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The Social Implications of Biology.

At the recent meeting of the British Association at Oxford several of the sectional presidential addresses necessarily dealt with biological themes. But what was noteworthy was that certain of these addresses were devoted to attempts to answer various aspects of the question: "Taking for granted that the laws of biology and heredity have been in broad outline correctly ascertained, what lessons can be deduced therefrom for us in our present social environment?" Prof. Graham Kerr dealt with "Biology and the Training of the Citizen," Dr. Drever with the "Psychological Aspects of our Social System," Sir Josiah Stamp with "Inheritance as a Social Factor," and Sir Daniel Hall with the "Relation between Cultivated Area and Population." We propose to consider some of the conclusions to which these representatives of scientific work and thought have been led by their survey of biology.

Prof. Kerr rightly stresses the fact that the general truth of evolution is doubted by no intelligent educated man. However much biologists may differ from one another as to the nature and causes of variation, they are all agreed that one form of life has gradually grown out of another, and that there has been no interruption of the stream of life by the intervention of a creative fiat, however this stream may have started. As Prof. Kerr says, the facts of palæontology and embryology are decisive on this point, and also as he might justly have added, the facts of detailed systematic biology. With the growth of our great museums and the gradual collection of abundant material from all parts of the world, the insensible passage of the slightly marked and barely distinguishable local variety into the well-marked species has been clearly demonstrated, and the man who cannot see in this the proof of evolution is wilfully blind.

But Prof. Kerr plaintively asks, If this be so, why is it that so small a portion of school time is devoted to teaching the all-important truths of science to the young? Why in the twentieth century is our education still predominantly academic and literary? We are living beings, and biology deals with the laws of life and physical science with the workings of this wonderful Universe in which we find ourselves placed; surely it is the knowledge of these things that should constitute the greater part of the teaching which we receive when we are young. Why in a word do we not imitate these noble savages, the Indians of El Gran Chaco, amongst whom Prof. Kerr's early years as a biological researcher were passed, and who have left such an indelible impress on his memory? These people make their knowledge of biology—in a word

the nature and habits of the animals which they hunt—the main theme of youthful education, whilst we stupidly burden the minds of our boys with the grammar of Greek and Latin, though scarcely any of them ever get far enough to read and enjoy classical literature.

Now reasoning of this kind appears to be at first sight unanswerable, but the matter is not so simple as it seems. To begin with, the 'academic and literary' education is given only to a comparatively small minority of our citizens: the pupils chiefly of our public schools. The vast majority receive only an elementary school education, which is intended just as truly as the education of El Gran Chaco Indians to fit citizens for their future environment. They learn something about the constitution and history of their own country, of its geography and place in the world, and of its traditional religious beliefs. They are also taught a number of things about the common domestic animals, and if they learn a good deal less than the Indian about wild animals, they are after all much less likely to meet them.

It is in their later years of school life, however, when children's minds have developed so that they could grasp such things, they might with advantage be taught a great deal more about the biological laws governing their own bodies. A great philanthropist and eminent man of business once complained to us that nowadays mothers trained in elementary schools could teach their daughters nothing about the care of babies. The traditional lore handed down from their own mothers had been forgotten, and he added the astounding statement that the lives of many babies were nowadays saved by the habit of giving them pickles! This crude and drastic introduction of acetic acid into the infantile stomach, to whatever local discomfort it might give rise, at any rate protected the baby against the deadly complaint of infantile diarrhœa by killing the putrefactive bacilli derived from the decomposing cow's milk on which it was fed.

Prof. Kerr thinks that an outline sketch of the laws of biology might also teach the alumnus of the elementary school that all life was necessarily striving and struggle, that men were born unequal, and that society could only progress if the best were selected. We think that on the whole he is right; but he is really knocking at a door which is already being opened; educational authorities are moving in the direction of increasing the amount of scientific teaching in elementary education. If, however, Prof. Kerr's knocking accelerates the opening we shall be the better pleased.

It seems to us, however, that the gravamen of Prof. Kerr's attack is directed against the literary education of the public schoolboy, for from the class to which he belongs are still drawn the bulk of our leaders, both in politics and in science. The leader amongst savages, Prof. Kerr avers, is chosen for his capacity of doing things, whilst under our system he is selected for his ability to talk. Now Prof. Kerr seems to forget that there are two elements in education; first, the giving of useful information, and secondly, and by far the most important, the training and development of the mind, the instrument by which this information is to be used. The question then arises, "How do the boys trained in public schools and in their extensions, our older universities, quit themselves in after life?"

The answer is not doubtful. Our political leaders, whatever their shortcomings, are on the whole the best in the world; and it is noteworthy that the exceptions to the rule have not been trained in public schools. Our colonial administrators are universally admired. Our Darwins, Lyells, Kelvins in most cases began their educations with a classical training. Michael Faraday was of course a great exception. Continental scientific men have in nearly every case also had a classical foundation for their education; this is certainly true of France and Germany. The one great country of which this is not true is the United States. Is Prof. Kerr prepared to maintain that our men of science cannot hold their own with those of the United States? If he is, we can only say that we do not agree with him, and in this we should be supported by the most thoughtful American opinion.

Space forbids our entering into a discussion as to how the classical training effects its object, but we would direct Prof. Kerr's attention to two things. First, that great naturalist, Dr. Bateson, whose untimely death we all deplore, admitted that he was a 'failure' so far as classics was concerned, yet he led a crusade in favour of the retention of compulsory Greek in Cambridge. Secondly, when about twenty-five years ago, classical training on account of its supposed inutility had been reduced to a minimum in American education, the consequences of this step were so flagrantly disastrous that a strong movement was begun to restore this teaching as an essential element in education. In general, it may be said that the English educational system is fundamentally good. Like all human things, however, it gradually becomes out of date, but the cure for this is careful modification and adaptation—such as is Nature's way in evolution—not uprooting and entire reconstruction as Prof. Kerr seems to suggest.

Dr. Drever deals with the evolution of punishment. He imagines that it began with anger and revenge,

the natural reaction of the human animal to any action which incommoded him or caused him pain. But this stage is common to man and the lower animals. The history of man is the history of the evolution of society, and punishment is a social phenomenon. Dr. Drever hints that the next stage was the limitation of revenge by the instinct of the onlookers to see 'fair play.' This we think rather doubtful. Even the most rudimentary form of social life has to be held together by rules or 'tabus.' The infringement of one of the tabus was believed to involve danger to the tribe because of its offence to the supernatural powers, and the punishment of the offender was an endeavour to avert their anger; and this motive in modern dress, namely, the protection of society, remains the fundamental justification of punishment to-day. This, it is true, Dr. Drever recognises, but he argues that if punishment is really to act as a deterrent, the psychological state of the criminal should be examined. This is altogether too narrow a view. The main deterrent effect of punishment is the fear which it implants in the hearts of others lest they too suffer the same fate.

The safety of society is the primary matter; the all-important thing is that the influence of the criminal should be removed, whether by temporary or permanent segregation, in a word, imprisonment or by execution. This is indeed the modern way of eliminating the unfit. If, however, the criminal can be reformed and restored as a useful member of society, so much the better, but we think that Dr. Drever exaggerates when he says that in this respect our penal code is glaringly inefficient. He would have each criminal psychologically examined before being sentenced, in order to form an opinion as to his probable reaction to punishment, and so make the punishment fit the crime. We shudder to think what would become of our administration of law were proposals like this carried out, and how soon the wily criminal would learn to adjust his 'psychological state' to the mind of the investigator. The most hopeful class of criminals with which to experiment are the youthful beginners; and here, as a writer to the *Times* has pointed out, the "First Offenders Act" and our Borstal institutions have already done enormous good. In large measure, therefore, Dr. Drever's hopes have been realised in practice, though modifications of detail may no doubt be desirable.

Sir Josiah Stamp in his address entitled "Inheritance as a Social Factor" has subjected to a penetrating and illuminating analysis the modern socialistic views upon the inequality of the distribution of wealth. The title expresses the truth that men inherit from their parents not only their bodies but also their social environments. According to Sir Josiah, one of the most important elements in this environment is the inheritance of property. This is the main factor which explains why A and B start the race of life better equipped than C or D; and one of the commonest socialistic panaceas is the partial or total confiscation of property at death.

Sir Josiah Stamp points out that there is no *a priori* way of coming to a conclusion on this question. He quotes the utterances of certain enthusiastic members of the "Liberal Summer School," who in their efforts to compete with their socialist rivals for the support of the masses, have proclaimed "that the present inequality of wealth is an affront to social justice." He says that there is no scientific way of attaining a conception of "social justice"; it is merely an emotional ideal, and emotional ideals vary from person to person.

The scientific way of dealing with the subject is to ascertain so far as possible how such measures would work out in practice. Sir Josiah Stamp says that in the last 120 years the 'standard of life,' *i.e.* the relative amount of well-being, of the manual worker, has improved four times, and has increased most in England, where right of bequest has been freest from restriction. On one side there is urged what seems to us the irrefragable argument that the increase of wealth of a community is due entirely—at any rate in an old country like England—to the efforts of the abler and more far-seeing members of the community, in a word to private enterprise. It is not true that labour creates all wealth; labour without the organising direction of the capitalist is as barren of useful result as the waves of the sea. This wealth, in the form of wages and employment, is necessarily shared with the rest of the community who are so much the better off. Directly the primitive impulse to confiscation, or in plain words to plunder, is allowed to intrude, the spur to accumulation fails and capital disappears; and without capital our complicated industries could not be carried on, and large numbers of our working class would starve.

On the other hand, it is urged that the excessive rewards of a few capitalists (for the returns to most capitalists are very modest) excite envy in the mind of the working man, and make him inclined to do as little as possible for his wage. Sir Josiah Stamp, after some research, is convinced that the jealousy of the working man is not directed against inherited wealth, as such, but against wealth in general. Jealousy of one's neighbour is a very ancient human characteristic; else the Hebrew legislator would not have devoted one of the ten Commandments to its prohibition. But it appears to us that Sir Josiah's concession that something must be done to appease the envy of the manual

worker so as to incite him to better work entirely overlooks one important consideration: it is that the manual labourer is a free Englishman, and, like every other freeman he is a merchant. His merchandise is his labour, which it is to his interest to dispose of at the highest price.

It is not a question of the labourer giving less or more according to his mood, but of his fulfilling his bargain. A grocer is not entitled to deliver thirteen or eleven eggs for a dozen according to whether he feels good tempered or bad tempered. In a word 'piece-work' is the one and only remedy for 'ca' canny' and under-production. The real cause for the relatively low wages of the English worker as compared with those of the American is the over-'reproduction' of the former. The wage is the reward for a certain product; the more mouths which have to be fed on this wage the worse off the individual will be.

In countries which have large untapped natural resources, revolutionary experiments may perhaps be indulged in without doing permanent irreparable damage, but in England it is a life-and-death matter to combat them. In a country with such a population that it is unable to feed more than two-fifths of them, our very existence depends on daring private enterprise, just as truly as did that of our Norse forefathers. As Mr. Walter Runcimann, who certainly will not be suspected of Toryism, once put it, "England lives on her business men." It must therefore be our constant endeavour to encourage private enterprise in every possible way, and especially by making its rewards secure, and the very worst manner of doing so would be by limiting the right of bequest.

The dependence of England for its food on foreign trade naturally leads us to the consideration of Sir Daniel Hall's address on the relation between cultivated area and population. Three years ago, at the Liverpool meeting of the British Association, Sir William Beveridge airily disposed of what he termed 'the Malthusian devil' by pointing out what large areas of the world in general and of the British Empire in particular were thinly peopled. His address was exploited by the leading socialist journal under the heading of "Malthusian Moonshine."

Sir Wm. Beveridge's conclusions were severely criticised at the time: and Sir Daniel Hall, speaking not only as a statistician but also as a distinguished biologist, substantially confirms all those criticisms. He points out that the possibility of increase of population is dependent on the increase of food supply, and that between 1850 and 1920 the numbers of the 'white race' increased from 200 to 700 millions. This increase in numbers was rendered possible by the addition of 500,000,000 acres of land to the world's farms: but no further reserves of such lands are to be found on the earth's surface. It is true that the product of those acres might be greatly increased by the adoption of more intensive farming, but intensive farming means greatly increased labour, and even now, despite very much higher wages, the product per man-power is much greater in the lightly farmed lands of Canada and Australia than in heavily farmed England. That the plant-breeder, by the production of better cropping varieties, might increase the yield without necessitating more labour, is conceded, but it will come as a shock to many to read Sir Daniel's opinion as to the narrow limits within which this improvement is to be expected. The main productivity of the plant, he avers, cannot be much increased; all that can be done is to alter the proportions between useful and useless products, such as grain and straw in wheat, sugar and starch in beet, and so on.

The return of the land in food-stuffs per acre is about twenty times greater for wheat than for beef. Further, a considerable portion of our cereal products are employed in producing beer and whisky. If we were all to become prohibitionists and vegetarians we could support a larger population on the same area; but we fully agree with Sir Daniel Hall when he says that the virile and enterprising races, such as have heretofore dominated the world's destinies, would never submit to such a pauperised mode of existence. On the other side of the ledger we have to take account of two grave facts: first, that the fertility of the virgin lands which produced such a great part of our supply is slowly but surely becoming exhausted; and secondly, that everywhere over the world, in Ontario no less than in England, there is the tendency for the rural population to drift into the towns. This tendency Sir Daniel attributes to the poorer rewards offered by agricultural labour as compared with industrial wages in towns. Greatly increased facilities of transportation, wide diffusion of news by wireless and other amenities of civilisation have certainly not diminished the tendency. It will eventually be checked in Sir Daniel Hall's opinion by the better organisation of agricultural workers, who will demand higher prices for the food which they produce. Certainly a cheerful prospect!

