Vegard; moreover, the definiteness of their range ensures the characteristic feature of the sharp boundary of the luminescence, and the magnitude of the range is fully sufficient to account for the penetration of that boundary to the altitudes observed.

The remarkable perturbations of the earth's magnetic field known as magnetic storms, which occur most frequently in association with high solar activity, suggest the entry into our atmosphere of electrified corpuscles during these periods, and it is natural to look to those corpuscles which are responsible for the conductivity and the aurora for an explanation of these storms. While alpha rays have been suggested, some of the difficulties inherent in the assumption may be gathered from considerations put forward by Lindemann. On the assumption of their production by alpha rays, these storms would call for an incredibly large amount of radioactive material in the sun. Again, a conical beam of alpha rays, such as appears to be necessary to account for the storms, would, on its journey here, suffer, by self-repulsion, an acceleration of about 10^{13} cm./sec.^{2} at its boundary, in such a sense as to make it spread, so that it could never arrive as a beam. Finally, even if the beam could reach our atmosphere, it would charge it at such a rate that the repulsion due to the charge which had arrived would, in a few seconds, attain a value sufficient to prevent the entry of any more rays.

It is for reasons such as these that Lindemann has been led to favour the view that the primary agencies responsible for magnetic storms are atoms of gas, ionised by the high temperatures in the solar prominences, and shot out of them by the pressure of the sun's radiation. He shows, moreover, that the velocities to be expected in these circumstances are such as to give the particles ranges in harmony with the requirements of auroral phenomena.

The Tercentenary of Sir William Petty.

OF the founders of the Royal Society, Wilkins was born in 1614, Goddard and Seth Ward in 1617, Evelyn and Bathurst in 1620, Willis in 1621, and Petty in 1623. Boyle and Wren were somewhat younger, being born in 1627 and 1632 respectively. Petty, whose tercentenary occurs on May 26, was thus thirty-seven years of age when the Society was inaugurated, and had already given evidence of great administrative powers. Unlike most of his fellow scientific workers, his education was gained mainly on the Continent, and he was a man of twenty-four or twenty-five when first he settled at Oxford. He was born at Romsey in Hampshire, the son of Anthony Petty, a clothier, and as a boy attended the Romsey Grammar School. From there at the age of fifteen, with a consignment of his father's goods, he crossed to France, where he entered the Jesuit College at Caen, apparently maintaining himself by the sale of his father's merchandise.

From Caen, Petty returned home, served for a short time in the navy, but at the outbreak of the Civil War went abroad again, spent some time at Utrecht and Amsterdam, and in 1644 matriculated as a student of medicine at Leyden. He is next found in Paris, becoming known to Hobbes, Sir Charles Cavendish, and other English refugees, and attending the meetings of Mersenne, from which ultimately sprang the Paris Academy of Sciences. Once more at home he took up his father's business, invented a process for duplicating letters, and in 1648 published his tract on education, "Advice to Mr. Samuel Hartlib, for the Advancement of Some Particular Parts of Learning." He proposed the establishment of a College of Tradesmen, with botanical theatre, observatory, etc., the members of which "would be as careful to advance arts, as the Jesuits are to propagate their religion."

Petty next removed to Oxford, where he was able to associate with the philosophers who during those troublous times kept the lamp of science burning. Many of the meetings which Wilkins and Boyle frequented were held at Petty's lodgings. In 1649 he took his doctor's degree in physic, and a year or two later became professor of anatomy.

From Oxford Petty was now sent by the Commonwealth Government to Ireland as physician general to the forces, where he quickly added to his reputation by reorganising the medical services. The terrible massacres of 1641 had by this time been ruthlessly avenged by Cromwell, and all who could not prove "consistent good affection" to the English Government were to be dispossessed of their lands. This resulted in some 3000 native landowners losing their property. To Petty was given the task of measuring and surveying the forfeited estates. His survey, which has been described as the first attempt to carry out a survey on a large scale and in a scientific manner, is curiously known as the "Down Survey" because it was measured "down" on maps. Besides this, Petty also made a map of Ireland, completed about 1673, largely at his own expense. By his work in Ireland Petty himself gained considerable estates in Kerry and later on set up ironworks, opened lead mines and marble quarries and started a timber trade. His duties were not carried through without gaining for him many enemies, and in the last Parliament of the Commonwealth he was impeached and for a time his fortunes hung in the balance.

With the Restoration, Petty, who disliked extremists of all parties, was received favourably by Charles II. and was confirmed in the possession of his Irish estates. He now was able to resume the society of his scientific friends, and he was present at Gresham College on November 28, 1660, when the Royal Society was formed. He became a member of the first council and often contributed papers to the Proceedings of a practical nature. He is several times mentioned in connexion with the subject of shipping, and in 1662 made some stir by the mention of a double-bottomed or twin-hulled boat which would go against wind and tide. A ship constructed to his plans made two voyages between Dublin and Holyhead and was then wrecked. The idea has been put into practice several times since the days of Petty, notably so in the case of the channel steamer *Calais-Douvres* constructed in the 'eighties of last century. At one meeting of the Royal Society Petty "was intreated to inquire in Ireland for the petrification of wood, the barnacles, the variation of the compass, and the ebbing and flowing of a brook." Among his other services to the science of his day was the part he took in the foundation of the Dublin Philosophical Society in 1684, of which he was president. He drew up for the Society a "Catalogue of mean, vulgar, cheap and simple experiments," and among his advice to the members was "that they carefully compute their ability to defray the charge of ordinary experiments fforty times per annum, out of their weekly contributions, and to procure the assistance of Benefactors for what shall be extraordinary, and not pester the Society with useless or troublesome members for the lucre of their pecuniary contribution."

Petty was full of worldly wisdom and possessed what Benjamin Martin called a "universal practical genius." One result of this was that he died a very rich man. But at a time when such studies were rare he wrote on taxes, revenue, the origin of wealth, trade, population, and the growth of cities. It is on his work as a political economist that his reputation rests. He condemned the farming of the revenue of Ireland, suggested free commercial communication between that country and England, and consistently urged upon the Government the necessity of a department for the collection of statistics. He co-operated with John Graunt, another original member of the Royal Society, in the production of a book entitled "National and Political Observations . . . made upon the Bills of Mortality," published in 1662, which may be regarded as the first book on vital statistics ever published.

A tall handsome man, Petty was known among his fellows for his unusually good temper. Evelyn said of him "there was not in the whole world his equal for a superintendent of manufacture and improvement of trade, or to govern a plantation," and Pepys refers to the charm of his society. Knighted by Charles in 1661, Petty in 1667 married a daughter of Waller the regicide, and was survived by three children. He twice refused a peerage, but his widow was created Baroness Shelburne. He died in Westminster on December 16, 1687, and was buried in the Abbey Church at Romsey.

Obituary.

PROF. E. W. MORLEY.

IN the issue of *Science* for April 13, appears an appreciative notice by Prof. O. F. Tower, professor of chemistry in Western Reserve University, of the life and work of Prof. E. W. Morley, whose death was announced in NATURE for April 28, p. 578.

Edward Williams Morley was born in Newark, New Jersey, on January 29, 1838, and in 1869 went to Western Reserve College, then in the town of Hudson, as professor of natural history and chemistry. In 1882 the College was moved to Cleveland, becoming Adebert College of Western Reserve University, and there Prof. Morley taught general chemistry and quantitative analysis until his retirement in 1906 as emeritus professor.

Prof. Morley's first work of importance, undertaken while he was still in Hudson, was on the relative proportion of oxygen in the air (1878–81). The work for which he is best known to chemists, however, was on the densities of oxygen and hydrogen and the ratio in which they combine; this was carried out at Cleveland and published in 1895. It is a remarkable tribute to his work that now, after nearly thirty years, the accepted values of these quantities are practically identical with those found by him. Prof. Morley was also eminent as a physicist, and his characteristic for precision of measurement is shown in his early papers on rulings on glass and on the probable error of micrometric measurements. While at Cleveland, he collaborated with Prof. A. A. Michelson in the development of the interferometer, and with this instrument the well-known Michelson-Morley experiment on the relative motion of the earth and the ether was carried out. The experiments, though giving negative results, were resumed later in conjunction with Prof. D. C. Miller.

The accurate work on the determination of the relative atomic weights of hydrogen and oxygen won for Prof. Morley the Davy medal of the Royal Society in 1907; while in 1904 he had been elected an honorary fellow of the Chemical Society. He was also an honorary member of the Royal Institution. In the United States he received the honour of being made president of the American Association and of the American Chemical Society in 1895 and 1899 respectively. He died on February 24, about a month after his eighty-fifth birthday.

SIR SHIRLEY MURPHY.

SHIRLEY MURPHY'S name during the last thirty years has been a household word in the ranks of public health workers; and his work as medical officer of health for the county of London during a period of twenty-two years was marked by great improvements in the administrative control and prevention of disease. From this post he retired a few years before the War, but at its onset his services were utilised in taking charge of the sanitary services of the London area, for which work he was created K.B.E. in 1919, having been previously knighted in 1904.

It is, however, rather in Sir Shirley Murphy's contributions to the science of epidemiology that NATURE is chiefly interested. The factors making for or reducing the prevalence of such acute infectious diseases as scarlet fever, diphtheria, measles, and whooping-cough are complex; they differ from such diseases as typhus fever, typhoid fever, cholera, smallpox, and epidemic enteritis, which can be entirely controlled, given the adequate application of general and specific sanitation. Like the uncontrolled and only partially controllable diseases enumerated above, the members of this last-named group are subject to cyclical waves, seasonal and longer waves; but the vehicles of infection can be put out of action, or by vaccination in the case of smallpox, personal immunity is obtainable. Murphy made many contributions in his annual reports and in the Proceedings of the Epidemiological Society to the study of seasonal influences on scarlet fever and diphtheria, showing that there have been in London seasonal variations in both the fatality (*i.e.* case-mortality) and age distribution of notified cases of these diseases. The cases of these diseases at ages under five form a larger proportion of the total cases at the beginning and end of the year than in its middle; and even when the necessary corrections are made for variations in age and sex of the cases, the fatality from these diseases is subject to seasonal variations. Murphy advanced the view that the change in the age incidence of death-rates from phthisis is explicable by successive additions by birth of a more resistant race, a tenable hypothesis, though not supported by international facts as to the phthisis death-rate.

The presidential address delivered by Murphy to the Epidemiological Society on "The Study of Epidemiology" is perhaps the best illustration of his wide knowledge and keen interest in epidemiological problems. At the same time it shows very clearly the complexity of factors making this study a formidable struggle with difficulties. He did much to assist in laying the foundations of a more accurate science of epidemiology; and in the pursuit of this study his annual reports to the London County Council will always be a valuable mine of information.

Murphy's work was recognised by his own profession, for he was awarded the Jenner medal by the Royal Society of Medicine and the Bisset Hawkins medal for distinguished services to public health by the Royal College of Physicians. His personality was singularly attractive; modest and unassuming, he was always ready to help his colleagues, and generous in his appreciation of their work.

MR. JOSEPH WRIGHT.

THE death of Joseph Wright of Belfast on April 7, at the age of eighty-nine, removes one of the fine old school of naturalists whose interests were bounded only by the earth itself. Though prolonged attention to specific details might have seemed to outsiders a sign of a mind cabined and confined, Wright's enthusiasm over the sheer beauty of the organisms that he studied was an inspiration to the wide circle of his friends.

Joseph Wright was born at Cork in 1834, and, his parents being members of the Society of Friends, he was educated at the Friends' School in Newtown, Co. Waterford. His wife came also from Cork City, and,

when he settled in business in Belfast in 1868, he brought the healthy and tolerant atmosphere of his upbringing to his new surroundings in the north. For a very long period of years Wright's daylight hours had to be at the disposal of firms for which he worked, and only on occasional holidays could he make excursions into the country. He was a warm supporter of the Belfast Natural History and Philosophical Society and of the Belfast Naturalists' Field Club. During his years in Cork he had made a fine collection of Carboniferous fossils, which is now in the British Museum; in Belfast he devoted himself mainly to the study of foraminifera, fossil and living, and was especially successful in extracting forms preserved in hollow flints or in friable chalk from the Cretaceous beds of northern Ireland. He was able to recognise forms derived from these beds in detrital deposits of the district, and he remained convinced that the occurrence of Pleistocene foraminifera in the glacial deposits studied by him necessarily implied an incursion of the sea over northern Ireland.

Wright joined, as a recognised expert, dredging expeditions in the Irish Channel and off the western coast, the latter being organised by the Royal Irish Academy. His judgment became sought by naturalists throughout our islands and abroad, and many of his correspondents, while appreciating the fulness of his knowledge, must have remained ignorant of the life of hard work and devotion in the intervals of which his researches were carried on. Those who became personally acquainted with him in his home could not fail to recognise his truly lovable personality.

Wright was elected a fellow of the Geological Society of London in 1866, and in 1896 received the honour of the award of the proceeds of the Barlow-Jameson fund. He contributed numerous papers to scientific journals, and his unique collection of foraminifera, mounted by his own hand, is now among the treasures of the National Museum in Dublin.

An excellent account of Wright's life and work, to which we are indebted for some of the details given above, appeared in the *Belfast Telegraph* for April 7.

Mr. Sidney H. Wells.

Mr. Sidney H. Wells, who died at St. Leonards on March 28, was formerly Director-General of Technical, Industrial, and Commercial Education in Egypt. Born in 1865, he was educated for the engineering profession at Birkbeck and King's College, London, and in 1885 he won a Whitworth Scholarship. Four years later he founded the Institution of Junior Engineers, of which he was chairman for five sessions. In 1889 he became a master at Dulwich College on the science and engineering side. Two years later he removed to the University of Leeds as senior assistant in the engineering department, and in 1893 he returned to London at the age of twenty-eight to become the first principal of the Battersea Polytechnic.

In 1906 Mr. Wells was requested by Lord Cromer to visit Egypt and report on technical education, certain branches of which had been previously entirely neglected. As a result of this visit, Mr. Wells was offered in 1907 the newly created post of Director-General of Technical, Industrial, and Commercial Education, a position which he held until his retirement eighteen months ago owing to continued ill-health. His fifteen years' work in Egypt was that of a pioneer, and the agricultural, commercial, and industrial schools which are to-day flourishing in all the larger towns of that country and in many of the provinces owe their existence entirely to Mr. Wells's untiring energy and far-seeing wisdom.

For his War work as Director of Civilian Employment for the Egyptian Expeditionary Force in 1917–19 Mr. Wells was made C.B.E.; he was twice mentioned in despatches, and held the second-class orders of the Medjidieh and the Nile. He was vice-chairman of the Egyptian Commission of Commerce and Industry, 1916–18.

Mr. Wells was an Assoc. M.I.C.E. and an original member of the Faculty of Engineering of the University of London, of which he was afterwards secretary, and also secretary of the Board of Studies. He was formerly a member of council of the Headmasters' Association, a member of council and for four years honorary secretary of the Association of Technical Institutions, and a member of the Examinations Board of the City and Guilds Institute, of the Teachers' Registration Council, and of the Consultative Committee of the Board of Education. He was the author of various text-books.

General E. A. Lenfant.

By the death of General E. A. Lenfant at the age of fifty-eight, France has lost one of the most noteworthy explorers of her African empire. He began his work in Africa in 1898, when he studied the course of the Senegal, and later the floods of the Niger. In 1901–2 he twice traversed the middle and lower Niger, passing the rapids successfully and collecting much useful information on the regime of the river and the geography of its valley. In 1903 Lenfant was again sent to Africa to investigate the possibility of water transport from the coast to Lake Chad. On this occasion he explored the Logone, a tributary of the Shari; the Kabi, a tributary of the Benue; and Lake Tuburi, which lies between the two. Between 1906 and 1908 Lenfant's explorations were in the western part of the Ubanghi-Shari country, around the head waters of the Shari. He showed that the Bara-Shari is a branch of the Shari, and that the Pende, which is the same as the Logone, provides the best route from the Sanaga to the Shari, and so to Lake Chad. Lenfant was the author of several works on Africa, including "Le Niger" (1903), "La grande route du Tchad" (1905), and "La découverte des grandes sources du centre de l'Afrique" (1909).

We regret to announce the following deaths:

Prof. J. Cox, lately professor of physics in McGill University, Montreal, on May 13, aged seventy-two.

Dr. G. H. Hume, for many years lecturer on physiology in the University of Durham College of Medicine, Newcastle-upon-Tyne, on May 8, aged seventy-seven.

Prof. C. Niven, F.R.S., lately professor of natural philosophy in the University of Aberdeen, on May 11, at seventy-eight years of age.

Colonel G. F. Pearson, formerly Inspector-General of Forests in India, on April 25, aged ninety-six.

Lieut.-Colonel J. C. Robertson, according to the *Times*, director of hygiene and pathology at Army Headquarters, Simla, and in 1912 sanitary commissioner with the Government of India, on May 14.

Current Topics and Events.

THE director of the Royal Botanic Gardens, Kew, undoubtedly does a public service when he forces upon the attention of the House of Commons and the general public the undesirable results that may follow from the thoughtless lack of control of smoke production in neighbouring industrial suburbs. There can be no doubt that heavy deposits of soot such as are borne by the evergreens at Kew are clear indication of atmospheric contamination which will markedy lower the vitality of the plants in the Gardens and in some cases may actually prevent their successful cultivation. When smoke particles are so numerous gaseous contamination with sulphurous acid is to be feared, and the evidence is conclusive that these acid impurities directly injure green foliage at the same time that their accumulation in the upper layers of the soil may injure root growth. The experimental results obtained by Drs. Crowther and Ruston and their colleagues in the agricultural department of the University of Leeds have supplied convincing examples of the extreme consequences that may follow industrial pollution in an industrial area, and the Kew authorities are wise in directing public attention to the danger before it has reached more serious proportions. At present, probably the greatest damage arises at Kew from the deposits of dark-coloured tarry material upon the leaf surfaces cutting down the supply of light which reaches them and clogging the pores through which are carried on gas exchanges vital to their healthy existence. Apparently the atmospheric pollution at Kew can be traced in the main to the industrial area on the opposite side of the Thames, and it is to be hoped that, as a result of the action taken by the director of the Gardens and by the Coal Smoke Abatement Society, prompt steps will be taken to bring about a cessation of a nuisance which, it must be emphasised, has frequently been shown to be capable of prompt control.

ARRANGEMENTS have now been completed for the celebration of the centenary of Pasteur at Paris and Strasbourg. The programme is as follows:— At Paris on Thursday, May 24, there will be a reception by the President of the French Republic at the Elysée; on Friday, May 25, a visit will be paid to the Institut Pasteur and tomb, and in the afternoon there will be a ceremony at the Sorbonne under the presidency of the President of the Republic; on Saturday, May 26, there will be a visit to the Ecole Normale, followed by a reception at the Hôtel de Ville; on Sunday, May 27, a reception will be given by the Sociétés d'Amitiés Françaises à l'Etranger, and there will be a *soirée* at the Opera and at the Théâtre Français; on Monday, May 28, there will be a banquet at Versailles; and on Tuesday, May 29, l'Institut de France is giving a garden-party at Chantilly. Thursday, May 31, will be spent at Strasbourg; the Pasteur monument will be unveiled, and a banquet will be held at midday; in the afternoon a visit will be paid to the Palais du Rhin, and the Pasteur Museum and the Hygiene Exhibition will be opened. The celebrations will conclude with a reception at the Hôtel de Ville in Strasbourg.

THE question of the deterioration of stonework in buildings is a matter of general economic importance. In the cases of our historic buildings and ancient monuments, prevention of the serious decay and gradual demolition of tooled surfaces and main structures constitutes a special problem which has engaged the attention of many investigators for a considerable time without, however, finding any generally satisfactory solution. The investigation involved is very complex and needs to be approached from different angles with the help of wide scientific knowledge. Accordingly, it has been decided to set up under the Department of Scientific and Industrial Research a special committee of the Building Research Board to report on the best methods by which decay in building-stones, especially in ancient structures, may be prevented or arrested. The following committee has been appointed: Sir Aston Webb (*Chairman*), Mr. R. J. Allison, Prof. C. H. Desch, Mr. A. W. Heasman, Mr. J. A. Howe, Sir Herbert Jackson, Dr. Alexander Scott, and Mr. H. O. Weller. All communications should be addressed to the Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1.

PRACTICAL broadcasting was discussed at an informal meeting of the Institution of Electrical Engineers on April 23. Mr. Shaughnessy, of the Post Office, in opening the discussion, pointed out that in America official reports are calling for a radical change in present arrangements so as to remedy the existing confusion. The problem for the British authorities is how best to serve the potential listeners in Great Britain, the number of whom he estimated at about two millions. The amateur experimenters are in a very small minority. The possible alternatives are (1) a super-station, (2) a number of broadcasting stations of medium power, and (3) any number of irresponsible stations. The method adopted has been to form eight areas, each served by a medium power-station, the wave-length of each station being as different as possible within the prescribed limits from that of neighbouring stations. They had been placed at the centres of thickly populated districts, for this is the justification for a popular entertainment. There is no easy way of detecting those who have circuits which interfere with the general distribution. The average listener wants to select his programme, but if he is too near a broadcasting station it is very difficult to tune it out. Those who are some distance away from a station have a much better chance of picking up the programmes given by several stations. The tendency at present is to send out sounds which can be readily heard on the cheapest type of crystal set. The general opinion was that it was advisable to encourage the use of the best apparatus.

THE Botanical Society of South Africa was founded in 1914, when with a membership of 352 it commenced its task, not merely of developing a general interest in botany in S. Africa, but also of assisting the establishment and development of a National Botanic Garden at Kirstenbosch. The value of the Society to the work of the Garden has been repeatedly acknowledged both by the former honorary director, the late Prof. Pearson, and the present honorary director, Prof. R. H. Compton. More than 3000*l.* has been handed over to the Garden from the Society's income, while special grants to specific pieces of developmental work have brought into being the rockery in the Deli, the pond in the Great Lawn, and a part of the Aloe Kopje. At the same time, still more valuable work has been done in interesting South Africans in the great scheme of which the shell as yet alone exists at Kirstenbosch, and many of the devoted collectors now supplying plants from all parts of S. Africa for the Garden were first brought into touch with the Garden through the Society. It is good to learn through its Journal (Part ix. for 1923) that its membership steadily increases and approaches its first thousand. The report for 1922 of the honorary director to the Trustees of the Garden has just been issued, and shows unmistakably the need there is for the efforts of such a society, which may with growing authority press more firmly the claims of these gardens upon the State. It is plain that the lack of capital prevents essential developments in the proper housing of a trained personnel, without which the real development of these gardens, an essential requirement for South Africa's future prosperity, cannot possibly take place.

THE American Chemical Society has undertaken the issue of two series of monographs—a "Scientific Series" under the editorship of Prof. W. A. Noyes, G. N. Lewis, L. B. Mendel, A. A. Noyes, and J. Stieglitz, and a "Technologic Series" under a Board of seven editors. This policy is one that carries with it certain risks. The mere fact that a book is required to be commercially successful is in itself some guarantee that the book is wanted, that a suitable author has been selected, and that the writing will be done carefully. When, however, a scheme is launched for stimulating artificially the production of books, there is a very serious risk that the standard created by these special conditions may be lower than when no outside stimulus to production is used. The conditions are, indeed, very similar to those which prevail in the publication of original papers. When a society has ample funds for publication, and is able to take the initiative in inviting authors to submit papers, it is only too probable that the standard of publication will fall below that which prevails when (for financial reasons or otherwise) the space available is so restricted that a very rigid censorship of papers is necessary. The particularly high standard now reached in the Journal of the American Chemical Society is indeed largely due to these limitations, which often prove a blessing in disguise, not merely to the readers of the Journal, but also to the authors of papers, who are compelled to adopt a high standard of clarity and conciseness. In its new enterprise, the American Chemical Society has been fortunate in securing a number of contributions which will bear comparison with work produced under more normal conditions; but there are already indications that unless a very stringent standard of writing and editing is maintained, inferior material may obtain publicity, as a direct result of the intervention of the Society in a field which has usually been reserved for private enterprise.