It seems to us that the imperative necessity of the limitation of the numbers of the human race in general and of the British Islands in particular is the lesson driven home in sledge-hammer blows by Sir Daniel's able address. If the principle be granted that every human being born in a civilised community may claim the right of full maintenance, whether at work or not, the obvious corollary is that society must be able to control its numbers or become bankrupt.

The Solid Foundation of Organic Evolution.

Evolution. By Prof. J. Graham Kerr. Pp. xii + 278 + 2 plates. (London: Macmillan and Co., Ltd., 1926.) 12*s.* net.

THE object of this book, as set forth in the preface, "is to provide a sketch in outline, approximately correct in its proportions and not overburdened with detail, of the evolutionary science of to-day." The author rightly claims that "a grasp of the main principles of biological science, and amongst these principles Evolution is one of the first, is an essential part of the intellectual equipment of the citizen of the modern state." The necessity was never greater than it is to-day. Although the proceedings in Tennessee last year would have been unthinkable in Great Britain, even amidst the fierce and embittered controversies of the early 'sixties, we often meet with the confident expression of opinions which are all the more injurious because less obviously absurd. Thus in the *Spectator*—on most subjects a sober and well-balanced journal—Mr. C. E. M. Joad wrote in the issue of February 20, 1926, on the causes of evolution: "There were two contemporary explanations in the field; that of Darwin and that of Lamarck. Darwin's was no explanation at all. He said, in effect, that he could not tell why variations occurred; all that he could affirm was that those which were suited to their environment survived." It might with equal force be maintained that the form of a house is not determined by an architect because he did not make the bricks, if I may thus condense an argument employed by Darwin in his correspondence with Asa Gray before the appearance of the "Origin of Species."

Quite apart from this old objection, raised long ago by distinguished controversialists, there is a tendency in these later years to depreciate natural selection, not indeed by contesting its truth but by maintaining that it is self-evident and obvious—a barren guide devoid of inspiration. In Prof. Graham Kerr's book we are provided with admirable and convincing answers to the mistaken opinions of those who maintain that evolution is a delusion, and of those others who admit evolution but deny or depreciate the value of natural selection as its cause. The author's answers are firmly based on a consideration of all the important aspects of the subject—embryology, palæontology, comparative anatomy, geographical distribution, heredity (cytological, statistical, and experimental), natural selection, adaptation, sexual selection, evolution in communities of cells and of individuals, evolution and man, the final chapter containing a summary and the brief discussion of certain general problems of evolution. The book is well and freely illustrated with 53 excellent text-figures and two beautiful coloured plates with well-chosen examples of mimicry in butterflies.

There is something deeply impressive, and to an open mind utterly convincing, in the convergence of so many and such widely different classes of evidence to one inevitable conclusion—the reality of organic evolution. It is not to be expected that the powerful and, in my opinion, irresistible arguments in favour of natural selection as the motive cause of evolution will meet with the same immediate acceptance as those which advocate evolution itself. The latter are driven home by the experience of every biologist; but in estimating the force of the case for natural selection, "the laboratory-trained zoologist lacking in field knowledge often shows a singular incapacity for understanding the importance of evolutionary factors which experience in the field, more especially tropical experience, drives home—such as, for example, the intensity of the struggle for existence or the adaptive significance of animal coloration" (p. 9). There is no doubt about the conclusions to which the author has been led by his own experience in South America. He writes on p. 272: "I adhere to the position of Darwin that the potency of natural selection is in actual fact enormous; I hold that the attempts that have been made to minimise its importance are to a great extent fallacious, invalidated in some cases by their author's want of experience and skill as field naturalists, and in others by the making of unwarrantable assumptions." Prof. Kerr is thus in no doubt about his foundations of belief.

A few slight changes in the excellent Chapter xi., on the "Coloration of Animals," might be advantageously introduced into the second edition, which is sure to be called for at an early date. Mombasa is not one of the localities where the females of *Papilio dardanus* resemble the males (p. 175). If space permitted it would be well to mention the Nairobi district, where ancestral forms of female occur, intermediate between the most primitive of the fully mimetic females and the male-like females of Madagascar and Abyssinia. Different forms of females have not been bred in the same batch of eggs in the Cape district, but in Natal; also in South-East Rhodesia, Southern Nigeria, Uganda, Tanganyika Territory, and of recent years on a very large scale by Dr. V. G. L. van Someren at Nairobi.

The section on "Aromatic Attractions" (p. 186) would be improved by a short account of the advance which has been made along lines originally laid down by Fritz Müller:—Lamborn's observations on male Danaine butterflies brushing the scent-patches on their hind wings and thus charging the anal tufts; Carpenter's, on the actual use of these tufts in courtship; Eltringham, on the minute structure of the scent-producing and

scent-diffusing apparatus of these butterflies and of Phryganidæ.

Returning to Chapter xi., it would be an advantage in such a complicated and difficult subject as butterfly mimicry to adopt a uniform system of illustration, with the models to the left and mimics to the right, and to print "Models" or "Danaine Models," etc., as the case may be, at the head of one column, and "Mimics" at the head of the other. In Plate I. four of the models are to the left, but the fifth butterfly (Fig. 9) would be generally looked upon as a mimic. It appears, however, to be commoner than its model *Heliconius telesiphe* (Fig. 10), but both species are probably distasteful and the mimicry Müllerian. In Plate II. the Danaine models are to right and the mimetic females of *Papilio dardanus* to the left.

The author has been misled, as so many have been, by Bates's use of the word "Heliconidæ" in his classical memoir on butterfly mimicry in the *Transactions of the Linnean Society*. It is extremely difficult, wellnigh impossible, to correct effectually and for all time a mistaken impression conveyed by a great man in his greatest contribution to thought, embodied in a memoir which has been read and re-read unnumbered times and handed on to a widening circle by reprint in hundreds of volumes and journals. It is impossible on the present occasion to discuss this unfortunate result in any detail. It must suffice to explain that the chief models for mimicry among the tropical American butterflies are not the far-famed "Heliconidæ" at all, but a specialised group formerly united with the Danainæ but now placed in a separate sub-family—the Ithomiinæ. These are not only extensively mimicked by other butterflies but also by an important section of the Heliconines. An excellent example is figured by Prof. Graham Kerr on Plate I., Fig. 8, and its Ithomiine model in Fig. 7, but this relationship would scarcely be gathered from the author's words on p. 171, where Fig. 8 is referred to as a "typical example of the . . . Heliconiides." It is by no means typical of these, but only of that large section which mimics the Ithomiines. A far more typical example is represented in Fig. 10 of the same plate. Furthermore, the description of the Heliconiides on p. 171 refers to the Ithomiine and only to those species among the Heliconines which mimic them.

It is scarcely necessary to point out that this criticism, which equally applies to nearly every published account of butterfly mimicry, does not in any way affect the immense strength of the author's argument, and I wish in conclusion to emphasise again the excellence of the work and draw attention to the comfort of its clear type and entire freedom from misprints.

E. B. P.

Sunshine and Health.

Sunshine and Open Air: their Influence on Health, with Special Reference to the Alpine Climate. By Leonard Hill. Second edition. Pp. vii+132+8 plates. (London: Edward Arnold and Co., 1925.) 10*s.* 6*d.* net.

PROF. LEONARD HILL possesses to a marked degree the facility of presenting to his readers a graphic picture of the facts he desires to convey. The first few sentences of his admirable book, "Sunshine and Open Air," vividly and felicitously illustrate this power. "Going out before breakfast at 8 A.M., before the sun has risen over the mountains, one passes into a cold, dry, exhilarating atmosphere, cold enough to make one draw down a cap over one's tingling ears. The snow, crisp with some 10° of frost, crunches beneath the feet. The frosty snowfields glitter with light, and the distant snow peaks of the mountains, catching the sun, blush rosy red; the pines stretch upwards their black boughs drooping heavy with snow." We are transported at once to the scene he so graphically visualises. He writes not only as a scientist but as a poet; and when a few lines further on he says, "So one comes back with a good appetite for breakfast after an hour's climb," we almost feel the healthy hunger that morning walk over the enchanting snow-clad mountains has aroused, and plunge with added zest into a book readable from cover to cover, and replete with information and original observation.

The author considers the characteristics of the Alpine climate and on which of these its curative value is based, contrasting the outdoor English climate on one hand, and the indoor city conditions on the other, with these Alpine conditions. He finds no evidence of differences in atmospheric pressure, ionisation of the air, or in chemical purity being of importance. The important factors are:

(1) Freedom of the air from pollution with infectious microbes, dust, and smoke which prevails in indoor city atmospheres.

(2) A high physiological saturation deficit; that is, a large difference between the water vapour in a cubic metre of air at atmospheric temperature and that held in the air when saturated at body temperature. On this depends the evaporation from skin and lung. The evaporation from the lung entails passage of blood and lymph through the respiratory membrane and a secretion which cleanses and immunises against infection. In crowded, warm rooms the physiological saturation deficit is lowered while microbic infection is increased, and with it the natural defensive cleansing

mechanism. The free evaporation from the skin is also of much importance to comfort and health.

(3) High drying power ensures dry clothes, houses, and soil; and these warmed with abundant sunshine prevent uncomfortable loss of body heat by radiation.

(4) Cool dry air stimulates the skin and exhilarates the feelings while keeping up the loss of body heat to an adequate level, maintaining appetite and good digestion.

(5) At night the cool air descending from the mountains prevents stuffy, warm conditions in the summer and gives an exhilarating change to the warm sunny day conditions. In winter the frosty cold air, with absence of wind, affords exhilarating conditions for sleeping in open-air balconies, the very antithesis of the stuffy, warm, stagnant, moist air of crowded city rooms which lowers the rate of cooling of the body and with this the respiratory metabolism. The absence of high wind prevents excessive cooling in the Alps.

(6) The sunshine, with its plentiful supply of ultra-violet light, acts beneficially on the skin and so on the general health.

The author discusses in detail the evaporative power of the air exerted on the body, the biological action of light, the cooling power of the air and its marked effect on the resting metabolism and heat production of the body.

In a volume so valuable and informative it is difficult to select special sections particularly deserving of mention, but in the concluding chapter is a section devoted to clothing which is of great practical interest. The author protests against excessive clothing, by which the natural vigour of the body is weakened. "It does no harm to go out and feel cold until warmed by exercise; the impulsion to vigorous exercise does good. It is only the old and feeble who require very warm clothing, those whose fire of life cannot be fanned up by vigorous exercise and exposure." Prof. Hill practises on himself his own preaching. He concludes his book by confessing: "The writer finds a light cellular shirt and pants and a woollen tweed suit ample for winter, and rarely wearing an overcoat, keeps himself warm and in good condition by walking on every possible occasion, covering to and fro from his place of work and in a walk before breakfast some five miles a day, and at week-ends having, whenever weather allows, a sunbath."

In a short appendix artificial light treatment is very briefly discussed.

"Sunshine and Open Air" is well worthy of careful study. The information it conveys cannot be too widely known and applied. Acquaintance with the facts described would do much to teach essential principles of sound hygiene and sensible care of the body. There is a lucidity and charm in this volume which adds greatly to its value. After perusal one cannot but wish that the author should be persuaded to issue an abridged edition suitable for the widest possible circulation amongst medical men, nurses, teachers, parents, and indeed all those who are concerned with and influence the management and upbringing of youth. Prof. Hill has rendered valuable service in producing a volume which may be commended in the highest terms as of great scientific and utilitarian merit.

Vacuum Practice.

Vacuum Practice. By L. Dunoyer. Translated by J. H. Smith. (International Text-Books of Exact Science.) Pp. x+228. (London: G. Bell and Sons, Ltd., 1926.) 12*s.* 6*d.* net.

IT must be very difficult to write a book on this subject, for it has to cover such a wide and varied range. There are two distinct aspects of the matter, theoretical and practical, both important and interesting. A complete exposition of the theories involved would require almost an entire text-book on physics, new and old; and most of them are still attended by considerable uncertainty. The practical side is no easier to treat; for practice is best taught by example and not by precept; and yet perhaps it is the more important. The principles—at least, of the theories—lie on the high road of academic physics and form a normal part of the training of every serious student; but the practice has developed in the factory rather than in the laboratory, and its literature consists of patent specifications rather than formal papers. In most of the university laboratories of Great Britain, the best designed and best executed piece of vacuum apparatus that they contain is the incandescent vacuum lamps (already almost obsolete) by which they are lit; and many a skilled experimenter with years of pure research behind him would be quite unable to produce such a common domestic article as a 'dull-emitter' valve. The reason lies partly in the lack of equipment from which all British universities suffer, but far more in the gulf between the followers of pure and applied science, which is only slowly being bridged.

No apology would therefore be needed (nor is any offered) for the appearance in English of a third book covering the same ground as those of Dushman and Newman, even if it possesses no merit that they lack. Actually in one respect M. Dunoyer's book is greatly superior to either. It is critical. Dushman dealt mainly with work in which he was so closely concerned

that he is not in a position to criticise; Newman aimed chiefly at being encyclopædic. M. Dunoyer has passed all the work through his own mind, and offers his opinion freely. His presentment is therefore better, and his book more readable; he has been greatly assisted by a translator of complete competence and sufficient wisdom to risk slang, if only he may avoid Gallicisms.

If fault has to be found with M. Dunoyer—and how else can a reviewer display his omniscience?—it must be sought in his selection of material. He tells us that his principal object is the study of technique. But then would it not have been well to sacrifice some part of the theory of monomolecular absorption to a recipe for making 'activated' charcoal (for which every investigator has his pet method) or even to advice in constructing ovens for baking during absorption? Would not a few details of the commercial process of 'gettering' be worth as much as the somewhat nebulous theories that have been advanced to explain it? Why should Knudsen's theory of gas-flow at low pressure be carried beyond the point at which it has any practical application, while Gaede's theory of diffusion is left before it has indicated the effect of dimensions and temperature on the performance of the pump, or even the relation between speed and the nature of the gas pumped? Lastly, the simple theory of metal to glass constructions is quite as interesting and much more practical than many others for which space has been found.

We would not leave the impression, however, that M. Dunoyer has not lived up to his professions. He is most admirable when he is most practical. He is really helpful in the sordid matter of leaks; he knows all about waxes and cements, but realises their limitations; and, though he writes before the recent startling developments in this direction, is aware that metal to glass joints are not so difficult as the amateur believes. But even in these matters his outlook is not perhaps quite that of the professional expert. It is possible, and indeed easy, to be too ingenious in leak-hunting; in most circumstances a leak which cannot be found by simple means in a few minutes is best eliminated by reconstruction. The disadvantage of waxes is not their vapour-pressure, but their low melting-point; apparatus which involves them cannot be baked. If so much is said of the physical properties of these makeshifts, surely some attention should have been paid to the physical properties of the essential material, glass. In Great Britain, nearly all laboratory workers continue to handicap themselves by the employment of treacherous and generally unsuitable soda glass; they seem never to have heard of the lead and boro-silicate glasses; a table of comparative thermal and electrical properties would do much to enlighten their ignorance.

There is only one matter, other than a choice of material, in which we differ seriously from M. Dunoyer. In his discussion of gauges, the account of the characteristics and limitations of the various types is excellent; but when he sums up in favour of a form of Knudsen gauge against the ionisation gauge, he misconceives the problem and might mislead a novice. A gauge is often used merely to indicate that a certain rough limit of pressure has been reached; for this purpose all that is needed is sensitivity, simplicity, and ease of attachment; in all these the ionisation gauge is vastly superior to the Knudsen. Sometimes only relative accuracy is required in the comparison of different quantities of the same gas; here again the dependence of the calibration of the ionisation gauge on the nature of the gas in immaterial. The Knudsen gauge is superior only if an absolute measure is required of mechanical pressure or of number of molecules per unit volume; the requirement is so rare and arises only in such elaborate researches that it should not be taken into account in offering a general recommendation.

NORMAN R. CAMPBELL.

Geography and Geology of Makalla.

Ministry of Finance, Egypt: Survey of Egypt, Geological Survey. The Geography and Geology of Makalla (South Arabia). By O. H. Little. With Two Appendices: (i.) Description of Fossils from South Arabia and British Somaliland, by Prof. G. Stefamini; (ii.) Note on some Terrestrial Mollusca from the Hinterland of Makalla, by P. Pallary. Pp. xi+250+36 plates. (Cairo: Government Publications Office, 1925.) 50 P.T.

THIS volume is the outcome of two expeditions led to Makalla at the request of the late enlightened ruler Sir Ghalib bin Awad bin Omer el-Kaitai, K.C.I.E., Sultan of Shehr and Makalla. Makalla is located on that little frequented coast-line of Arabia between Aden and Muscat. Under the impression that minerals of economic value existed in the territory he ruled, the Sultan requested the British Government to undertake an examination. A reconnaissance survey was made in May 1918, but so great are the difficulties of travel, and so lawless the tribes outside the immediate control of Makalla, that even under the protection of the Sultan's troops geological work is greatly hampered and every excursion is, in fact, an adventure.

The later and more detailed survey of Mr. Little confirmed the view that there were no minerals of economic value in the country even if the difficulties of access were surmountable. Exaggerated importance is attached

by the Bedouins to any unusual rock or mineral, and the slightest attention from a European is sufficient to convince them that something of enormous value exists.

Every tribe claims the right of imposing tribute on travellers passing their territory, even if permission is granted, and camels must be hired in the country being traversed. Any departure from recognised custom invites trouble, and the country is very convenient for ambushes. A virulent form of malaria prevails in the swampy regions along some of the nullahs and near the sea, and many of the expedition were incapacitated for long periods. The heat is very trying from May onwards, and even at night the air breathed resembles furnace gases at times. The tribes do not trust each other, and any unusual sound at night usually results in an outburst of wild firing from any strange party encamped in hostile country. One member of Mr. Little's party was, indeed, murdered shortly after he had left the main body.

The physiography of the region is extremely fascinating, as the interior is reached by traversing deep wadis which narrow down at times to cañons with precipitous sides, 1000 to 1500 ft. high. Men and animals trapped by a sudden flow of water due to rains in the interior can find no escape. At intervals these cañons are broken by steep falls, which make it necessary to climb out of the gorge by a zigzag track to reach a higher stretch. Immense boulders strew the path in these gorges and at times exceed 1000 cubic metres in size. Water disappears and appears in some at intervals where the valley floor is pervious or impervious.

Some of the roads, which traverse narrow spurs and ridges leading into the mountains of the interior, are so steep and so polished by the constant treading of the bare feet of men and camels that passage is exceedingly dangerous, and both animals and men occasionally lose their lives through falls of many hundreds of feet.

Sufficient fossils were found to distinguish the age of the sedimentary rocks. Beds of Pleistocene, Pliocene, Miocene, Oligocene, Eocene, Cretaceous, and Jurassic age were recognised. The Pliocene conglomerates appear to correlate with the Bakhtiari series of the Persian Gulf and the great calcareous conglomerates of Somaliland.

The Miocene beds are not well developed and are gypseous in character; they are thought to correspond with the Fars series of the Persian Gulf, and they resemble the Miocene gypsum series of Egypt. It is, however, the Eocene and Cretaceous beds which cause the most striking topography of the country. Imposing vertical scarps 1500 feet and more in height often border the side of the wadis and the edges of valleys. The middle Eocene semi-crystalline limestones reach sometimes a thickness of nearly 1000 ft., and they overlie a series of massive variegated sandstones of Cretaceous age approximating another 1000 ft. in thickness. Where the Jurassic is absent these Cretaceous beds directly overlie the igneous basement rocks. Apart from occasional granites the igneous rocks are basic in character. Lignites are found in the Cretaceous sandstone series, while oil shales occur in the Jurassic rocks.

The only mineral deposits of any likely value are the lignites and oil shales, but neither are in sufficient bulk to warrant development to-day.

Two appendices with excellent illustrations describe the fossils of Southern Arabia and Somaliland; consequently the volume will prove valuable to all those studying the geology of that part of the world. The country and the customs of the inhabitants are admirably described, and many useful hints may be obtained by would-be travellers in these wild regions.

A. B. T.

Our Bookshelf.

Commission Internationale de l'Éclairage en succession à la Commission Internationale de Photométrie. Sixième session, Genève, Juillet 1924. Recueil des travaux et compte rendu des séances. Publié sous la direction du Bureau Central de la Commission, the National Physical Laboratory, Teddington, Angleterre. Pp. 432+19 planches. (Cambridge: At the University Press, 1926.) 15*s.* net.

THE initial portion of this comprehensive volume contains a list of the members of the International Illumination Commission, an account of the proceedings at the various meetings, and a summary of the chief decisions taken. The Commission recommends the initiation of researches on the incandescent black body as a primary standard of light, and adopts a series of values for the relative visibility factor for light of different wave-lengths. A series of terms and definitions for international adoption (in French) is also presented. In an appendix, recommendations on the lighting of schools and factories, presented by Mr. L. B. Marks, the chairman of the committee devoted to this subject, are reproduced. Values of illumination range from 0·2 to 50 lux (approximately 5 foot-candles) according to the purpose served by the light.

The remainder of the volume is devoted to papers read. These fall into several well-defined groups. Amongst those of a more purely scientific character may be mentioned researches on the primary standard of light, characteristics of tungsten lamps, notes on symbols and nomenclature, and heterochromatic photometry. A new feature is the inclusion of several papers dealing with educational propaganda in favour of good lighting, and illustrating methods of co-operation between supply undertakings, manufacturers, and the public in the United States. There are several papers dealing with the public lighting of Paris and with motor-headlight problems. Finally there is a

group of papers by representatives of different countries dealing with industrial lighting. The various papers presented thus cover a wide ground, and it is evident that the work of the Commission is extending. The interchange of views between experts in different countries is helping towards the formulation of common principles of illumination, and it is to be noted that international committees are now engaged on a variety of problems.

The Historical Geography of Early Ireland. By Walter Fitzgerald. (*The Geographical Teacher* Supplement No. 1.) Pp. vii+100. (London: George Philip and Son, Ltd.; Liverpool: Philip, Son and Nephew, Ltd., 1926.) 5*s.* net (to Members of the Geographical Association, 4*s.* net).

THIS work is worthy of a better exterior. A closely printed pamphlet is apt to repel a reader, who would peruse with delight the same matter in an attractive book. Having said this, and having added a word of censure on the poor scratchy drawings of gold ornaments (p. 70), we proceed to the pleasant task of commendation. Mr. Fitzgerald has undertaken, and has done well, a work long overdue; although the way was prepared by the late Prof. Cole's short but notable "Ireland the Outpost." In the past the history and antiquities of Ireland on one hand, and her geology and geography on the other, have received attention; Mr. Fitzgerald shows the interrelation of the two sets of facts. The first half of the book is occupied with geography, and is illustrated with many valuable maps; the second half is archæological and historical, and is likewise illustrated with maps of the distribution of types of implements, roadways, colonisation-areas, the routes of early Irish enterprise on the Continent, etc.

We sincerely hope that the author will expand his work into a 'full-dress' book, and we venture in anticipation to offer a friendly hint or two. 'Gaeillon' (p. 63) should be *Gaileoin*: 'Ushnagh' should be *Uisneach*. The Cat-stone is not on this hill, but on the slope of the hill next to it; and it is not a dolmen, but a large erratic boulder (the author has been misled by Borlase's imposing but unsatisfactory "Dolmens of Ireland," which should be used with discretion). And let him be cautious about taking literally the legends of the Tuatha Dé Danann; the complex stratification of these strange tales must be worked out much more critically than has yet been done, before they can be safely utilised in a study such as this.

R. A. S. MACALISTER.

Coal: Ways to Reconstruction. Being a Sequel to "The Coal Crisis and the Future." By Members of Leplay House. Pp. vi+58. (London: Leplay House Press, 1926.) 2*s.*

THIS volume consists of a number of articles by various contributors, and, as is stated in the preface, the studies are both complementary and divergent. The main thesis, however, is that reconstruction in the coal industry is to be effected by means of regional planning. The application of the surveys is to be based on the co-ordination of the recommendations of the several experts, while the corresponding theory of the "transition from the confused empiricism of current business and politics to an ordered advance" is to be supplied by the sociologist. Prof. Geddes contributes an interesting summary of the methods of regional planning, and advocates regional surveys of the coal districts as a preliminary to the solution of the problem. Then follow articles by Prof. Desch and Prof. Hay, who both emphasise the importance of better methods of coal utilisation. The former deplores the present wasteful methods, while the latter holds that there is more hope for the industry in improved systems of coal consumption than in reorganisation of the mines.

Prof. Hay's thoughtful survey, which can be commended to those interested in the problem, stresses the importance of a greater production per man-shift, the development of markets, and the stabilisation of prices. At the same time he pleads for more understanding among the various parties, consumer, owner, and miner. An abstract of a previous volume is given by Mr. Sandeman, while Mr. Victor Branford contributes a theoretical exposition illustrating the application of sociological principles.

Superpower: its Genesis and Future. By William Spencer Murray. Pp. ix+237. (New York: McGraw-Hill Book Co. Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925.) 15*s.* net.

THE term 'superpower' is used to indicate a "greater unity of effort and broader co-ordination in (electrical) power production and utilisation." The author was chairman of a committee authorised by Congress to study the possibilities of superpower in the Boston-Washington zone. This committee began its activities in July 1920 and twelve months later presented its report (*Professional Paper* 123, U.S. Geological Survey).

The present book is to some extent an amplification of that report. It contains many interesting reflections and personal touches which will make it good leisure-time reading to those who have read the original report. A wide survey of the problem is made and a considerable portion of the book is devoted to finance, but the difficulties involved in standardisation of frequency and the stereotyping of generation and distribution methods in an age of rapid progress do not appear to have been dwelt upon sufficiently. W. T. D.

A Bibliography of Indian Geology. Part IV. *Palæontological Index.* Compiled by T. H. D. LaTouche. Pp. iv+vii+414. (Calcutta: Government of India Central Publication Branch, 1926.) 7.4 rupees; 11*s.* 6*d.*

SINCE his retirement from the Geological Survey of India, Mr. T. H. D. LaTouche has devoted his leisure time to the great task of compiling a bibliography of Indian geology. Part I. A gives a list of authors' names in alphabetical order with the titles of their papers arranged chronologically; Part I. B is an index of minerals; Part II. an index of localities; Part III. an index of subjects. Part IV., which has just been issued, gives an alphabetical list of the species of Indian fossils, followed by references to the works in which each species is described. This index will be indispensable to palæontologists whether they are dealing with the fossils of India or of other countries.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Recurrence of Magnetic Storms.

In recent communications to the French Academy of Sciences Prof. H. Deslandres (see NATURE, vol. 118, p. 71), the distinguished director of the Meudon Observatory, has described a tendency in magnetic storms to follow one another at intervals $iT/6$, where i is integral, T being the rotation period shown by sunspots. It is now, I think, generally agreed that there is a tendency to a repetition in magnetic conditions, whether disturbed or quiet, in what is described for brevity as the 27-day interval. Investigations (*Phil. Trans.* A, vol. 212, p. 75, and A, vol. 213, p. 245) which I made in 1912 and 1913 showed a tendency to recurrence in intervals which were multiples of T, but in none shorter. Supposing in accordance with modern ideas, as seems to have been first suggested by Kr. Birkeland, that magnetic storms are due to the discharge of ions from the sun, if such discharge, whether from sunspots or other approximately fixed limited areas, went on for a long time, a repetition of disturbance according to the solar rotation period is exactly what we should expect. But repetition at intervals submultiples of T would suggest a different explanation, namely, that the sun as a whole acts somewhat like an intermittent geyser. The subject seemed so important both to magneticians and astronomers that I have further considered it.