IT is announced in *Science* that the City of Philadelphia, through its board of directors of city trusts, made the annual presentation of the John Scott medal awards at a special meeting of the American Philosophical Society on the evening of April 10. The recipients were: Sir Joseph Thomson, for his researches on the physics of the electron; Dr. F. W. Aston, for his development of the mass-spectrograph and his studies of isotopes; Dr. C. Eijkman, of the University of Utrecht, for his researches on dietary diseases; Dr. Arthur Louis Day, director of the Geophysical Laboratory of the Carnegie Institution of Washington, for his researches on optical glass. The awards, which are made annually by the City of Philadelphia, are provided from the income of the John Scott fund, and they are made upon the recommendation of an advisory committee of five, consisting of representatives from the National Academy of Science, the American Philosophical Society, and the University of Pennsylvania.

AT the meeting of the Linnean Society held on May 3 Dr. John Isaac Briquet was elected a foreign member. Dr. Briquet received part of his early education in Scotland, and has always retained a pleasant recollection of his sojourn there. His botanical publications extend over the last thirty years, very largely upon Labiatæ and the botany of Switzerland. The most important works by which he is known in the botanical world are the "Texte synoptique," drawn up to guide the International Congress at Vienna in 1905, a quarto volume of 150 pages, and his "Prodrome de la flore de Corse," which began in 1910, and reached a second part in 1913. As director of the Botanic Garden at Geneva, conservator of the Herbarium belonging to that city (formerly "L'Herbier Delessert"), and professor in the University, his energies have been of late years largely absorbed in his administrative duties.

ON March 18 the National Acclimatisation Society of France conferred on Prof. A. Henry its large silver medal. This honour, which was bestowed in recognition of his services to forestry and to horticulture, could not have had a more worthy recipient. Prof. Henry's services to botany have not been less valuable. It is now nearly forty years since he began to collect plants in Central and Western China, largely over areas new to Europeans. Of his industry and efficiency in that work all the important herbaria in Europe and some in America contain ample evidence. By foresters and arboriculturists his name will always be held in high esteem as the joint author with the late Henry John Elwes

of "The Trees of Great Britain and Ireland," for the botanical part of which he was responsible. Since the conclusion of that fine work Prof. Henry has taught forestry, first at the University of Cambridge, and latterly at the Royal College of Science, Dublin. He has made important investigations into the origin of hybrid trees, especially of poplars and the London plane, and recently has been studying the geographical races of Corsican pine and European larch, which has involved several journeys to their natural sites in Poland, the Carpathians, and other parts of Europe.

THE sixth annual general meeting of the Society of Glass Technology was held in Sheffield on April 18. Prof. W. E. S. Turner was re-elected president. The other officers elected were: *Vice-Presidents:* Mr. E. A. Coad-Pryor and Mr. W. J. Gardner. *Members of Council:* Mr. F. F. S. Bryson, Miss Violet Dimbleby, Major G. V. Evers, Col. S. C. Halse, and Mr. T. Teisen. *General Treasurer:* Mr. J. Connolly. *American Treasurer:* Mr. W. M. Clark. *Hon. Secretary:* Mr. S. English. *Auditors:* Mr. Edward Meigh and Mr. Dennis Wood. The president's address on "The Year in Review in the World of Glass-making" was taken as read. A general discussion followed on works organisation. Mr. W. W. Warren opened the discussion with a paper on "Organising for Production from Pot Furnaces." The case for "Tank-furnace Works Organisation" was presented by Mr. T. C. Moorshead, who said that the difficulties, troubles, and failures which beset the factory manager every day may all be traced to inefficiency on the part of the management, and probably to three things: (*a*) lack of foresight, (*b*) lack of a thorough knowledge of the factory operation, and (*c*) lack of initiative. The causes for these losses of efficiency can be grouped under five headings: (1) faulty material, (2) poor labour, (3) poor attendance, (4) large labour turnover, and (5) machine and mechanical breakdowns.

THE anniversary meeting of the Linnean Society will be held on May 24, when the High Commissioner for New Zealand will receive the Linnean gold medal on behalf of Mr. T. F. Cheeseman of the Auckland Museum, New Zealand.

DR. MORLEY FLETCHER has been nominated to represent the Royal College of Physicians at the commemoration of the centenary of the birth of Louis Pasteur, to be held in Paris on May 24 and in Strasbourg on May 31-June 1.

PROF. J. B. LEATHES'S subject for the Croonian lectures of the Royal College of Physicians, to be delivered on June 7, 12, 14, and 19, is "The Rôle of Fats in Vital Phenomena." The FitzPatrick lectures, on the "History of Medicine," will be delivered in November by Dr. C. J. Singer.

A VACATION course for mechanics and glassblowers is to be held in the last half of August next in the workshops of the Physical (Cryogenic) Laboratory of the University of Leyden, of which Prof. H. Kamerlingh Onnes is the director. Information concerning the course can be obtained from Dr. C. A. Crommelin, The Physical Laboratory, Leyden, Holland.

THE council of the Royal Society of Edinburgh has awarded the Makdougall-Brisbane prize (1920–1922) to Prof. W. T. Gordon for his paper on "Cambrian Organic Remains from a Dredging in the Weddell Sea," published in the Transactions of the Society within the period, and for his investigations on the fossil flora of the Pettycur Limestone, previously published in the Transactions.

DR. FRANK SCHLESINGER informs us that Yale University Observatory has given a contract to the J. B. McDowell Company, Pittsburgh, U.S.A., for the optical parts of a 26-inch photographic telescope of thirty-six feet focal length. It is expected that this telescope will be in use within a year. It is to be erected at a site south of the equator, probably in South Africa or in New Zealand.

ON Saturday, May 19, at 2.30 P.M., a display of dancing will take place at the Alexandra Palace Theatre in aid of the Royal Northern Hospital. The performance deserves mention not only in view of its worthy purpose, but also because one of the items is a floral ballet written for the occasion by Dr. G. Rudorf, a chemist who is inspector in charge of non-metallic materials for the Air Ministry. The ballet, which lasts three-quarters of an hour, is scored for full orchestra, and will be conducted by the composer.

APPLICANTS for grants from the Chemical Society Research Fund must be made, upon a prescribed form, on or before June 1, addressed to the Assistant Secretary, Chemical Society, Burlington House, Piccadilly, W.1. The income arising from the donation of the Goldsmiths' Company is to be more or less especially devoted to the encouragement of research in inorganic and metallurgical chemistry, and the income from the Perkin Memorial Fund is to be applied to investigations relating to problems connected with the coal-tar and allied industries.

IN connexion with the Falkland Islands Government ship *Discovery* which is now being fitted out for marine researches, mainly on whales and whaling, in the Antarctic and other waters, a director of research will shortly be appointed. Candidates should preferably be graduates in natural science with a record of research work in biology and experience in the carrying out of scientific work at sea. Applications must be sent by June 15, upon a prescribed form if the applicant be resident at home (for those abroad the form is not required), addressed to the secretary of the *Discovery* Committee, Colonial Office, S.W.1.

MR. WILLIAM MUIR (538 Romford Road, London, E.7) sends us a note of a curious individual habit developed by a house-sparrow. During the greater part of two years this bird came to the sill of a particular window and tapped forcefully and persistently on the glass: this occurred daily during some periods and was maintained for hours at a time. Many sparrows were often present, but no more than the one ever took part in this performance.

MR. LOUIS STROMEYER, of Kolar Gold Field, Mysore State, South India, whose book "The Constitution of the Universe" was noticed in our issue of March 10, p. 319, has sent us a courteous protest against the review, particularly on the ground that it contained no direct detailed criticism of his theory. He contends that the review "would have been more to the point had it averred that the theory was incomprehensible and thus could not be criticised at all." This was substantially our view, with the addition that such parts as could be understood were so frequently wrong as to exclude the author from any right to serious and lengthy attention in our columns.

WE have received a letter from Mr. Leonard Hawkes with reference to Dr. Jeffreys' conclusion (noticed in NATURE of April 28, p. 585) that the Pamir earthquake of February 18, 1911, was the result of a great landslip. Mr. Hawkes directs attention to the view that the earthquake originated at a considerable depth below the surface and was itself the cause of the landslip. The point is dealt with by Dr. Jeffreys, who considers that the energy in the seismic wave was approximately equal to that which would be developed by the impact of the falling mass on the ground, and not greatly in excess, as it would have been if the rock-mass were loosened by a deeply-seated earthquake.

OWING to the proportions to which it has grown, the book department of Benn Brothers, Ltd., has been formed into a separate branch of the business, to be known as Ernest Benn, Ltd. Sir Ernest Benn, chairman of Benn Brothers, Ltd., will be chairman also of the new company, and the managing director will be Mr. Victor Gollancz, who for the past two years has been manager of the book department of Benn Brothers, out of which the new business has developed. This development will involve no change in general direction or financial control, and the address is the same as that of the parent company, namely, 8 Bouverie Street, London, E.C.4.

A SPECIMEN of a new fountain pen, called the "Research Fountain Pen," has been submitted to us by the manufacturer, Mr. A. Munro, 65 Preston Road, Winson Green, Birmingham, and we have used it with much satisfaction. The pen has two reservoirs, one of which is first filled with ink in the usual way, and the ink is afterwards transferred as required to a reservoir at the nib end by pulling out a knob and pushing it in again. The walls of the reservoirs are made of celluloid, so that the amount of ink in either of these can be clearly seen. It is claimed that the pen will not blot or leak, and that when it contains ink it will always write without being shaken. The pen certainly has some decided advantages, and so far as we have tested it the claims made are fully justified.

MESSRS. W. HEFFER AND SONS, LTD., Cambridge, have in the press "The Expert Witness," by C. Ainsworth Mitchell, which will deal with, among other things, methods of identification by means of patterns on the feet; by the pores of the skin; by the detection of latent prints on paper, etc.; methods of estimating the age of ink in writing, and the application of X-rays to the identification of old masters.

Our Astronomical Column.

MAY METEORS.—Meteoric phenomena are usually somewhat scarce in May, but fireballs are often more abundant than in other months. The chief display of shooting stars, next perhaps in importance to the Aquarids of Halley's Comet, is a shower radiating from a position eastwards of Corona and near ζ Herculis at about 247° +29°. They are swift white meteors of average magnitude and moderately short paths, and have been most plentifully observed on about May 18 and 24, but further observations are required to determine the epoch of maximum. Fireballs are occasionally recorded from Scorpio and from the western region of Aquila in May, and a few very slow-moving meteors are seen in some years from near Capella. Although the meteors visible at this time of the year are not equal in number to those appearing on autumn nights, they are of considerable interest, and have never been sufficiently observed. The bulk of the observations in this department of astronomy has been accumulated in the last half of the year, and it follows that many of the meteoric systems visible in the spring season have been comparatively neglected.

IRREGULARITIES IN THE MOON'S MOTION.—Prof. Newcomb regarded the irregularity in this motion, the period of which is about $2\frac{1}{2}$ centuries, as the most perplexing enigma in astronomy. Mr. Walter Child, of Ashford, Middlesex, has made a suggestion which, although of no practical value, is worth mentioning, as it recalls one of the exact solutions of the 3-body problem. He points out that there is a conical space behind the moon, 83,000 miles long, which is perpetually invisible to us. In this space he locates a moonlet, which he supposes to influence the moon's motion. It is true that there is an exact solution of the 3-body problem with the bodies in a straight line. The distance behind the moon comes out almost 40,000 miles for a particle of small mass; it would be greater if the mass were comparable with that of the moon (Mr. Child's diagram places it much too near the moon). It is also true that the larger solar perturbations on the particle would be the same as those on the moon, since they depend only on the ratio of mean motions. But in view of the fact that the configuration would involve an incredibly exact adjustment, and is unstable, it is undeserving of serious consideration. Moreover, Mr. Child does not explain how the arrangement could give rise to perturbations of long period without causing any short-period ones. Strangely, he seems to imagine that the moon's librations stand in need of explanation; the extraordinary thing would be if they failed to exhibit themselves. They are the natural consequence of an appreciably uniform rotation combined with an orbital motion that is far from uniform; also of the inclination of the moon's equator to the orbit-plane.