Some things fairly patent to magneticians may be less so to others. A magnetic storm is not definable with the same precision as a solar eclipse. It is true that an eclipse commences at different times at different parts of the earth, whereas the S.C. (sudden commencement) of a magnetic storm may, for all we know, be absolutely simultaneous all over the earth. But many storms have no S.C.'s, and, when S.C.'s occur, highly disturbed conditions may not follow for some hours. Thus, in general, the time when a storm begins at a particular station, and still more the time when it ends, cannot be specified exactly. Again, there seems to be at all stations a marked diurnal variation in disturbance, and this renders it extremely difficult to estimate to the fraction of a day the interval between successive storms.

The accompanying table gives some of the results which I have obtained. The results all ultimately depend on daily character figures assigned on the international scheme 0 (quiet), 1 (moderately disturbed), and 2 (highly disturbed), and they further depend on the selection of five highly disturbed days a month. Take, for example, the 11-year data distinguished by the letter A. The entry in column n is the mean character figure from the $5 \times 12 \times 11$, or 660, selected disturbed days, the entry in column $n+1$ the mean character figure from the 660 days immediately following these selected days, and so on. In the case of A and B, the 5 days selected for each month were the days of largest horizontal force range at Kew. A includes the whole eleven years 1890 to 1900, while B represents only three of these years, 1891, 1895, and 1896, selected for a special reason. In the case of A and B the daily character figures depended entirely on the estimate of disturbance at Kew. In the case of C and D the selected days were the days of largest international character figure, and use was made of the daily international character figures which range from 0·0 to 2·0. C includes six years, 1906 to 1911, and D five years, 1920 to 1924.

If, to take a round figure, we suppose 27·0 days to be the solar rotation period, M. Deslandres' conclusions would suggest maxima answering to days $n+4{\cdot}5$, $n+9$, $n+13{\cdot}5$, $n+18$, $n+22{\cdot}5$, $n+27$, and $n+31{\cdot}5$. As disturbance is seldom limited to a few hours, we should expect to find maxima in the table in columns $n+9$, $n+18$, and $n+27$, and to perhaps a minor extent in columns $n+4$, $n+5$, $n+13$, $n+14$, $n+22$, $n+23$, $n+31$, and $n+32$. High disturbance is seldom confined to single (Greenwich) days. It is not unusual for it to extend to 3 or 4 consecutive days, and sometimes even to 6 or 7. This explains

	Mean.	$n-3$.	$n-2$.	$n-1$.	n.	$n+1$.	$n+2$.	$n+3$.	$n+4$.	$n+5$.
A	0·70	0·64	0·77	1·05	1·51	1·11	0·86	0·77	0·70	0·66
B	0·84	0·77	0·94	1·22	1·73	1·32	1·06	0·96	0·87	0·76
C	0·66	0·57	0·67	0·95	1·32	1·02	0·77	0·66	0·65	0·63
D	0·58	0·53	0·63	0·90	1·30	0·94	0·69	0·55	0·47	0·47

	$n+6$.	$n+7$.	$n+8$.	$n+9$.	$n+10$.	$n+11$.	$n+12$.	$n+13$.	$n+14$.	$n+15$.
A	0·62	0·63	0·64	0·62	0·61	0·63	0·63	0·63	0·64	0·63
B	0·68	0·73	0·74	0·73	0·70	0·75	0·75	0·81	0·84	0·80
C	0·63	0·65	0·64	0·62	0·59	0·59	0·59	0·60	0·59	0·57
D	0·48	0·53	0·52	0·54	0·53	0·53	0·55	0·54	0·54	0·57

	$n+16$.	$n+17$.	$n+18$.	$n+19$.	$n+20$.	$n+21$.	$n+22$.	$n+23$.	$n+24$.	$n+25$.
A	0·63	0·63	0·61	0·61	0·62	0·64	0·64	0·63	0·65	0·71
B	0·82	0·78	0·70	0·74	0·77	0·74	0·78	0·76	0·84	0·87
C	0·60	0·61	0·62	0·63	0·63	0·63	0·63	0·62	0·62	0·65
D	0·57	0·58	0·58	0·58	0·53	0·52	0·48	0·49	0·52	0·59

	$n+26$.	$n+27$.	$n+28$.	$n+29$.	$n+30$.	$n+31$.	$n+32$.	$n+33$.	$n+34$.	$n+35$.
A	0·83	0·94	0·92	0·84	0·79	0·72	0·70	0·67	0·64	0·61
B	0·98	1·13	1·15	1·02	0·94	0·82	0·79	0·73	0·72	0·66
C	0·75	0·84	0·81	0·75	0·70	..	..	..	..	..
D	0·74	0·83	0·76	0·67	0·60	0·54	0·52	0·51	0·54	0·55

why outstandingly high mean values are not confined to column n, but extend to at least columns $n-2$ and $n+2$. The existence of high mean values for the five columns $n-2$ to $n+2$ entails values somewhat below the all-day means (given in the first column) in the majority of the other columns. Individual years give usually somewhat irregular results, and minor irregularities appear even in 11-year data. But it will probably be admitted that in addition to the primary disturbance pulse extending from column $n-2$ to columns $n+3$ or $n+4$, A shows clearly only one secondary pulse, extending from column $n+25$ to column $n+30$, or possibly $n+31$. The maximum appears in column $n+27$, with column $n+28$ not far behind. The three years included in B are given separately because they rather suggest a minor peak value in column $n+14$. But as the B results form a part of the A results, this is presumably purely accidental. Again, the D results may suggest a small secondary peak centring about column $n+17$, but there is no suggestion of this in the C results. The full 27-day interval is shown particularly clearly in D, which includes the latest international data available. No entry from column $n+3$ to column $n+24$ exceeds 0·58, the all-day mean, while the entry in column $n+27$ exceeds this by 0·25. Magnetic disturbance is the rule rather than the exception, and in the absence of any exact definition of a magnetic storm it is specially necessary to study the phenomena with an unprejudiced mind. The method employed here ensures impartiality. The table does not seem to me to suggest any real recurrence interval

shorter than 27 days, but any one can judge for himself.

Obviously, if two or more solar areas are highly active simultaneously, for a time which includes several rotation periods, we may have several pairs of (unconnected) storms separated by approximately constant time intervals, which might happen to be approximately sub-multiples of 27 days.

C. CHREE.

75 Church Road, Richmond, Surrey,
July 29.

Prof. Labbé's Production of 'Allomorphs' by the Action of increased Hydrogen Ion Concentration.

PROF. LABBÉ, in a series of recent papers (*C.R. Acad. Sci.*, Paris, 1924, t. 178, p. 132, 594; t. 179, p. 928; 1924, *Arch. Zool. Exp.*, t. 62, p. 401), has communicated the results of observations made on the Salines of Croisic, and the conclusions he draws therefrom as to the nature and stability of species would, if substantiated, seriously shake the foundations of systematic zoology. For example, he asserts that, from the eggs of a parent form *Canthocamptus minutus* O.F.M. exposed in the ovisac to the influence of a high P_H, he has obtained a mixed progeny consisting of:

(*a*) *C. minutus* (typical).
(*b*) 'Allomorph' *Mesochra* (*Wolterstorffia*) *blanchardi* Rich.
(*c*) 'Allomorph' *Canthocamptus lucidulus* Rehb.
(*d*) 'Allomorph' *Mesochra salina* n. sp.

From these and other results Labbé draws very far-reaching conclusions which will, no doubt, receive serious consideration from all concerned with biochemical investigations; and it is possible that many will accept the premisses on which the conclusions rest without the close critical study which is the province of the systematist. For this reason the following remarks may be justified. I will take only the example given above of *C. minutus* and its 'Allomorphs.'

(1) 'Allomorph' *C. lucidulus* Rehb. In the first place one may observe that *C. lucidulus* is a common *fresh*-water species; secondly, the descriptions and figures given (*Arch. Zool. Exp.*, 62) are sufficient to show that the specimens described did not remotely resemble *C. lucidulus*. The antenna figured (Fig. 17) is unlike that of any Harpacticid of which I can find a description, since in all 8-jointed antennæ[1] the æsthete or "organ of Leydig" is borne by the fourth joint, which is followed by four more small joints; whereas in Labbé's figure it is borne on the fifth, and followed by two joints only. The fifth legs of both male and female (Figs. 28 and 29) are not only totally unlike those of *C. lucidulus* but have no parallel among Harpacticids. I can only call to mind two examples of a fifth leg having a two-jointed exopod—*Misophria pallida* and the male of *Microthalestris forficula*. It is conceivable that Labbé's figures are inaccurate drawings of swimming legs of immature individuals; but they are quite certainly not those of the fifth leg of *C. lucidulus*. Lastly, the operculum of his allomorph is, as he admits himself, quite different from that of *C. lucidulus*.

(2) 'Allomorph' *Mesochra blanchardi* Rich. Fig. 31 of the fifth foot bears some resemblance to that of *M. blanchardi*, but those of the antennæ, the furca and the first leg do not. The antennæ, if correctly drawn, can only be interpreted as monstrosities.

(3) 'Allomorph' *M. salina* n. sp. Here there is no question of alleged identity with a known species, but Labbé states that it differs from *M. blanchardi* only in the structure of the fifth legs. Curiously enough Fig. 32, which is said to represent the fifth leg, is so nearly like the *first* leg of *M. blanchardi* that (apart from a discrepancy in the proportional length of the joints) it might represent that limb, while Fig. 26 of the first leg represents an appendage described in the text as the fifth, but quite unparalleled among known Harpacticids.

Similar criticisms might be directed upon the 'Allomorphs' *Eurytemora affinis* and *E. lacustris*, while the remarks concerning *Artemia salina* are open to serious objection.

The experimental methods are so briefly described that any one acquainted with the difficulties of breeding Copepods without accidental introduction of the Nauplii of other species cannot fail to be sceptical of the results. Prof. Labbé's statement that the parents died on being placed in the new medium, but that their eggs were successfully hatched, leads one to doubt very much if the larvæ observed actually came from those eggs. In the brackish water such as fills the Salines at Croisic in winter, a number of Harpacticids may be expected to occur—*e.g.* species of Amphiascus and Nitocra—and it seems quite probable that the unsuspected presence of such species may have vitiated the results.

Having regard to the importance of the questions at issue it is essential that the foundation of fact should be impregnably secure, and it is to be hoped that, before Prof. Labbé's conclusions are accepted, he will be required to produce not only a detailed account of his experiments, but also accurate figures of his 'Allomorphs.'

I do not find anything at present in his writings which "fera malheureusement le désespoir des morphologistes classificateurs."

ROBERT GURNEY.

Stalham,
Norwich.

[1] Labbé's figure shows seven joints only, though all species of the genus have eight. The legend of the figure is "Canthocamptus minutus O.F.M. ♀ Antenne antérieure gauche de l' 'allomorphe'" and presumably is intended to represent that of "Allomorphe Canthocamptus lucidulus Rehb."

Scattering of Electrons in Helium.

THE energetic relations in collisions between electrons and gas molecules have been made the study of a very large group of workers, all of whose results show the essentially unmechanical nature of the processes involved. Our picture of the nature of such a collision must remain incomplete, however, until the angular relationships of the electron and molecular paths are also known.

Such information as we already possess of the scattering of electrons is in the highest degree unexpected. The work of Ramsauer has shown that slow electrons in the rare gases possess free paths much longer than would be anticipated on the kinetic theory, while that of Davisson and Kunsman (*Physical Review*, **22**, 242, 1923), on the scattering in metal films is also of revolutionary character. Quite recently Langmuir (*Physical Review*, **27**, 806, 1926) has shown that inelastic collisions in several gases lead to very small angles of scattering. Elsasser (*Die Naturwissenschaften*, **13**, 711, 1925) has put forward an explanation of these results on the basis of the theory of de Broglie, in which a moving particle is associated with a 'phase wave,' the interference of which governs the scattering.

In the course of an investigation of the energy distribution of electrons after a collision with a gas molecule, it was found possible to study at the same time the angular distribution of scattering.

Electrons from a tungsten filament were restricted by two slits to a narrow beam and traversed the gas under investigation, which was helium at a pressure of 0·03 mm. A beam of scattered electrons could be selected by two slits and afterwards bent in a magnetic field to determine the velocity distribution. Fast pumps maintained a low pressure in this region. The filament and first two slits could be rotated, so that the scattering angle could be varied from 0° to 90°.

The results for the scattering of electrons, which have suffered inelastic encounters and have lost 20 volts energy, are shown for two initial velocities, $V_i = 100$ and $V_i = 400$ volts, in Figs. 1 and 2. For $V_i = 100$, there are two maxima, the principal one at 5° agreeing with the observation of Langmuir, and another, much broader, at about 60°. For $V_i = 50$, the principal maximum broadens and moves to 20°. At higher initial velocities this maximum moves to smaller angles and for $V_i = 200$, is at less than 2·5°, the smallest angle at which measurements could be made. At the higher velocities a very remarkable third maximum appears at 30°, which is much sharper than the other two. It is found first at 200 volts and increases in importance to 400 volts, which was the highest point at which measurements could be taken. The position of this peak was found to be independent of the velocity. This type of scattering is limited to the inelastic collisions, as is shown in Fig. 3, which shows the distribution of 400 volt electrons which have lost no energy, and is very similar to that of 100 volt electrons that have lost 20 volts energy (Fig. 1).