Research Items.

FIRE-MAKING IN THE MALAY PENINSULA.—The fire-piston for the production of fire is used in a limited area among the Shans and people of Pegu in Burma, among the Khas and Mois, in the Malay Peninsula, Western Sumatra, Java, Bali, Lombok, parts of Borneo, and in Mindanao and Luzon. Seven specimens of the implement deposited in the Perak Museum are described by Mr. Ivor H. N. Evans in the Journal of the Federated Malay States Museum (vol. ix. Part 4). They are made of buffalo-horn, wood, and tin. Mr. Evans finds that in two out of three attempts he can make fire by means of it. The important part is the binding of a rag near the distal end of the piston, which acts as a washer, and prevents the escape of air. This must be so adjusted that it allows the piston to pass smoothly down the cylinder when the piston-head is struck sharply with the palm of the hand, and it must not be so tight that there is difficulty in withdrawing the piston fairly quickly, nor so loose that air can escape from within.

RECORDS OF BRITISH COLEOPTERA.—In the *Entomologist's Monthly Magazine* for April Messrs. J. C. F. and H. F. Fryer record a species of weevil, *Sitones gemellatus* Gyll., from Sidmouth. Its occurrence in this country was scarcely to be expected. The only British species of Sitones with which it could be confused is *S. cambricus*, which lacks the mesosternal tubercle, and has the sides of the prothorax much more rounded. The same writers also record the very local beetle *Dibolia cynoglossi* from Chatteris, Cambs., where it occurs on Galeopsis. It is an extremely agile insect, and so quick in its movements that it is almost impossible to take it by ordinary sweeping. This may perhaps account for the absence of records in Britain, Cambridgeshire being apparently the first addition to its known distribution since Mr. Donisthorpe's discovery of it at Pevensey in 1902. Messrs. Fryer further record *Chrysomela marginata* at roots of *Reseda lutea* (?) in the Breck sand district, near Mildenhall. The record is not conclusive evidence as to the food-plant of this insect, but it is suggestive that the larval instars may be spent on that plant.

A TAXONOMIC STUDY IN THE CRUCIFERÆ.—Vol. 9, No. 3, of the Annals of the Missouri Botanical Garden is mainly occupied by a very full taxonomic study of the genus Thelypodium and its immediate allies (Chlorocrambe, Caulanthus, Streptanthella, Warea, and Stanleyella) by E. B. Payson, which has been carried out with the view of throwing light upon the phylogeny of the Cruciferæ. The genus is characterised by the possession of a gynophore or stipe which raises the ovary and fruit above the torus; while sometimes nearly negligible, in the species *T. laciniatus* and *T. eucosum*, the stipe is usually more than two millimetres long. In view of the fact that a very characteristic stipe is frequently found in the Capparidaceæ, a close study of the species of Thelypodium would seem to be a necessary step toward the fuller examination of a favourite phylogenetic view which relates the ancestral form of the Cruciferæ closely to the Capparidaceæ. It is further of interest to find that the characteristic septum traversing the pod in the Cruciferæ shows a striking peculiarity in the genus Thelypodium, although no developmental series can be traced in this character and its interpretation is very difficult. Extending nearly or quite from end to end of the pod, through the middle of the septum, is a broad region composed of cells elongated parallel to the marginal framework, and in this region the cell walls are more or less closely compacted. No species are now admitted to the genus Thelypodium that do not exhibit this type of septum.

A JOURNAL OF HELMINTHOLOGY.—The new *Journal of Helminthology*, edited by Prof. R. T. Leiper, is primarily intended as a medium for the prompt appearance of original communications by the staff of the Department of Helminthology at the London School of Tropical Medicine. Up to the present no British journal has dealt solely with this branch of parasitology, and Prof. Leiper is to be congratulated on this latest addition to scientific literature. The Journal is to be published bi-monthly, and the subscription is 25*s*. a volume. The first number (price 5*s*. net) contains five papers, three of which have a direct bearing on medical and veterinary science. Dr. A. J. Hesse contributes a paper on the free-living larval stages of *Bunostomum trigonocephalum*, a common intestinal nematode of the domestic sheep. Although this parasite is closely related to the hookworm, infection does not take place through the skin but by the mouth; moreover, the embryos at the infective stage exhibit negative thermotropism, whereas hookworm embryos are positively thermotropic. An epidemic of ascariasis on a skunk-farm has resulted in an inquiry, by Dr. T. Goodey and Mr. T. W. M. Cameron, into the morphology and life-history of *Ascaris columnaris*, a common parasite of the skunk. The results of their experiments indicate that the larvæ of *A. columnaris*, in the course of their migrations in the body of the definitive host, pass through the lungs, as is the case with *Ascaris lumbricoides* and *A. megalocephala*. Dr. M. Khalil re-describes a trematode (*Xenopharynx solus* Nicoll, 1912) from the gall-bladder of a "Hamadryad" (*Naja bungarus*); he also emends the genus Xenopharynx. Dr. G. M. Vevers contributes two papers. The first deals with the genus Paragonimus, which contains all the mammalian lung flukes of America and the Far East. He confirms Ward and Hirsch's view that the cuticular spines are the only trustworthy structures on which to distinguish the four species of the genus, and also suggests that more than one species occurs in man. His other paper contains a descriptive account of some new helminths from British Guiana.

LINKAGE IN SWEET PEA.—In a paper on linkage in the sweet pea (*Lathyrus odoratus*), Prof. R. C. Punnett (*Journ. Genetics*, vol. 13, No. 1) reviews the work begun by Bateson and Punnett nearly twenty years ago, much of which is now classical in the history of genetics. He considers the relation between the number of linkage groups and the haploid number (7) of chromosomes, and concludes that the two will eventually be found to correspond. The numerous pairs of characters such as purple-red corolla, long-round pollen, and erect-hooded standard are given new symbols according to the linkage group to which they belong, and provisional "chromosome maps" of five of the linkage groups are made, based on the percentages of crossing-over. The number of linkage groups at present appears to be eight, but there are several groups with as yet untested possibilities of low-grade linkage, and it is anticipated that the number of linkage groups will in this way be eventually reduced to seven, as the chromosome theory of heredity demands.

DESTRUCTIVE DISTILLATION OF BONES.—Mr. E. V. Aleksejevski, in the Journal of the Russian Physical and Chemical Society, 1921, vol. 53, describes a research he has carried out, at the request of the Russian Government, on the dry distillation of large quantities of bones which have accumulated in the towns of the Tersk district since 1914. He finds that the quality of the bone charcoal obtained is better if horizontal retorts are used, instead of vertical ones. The ammoniacal liquor produced by distillation from such retorts contains more than twice as much ammonia as was usually obtained by the old method. The bone charcoal left in the retorts has a medium carbon content, and possesses a high degree of efficiency as a decolourising agent, for which purpose it is used in the beet sugar industry. It may with advantage be used as a contact catalyst, as, for example, in the direct synthesis of phosgene from carbon monoxide and chlorine, or in any other reaction of gaseous combination. Its catalytic power is found in a number of cases to compare very favourably with that of cocoanut-shell charcoal, which is considered to be the most efficient carbon containing contact catalyst.

CORRELATION OF UPPER AIR VARIABLES.—Mr. P. C. Mahalanobis contributes two Memoirs to the Indian Meteorological Department (Volume xxiv. Part ii.) entitled "The Errors of Observation of Upper Air Relationships" and "The Seat of Activity in the Upper Air." He comes to the conclusion that Chapman's corrections to W. H. Dines's correlation coefficients are open to doubt. But he has fallen into error in stating that Douglas's coefficients are based on true heights. In a footnote in the Professional Notes of the Meteorological Office, No. 8, Douglas explains how he obtained his heights. He (Douglas), in the quotation given, merely meant that he did not use altimeter heights based on the erroneous supposition of a uniform temperature of 50° F. In the second Memoir Mr. Mahalanobis discusses the height at which the correlation coefficients between the five variables are numerically greatest and obtains a much lower value than 9 kilometres. However, he seems to have confused the T_m used by Dines, namely, the mean temperature between 1 and 9 kilometres, with the mean temperature between 0 to 9 kilometres, and this fully explains the discrepancies he finds. Leaving out the temperature of the first kilometre in forming the mean prevents the relationship between P_0, P_9, and T_m being a fixed one, whereas the relationships between the partial correlation coefficients given by Mr. Mahalanobis depend upon P_0, P_z, T_z being connected by a definite equation. If these three quantities be rigidly connected, the connexion is equivalent to reducing the independent variables from five to four, and as a matter of course the partial correlation coefficients involving the three related quantities must be 1 or −1, and the second and third order partials must take the form found by Mr. Mahalanobis.

DEVELOPMENT CENTRES IN THE PHOTOGRAPHIC PLATE.—It is well established that photographic development starts at definite points or "reduction centres" in the individual grains of silver bromide. Silberstein favours the view that the corpuscular nature of light is the cause of this, while others regard these centres as pre-existing in the grains. The practical importance of the matter is that, if the latter is true, the emulsion maker may eventually be able to control the production and sensitiveness of these centres, and perhaps even to isolate them. Mr. Walter Clark, of the British Photographic Research Association, gives some important results of his investigation of this question in the May number of the Journal of the Royal Photographic Society. He finds that a solution of sodium arsenite has no measurable reducing action on silver bromide produced by precipitation, and confirms the fact that a dilute solution of it applied to a plate renders the plate developable. This is evidence that there is in the plate something besides simple pure silver bromide, which is affected by sodium arsenite (as well as by light) to form development centres. By giving a plate a suitable exposure to light to render the centres developable and then treating the plate with chromic acid, the sensitiveness of the plate is reduced to a very low figure but always of the same order of magnitude if the action is thorough (the preliminary exposure is necessary). It appears probable that the chromic acid dissolves the "centres" produced by the exposure and that the low remaining sensitiveness is the sensitiveness of pure silver bromide.

MASS SPECTRA.—In a communication which appears in the May issue of the *Philosophical Magazine*, Dr. F. W. Aston gives an account of his work with the mass spectrograph to the end of 1922. The general technique has been in the main unchanged, but softer rays from the discharge tube are being used, and the photographic plates have had some of the emulsion dissolved from them to concentrate the sensitive grains more highly. Helium, nickel, lead, zinc, xenon, tin, iron, cadmium, thallium, selenium, tellurium, beryllium, aluminium, and antimony have been tested, and the constitution of nickel, tin, iron, selenium, aluminium, and antimony determined for the first time. Two new isotopes of xenon have also been discovered. Tin and probably iron show deviations from the whole number rule on the oxygen scale, and with hydrogen give three exceptions to that rule. A complete table of elements and isotopes determined by any of the positive ray methods up to the present time is given.

A FRENCH OIL-WELL.—In the *Comptes rendus* of the Paris Academy of Sciences of March 19, M. Ph. Glangeaud gives a note of the oil-well of Crouelle, near Clermont-Ferrand, Puy-de-Dôme, about which some paragraphs have recently appeared in the Press. The well-log is an interesting one, particularly from the geological point of view, and much information has been obtained regarding the Oligocene facies of the district between the Puy de Crouelle and the better-known Puy de la Poix. The beds traversed seem to belong to the Upper Sannoisien and Lower and Middle Stampien stages of the system, and, according to M. Glangeaud, recall in many respects similar Oligocene beds at Pechelbronn; further, the prevalence of abundant organic material and the conditions of sedimentation are cited as being distinctly favourable circumstances to the formation and accumulation of petroleum. The well was carried to a depth of about 856 metres, but operations were subsequently interrupted by casing breaking at 787 metres, which, with consequent water trouble, curtailed developments. Notwithstanding this, M. Glangeaud regards the results as being among the most important and encouraging yet achieved in this district, still an unknown factor as regards oil potentialities. Certainly the oil obtained from the well, both in quality and quantity, seems to augur well for future developments in the area, though on general geological grounds one can scarcely be optimistic as to the possibilities of a large field being discovered in this region of France.

The Italian Society for the Advancement of Science.

THE Italian Society for the Advancement of Science is not so ancient an institution as the British Association, but its objects are identical with those of its elder sister, and its methods are in many respects the same. In its present shape it dates from 1908, and its twelfth general session was held at Catania on April 5-11. This was the first occasion on which the Society has visited Sicily, and it was evidently a matter of friendly rivalry between visitors and hosts as to which could do most to make the meeting a success. Naturally the ancient "Università dei Studî" of Catania was in the forefront, with its picturesque and convenient Palazzo in the centre of the city, and its numerous laboratories and affiliated institutes in other quarters. Some sections, however, were lodged in the municipal buildings which overlook the University Piazza; and the opening meeting was held in the spacious Bellini Theatre, only a few minutes' walk from that square. The Italian Society does not share the apprehensions of some critics of our own Association in regard to multiplication of "sections": it enjoys no less than twenty-one of these, and includes in its scope, not only the physical, biological, and statistical sciences, but also medical, legal, philosophical, and historical studies. This accords with the organisation of higher studies in the faculties of Italian universities, and certainly has the effect of bringing a wider diversity of members together, without evident disadvantages.

Two other points of contrast with the procedure of the British Association may be noticed at this point. The inaugural address was delivered, not by the president of the Society, Prof. Pietro Bonfante, but by an honoured guest, the Minister of the Interior, Signor Gentile, who was supported by representatives of the ministries of Public Works and Justice, the War Office, and by the Admiral of the local squadron representing the Italian Admiralty. Shorter addresses of welcome were given by the president, and by Dr. Alessandro Russo, Rector Magnificus of the University, but there was no specialist presidential address as with us, nor were such addresses given by the presidents of sections. The sections, being more numerous, were more specialist than with us, and the attendance at them smaller. There appeared to be no such apparatus of sectional committees as we have, and the sectional proceedings were delightfully informal, and correspondingly profitable. Papers were short and gave the main points only, leaving details to be elicited in discussion. There was little display of specimens or diagrams, and one could have wished for more frequent illustration of objects and sites.

The great variety of the sections was compensated also by the custom (which has been advocated from time to time in the British Association also) of grouping sections in three large "classes," essentially of the physical, biological, and humanist sciences, and devoting quite half of the programme on each working day to discourses of general interest, some delivered to a whole "class" of sections, which suspended their sectional meetings meanwhile, others to "reunited classes," *i.e.* practically to the Society as a whole. These more general lectures were admirably done, and in some instances led to animated discussion; exceptionally even to adjourned debate and to resolutions addressed to the Society as a whole, or to the Government. As the general, semi-general, and sectional parts of the programme alternated between morning and afternoon on different days, there was ample opportunity for local members to fit in a fair sample of the Society's work with their ordinary avocations.

Excursions and social intercourse were not forgotten. The *Regio Commissario* gave an evening reception; the Prefect of Catania gave another; there was a gala performance of Mascagni's opera *Il piccolo Marat*, conducted by the composer himself; there was a whole-day excursion round Etna, arranged through the Etnæan Railway Company, and admirably organised, both on the part of the *Congressisti* and on that of the townships on the route, which turned out in gala array with school children, banners, music, and lavish distribution of home-grown oranges. The Etnæans will long remember this invasion of the *scientisti* of the peninsula; nor will the foreign guests forget the evident pride and confidence of the peasantry in the men who are doing so much to make that *terra di lavoro* the paradise which it deserves to become. Another day was devoted to the beautiful and historic Syracuse, which is easily reached from Catania by train. More specialist excursions to factories, agricultural stations, and other local establishments were arranged for those who desired them. A serious exploration of Etna had to be postponed, owing to inclement weather, until after the meeting; but even those who are not mountaineers could appreciate the amazing film-record of a mid-winter climb to the crater-rim, and the numerous papers on the habits and products of "our mountain," which, in spite of its occasional tantrums, is regarded with a queer mixture of reverence and affection by the Catanians, and becomes an object of daily inquiry and observance even to the foreign visitor. Its full glory, however, is not revealed at Catania; for that, you must go to Syracuse on such a day, cloudless and exquisite in form and colour, as fell to the good fortune of the Congress excursion.

Italian hospitality is proverbial, and the authorities of the Province, of the city of Catania, and of the University welcomed the *Congressisti* with open arms. Visitors, and especially foreign visitors, will not easily forget the many acts of unsolicited attention and courtesy which occurred during their stay, or the evident friendliness with which the Italian Society for the Advancement of Science is regarded in the locality of this year's meeting. Not the least durable token of this interest is the enrolment in Catania of about four hundred new members of the Society.

JOHN L. MYRES.

Industrial Paints and the Health of the Worker.[1]

IT is unfortunate that a question as to the use or disuse of a paint which is, in essence, a matter of efficiency and industrial hygiene, should be complicated by international and labour politics and by trade interests. Such has, for many years, been the position of the white-lead question.

In Great Britain, at least, the weight of evidence is to the effect that for covering power and durability, especially in exposed positions, there is no white paint or paint base equal to white lead. The one serious drawback to the use of this and of other lead compounds which are dissolved by dilute acids is their

[1] Committee on Industrial Paints: Report of the Departmental Committee appointed to re-examine the Danger of Lead Paints to Workers in the Painting Trades, and the Comparative Efficiency, Cost, and Effects on the Health of Workers, of Lead and Leadless Paints, and to advise whether any modifications of the conclusions and recommendations of the Departmental Committees appointed in 1911 have become necessary. Pp. 66. (London: H.M. Stationery Office, 1923.) 2s. 6d. net.

undoubted poisonous character. So impressed were the two Departmental Committees appointed in 1911 to investigate the incidence of lead poisoning in the two largest trades concerned with painting—buildings and vehicles respectively—that they recommended that, except for special classes of work of very minor importance, the use of paints containing more than a very small percentage of lead compounds soluble in dilute acid should be prohibited.

During the War much experience was gained with many materials, and the mere omission to repaint so many buildings and other structures enabled much valuable information to be gained. In 1921 the Home Office found that the information collected in view of the consideration of the use of lead paints by the International Labour Organisation of the League of Nations, was not in the main in accord with the findings of the 1911 committees. Another Departmental Committee, with Sir Henry Norman as chairman, has therefore reviewed the whole question and come to rather different and, it may be said, more reasonable conclusions.

The Committee is satisfied that the specific illnesses of the paint trade are due to lead poisoning and not, as Sir Kenneth Goadby and Prof. H. E. Armstrong were inclined to maintain, to the fumes of turpentine or other hydrocarbon solvents. There certainly appears to be little evidence of chronic disease due to these substances when used apart from lead. The Committee considers it to be generally admitted that dust from the sand-papering of old or new paint-work is almost the only cause of lead poisoning. The introduction of a waterproof sand-paper and the prohibition of dry rubbing-down bids fair to remove this main cause, and rules as to cleanliness simple enough to be enforceable may dispel minor causes.

Sir Frank Baines, of H.M.'s Office of Works, was emphatic as to the superiority of white-lead paint over any substitute for outdoor painting of buildings. Analyses of scrapings from various public buildings confirmed the view that zinc oxide coatings had almost disappeared, exposing the old lead paint beneath. On the other hand, it must be pointed out that leadless paints seem to have given satisfaction when used on vehicles.

Great Britain is pledged to bring in legislation to give effect to the decisions of the Labour Organisation of the League of Nations, and the Committee has prepared draft regulations accepted by both sides of the Joint Industrial Council. It seems doubtful, in view of much of the evidence, whether the prohibition of white lead in internal painting should be strictly enforced, but on the whole, the regulations are salutary and should reduce the number of cases of lead poisoning, while a system of medical inspection should prevent mild cases from becoming chronic.

Lord Askwith in the *Times* of April 4 points out certain international aspects of the question, and expresses the hope, partly on economic grounds, in view of the possibility of minimising danger from white lead, that prohibition of its use for internal painting in 1927 may not be enforced.

The Duddell Memorial of the Physical Society.

IN October 1920 the council of the Physical Society of London decided that Mr. W. du B. Duddell's memory should be perpetuated, and invited the council of the Institution of Electrical Engineers and the council of the Röntgen Society to join in forming a committee to collect funds for the Duddell memorial. The following were the members of the Memorial Committee so formed: Sir William Bragg, Sir Horace Darwin, Sir R. T. Glazebrook, Dr. R. Knox, Prof. T. Mather, Mr. Roger T. Smith, and Mr. Robert S. Whipple. A gratifying response was made to the appeal, nearly 700*l.* being subscribed.

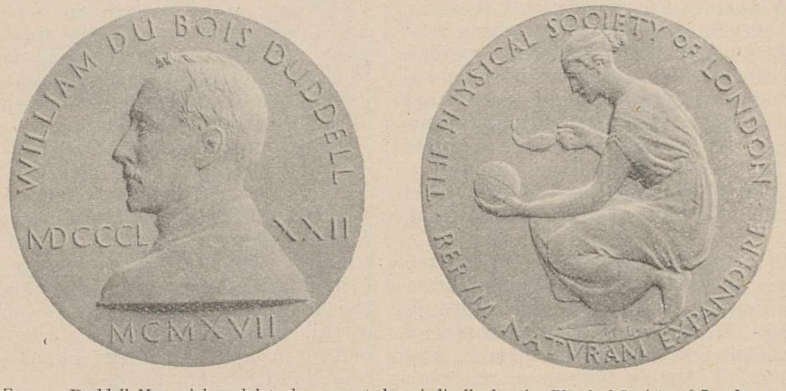

FIG. 1.—Duddell Memorial medal to be presented periodically by the Physical Society of London to those who have advanced knowledge by the invention or design of scientific instruments or of the materials or methods used in their construction.

The council of the Physical Society, feeling that Duddell's name will always be associated with the development of scientific instruments, has decided that the memorial shall take the form of a bronze medal to be awarded periodically to those who have advanced knowledge by the invention or design of scientific instruments or of the materials or methods used in their construction. The interest on 400*l.* (invested in 5 per cent. inscribed stock) will be given to the recipients of the medal.

At a meeting of the Physical Society held on Friday, May 11, Sir William Bragg as chairman of the Memorial Committee handed to Dr. Alexander Russell, the president of the Society, the dies for the medal and the scrip for the investment. Sir Richard Glazebrook, speaking also on behalf of the subscribers to the Memorial Fund, dwelt on Duddell's ability and labour.

Dr. Russell, in accepting the dies, etc., on behalf of the Society, expressed his pleasure that Duddell's work, and especially his work in connexion with the Society, should be perpetuated by a memorial of this kind.

The medal (Fig. 1), which is in bronze, was designed by Mrs. Mary G. Gillick. The obverse shows the head of Duddell in profile, with his name "William Du Bois Duddell" written above it. The dates of his birth and death —1872 and 1917 —are placed in Roman characters horizontally across the medal. The artist has succeeded in showing in a striking manner the alert energy of Duddell as well as the erectness of his carriage. The reverse represents the quest of science for knowledge, a symbolic figure, throwing light on the mysteries of the earth. Above the figure the words "The Physical Society of London" appear, while below is the motto "Rerum naturam expandere," which may be freely translated, "To elucidate the causes of things."

The Sir Ralph Forster Tablet at University College, London.

VISCOUNT CHELMSFORD, chairman of the University College Committee, unveiled, in the presence of a distinguished audience representative of chemical teaching and of chemical industry, a marble tablet placed in the hall of the Chemistry Laboratories at University College to commemorate the munificent donations made by Sir Ralph Forster, Bt., towards the erection and equipment of these laboratories.

Lord Chelmsford, in his opening speech, referred to the old Chemistry Laboratories erected in 1871 by the late Prof. Alexander Williamson, which, though in their time the latest thing in chemical laboratories, had proved quite insufficient and inadequate both in space and in equipment. They had, nevertheless, proved the scene of some of the greatest discoveries made by the late Sir William Ramsay, ably supported by Prof. Collie, Prof. Baly, and Prof. Travers. He recalled how Sir Ralph Forster had intervened at the last moment with a contribution of 4500*l.* just two days before the option for the purchase of the present site of the Chemistry Laboratories was to expire on January 31, 1911. At a later date, when the question of the funds for the erection and equipment of the buildings arose, Sir Ralph Forster had again come forward, this time with a donation of 30,000*l.* Lord Chelmsford dwelt upon the need for private benefactors to carry on the work thus begun, and mentioned that a sum of 15,000*l.* is still needed to complete the physical chemical equipment and the electrical installation in the new laboratories.