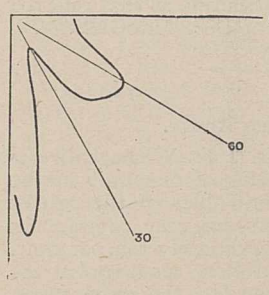

FIG. 1.—Scattering of electrons losing 20 volts energy; initial velocity, $V_i = 100$.

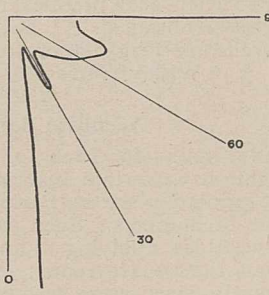

FIG. 2.—Scattering of electrons losing 20 volts energy; initial velocity, $V_i = 400$.

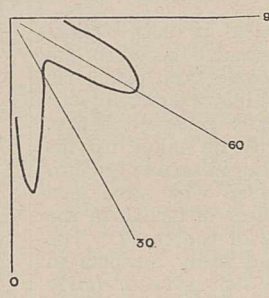

FIG. 3.—Scattering of electrons losing no energy; initial velocity, $V_i = 400$.

The occurrence of these maxima is strongly suggestive of an interference pattern, as suggested by Elsasser, but the fact that the position of the sharp maximum at 30° is independent of the velocity does not agree with his explanation.

It is hoped to extend this work to higher velocities and to the case where collision leads to ionisation and not excitation of the atom.

E. G. DYMOND.
Palmer Physical Laboratory,
Princeton University,
Princeton, New Jersey,
June 18.

Intensity and Polarisation of Skylight at Sunrise and Sunset.

IT is now well-established that the illumination of the clear day-sky at high-level stations is almost entirely due to molecular scattering by the atmosphere. The remarkable changes in the character of sky-illumination which take place when the sun approaches and gets below the horizon have been the subjects of study of a number of investigators and in recent years, particularly of Profs. Dorno[1] and Gruner.[2] Some of the phenomena, as for example, the changes of colour and polarisation of skylight and the appearance of the earth-shadow, occur in the clearest of weathers and at such high-level stations that their origin cannot be attributed to anything other than molecular scattering. Gruner has, indeed, shown that the observed changes of colour of skylight when the sun is near the horizon can be explained by scattering by a pure atmosphere.

The writer has recently calculated the intensities of sky illumination due to molecular scattering when the sun is on the horizon at a place 2 km. above sea-level for the wave-lengths 0·45 μ, 0·55 μ, and 0·65 μ by a method somewhat different from that of Gruner, and as some of the results obtained are new, they may be of general interest. The light from the sky when the sun is on the horizon has a much smaller proportion of the shorter waves than the normal daylight sky. In the zenith, where the relative proportion of the short waves is the largest, the ratio of blue (0·45 μ) to red is only 1·3 while, according to the inverse fourth-power law, it would be 4·3. As we move from the zenith to the horizon, the proportion of blue decreases still more, the ratio becoming 0·48 at a zenith distance of 80° in a direction perpendicular to the sun's rays, and 0·45 at the same zenith distance on the side opposite to the sun. The calculated absolute values of intensity are also of the same order of quantities as the values observed by Dorno at Davos (1·6 km. above sea-level), but there is a tendency for the observed values to be larger in the quadrant of the sky containing the sun.

The way in which different layers of the atmosphere contribute to the illumination is also interesting. The proportions of the total light of wave-lengths 0·45 μ and 0·65 μ coming from different layers of the zenith sky are as follow:

Height.	Wave-length.	
	0·45 μ.	0·65 μ.
2-10 km. . . .	8 per cent.	38 per cent.
10-20 ,, . . .	47 ,,	44 ,,
20-30 ,, . . .	33 ,,	15 ,,
30-50 ,, . . .	12 ,,	4 ,,

The single kilometre layers from which the maximum percentages come are 17 to 18 km. for the shorter wave and 9·5 to 10·5 km. for the longer.

In the calculations mentioned above, only primary scattering has been taken into account. But observation shows that complete neglect of self-illumination is not justifiable. For example, even in the clearest weather during the winter months at Simla (1·9 km. above sea-level), when the light from the zenith sky is analysed by a double-image prism and nicol, the weaker component is found to be richer in blue than the stronger, due, no doubt, to the self-illumination being greater for the shorter waves.

The effect of self-illumination may be expected to be a minimum, if confining our attention to the longer

[1] C. Dorno, "Himmelshelligkeit, Himmelspolarisation und Sonnenintensität in Davos, 1911 bis 1918," *Veröffent. des Prüssischen Meteor. Instituts, Abhandlungen*, Bd. 6, 1919.

[2] P. Gruner, "Beiträge zur Physik der freien Atmosphäre," Bd. 8, pp. 1 and 120 (1919).

waves, we observe in a direction perpendicular to the sun's rays but at a zenith distance of 70° to 80°, where the absolute intensity of the primarily scattered longer waves is greater and the greater part of the radiation comes from a comparatively thinner layer nearer the surface of the earth. Observations at Simla show that the polarisation for the red in these directions often reaches values so high as 30 per cent., which may be compared with 91·6 per cent., the value of the polarisation of the light transversely scattered by pure air. K. R. RAMANATHAN.

Colaba, Bombay, June 25.

Medical Entomology and the Tropical Field Worker.

WITH a wider enlightenment on matters of public health among all communities, east and west in the tropics and sub-tropics, nowadays the medical officer of health finds a more insistent demand on his attention to problems connected with medical entomology.

Before proceeding to his tropical or sub-tropical appointment the medical officer of health has doubtless had a training in medical entomology, and often has acquired an active interest in this important subject; so much so, that if his destination is to some locality, let us say, where malaria is rife, he takes up his appointment with an enthusiastic intention of improving conditions. To those of us who have seen the arrival of many a medical officer of health in the tropics that is but the beginning of the story. The remainder is less satisfactory, and sadly uniform in most instances: on arrival he can give a fairly excellent account of the systematic divisions of the Anophelini, and a poorer—often a decidedly bad account—of the Culicini, and can readily distinguish an anopheline from a culicine larva (when it is in the laboratory, or microscopically mounted). So he arms himself with a few tubes, and then usually wonders where on earth he can find the species of his locality. At the back of his mind is the recollection that 'old tin-cans, broken bottles, gutters, and water-tanks' have been mentioned as being dangerous mosquito-breeding places, and a search is therefore diligently made in these situations. His efforts are rewarded, maybe, by the capture of what ninety-nine times out of a hundred are culicine larvæ—which he distinguishes by the presence of the siphon. Ere long the capture of 'Culexes' becomes less exciting, and he possibly seeks in the foulest pond in the district for the more interesting anopheline larvæ. By great good luck he may find one or two, and with a feeling of just pride orders the abolition of that breeding-place; while some clearer, but, in reality, more pestilential pond in which he found no larvæ, yet where there are actually thousands, continues to breed its pests.

In the end, supported only by a meagre knowledge of the systematic divisions of the Culicidæ, upon the capture of a few larvæ which all look horribly alike and cannot be identified as anything particular, and perplexed by the unaccountable numbers of mosquitoes which continue to swarm, enthusiasm speedily dies with the feeling that "this mosquito business is a subject only for the expert."

The reason for all this is obvious: we might as well expect to produce competent surgeons by a training devoted to descriptions and the examination of excised pathological exhibits. At present, astonishing as it is, instruction in medical entomology follows an absurdly parallel course: academic teaching and laboratory exhibitions (decidedly essential as they are) are almost the sum total of what instruction in medical entomology constitutes. The bionomics, the remarkable habits of some species, the practical methods of demonstrating the breeding-places in Nature, the varied methods of collection, the practical application of control measures in the field; all these matters of paramount importance in the training and successful work of the sanitarian receive no more attention than can be given in lectures. Consequently, once the sanitarian finds himself in the field, he discovers immediately that for all he has learnt he has no idea how to proceed.

I have merely taken the case of mosquitoes as an example. The same thing is true of the 'field' aspects of all other insect-enemies, and it is indeed time that the essential importance of proper field instruction should be taken into account so as to ensure that the men whom we send out from our schools are not so completely stranded when they meet the problems as Nature herself presents them. To avoid misapprehension, I should perhaps add that the Wellcome Field Laboratory is *not* a teaching centre where such practical instruction as that referred to can be obtained. MALCOLM E. MACGREGOR.

Wellcome Field Laboratory,
Wisley, Surrey.

Accurate Square Roots.

IN NATURE for June 19, Mr. John Wishart directs attention to certain inaccuracies of one unit in the last printed place in Barlow's Tables of the square roots of numbers. Such errors are very common in these tables, applying to approximately ten per cent. of all the square roots; and they also apply, apparently even more frequently, to the cube roots. The reciprocals in the same tables are much more accurate, but even these are occasionally in error by a unit of the last printed place.

Mr. Wishart says that "there are some who have need of all the figures that existing tables give them, who sometimes wish, indeed, that more were available." I gather from this and from other hints in his letter that he may not be acquainted with the very useful collection: Hülsse's edition of Vega's Tables, published by Weidmann at Leipzig, 1849. On pages 476 to 575 are there given the square roots of all integers up to 10,000. They therefore have the same extent as Barlow's Tables but they give the roots to twelve decimals, five more than Barlow. The same table gives cube roots to seven decimals just as Barlow does, but they are carefully rounded off to the correct digit.

The best table of reciprocals is that by Oakes (published by Layton, London), which gives them to seven significant figures for all integers up to 100,000; care was taken to make the last printed digit correct. Hülsse's and Oakes' tables together should replace Barlow's where great accuracy is needed. But Barlow's tables, as Mr. Wishart intimates, are very convenient indeed whenever an error of one part in 100,000,000 is not important, and this is almost always the case.

The following method for deriving or testing square roots to many places may be of interest. Let N be the number the root of which we wish to extract, and let a and b be two nearly equal numbers such that

$$ab = N.$$

We have then

$$\sqrt{N} = \sqrt{ab} = \frac{1}{2}\sqrt{(a+b)^2 - (a-b)^2}$$

$$= \frac{a+b}{2} - \frac{(a-b)^2}{4(a+b)} + \cdots$$

If, therefore, b differs from a by one part in 10^7 say, $\frac{1}{2}(a+b)$ will differ from $\sqrt{N}$ by only about one part

in 10^{15}. With an eight-bank computing machine we can readily find values for a and b that do not differ by more than one part in 10^7 and will usually differ by much less than this. Their arithmetical mean will therefore be the square root of N with an error of, at most, one part in 10^{15}. If still more digits are required, eight additional ones can be obtained in a few minutes by computing the term in $(a-b)^2$ above.

The same method can be used to extract square roots to three significant figures by mere inspection, and this degree of accuracy is sufficient in many computations, including solutions by least-squares. Thus, for example, the square root of 8·46 is seen to be not far from 3; dividing by 3 we get 2·82; the mean between this and 3 is 2·91, which differs from the square root of 8·46 by only 0·0014.

FRANK SCHLESINGER.

Yale University Observatory, July 12.

The Polishing of Surfaces.

THE manner in which an optical polish is produced on glass and metal surfaces has been considered by the late Lord Rayleigh ("Polish," Collected Papers, vol. 4, p. 542, "Interference Bands," vol. 4, p. 54). The amorphous layer theory of the late Sir George Beilby is well known. The article by Dr. J. W. French on "The Working of Optical Parts" ("Dictionary of Applied Physics," vol. 4) summarises and extends these considerations. Reference may also be made to a paper by M. M. Fichter, a notice of which appeared in NATURE, August 2, 1924, p. 173.

The object of this present note is to suggest that, in the process of polishing, surface layers are really melted by the communication of heat vibrations to them. Consider a single surface layer of glass molecules of area 1 sq. cm. If glass consisted wholly of silica there would be approximately 9×10^{14} molecules per unit area, each of mass 9×10^{-23} gram. Taking the specific heat of glass as 0·16, initial temperature 20° C., melting-point 1100° C., and assuming a latent heat of fusion 100 calories per gram, the heat required to melt a single layer of molecules of 1 sq. cm. area would be 900 ergs.

Now Beilby gives a pressure of 4 lb. per sq. inch (280 grams per sq. cm.) as sufficient to produce surface flow with rouge polishing. Taking a coefficient of 0·3, the work done against friction when this force is overcome through 1 cm. is 83,000 ergs.

As one stroke of a polisher will polish only a small proportion of the 1 sq. cm. area considered, there will be available in the ordinary polishing procedure frictional energy of amount many hundreds of times that required to melt one layer of glass molecules.

At first sight it might be thought that any great rise in the temperature of the surface molecules would be prevented by the loss of heat due to conduction, etc. But this is to suppose that conduction would take place across plane interfaces. Is it not more reasonable to consider the heat as being produced at *points* of contact? If these were mathematical points, then no matter how small the rate of production of heat at a point, the temperature at the point would be infinite (the expression for the steady temperature v at distance r from a point in an infinite solid where heat is being supplied at the rate of q calories per sec., is $v=q/4\pi rk$, where k is the thermal conductivity of the material).

That the temperature attained by a surface depends essentially on the manner in which the heat is applied, is illustrated by the fact that a bunsen flame (of high temperature) may be played on a block tin surface without melting it, while a small globule of molten lead (only 100° C. above the melting-point of tin), if dropped on to a tin surface, will melt the tin below.

As an analogy to the manner in which high temperature vibrations may be set up locally, in polishing a surface, reference may be made to the setting of a Kundt's tube into vibration by slowly stroking it by hand, or a violin string by the slow stroke of the bow.

JAMES M. MACAULAY.

Natural Philosophy Dept.,
The Royal Technical College,
Glasgow, C.1, August 4.

The Planetismal Hypothesis.

As there is a rising tide adverse to the planetismal hypothesis, may I record the following observation in its favour? Looking at the moon with a 9½-inch reflector, I saw details of the structure of the great south wall of the crater Hommel; the circular fault is perfectly fresh, and the rock exposed is a giant conglomerate, the boulders several hundred yards in diameter, with cavernous spaces between. In moments of perfect pellucidity, my instrument is quite capable of defining objects half a mile in diameter. My observation confirms Pickering's at Arequipa, when he was looking at the fault-scarp of the Sinus Iridium, in the opposite quadrant.

On the earth, iron is being taken from the surface rocks by weathering; it is washed down in solution into the rivers, but does not reach the sea. It goes downwards, and where there is a precipitant, it replaces limestone, forming deposits of iron-ore; where there is nothing to stop it, it must proceed towards the centre of the earth. Reversing the process, it follows that this iron would have made the crust of the earth an ultra-basic material in the early history of our planet, or in other words, it would have been similar to what we now find on the moon, where there has been no water to obscure matters. The lower specific gravity of the moon would be accounted for by the boulders making an arch and girder formation, with spaces between.

E. H. L. SCHWARZ.

Rhodes University College,
Grahamstown, July 9.

Zoological Nomenclature: Suspension of *Sarcoptes*, type *passerinus*, in favour of *Sarcoptes*, type *scabiei*.

THE secretary of the International Commission on Zoological Nomenclature has the honour to invite attention of the zoological profession to the fact that application has been made to the Commission to suspend the rules in the case of *Sarcoptes* Latr., 1804, tsd. (Latr., 1810) *passerinus*, and to place *Sarcoptes*, 1804, in the Official List of Generic Names with *S. scabiei* as type.

The argument states that the application of the rules to this 'transfer' case will result in greater confusion than uniformity, involving generic, subfamily, and family names, and designations of diseases in human and comparative medicine. The suspension requested will result in validating internationally accepted (though erroneous) nomenclature in consistent use for more than a century in zoology, and in human and comparative medicine.

The secretary is familiar with the premises, and in his report to the Commission will state that he considers this a typical case in which suspension is justified. He will, however, delay announcement of final vote until about October 1, 1927, in order to give ample opportunity to interested persons to express their views for or against the suspension.

C. W. STILES,
Secretary to Commission.

Hygienic Laboratory, Washington, D.C.,
August 3.

The Optical Works of Sir Howard Grubb, Parsons and Company.

A FEW years ago it was very difficult to obtain a large object glass for an astronomical telescope. The optician would only promise a glass conditionally on his being able to procure suitable discs. For example, the director of the Johannesburg Observatory placed a contract for a 26-inch refractor in 1909, and four years later, in 1913, he reported that "it is hoped that glass discs will be obtained shortly." Large discs of optical glass are required only rarely, and their manufacture is a delicate operation requiring special plant; consequently very few people make them.

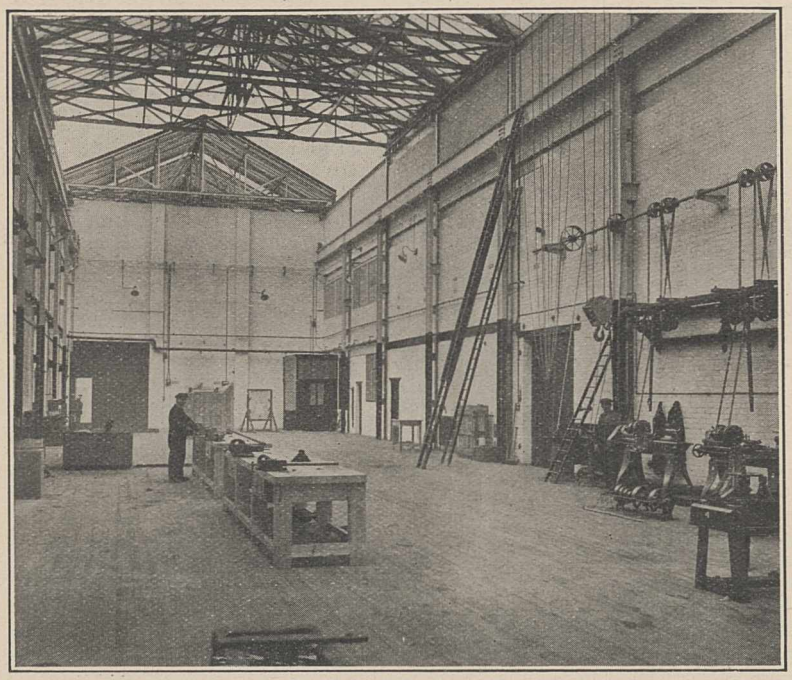

FIG. 1.—Erecting bay showing sliding roof partly open.

British astronomers were greatly pleased when the manufacture of large discs of optical glass was taken up by Sir Charles Parsons, who acquired the business of the Derby Crown Glass Works from Messrs. Wood Brothers, in 1921. Sir Charles Parsons has an hereditary interest in astronomy and the manufacture of large astronomical telescopes, as his father, the Earl of Rosse, built the famous six-foot reflecting telescope at Birr Castle, Parsonstown, King's County, Ireland. This early interest doubtless influenced him in taking up the manufacture of astronomical instruments from beginning to end—the manufacture of glass, the grinding and figuring of lenses and mirrors and the mechanical parts of telescopes. Near the beginning of 1925 he acquired the old-established business of Sir Howard Grubb. This famous firm was founded by Thomas Grubb a hundred years ago, and developed by the optical and mechanical skill of Sir Howard Grubb, under whose direction many fine telescopes, refractors, and reflectors have been produced. In 1918 the works were moved from Dublin to St. Albans in connexion with the manufacture of periscopes for the Navy, instruments which have been a standard product of the firm since the date of the first British submarine.

New works were set up in 1926 at Walker Gate, Newcastle, in close proximity to the well-known works of Messrs. C. A. Parsons and Co., Ltd., makers of steam turbines, electrical machinery, and searchlight mirrors. Close association with large engineering works is a great asset for makers of astronomical instruments. For small telescopes comparatively small plant is required, but for large ones the resources of engineering works with machines of the necessary size and accuracy are essential. In such accessories as large domes and rising floors, which are necessary with big instruments, large machinery is also required. For all heavy machine work the large machine shops of the Heaton works of Messrs. C. A. Parsons and Co. will be used. Nor must the great advantage be overlooked of the interchange of ideas among the staff, made possible by close association with the larger world of engineering.

An internal view of the principal bay of the new optical works is shown in Fig. 1. An important feature of this building is the provision for sliding off a large portion of the glass roof by carrying it on a supporting gantry moved by electrically operated motors. The shop possesses a five-ton electric travelling crane; one end of the bay is fitted up as a machine and fitting shop, and the other is used for the erection of instruments. Means of testing large instruments in course of construction by actual observation of stars are thus provided. Generally this is a matter of difficulty at optical works, but however well the laboratory tests may be satisfied, the purchaser of a telescope, as well as the maker, wishes to see how the instrument performs the end for which it is intended, before it is taken away from the works and erected in a possibly distant observatory.

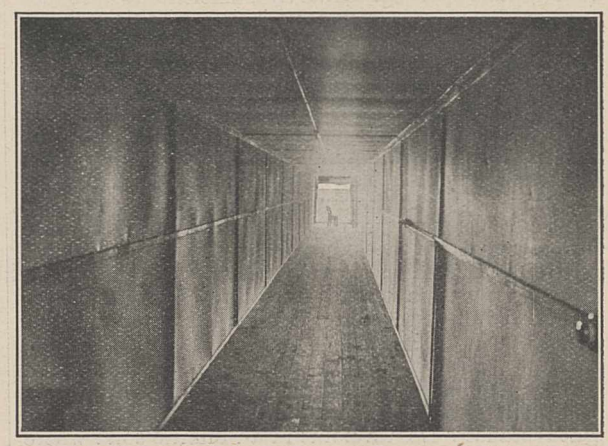

FIG. 2.—Insulated tunnel for the horizontal testing of mirrors and objectives.

In the transfer of the optical works from St. Albans to Newcastle the essential personnel as regards both staff and workmen was retained. One establishment is in complete continuity with the other, and it may well be that some of the improvements in the fitting up have been suggested by the previous long experience of the firm of Sir Howard Grubb. The means for testing large mirrors and objectives in the course of construction have been carefully planned. While in position on the polishing machine they can be conveyed by an electrical lift to the bottom of a shaft belonging to the optical testing room. Much labour and time is thus saved in the course of polishing a large mirror or objective which will be tested many times. Fig. 2 shows the horizontal testing tunnel. This is 100 feet in length, and gives the means of testing mirrors and objectives in a room of constant temperatures and free from disturbing effects of air currents. The rough polishing shop is shown in Fig. 3.

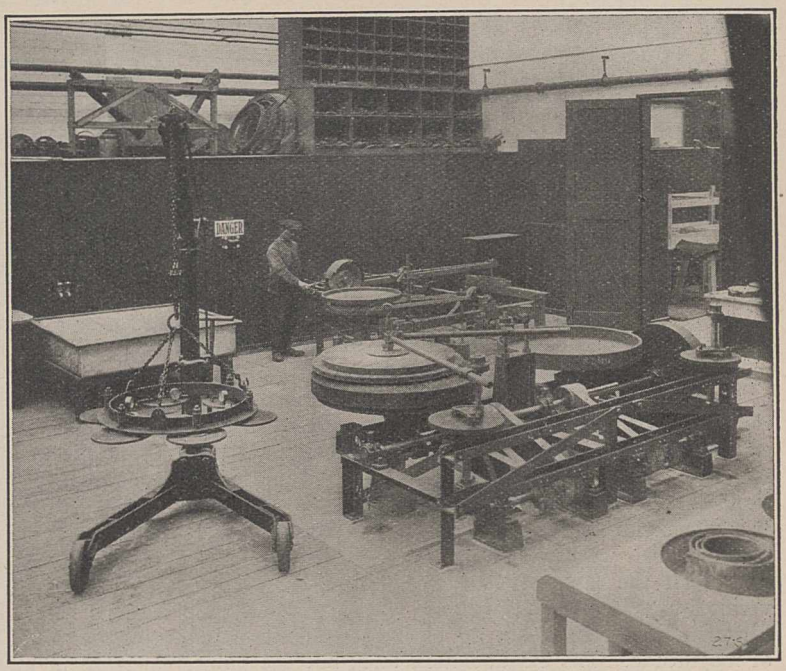

FIG. 3.—Optical roughing shop.

Among the instruments already constructed by the firm are a seven-metre solar spectrograph for the Pulkovo Observatory and a 40-inch reflecting telescope for the Observatory of Simeis in Southern Russia. In the annual report of the Observatory, published in the *Vierteljahrschrift*, and quoted in NATURE of July 17, p. 97, an account is given of the mounting and testing of the mirror. The departure of the mirror from paraboloidal state is found to be of the order of one-tenth of a wave-length, showing the mirror to be of very perfect figure. A description of the telescope, and of its mounting and control, was given in NATURE of April 12, 1924.

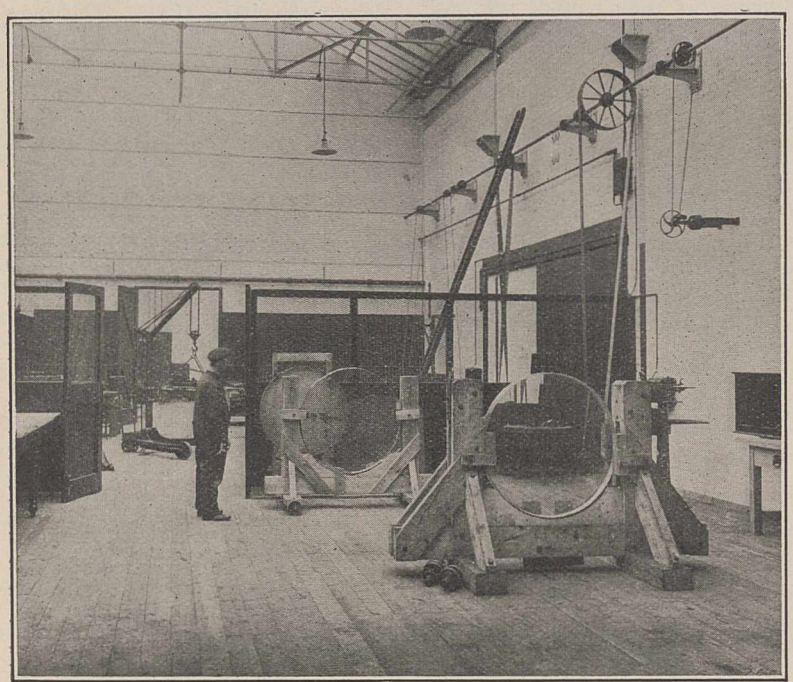

FIG. 4.—Optical discs for 41-in. objective.
These discs were manufactured by The Parsons Optical Glass Company at Derby.

At the present time, Sir Howard Grubb, Parsons and Co. are engaged on the ambitious task of constructing a refracting telescope with an object glass of 41 inches diameter. When completed, this telescope, which is also intended for the Simeis Observatory, will have a slightly larger aperture than that of the Yerkes Observatory. The focal length will, however, not be so long, as the instrument is designed for photographic rather than visual work. The discs have already been made at the Crown Derby works, and Fig. 4 shows them in the optical testing shop in Newcastle. Some time ago it was reported by a news agency that the discs had failed to satisfy the optical tests specified, but, as was announced in NATURE of June 19, p. 868, the statement was entirely erroneous. The progress of this large telescope will be watched with great interest and in confidence that a very fine instrument will be constructed.

The Mechanics of the Electric Field.[1]

By Sir J. J. THOMSON, O.M., F.R.S.