The Vice-Chancellor of the University of London, Mr. H. J. Waring, speaking in the name of the Senate of the University, expressed to Sir Ralph Forster the grateful thanks of the University for his striking and timely munificence. The Vice-Chancellor developed further the theme already mentioned by Lord Chelmsford, namely, the urgent need for private benefactors for university education in this country, to supplement the funds devoted to university education by the Treasury through the University Grants Committee.

Prof. J. Norman Collie gave an interesting account of the conditions which prevailed in the old Chemistry Laboratories when Sir William Ramsay and he began their work there in 1887, and referred to the work which had been carried out in those laboratories during the time when Sir William Ramsay and himself had worked in them from 1887 until 1912.

Sir Ralph Forster replied, expressing his deep appreciation of the recognition given to his help by the perpetuation of his name in connexion with University College. He expressed his sense of the importance of the work which is being carried on at University College, not only in chemistry but also in other branches of study. Sir Ralph Forster explained that from his earliest days he had been deeply impressed by the need for providing the best facilities for university education for young men of promise, especially in science, and that it was this feeling which led him to come forward and supplement the efforts which were being made at University College for the provision of chemical laboratories of the best and most up-to-date character.

After the speeches, the company adjourned from the large Chemistry Theatre to the Hall of the Chemistry Laboratories, when the unveiling was performed by Lord Chelmsford. The tablet, which was designed by Prof. F. M. Simpson, is of white marble surrounded by a green marble border. It bears the inscription: "The Ralph Forster Organic Chemistry Laboratory, so named in grateful recognition of the generosity of Sir Ralph Forster, Bt. MCMXI."

Cinema Film of the Total Eclipse of the Sun at Wallal, Australia, September 21, 1922.

THERE have been in the past several proposals to take a cinema film of a total eclipse of the sun, but the first real outcome of these proposals is the film now being shown at the Royal Albert Hall. The pictures illustrate the experiences and the work of the astronomers of the expedition, under Prof. W. W. Campbell, to Wallal, on the north-west coast of Australia, from the time they left Perth until after the eclipse. The journey to Broome was made on the S.S. *Charon*, and afterwards on the lugger *Gwendoline*, towed by a lighthouse tender, to Ninety Mile Beach. On account of the great rise and fall of the tides, the ship had to anchor five miles out, and the astronomers with all their baggage had to be landed in boats through the surf. The equipment was then transported on donkey waggons to the site selected for the camp, and in this work the aboriginal inhabitants of the country, both men and women, gave considerable assistance. The large amount of dust, which rose in clouds wherever there was any work being done, caused great inconvenience. Nevertheless a large camp was soon set up and the assembling of the instruments commenced. The process of erection of the tower telescope and of the equatorials and cœlostats, as well as the various rehearsals in changing plates and uncovering object-glasses, are well illustrated. The part of the film showing the solar corona is good, considering that it was taken with a cinema lens, but a better picture could easily be constructed from the negatives taken by the eclipse party.

The film will enable those who are interested in scientific work to appreciate the difficulties which eclipse observers often have to face. Large and cumbersome instruments have to be transported long distances and often erected in almost inaccessible places where little or no skilled labour can be obtained. The conditions at Wallal were probably more difficult than usual, but were bravely faced and overcome. A wireless apparatus was erected to keep the eclipse party in communication with the outside world, and a weekly aeroplane service was instituted. The film is well worth seeing by those interested in the work of scientific expeditions. It would have been too much to expect that a film of this kind, taken under such difficult conditions, would come up to the standard of the films produced by special actors in artificial conditions. However, the fact that the actual work of the astronomers is interspersed with pictures illustrating the life of the natives should make the film one of more general interest. With these additions the showing of the film takes a little over an hour. The attempt to produce a film showing the actual work of a scientific expedition is one which deserves every encouragement and we wish it every success.

University and Educational Intelligence.

BIRMINGHAM.—Applications are invited for the James Watt research fellowship in the thermodynamics of internal combustion engines. Particulars of the fellowship, which is of the annual value of 220*l.*, may be obtained from the Dean of the Faculty of Science of the University. The latest date for the receipt of applications is May 31.

CAMBRIDGE.—The University proposes to confer honorary degrees on Viscount Grey of Fallodon, Lord Plumer, the Rt. Hon. Stanley Baldwin, Chancellor of the Exchequer, Sir Aston Webb, president of the Royal Academy, Mr. M. C. Norman, governor of the Bank of England, Sir Arthur Evans, Prof. H. A. Lorentz, Dr. W. H. Welch, and Prof. Niels Bohr.

The vacancy in the newly founded professorship of animal pathology is announced.

LONDON.—Notice is given that applications for grants from the Thomas Smythe Hughes Fund for assisting medical research must be sent not later than June 15 to the Academic Registrar, University of London, South Kensington, S.W.7, accompanied by the names and addresses of two references.

MANCHESTER.—The council has appointed Mr. L. J. Mordell as Fielden professor of pure mathematics as from September next. Mr. Mordell, who was awarded the Smith's prize in 1912, has won a high reputation as an investigator in the theory of numbers, and has been invited by the University of Chicago to deliver a course of lectures in that subject during the present summer.

Lord Crawford has been nominated as Chancellor in succession to Lord Morley of Blackburn.

WE learn from the *Times* that the University of Cracow has conferred on the Earl of Balfour the degree of Doctor of Philosophy, and the Polish Minister, who was accompanied by Prof. R. Dyboski (representing the Senate of the University), recently called upon Lord Balfour to present the diploma.

THE Society of Merchant Venturers, Bristol, offers for competition fifteen scholarships tenable in the day classes of the faculty of engineering of the University of Bristol, which is provided and maintained in the College. Candidates must be not less than seventeen years of age and must have matriculated. The scholarships provide free tuition: one is open to pupils in secondary schools; three are restricted to pupils of secondary schools in Gloucestershire, Somerset, and Wiltshire; ten are restricted to the sons of officers in His Majesty's service who were killed in the War; and one is restricted to a son of a citizen of Béthune who has passed either the B. ès L. or the B. ès Sc. examination. A War memorial scholarship is also offered, with a preference to a candidate who needs pecuniary help and is the son of a former student who lost his life during the War. Further particulars can be obtained from the Registrar of the Merchant Venturers' Technical College, University of Bristol.

THE programme of the summer meeting arranged by the University of Oxford Delegacy for the Extension of Teaching, to be held on July 27–August 16, contains a noteworthy list of lectures. The main subject of study will be "Universities, Medieval and Modern, and their place in National Life," and in this connexion there will be lectures on various universities, on the relation of the university to the State and to the community, and on the place of science in university study, the last by Prof. H. H. Turner. The special economic subject of the meeting will be "The Social and Economic Problems of English Country Life," and Sir Daniel Hall is giving an introductory lecture on "Agriculture and the Community." Among the lectures in this course is one by Prof. W. Sommerville on "Grasslands." Provision has also been made for a special course on the methods of research in organic chemistry. The course has been arranged to meet the wishes and needs of the science teachers in secondary schools, and will be under the supervision of Dr. F. D. Chattaway. Inquiries should be addressed to the Secretary of the Delegacy, Rev. F. E. Hutchinson, University Extension Delegacy, Examination Schools, Oxford, and marked "Summer Meeting."

IN NATURE of August 26, p. 298, reference was made to the department established by the University of Calcutta for the study of poverty, and particularly unemployment, from a purely scientific point of view apart from class or political bias of any kind. We have now received from the department the first two of a series of lectures by Capt. J. W. Petavel, principal of the Kasimbazar Polytechnic Institute, on "The New Social Question"—the question, namely, how to apply "quite practically and as a matter of business" those principles of co-operation in industry which socialists have proposed to apply by establishing State socialism. The lecturer restates the "Deserted Village" problem, which is of special interest at the present time in India. There are as yet comparatively few town-dwellers, but there is a steady and increasing drift from the country districts to centres of manufacturing industry, and the problem of unemployment of middle-class townspeople is acute. The lecturer suggests that a solution can be found in a system of combined field and factory labour colonies, the homesteads being located along radial lines of communication converging on the factories. The first step is to be the establishment of schools combined with farms and workshops within easy reach of towns. A substantial amount of the pupil's time at school would be devoted to productive work. The Vice-Chancellor of the University and many other prominent citizens of Calcutta were so impressed by Capt. Petavel's arguments that they issued an appeal last year for support for such a scheme.

THE report of the University of Leeds for 1921–22, issued recently, deals with a number of topics of more than local interest. It includes a record of resolutions passed in January 1922 at a conference at Leeds of the six universities of the midlands and north of England defining the factors of university evolution which ought, in the opinion of the conference, to be considered before any institution is raised to the status of a university, and formulating opinions regarding several other questions of university policy. The resolutions were submitted to and discussed with the University Grants Committee. There is also a copy of an important letter addressed by the same universities jointly to the Prime Minister in December 1921 stating the case against the reduction of the Treasury grants to universities and university colleges in Great Britain. Appended to this is a comparative table of grants by local education authorities to each of the six universities in 1913–14 and 1921–22. It shows increases amounting in the aggregate to nearly 100 per cent.—from 74,000*l.* to 136,000*l.*—the most striking being in the grants to Durham (5501*l.* to 16,346*l.*) and Sheffield (17,226*l.* to 39,691*l.*). The number of full-time students at Leeds in 1921–22 was 1646—the highest on record and 150 per cent. higher than in 1913–14. Reviewing the University's finances, it is stated that raising the fees payable by students has for the time being saved the situation, but that a considerable falling off in the number of students must be looked for partly owing to the departure of the ex-service students and partly on account of the limit placed by the Board of Education on the number admitted to the Training Department. Among developments at the School of Medicine the report mentions the institution of a Diploma in Nursing, and claims that Leeds is the first university in this country to introduce such a diploma.

Societies and Academies.

LONDON.

Royal Society, May 10.—A. **Fowler**: The series spectrum of trebly-ionised silicon (Si IV). Numerous new lines of silicon have been observed and have been classified in four groups representing successive stages of ionisation. They have been designated Si I, Si II, Si III, and Si IV. The spectra consist alternately of triplets and doublets, and the series constant has successive values N, 4N, 9N, and 16N. For the series of Si IV the series constant is 16N. The spectrum is similar to that of neutral sodium, Na I. Including Paschen's recent work on Al III, and the author's previous work on Mg II, which also have spectra similar to that of Na I, data are thus available for the comparison of the spectra given by four similarly constituted atoms, which differ mainly in the charge of the nucleus. The highest limit of the Si IV system is 364,117, corresponding to an ionisation potential of 40·6 volts.—Sir R. **Robertson** and W. E. **Garner**: Calorimetry of high explosives. A calorimetric bomb was devised in which high explosives could be brought to true detonation under comparable conditions as regards density of loading and confinement, without using a large quantity of explosive. In an explosive balanced in respect to total combustion, where it is possible to calculate values for heat of detonation and volume of gases, the results agree with theoretical calculations. The influence of the higher heat of formation of phenol with respect to toluene is reflected in the similar values for heat of detonation of trinitrophenol and of trinitrotoluene, although the latter has much less oxygen for its combustion. The nature of the products, and the effect of conditions under which detonation is carried out on heat generated, and gaseous reactions involved, chiefly with regard to liberated carbon, are discussed.—H. S. **Hele-Shaw**: Stream-line filter. Very thin films of coloured liquid, or liquid containing matter in very fine suspension, either lose their colour in one case, or become deprived of their suspended matter in the other, on entering such thin films. In the new form of filter, sheets of paper made impervious to the fluid containing the suspended matter are arranged in a pack. By perforating the pack with a large number of holes it is possible to get the equivalent of a number of sources and sinks. This was obtained by using high pressures, so as to force the matter from one row of holes, acting as sources between the interstices of the paper, to another row of holes, each hole in the latter acting as a sink. Filtration can be made sufficiently rapid for actual use. The colouring matter of various dyes, from what were apparently complete solutions, can be removed, and substances like peat-water rendered clear and colourless.—F. W. **Aston**: A critical search for a heavier constituent of the atmosphere by means of the mass-spectrograph. The residues absorbed in charcoal from more than 400 tons of air were dealt with. Analysis with the mass-spectrograph gives a negative result and indicates that such an element certainly does not exist to the extent of 1 part in 10^{15} of air, and probably not to the extent of 1 part in 2×10^{16} parts of air by volume. Faint bands observed in the region corresponding to masses 150 and 260 were found. The first is due to a complex molecule of mercury with a multiple charge, but no conclusion is reached in the case of the other. The results of the experiments are not in accordance with the presence of molecular krypton and xenon in the air, recently suggested.—H. E. **Armstrong**: The origin of osmotic effects. IV.—Hydrono-dynamic change in aqueous solutions. "Water" is a complex saturated with the gas *Hydrone*, OH_2. Primarily, hydrone is the sole potentially "active" constituent, but it becomes actually active only under conditions which suffice to determine electrolytic change. The vapour pressure either of water or of a solution is the measure of the proportion of free hydrone molecules present in the liquid. Although the vapour pressure is lowered in the presence of any solute, the solution acquires attractive properties. The internal activity is increased while external activity is diminished. The effect produced may be ascribed to an interaction of molecules of the solute and those of hydrone. From non-electrolytes (under the influence of conducting impurity) a simple hydrol is formed $M\langle^{H}_{OH}$, only a single molecule of hydrone being "distributed" upon the molecule of the solute, whatever its magnitude. In the case of potential electrolytes, a reciprocal interchange of radicles of salt and hydrone is to be postulated. Not only is the solute hydrolated, but it is also distributed upon hydrone, the salt X′R′ giving rise initially to the reciprocal systems