THE subject which I have selected for the Kelvin Lecture is one that from the very beginning of his scientific career was never long absent from Lord Kelvin's thoughts. It is one, too, which researches only dawning towards the close of his life have put into quite a new aspect. These researches have given us very definite information as to the structure of the atom; they have taught us that the atom is made up of electrons and positively electrified particles of known masses; they have told us the number of electrons and positive particles present in each atom; they have, in fact, given us a definite specification of the electrical state of the atom. With this in our possession it would seem as if we ought to be able to deduce the properties of the atom, by calculating by means of the laws of electromagnetism the behaviour of this definite electrical system. We find, however, if we do this, that the properties of our mathematical atom are in some respects in contradiction to those of the real atom. It is of course a gigantic extrapolation to pass from any system which we can test by direct experiment, and for which the laws of electromagnetism have been verified, to systems like the atoms, where the times and distances involved are of an entirely different order of magnitude. The extrapolation fails, but the point is that if the usual interpretation of these laws is the right one it ought not to fail.

I propose to discuss the question whether the equations of classical electrodynamics or, for the matter of that, classical dynamics are as fundamental as they have been thought to be; whether, instead of giving us a complete representation of the field of force, they do no more than give us the relations between the average value of the quantities used to define the field. That, in fact, they express statistical and not particle dynamics.

Let us consider some of the consequences of supposing that electric force consists of separate impulses separated by finite times. I must point out that this conception involves the existence in the universe of a structure beyond that represented by electrons and positive particles; if there were no structure of this kind, we could not account for the intervals which elapse between the impulses. This structure must be far finer in texture than the electrons; thus, on this view, the electron does not represent the last word in minuteness and there are still smaller entities awaiting discovery by the physicists.

For heuristic purposes, *i.e.* for the purpose of making our meaning clear, and without committing ourselves to the reality of this particular structure, we may liken it to a sub-atomic and sub-electronic gas the particles of which are much finer than the electrons. It is in these particles that the energy and momentum of the electric field are stored. We may regard these particles as concentrated round the electric charges, each charge carrying with it an atmosphere of these particles. The particles are crowded together near the centre of the charge, but get more and more widely separated as the distance from the centre increases. To distinguish between the positive and negative charges, we may suppose that the particles rotate round the charges and that the rotation as viewed from the centre of the charge is in one direction for the positive and in the opposite direction for the negative charge.

The particles bombard intermittently the charges round which they are congregated. If there were only one charge in the field the particles would be symmetrically distributed around it and the bombardment would not, on the average, make it move in one direction rather than in another; but when two or more charges are near together the symmetry of the distribution of the particles is disturbed and the bombardment results in the charges acquiring momentum.

Let us now consider in some detail the way in which the effects produced by intermittent forces differ from those due to continuous ones. We may represent the intermittent force analytically by saying that the chance of a body on which this force is acting receiving in time δt an increment of momentum is $\delta t/D$, where T is the average time between two increments and is a measure of the fineness of the time structure of the electric field. Let I be the increment of momentum given at each impact; then the expectation of the increase in momentum in time δt is $(I/T)\delta t$. If the force had been continuous and equal to F, the increase in momentum would have been equal to $F\delta t$ and have had a definite value. On the intermittent view, instead of a certainty we have an expectation: sometimes the results will exceed expectations, sometimes they will fall below them; but on the average, when there are a great many increments, *i.e.* when δt is large compared with T, they will differ but little from the expectation, so that the increase of momentum will be $(I/T)\delta t$, or the same as the body would receive from a continuous force $F=I/T$. Thus for effects lasting for times long compared with T, the results will be very nearly the same whether the forces are continuous or discontinuous; but for shorter times they will be very different.

We may illustrate the difference between a continuous and an intermittent force by considering a simple case. Take that of an electron projected horizontally and exposed to the influence of a vertical force for a time t. Whether the force be continuous or intermittent the horizontal velocity will remain constant and the horizontal distance travelled is not affected by the intermittence of the force. When the force is continuous and constant there is only one orbit, the parabola. If the force is intermittent there will be an infinite number of possible orbits. In fact any polygon is a possible orbit, provided the rth side makes an angle with the horizontal such that $\tan \theta r = kr$, where k is a constant. Thus a horizontal straight line is a possible orbit, because there is just a chance that the electron may escape a collision for the time t.

There is an infinite number of two-sided orbits where the electron makes one collision in the time t. At the end of these orbits all the electrons have the same kinetic energy, but they will not all have suffered the same vertical fall, *i.e.* they will not all have the same potential energy; this is an illustration that the

[1] From the Seventeenth Kelvin Lecture, delivered before the Institution of Electrical Engineers on April 22.

conservation of energy in the ordinary sense does not hold for these intermittent forces. To get the same increase in kinetic energy as they would under the action of a continuous force, some of the electrons under the intermittent force would have lost less, others more, "potential energy" than they would under the continuous force.

Again, there is an infinite number of 3-, 4-, 5-sided orbits; there is no limit to the number of sides, and the greater the number of sides the greater the kinetic energy acquired by the electron describing the orbit. All these are possible orbits, but some of them are very improbable. We can calculate the probability of any type of orbit. We have already seen that the most probable number of sides for the orbit is t/T; this makes the final momentum have the same value and direction as it would under the continuous force. But even when the number of sides is given, the individual sides may have very different lengths. We can show that the most probable orbits are those where the impacts are equally spaced over the journey. Again, the most probable orbit is the one that approximates most closely to that described under a continuous force. It is, however, only when t/T is a very large number that the chance of orbits departing widely from this becomes inconsiderable.

I have already pointed out that the principle of the conservation of energy in its usual form does not apply when the forces are discontinuous. This is because the energy is stored in the particles which constitute the electric field, and the distribution of these particles and their energy may change, even though the electrons and positive particles do not move; an electron may take energy from these particles or give up energy to them without suffering any change in its potential energy.

Take, for example, the case of an electron starting from an infinite distance from a positive particle, falling close to the particle and then receding from it until it is again at an infinite distance away. The potential energy is the same at the beginning and end, so that if the principle of the conservation of energy holds, the kinetic energy at the end must also be the same as at the beginning. If we suppose that the mass of the positive particle is infinite compared with that of the electron, so that it absorbs no kinetic energy, the velocity of the electron at the end of the journey must be the same as that at the beginning.

This need not, however, be the case if the force is discontinuous, for when the electron is falling from aphelion to perihelion the increase in its kinetic energy depends upon the number of increments of momentum it receives during its journey from aphelion, and when it goes away from perihelion to aphelion its loss of energy depends upon the number of increments of momentum it receives on the return journey. Now, according to the intermittent theory of the force, these numbers are not fixed but are a matter of chance, so that there is a finite probability that the electron on its journey from aphelion to perihelion may receive more than a normal number of increments, whilst on the return journey it would receive less. If this were so, the electron would receive more energy in its approach than it would lose on its return, so that it would have gained by the journey kinetic energy without losing potential.

The chance of losing more energy on its return than it gained on the approach is just as great as in the case we have considered, so that some electrons may lose kinetic energy by the journey without gaining potential energy. The fact that it is possible for an electron to gain energy in this way has, I think, an important application to the question of the spontaneous dissociation of atomic systems.

Let us take the case of an electron describing an elongated orbit about a positive centre, and suppose that in going from aphelion to perihelion it receives more than the normal number of increments of momentum; when it gets to perihelion it will have more than the normal amount of kinetic energy. Suppose that the increments in the return journey are not more than normal, then on reaching aphelion again the electron will have more kinetic energy than when it started. If this increase in energy exceeds a certain amount, *i.e.* if it is so great that when the electron approaches the place from which it started it has sufficient energy to carry it against the attraction of the positive centre from this place to an infinite distance, the electron will break away and separate from the positive centre.

In this way the discontinuous character of the force may give rise to a spontaneous dissociation of the system—spontaneous in the sense that it is a consequence of the character of the forces acting between the members of the system, and does not depend upon collisions with other molecules or electrons or on the influence of radiation.

An example of this spontaneous dissociation is afforded by the negative ions in gases; these have two phases, one being the electron, the other a complex of the electron and one or more molecules. The first phase is continually passing into the second by the combination of electrons with molecules, and the second into the first by the dissociation of the complex. The rate of this dissociation is independent of the pressure of the gas, and there is no evidence that it is affected by radiation. Similar considerations show that when the force is intermittent an electron moving past a positively electrified particle may acquire or lose energy by the collision, even though the mass of the particle is infinitely greater than that of an electron, when if the force were continuous there would be no transference of energy to or from the electron. Thus it might be possible for an electron projected with less than the energy required to ionise a gas to acquire by collisions with positive particles enough energy for this purpose.

Let us now consider more in detail other characteristics due to the intermittence of the electric force; these will naturally occur only when the phenomena involve times short enough to be comparable with the time interval of the electric field. This time interval, we may say in passing, is not constant but varies with the strength of the electric field, diminishing as the strength of the field increases. Now suppose the electric field acts on an element of volume which contains a very large number of systems, be they electrons, atoms, or anything else which can be effected by electric force; and suppose the time t the force acts is small compared with T the time interval of the force. We can easily show that the momentum received by

the whole system will be the same as if the force had been continuous and equal to I/T. This will be true whatever the time may be during which the force acts. The distribution of momentum will, however, be very different in the two cases, when the time of action is small compared with T.

The difference between the continuous and the intermittent force is accentuated when the forces are reversed after short intervals. If the field is intermittent and t is small compared with T, only a small fraction of the systems will have received any energy. When the field is reversed, the chance that any of the few systems previously excited will receive negative momentum and so lose energy is exceedingly small, and the great majority of systems which receive energy in the second interval will not have received any in the first. Thus the systems absorb practically as much energy from the electric field in the second interval as they did in the first. Under the continuous field, instead of absorbing energy, in the second period they gave up all they had got in the first.

Thus the intermittence of the field may lead to a great increase in the absorption of energy from alternating fields by systems exposed to the action of the field. The question of the transmission of waves of electric force when the period of the wave is shorter than the time interval of the electric force, is therefore one that introduces considerations quite different from those of electrical waves of longer period, and requires special treatment.

In the first place, the equations of the electric field do not, if we take the view of the intermittence of force, represent relations between physical quantities which have an existence at any particular time; they have respect rather to the relations between certain statistical quantities, averages taken over a time which is long compared with the time interval of the electric field; for these equations represent relations between electric and magnetic forces. From the point of view of the intermittent theory, electric and magnetic forces do not represent anything that is happening at any particular instant, but an average taken over a time which is long compared with the time interval of the electric field. Thus these equations are meaningless when the times available are not long enough to allow this average to have a definite value. They would not apply, for example, to the case of electrical waves if the period of the waves were less than the time interval of the electric field.

The consideration of what would happen to electrical oscillations the period of which is shorter than the time interval of the electric field, is a matter of great interest and importance. The time interval T of the electric force is connected with F, the intensity of the force by the relation $F=I/T$, where I is the momentum communicated at each impulse, so that as the intensity of the electric field diminishes I/T diminishes also. Now, whatever view we may take of the origin of the impulses which produce the force, whether, for example, we regard them as due to collisions with a swarm of very minute particles or in any other way, we should expect the interval between the collisions to increase as the field gets weaker. The time interval would be a function of the intensity of the field and would be longer for weak fields than for strong. Now consider an electron oscillating with a definite period T_0. Close to the electrons the electric field may be very intense, and its time interval may be short compared with T_0, the period of the oscillations. In such a region as this the classical theory would apply and electrical waves would travel through it, starting from the source of the oscillations. But as the distance from the source increases, the electrical field gets weaker and the time interval continually increases until when a certain distance is reached the time interval becomes comparable with T_0. When this region is reached it seems clear that the waves must stop, as Maxwell's equations from which the wave motion is deduced do not hold.

We have seen too that when T_0, the interval between the reversals of the electric force, is small enough to be comparable with the time interval, the absorption of the energy of the electric field is far greater than when T_0 is long compared with the time interval. We should not therefore expect these waves to travel farther away from the source than the place where the time interval of the electric field is equal to the period of the oscillations. For oscillations of very long period the critical place would be one where the time interval is long, *i.e.* where the field is very weak, and thus may be at a very great distance from the source; whilst for oscillations of very short period the critical place would be one where the time interval is short, *i.e.* where the force is very intense, and thus, *ceteris paribus*, much closer to the source of oscillations than for the slow vibrations.

As an illustration we may take one often used by Lord Kelvin. This is the case of a tightly stretched long string loaded at equal intervals with equal masses. This system has many periods. If P is the fastest of these, $P=\pi\sqrt{(lm/T)}$, where T is the tension in the string, m the mass of one of the particles loading the string, and l the distance between two adjacent particles. If one end of the string is agitated harmonically with a period p, waves will travel freely along the stretched string as long as P is less than p. If, however, the string is made more sluggish by increasing the mass of the particles or otherwise, so that p becomes less than P, the string will no longer transmit the waves, and the energy, instead of travelling along the string, will be localised close to the extremity which is agitated. The model would resemble the electrical case more closely if, instead of spacing the particles at equal intervals, the distance between two adjacent particles increased with the distance from one end A of the string; the value of P would increase with the distance from this end. If the end A were agitated harmonically with a period greater than the value of P close to A, but less than the value of P at some distance from A, the waves would travel along the string until they reached the place where P was equal to the period of agitation. Here they would be reflected back and the farther parts of the string would be free from agitation.

To return to the case of the vibrating electron: we see that though it may send out electrical waves, these waves, after travelling through a distance which depends on the period of the vibrations and also upon their amplitude, will reach a region through which they cannot penetrate, and will be reflected back. Thus the energy emitted by the radiator will not travel out

into space but will be reflected back and again absorbed by the radiator, and thus there will be no escape of energy.