$$R\,X\langle^{H}_{OH} \qquad \text{and} \qquad H_2O\langle^{R}_{X}$$

As the concentration is lowered, under the influence of hydrone, the complex $R\,X\langle^{H}_{OH}$ is more and more converted into *hydronol*, $H_2O\langle^{OH}_{H}$. Ultimately the solution contains the solute only in the form $H_2O\langle^{R}_{X}$ together with an equal number of molecules of hydronol. The "distributed" reciprocal complexes, including hydronol, are the electro-chemical agents in a solution. The negative radicle in such complexes has greater residual affinity than it has in the original simple molecules. The osmotic pressure manifest in an aqueous solution is the pressure exercised by the extra molecules of hydrone attracted into it by the "distributed" complexes, one by each complex, acting as though they were present in the gaseous state. In short, osmotic pressure developed within an aqueous solution, whatever the solute, has its origin in one and the same cause and is properly spoken of as *hydrono-dynamic*—if the word be permissible: indeed, this term may be used as expressive of the general activity of water, *electro-chemical and osmotic*.—H. E. **Armstrong**: Electrolytic conduction: sequel to an attempt (1886) to apply a theory of residual affinity. Referring to the distinction which he drew in 1886 between simple and composite electrolytes—the former being electrolytes *per se*, the latter solutions of "salts"—the author directs attention to the diverse behaviour of the silver and lead haloids on electrolysis; the current being carried, as it were, by the metallic ion of the silver and by the halogen of the lead compound. The conclusion is drawn that the salts of the two metals differ in structure—perhaps thus:

Ag Ag Ag	Cl_2 Cl_2 Cl_2
I — I — I	Pb — Pb — Pb
| |	| |
I — I — I	Pb — Pb — Pb
Ag Ag Ag	Cl_2 Cl_2 Cl_2

The assumption is made that the primarily active unit is the fundamental molecule, and that the

circuit is formed by these molecules being coupled with (distributed at) the electrode face and with the complex molecules. A similar interpretation is applied to aqueous solutions.—R. W. **Wood** and A. **Ellett**: On the influence of magnetic fields on the polarisation of resonance radiation. In the case of the resonance radiation of mercury and sodium vapour, strong polarisation of the light can be produced by weak magnetic fields properly orientated, and the polarisation of the light normally present can be destroyed by a magnetic field in a certain orientation. The field strength necessary for the destruction of the mercury vapour polarisation is less than one Gauss.—W. G. **Palmer**: A study of the oxidation of copper and the reduction of copper oxide by a new method. A film of copper about 1/1000 mm. thick is prepared by chemical means on a china-clay rod, which is then clamped in a circuit carrying a small current at constant E.M.F. The film is oxidised at 130°-210° C. with gaseous oxygen at pressures up to 1 atmosphere, and the rate of oxidation determined by measurements of the resistance of the film. The rate of oxidation is proportional to the second power of the amount of metal in the film, and, for pressures up to 300 mm., to the square root of the oxygen pressure. Between 170° and 190° C. the temperature-coefficient of the oxidation is negative owing to the simultaneous oxidation of cuprous oxide first formed. When hydrogen or carbon monoxide is mixed with the oxygen the rate of oxidation is greatly enhanced after a short initial period. In the reduction of copper oxide by hydrogen and by carbon monoxide, both gases are adsorbed on the metal and reduce adjacent oxide, but with hydrogen the water formed also adheres to the metal. The rate of reduction in both cases is directly proportional to the amount of metal present, an additional term in the case of hydrogen representing the action of the water.—E. A. **Fisher**: Some moisture relations of colloids. II.—Further observations on the evaporation of water from clay and wool. The curvature occurring in the evaporation curves of clay soils, formerly attributed to shrinkage, is not found with ball clay, although this substance also shrinks on drying. This type of curvature appears only in the evaporation curves of such materials as soils, which are mixtures of colloidal and non-colloidal substances, and is due to the simultaneous evaporation of imbibitional water held by the colloidal and of interstitial water held as water-wedges between the soil grains. The former evaporates at a practically constant rate, while the latter evaporates at a rapidly diminishing rate. The linear rate-curve of wool is not inconsistent with a real shrinkage occurring, although no such shrinkage has been demonstrated.

Faraday Society, April 23.—Sir Robert Robertson in the chair.—J. H. **Shaxby** and J. C. **Evans**: On the properties of powders; the variation of pressure with depth in columns of powders. In the theoretical section an approximate mathematical solution is given of this problem for the case of powder in a cylindrical tube and in the absence of external pressure and where the surfaces of equal pressure are plane. The following equation is arrived at, $p = p_m(1 - \epsilon^{-kx})$, where p is the pressure at depth x, p_m is equivalent to $\rho g R/2c$ and μ to $2c/R$; ρ being the mass per unit volume of the powder, R the radius of the tube, and c a constant depending on the coefficient of friction. In columns of lead shot and of powder, the absolute value of the pressure appears to depend on the state of packing of the column, and the resulting shape of the equal-pressure surfaces.—E. E. **Walker**: On the properties of powders. (1) The compressibility of powders. The resistance offered by powders to static loads and to blows from a falling weight has been investigated. (2) The distribution of densities in columns of compressed powders. Local densities in columns of compressed powder have been measured, and from the form of the density gradient curve the distribution of pressure in a column of compressed powder has been deduced.—E. K. **Rideal**: On the rate of hydrogenation of cinnamic and phenyl-propiolic acids. Solutions of sodium phenyl-propiolate and sodium cinnamate undergo hydrogenation at equal rates of hydrogen uptake in the presence of palladium sol in large quantities. The rate of hydrogenation is governed by the rate of supply of hydrogen to the palladium in the liquid and is proportional to the square of the shaking speed, the reaction velocity being of zero order. Both old and fresh sols commence reaction with a velocity curve of zero order, but terminate in a reaction velocity curve of the first order. The salts undergoing hydrogenation as well as the hydrogen are adsorbed. The adsorbed salt remains on the surface until completely hydrogenated; thus the rate of hydrogenation of phenyl-propiolate is the same as that of the cinnamate, the former taking up two molecules of hydrogen in the same time as the latter takes up one.—Leonard **Anderson**: Note on the coagulation of milk by acid. Addition of hydrochloric acid to milk of various dilutions causes precipitation of casein, the amount of precipitation increasing with increasing amounts of acid until a maximum rate of settling of the casein occurs which is inversely proportional to the dilution of the milk. The fat globules are mechanically carried down by the casein curd. At higher concentrations of acid the casein goes into solution again, and at still higher concentration is again precipitated; this is the salting out of the casein chloride by hydrochloric acid. Emulsions of benzene and olive oil in casein solution behave in an analogous manner to milk with respect to acid and alkali. Casein is probably the protective agent for the particles of fat in milk.—A. **Taffel**: The temperature of maximum density of aqueous solutions. The decrease in the total volume which occurs when 1 gram of a substance is dissolved in water at a definite temperature has been termed the "solution-contraction" for that substance at that temperature and concentration. Solution-contraction increases as the temperature at which solution is brought about is lowered. With methyl, ethyl, and propyl alcohols, the solution-contraction decreases with the temperature. The temperature of maximum density of the solution is below 4° C. The specific effect of ions and molecules on the depression of the t.m.d. of water results from their specific solution-contraction.

Zoological Society, April 24.—Prof. E. W. MacBride, vice-president, in the chair.—Baron F. **Nopcsa**: On the origin of flight in birds.—E. C. Stuart **Baker**: Cuckoos' eggs and evolution.

Royal Microscopical Society (Industrial Applications Section), April 25.—Prof. F. J. Cheshire, president, in the chair.—W. N. **Edwards**: The microscopic structure of coal. The study of the microscopic structure of coal, though dating back to Henry Witham (1833), made rather slow progress until recent years owing to the difficulty of preparing thin sections. Much detailed work has now been done by Lomax, Hickling, Stopes, Thiessen, and others, which has considerably widened our knowledge of the mode of formation of coal, and has important economic bearings on questions of fuel economy, seam correlation, spontaneous combustion and in-

flammability of coal dust. Stopes recognises four fairly distinct constituents with different physical and chemical characteristics in bituminous coal. The "anthraxylon" of Thiessen, regarded as being derived from wood rather than from general plant debris, seems to correspond on the whole to the clarain of Stopes, whose classification is based on present constitution rather than probable derivation.

Physical Society, April 27.—Dr. Alexander Russell in the chair.—J. W. **Ryde** and R. **Huddart** (Research Staff of the General Electric Co.): The analysis of bubbles in glass. In order to distinguish bubbles generated by chemical action in glass from those introduced by mechanical processes, spectroscopic tests are made for the presence of nitrogen. To liberate the gas from the bubbles a specimen of the glass is placed in one limb of a quartz U-tube containing mercury; the glass is heated and disintegrated by sudden cooling, the tube being plunged into cold water at the same time that the mercury is thrown on to the glass.—H. P. **Waran**: A simple regenerative vacuum device and some of its applications. Residual traces of air foul the vacuum above the mercury column in syphon gauges and other devices. A bent capillary tube ending in a bulb attached to the top of a siphon gauge will remedy this. It enables the air to be pushed repeatedly into the vacuum of this bulb, the mercury at the bottom of the capillary preventing the subsequent return of the air. The device is regenerative in the sense that, irrespective of any progressive fouling of the vacuum, a fresh-air-free vacuum is automatically created by it every time it is brought into action.—H. **Shaw** and E. **Lancaster-Jones**: Application of the Eötvös torsion balance to the investigation of local gravitational fields. In view of the sensitivity of the balance, which measures derivatives of gravity of the order of 10^{-9} C.G.S. units, it was anticipated that a gravitational survey of the laboratory would disclose the varying effects of the neighbouring masses of the walls, pillars, etc. The consistency of the results obtained at each station and their general agreement with the calculated effects exceeded expectations, as the local gravitational field varied so rapidly that the theoretical assumption of a uniformly varying field in the neighbourhood of a station was obviously vitiated.—L. F. **Richardson**: An electromagnetic inductor. Two bicycle wheels are mounted vertically and co-axially, and are driven in opposite directions by a 4-volt motor, the driving band being constituted by an endless wire. The electromotive forces generated by the revolution of the wheels in the earth's field are thus added, the rims of the wheels being electrically connected through the driving wire. The speed of the wheels is found by counting the revolutions against a stop-watch, one of the spokes being marked for this purpose, and from this speed and the length of a spoke the E.M.F. can be found in terms of H.—F. Ll. **Hopwood**: Pulfrich's experiment demonstrating time-lag in vision. The time-lag in visual perception is greater for dimly than for brightly illuminated objects. A pendulum carrying a glow lamp at its lower end swings over a second glow lamp fixed immediately below the mid position of the swinging lamp. Both are viewed with one eye, while in front of the other eye a metal disk perforated at its centre is placed. The pendulum then appears to be a conical instead of a plane pendulum, the apparent direction of rotation changing when the disk is transferred from one eye to the other. The image seen by the obstructed eye corresponds to an earlier position of the swinging lamp than does the image seen by the free eye, in consequence of the greater time-lag in the former case.

PARIS.

Academy of Sciences, April 23.—M. Albin Haller in the chair.—Henri **Lebesgue**: The singularities of harmonic functions.—G. **Bigourdan**: The propagation of Hertzian waves over great distances: the order of magnitude, in time, of the perturbations of the propagation. An analysis of the measurements obtained at five observatories of the time taken by the 300 rhythmic signals (about 4 m. 53 sec.) sent out by the military wireless station at Paris each day. The observed times are not affected by the atmospheric perturbations, nor by the receiving apparatus.—A. de **Gramont**: The use of the oxyacetylene blowpipe in spectrum analysis. Applications to mineralogy. Compared with the oxyhydrogen or oxygen-coal gas flames, there are more lines in the spectra, and the time of exposure can be shortened. Reproductions of flame spectra obtained by this method from chromite, oligiste, and lepidolite mica are given.—C. **Guichard**: The triply indeterminate systems of Ω circles.—L. **Cuénot** and L. **Mercier**: The flight muscles in the winged forms of *Drosophila melanogaster*.—N. **Gunther**: An auxiliary theorem.—Paul **Lévy**: The application of the derivative of non-integral order to the calculus of probabilities.—René **Lagrange**: Varieties without torsion.—Maurice **Fréchet**: The distance of two *ensembles*.—Alf. **Guldberg**: The problem of drawing from lottery urns.—Stanislas **Millot**: The probability of the existence of biological laws.—D. **Riabouchinski**: The paradox of d'Alembert.—M. **Sudria**: The determination of the position of flexure in a bent beam.—A. **Leduc**: A new equation of state for gases. The expression

$$p = \frac{RT}{M}\left[\frac{v}{(v-a)^2} - 3{\cdot}16\frac{a}{(v+a)^2}(4^x - 1)\right],$$

which is based on compressibility experiments between 1 and 2 atmospheres only, has been applied to the results of Amagat for carbon dioxide. Over a pressure range between 31 and 100 atmospheres and at temperatures from 0° C. to 100° C., the relative differences between the experimental result and that calculated from the above equation do not exceed $\pm 0{\cdot}6$ per cent.—Hector **Pécheux**: The magnetism of nickel. Magnetic measurements are given for three samples of nickel (the analyses of which are given) without heat treatment, after tempering and after annealing.—Nicolas **Perrakis**: Contribution to the cryoscopic study of binary organic mixtures. An account of a cryoscopic study of the systems phenol-ethyl alcohol, *o*-cresol-ethyl alcohol, phenyl ether-ethyl alcohol, benzene-methyl alcohol, benzene-isopropyl alcohol, and benzene-normal-butyl alcohol.—E. **Darmois**: The action of molybdic acid on the rotatory power of the tartaric and malic esters. An account of the changes in rotatory power produced by the action of aqueous solutions of molybdic acid and alkaline molybdates on methyl tartrate and ethyl malate.—Victor **Henri**: The production of narrow bands and wide bands in the absorption spectra of bodies in solution and in the state of vapour. A study of the conditions under which a modification of the structure of an organic substance causes the change from a line absorption spectrum to a band spectrum. For molecules containing only one double linkage, the first postulate of Bohr does not apply and the second postulate alone holds; for molecules with two neighbouring double bonds, both postulates apply, the first being determined by the existence of an electric polarity in the molecule.—M. **Sauvageot** and H. **Delmas**: Tempering extra soft steel at a very high temperature. A mild steel containing 0·09 per cent. of carbon was tempered in water, starting with temperatures from 950° C.

up to 1450° C. There was a rapid increase in the elastic limit, resistance and hardness, as the temperature rose.—E. E. **Blaise**: Syntheses by means of the mixed α-ketone zinc derivatives.—Marcel **Godchot**: The oxidation of 1.3.4-dimethylcyclohexanone and the synthesis of cyclopentane diketones. The oxidation of the above ketone with potassium permanganate gives a good yield of γ-methyl-δ-acetyl-valeric acid. The ethyl ester of this acid, treated with powdered sodium ethylate in ether solution gives α-acetyl-β-methylcyclopentanone. The latter, being a β-diketone, forms a sodium derivative capable of reacting with alkyl iodides.—Raymond **Delaby**: The action of mixed organomagnesium compounds on the epibromhydrin of ethylglycerol.—M. **Caille** and E. **Viel**: A new reagent for alkaloids and the preparation of the iodostibinates of these substances in the crystallised state. The reagent consists of a slightly acid solution of antimony chloride with potassium iodide. One part of quinine in 100,000 can be detected; it forms a yellow precipitate. The method appears to be equally sensitive with other alkaloids. By a suitable treatment the alkaloid can be recovered from the precipitate unchanged.—A. **Mailhe**: The decomposition of the formamides of the fatty amines. Isoamylformamide vapour, passed over nickel at 360° C. gives a mixture of isoamylamine and isoamyl nitrile.—M. E. **Denaeyer**: The rocks of Adrar des Iforass and Ahaggar. Two salient facts are shown by the study of the rocks from the central Sahara, their crushing, related to the existence of the Saharan folds, and the existence of alkaline amphibole granites. These rocks mark a new extension towards the west of the limits of the alkaline petrographical province of the Tchad.—E. **Chaput** and L. **Perriaux**: The existence of Albian sands and calcareous pudding stones on the high plateaux of the Côte-d'Or.—Léon **Bertrand**: The Provençal sheets to the east of the lower valley of the Var.—L. **Barrabé**: The transported origin of the Lias massif situated to the west of Narbonne.—Paul **Corbin** and Nicolas **Oulianoff**: The Mesozoic of Prarion (Arve valley).—A. **Allemand-Martin**: The Pliocene of the Cap Bon peninsula (Tunis).—Henri **Coupin**: The morphological nature of the head of the cauliflower. The head of the cauliflower is not formed by flowers, but by stems arrested in their development. This arrest is of tetratological, not parasitic, origin.—R. **Chavastelon**: A method for the preservation of wood. A solution of copper bichromate is recommended and instructions for its preparation are given. Wood thus treated is very resistant to the attack of moulds.—Fred **Vlès**, Mlle. G. **Achard**, and Dj. **Prikelmaier**: Some physico-chemical properties of the constituents of the egg of the sea urchin.—E. **Leblanc**: Experimental acerebellation in lizards.—J. **Gautrelet**: Shock and parasympathic reactions.—A. **Policard**: The histochemical detection of total iron in tissues by the method of incineration. The section is ashed and the iron detected by the colour of its oxide under the microscope.—C. **Levaditi** and S. **Nicolau**: The mode of action of bismuth in trypanosomiasis and spirillosis.

Official Publications Received.

U.S. Department of Agriculture. Department Circular 187: List of Serials currently received in the Library of the U.S. Department of Agriculture; exclusive of the U.S. Government Publications and Publications of the State Agricultural Colleges and Experiment Stations. Arranged by Title, by Subject, and by Region. January 1, 1922. Pp. iii+358. (Washington: Government Printing Office.)

Department of the Interior: Bureau of Education. Bulletin No. 6: State Policies in Public School Finance. By F. H. Swift. Pp. iv+54. 10 cents. Bulletin No. 15: A Kindergarten First-Grade Curriculum. By a Sub-Committee of the Bureau of Education Committee of the International Kindergarten Union. Pp. vii+66. 10 cents. Bulletin No. 23: High-School Buildings and Grounds: a Report of the Commission on the Reorganization of Secondary Education, appointed by the National Education Association. Pp. xi+49. 15 cents. Bulletin No. 26: Philanthropy in the History of American Higher Education. By J. B. Sears. Pp. vi+112. 15 cents. Bulletin No 29: Statistics of State School Systems, 1919-20. Prepared by Florence Du Bois and H. R. Bonner. Pp. 68. 10 cents. Bulletin No. 30: Accredited Higher Institutions. By G. F. Zook. Pp. vii+106. 15 cents. Bulletin No. 34: Statistics of Land-grant Colleges, Year ended June 30, 1921. By L. E. Blauch. Pp. iii+67. 10 cents. (Washington: Government Printing Office.)

The Record of the Royal Institution of Great Britain, 1922. Pp 122. (London: Royal Institution.)

Year-Book of the Department of Agriculture, Ceylon, 1923. Pp 64+41 plates. (Colombo: H. W. Cave and Co.)

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok 4, 1922. 1: Månadsöversikt över väderlek och vattentillgång. Pp. 139. (Stockholm.) 2.50 Kr.

The Kent Incorporated Society for Promoting Experiments in Horticulture. Annual Report, together with Notes upon the first Ten Years' Work, East Malling Research Station, 1st January 1922 to 31st December 1922. Pp. 52. (East Malling.) 1s.

Diary of Societies.

SATURDAY, MAY 19.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—J. B. McEwen: Harmonic Evolution.

TUESDAY, MAY 22.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. W. M. Flinders Petrie: Discoveries in Egypt (1).

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—A. J. Bull: The Relation of Selective Absorption of Printing Colours to the Errors occurring in Three-Colour Photography.

WEDNESDAY, MAY 23.

ROYAL MICROSCOPICAL SOCIETY, at 7.30.—Annual Pond Life Exhibition.

THURSDAY, MAY 24.

MEDICO-PSYCHOLOGICAL ASSOCIATION OF GREAT BRITAIN AND IRELAND (at Royal Society of Medicine), at 3.—Dr. C. K. Clarke: The Fourth Maudsley Lecture.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. E. G. Coker: Engineering Problems Solved by Photo-elastic Methods (2). The Testing of Materials; The Action of Cutting Tools.

LINNEAN SOCIETY OF LONDON, at 5.—Anniversary Meeting. Presentation of the Linnean Gold Medal to the High Commissioner of New Zealand for transmission to T. F. Cheeseman.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—D. Baxandall: Telescopes from a Historical Standpoint. (Illustrated by exhibits from the collection in the Science Museum, South Kensington.)

FRIDAY, MAY 25.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section) (Annual General Meeting), at 5.—Discussion on Birth Injuries.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—Prof. C. H. Lees and J. E. Calthrop: The Effect of Torsion on the Thermal and Electrical Conductivities of Metals.—A. Rosen: The Use of the Wien Bridge for the Measurement of Dielectric Losses.—C. R. Darling: Demonstration of an Experiment on the Production of an Intermittent Pressure by Boiling Water.—Dr. N. W. McLachlan: Demonstration of a Novel Instrument for recording Wireless Signals.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section) (Annual General Meeting), at 8.—Prof. E. L. Collis: An Inquiry into the Mortality of Coal and Metalliferous Miners in England and Wales.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Aston Webb: The Development of London.

SATURDAY, MAY 26.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—J. B. McEwen: Musical Education.

PUBLIC LECTURES.

TUESDAY, MAY 22.

GRESHAM COLLEGE, at 6.—Sir Robert Armstrong-Jones: Physic (succeeding Lectures on May 23, 24, and 25).

THURSDAY, MAY 24.

ST. MARY'S HOSPITAL (Institute of Pathology and Research), at 4.30.—Dr. B. Hart: The Development of Psychopathology as a Branch of Medicine.

ROYAL SOCIETY OF MEDICINE (Robert Barnes Hall), at 5.15.—Prof. E. D. Wiersma: The Psychology of Epilepsy.

FRIDAY, MAY 25.

UNIVERSITY COLLEGE, at 5.—Prof. C. Spearman: Psychology as a Career.