If the oscillations were due to an electron describing a circular orbit, the reflected waves when they struck the electron and gave up their energy to it would, in general, deflect it and cause it to describe a different orbit. Thus the motion of the electron would not be steady. There may, however, be some orbits where the distance of the boundary at which the reflection takes place from the orbit is such that the reflected waves are in such a phase when they reach the electron that they just compensate for the changes in the motion of the electron produced by the emission of the radiation. For such orbits the uniform circular motion might be a steady state. It is evident that certain conditions have to be fulfilled for this to happen, so that it is only orbits with particular periods which possess this property. Since the application of a strong electric force would diminish the time-constant of the field, these orbits would be displaced by electric force. We may illustrate this point by the case of a piston vibrating at one end of an organ pipe which is closed at the other. In general, the waves reflected from the closed end will influence the motion of the piston, but they will not do so if the period of the piston is such that a loop of the vibrations of the pipe coincides with the position of the piston.

Let us apply similar considerations to light waves. Assuming that light is an electrical effect, we see at once that there can be no unlimited propagation of spherical electrical waves diverging from a source such as is contemplated in the usual conception of the electromagnetic theory of light; for on this view energy in the light is distributed continuously through space, and the energy per unit volume diminishes indefinitely as the light travels farther and farther away from the source. Now we have seen that the condition for the propagation of a periodic disturbance is that the period of the disturbance should be greater than the time interval of the electric field; this interval increases, however, as the energy in the light diminishes, so that when the energy falls below a certain value, which is small for long-period vibrations and large for short-period ones, any further propagation is impossible. Thus the intermittence of electrical force demands a corpuscular theory of light, *i.e.* a theory where the energy is done up in bundles which do not alter in size as they travel through space. The bundle may consist of a periodic distribution of electric force, like a piece cut out of what on the classical theory represents a beam of light. This piece is prevented from spreading because the energy density at its boundary has the critical value, and this boundary acts, on our view, like a reflecting surface and sends back any disturbance which tries to get outside it.

I picture these units as consisting of two parts: a central core in the form of an anchor ring, the plane of the ring being at right angles to the direction in which the unit is travelling. This ring is the seat of an intense electric field, and the circumference of the ring is equal to the wave-length of the light. This ring corresponds to the quantum of the light. This ring vibrates and emits electrical waves which, after travelling to a certain distance from the centre, get to the limit where the time interval of their electric field is equal to the period of the light. This forms the boundary of the unit, and the space occupied by the waves and the energy in them remain unaltered as the unit travels through space. On this view, light has a dual structure consisting of electrical waves with a quantum as the core. The electrical waves give rise to interference effects, the quanta to the photo-electric ones.

On the view that the force is intermittent the electric field must have a structure, and as electrons and positive particles are the centres of intense electric fields, they are probably much more complex than the usual conception of them, and must be regarded as centres of complex systems associated with an electron or a positive particle. If we compare the atom with its electrons to a solar system, we may compare an electron or a positive particle to the centre of a nebula and regard the electron as surrounded by an atmosphere of small particles.

This atmosphere can be distorted by the presence in its neighbourhood of other electrons or positive particles with their atmospheres, and will assume a shape appropriate to its surroundings. Thus the atmosphere round an electron far from other charges would be symmetrical and, if it were distorted, would vibrate about the symmetrical shape. Thus we could have vibrations associated with single electrons or single positively charged particles, even though the electron or particle were itself at rest; for example, without becoming neutralised by the absorption of an electron, a positively electrified hydrogen atom might be able to give out radiation. The possibility of vibrations of an electric field apart from any movement of the charges in the field has not, I think, been sufficiently realised.

These considerations suggest that just as matter is made up of molecules, and molecules are made up of electrons and positive particles, this is not the end of the story; there are still other worlds to conquer, the worlds which build up the electrons and positive particles.

Coal Ash and Clean Coal.[1]

IT is the normal view that the incombustible part of coal is not only a useless but even objectionable diluent. At times in the past, chemists, familiar with the theory of contact catalysis of gas reactions, have speculated that the ash constituents might well play an active rôle in the processes of carbonisation and combustion. None have been more prominent than Dr. Lessing, but his opinions met with no great support. The reactions in question seemed too complex, and no experimental confirmation had been adduced. Even Dr. Lessing himself waited until 1924 before disclosing evidence that inorganic substances altered the course of carbonisation. Since then, however, the subject has aroused greater interest. It is possible now for

[1] Cantor Lectures by Dr. R. Lessing before the Royal Society of Arts, Nov. 23, 30, and Dec. 7, 1925.

Dr. Lessing's ideas to receive independent support. Processes have even been patented for modifying the results of coal carbonisation by means of control of the ash constituents.

In the Fuel Department of the University of Leeds, where the process of gasification of coal has been under experimental study for some years, it was soon observed that the inorganic constituents could not be ignored. They might be incombustible but were not necessarily inert. It was the availability in the West Yorkshire area of seams of coal almost free from ash which made it possible, by the controlled addition of inorganic matter, to investigate the influence of individual compounds on carbonisation. The results exceeded expectations, and it was shown by C. B. Marson and J. W. Cobb that the character of the coke produced was beneficially and extensively modified by the addition of certain substances, especially oxide of iron and sodium carbonate. Certain other oxides examined were apparently inert. Since the publication last year of this paper, further experience has only strengthened their conclusions. There is good ground for hope that a valuable control over the carbonisation process may be secured by means of the ash constituents. Indeed, it is no exaggeration to say that there is to-day no prospect in the distillation of coal more alluring than that offered by this method. Obviously, then, the subject is of great practical interest, especially in connexion with the production of smokeless fuel. It may well be that too much attention has been paid to the possibilities of varying temperatures of carbonisation, and too little to the variation of the character and quantity of the incombustible constituents. This oversight is, however, in the way of being remedied.

It is, however, a condition precedent to the most effective use of this new method of control, that the raw material, coal, shall be adequately clean to begin with. Any coke or smokeless fuel product will have to compete for popular favour with good household coal, which may in the best cases be even so low in ash as 2 per cent. It is, unfortunately for those who set out to provide smokeless fuel, only too true that the housewife is apt to think more of dirt on the hearth than of smoke leaving the chimney-pot. If the carbonised product is to contain added inorganic matter, as well as the ash originally present, it is obviously essential that the raw coal must be very clean, for the ash content of the coke produced from it will necessarily be higher. Nothing is more important to the popularisation of smokeless fuel than the supply of clean coal. The stigma which rests on coke as a fuel is largely due to a reputation for 'dirtiness,' and the smokeless fuel problem can never be regarded as solved until a product is obtained which will find favour in the drawing-room of the most fastidious householder.

It is, however, essentially a problem for the mining industry, and its solution would give a powerful fillip to the popularisation of carbonised fuel for domestic purposes. The problem implies the identification of seams of coal which lends itself to cleaning, the improvement of cleaning technique, and the installation of plant necessary to turn out a fuel of the desired standard. The consumer would have to pay more for the product, but it would be necessary and possible to demonstrate that he was not a loser. Time, study, and capital would be required to carry these ideas into effect. It is then the more depressing to see the mining industry dissipating energy and resources of all kinds in a barren struggle instead of wrestling with its own more fruitful problems.

Dr. Lessing believes that these objects will be attained, that the carbonising industries "will feel constrained to insist for their raw material on coal containing only a fraction of the proportion of mineral matter which is customary to-day," and "that the provision of such a commodity will be technically possible and commercially profitable, and that it will be of economic advantage both to supplier and user."

The three lectures are, however, not confined to the importance of ash to coal carbonisation. They also traverse the chemistry of coal ash and its origin, the technique of coal cleaning, the economic aspects, and present a valuable survey of the whole subject. H. J. HODSMAN.

Obituary.

DR. C. W. ELIOT.

AT a luncheon recently given by King's College, London, for the delegates to the Congress of the Universities of the Empire, Principal Barker introduced President Lowell as "the most distinguished permanent academic officer in the English-speaking world." The phrase was happily taken, and its substantive truth dates from Charles William Eliot, whose death on August 22, fuller of honours even than of years, removes the last survivor of the three captains who bridged the incredible gap between the primal 'college' and the contemporary university; the others were Angell (Michigan) and Gilman (Johns Hopkins). They mediated a change wherein sober fact nigh outruns imaginative fiction. Eliot, the most conspicuous, foresaw the unbelievable, and it came true.

Circumstances must conspire with men to produce significant results. Accordingly, Eliot was fortunately born (1834) from the soundest New England stock, and educated at the best New England institutions. After graduation at Harvard in 1853 he taught mathematics and chemistry in the College and the Medical School for a decade; resided two years in Europe (1863–65), observing the universities shrewdly; returned to occupy the chair of chemistry in the Massachusetts Institute of Technology, where he pioneered for four years. In 1869, after keen opposition, still the subject of piquant legend, he was elected president of Harvard, and launched upon a unique incumbency of forty years. He found the College (1636) with Medical (1782), Divinity (1816), and Law (1817) Schools of a narrow type; he left the foremost American university with a transformed College and a score of other departments.

As the Harvard inscription bears, the New England College was founded "to advance learning and perpetuate it to posterity, dreading to leave an illiterate ministry to the churches"; or, as the Yale charter runs, "fitting youth for public employment, both in church and civil society." In other words, vocation, and one vocation mainly, took precedence over the

advancement of knowledge. Moreover, although Agassiz used a Charles River shed for a laboratory so early as 1848, acquaintance with the natural sciences was usually confined to little physics and less astronomy. Further, the human sciences, as now understood, enjoyed no independent recognition. While striking persons were to be found on the staffs, they were seldom specialists—Mark Hopkins (Williams) taught all subjects to all undergraduates in their final year! Modifying the clerical and bellelettrist tradition, Eliot, though but thirty-five years of age, set himself to create a new order; in addition, he proceeded to reform the meagre curricula and otiose methods of the professional schools. He agreed with his brilliant colleague Barrett Wendell that "the use of heresy is to vitalise creed." Inevitably, he drew much fire; a rare combination of courage, candour, penetration, patience, above all, aplomb, enabled him to make very rough places plain. Under his leadership Harvard rose to unchallenged primacy in twenty-five years, and the example of her chief began to affect academic policies from coast to coast. Blunders were perpetrated in his name and, being human, he added his personal quota. But in sum and substance he won universal recognition as a national asset.

Eliot's remarkable dignity of address and statement came to him by right of heritage. Democratic puritanism, bred of self-understanding, flowered in a peculiar aristocracy, secure in appeal to sense of duty. Eliot was its most conspicuous example. For, elevated far above sordid affairs, his qualities were means to spiritual ends; thus he could confront the American people as a vocal public conscience. He said his say with none to gainsay on grounds of petty interest. He blandly exposed illusions and dangerous symptoms, protesting against the mediocrity of efficient technique as a peril incident to universal education; telling his countrymen that, after all, they must apply for guidance to the select minority who know; insisting upon the equality of every subject open to sober investigation.

Hence, although the United States had passed to another phase during the period of his retirement, he could still speak forthright to the very end. He contributed to science in particular by affording ample facility and genial stimulus to inquiry. His was an exceptional life, because he rose greatly to a great opportunity. Attempting to sum it in a phrase, one might perhaps venture to say that he furnished a striking illustration of that peculiarity of American culture which most baffles other nations—"the parts are greater than the whole." R. M. WENLEY.

MR. W. FAWCETT.

WILLIAM FAWCETT, who died suddenly at his residence at Blackheath on August 14, in his seventy-sixth year, was originally a schoolmaster and graduated B.Sc. at the University of London. In 1880 he was appointed assistant in the Botanical Department of the British Museum, shortly before the collections were transferred to South Kensington. In 1881 he became a fellow of the Linnean Society, from which he withdrew in 1915, but rejoined in 1923.

On December 29, 1886, Mr. Fawcett sailed to take up his appointment as director of Public Gardens and Plantations, Jamaica, a post he retained after the amalgamation in 1903 of the Botanical Department with the Department of Agriculture until his retirement in March 1908. He edited the *Bulletin of the Botanical Department*, Jamaica, from April 1887 until 1902, and the *Bulletin of the Department of Agriculture* from 1903 until his departure in March 1908, when a new series of the latter was commenced by the Hon. H. H. Cousins, the present director. A note on this department was published in the *Kew Bulletin*, 1906, p. 68. In addition to notes in these journals, he published in 1893 "A Provisional List of the Indigenous and Naturalised Flowering Plants of Jamaica," and in the same year "An Index to Economic Products of the Vegetable Kingdom in Jamaica." He also delivered lectures, one of which, an "Introduction to the Classification of Plants," was published at Kingston in 1889. "Historical Notes on Economic Plants in Jamaica" appeared in vol. 6 of the *Bulletin of the Department of Agriculture*, and dealt largely with cigar and tobacco production. After returning to England he commenced, in collaboration with Dr. A. B. Rendle, a flora of Jamaica, the first volume of which, on Orchidaceæ, including text-figures, was published in 1910, and vol. 5 in July 1926; vol. 2 has yet to appear. Most of the work for this was done at the British Museum, but Mr. Fawcett frequently visited Kew to consult the collections there, his last visit being so recent as July 29 last.

As the titles of some of the above-mentioned papers show, Mr. Fawcett was keen on developing the applied side of botany, and in 1913 published a book entitled "The Banana: Its Cultivation, Distribution and Commercial Uses." During his residence in Jamaica he rendered valuable service in developing the vegetable resources of the island, in association with Sir Daniel Morris, the commissioner of the Imperial Agricultural Department of the British West Indies, after the threatened failure of the sugar crop. To Mr. Fawcett was also due the inception of the Imperial Exhibition in Jamaica in 1891. C. H. W.

WE regret to announce the following deaths:

Dr. J. George Adami, F.R.S., Vice-Chancellor of the University of Liverpool, on August 29, at sixty-four years of age.

Dr. R. D. Carman, president of the American Roentgen Ray Society and chief of the section of radiology of the Mayo Clinic, known for his work on the radiology of the digestive tract, on June 17, aged fifty-one years.

Mr. Charles A. Coffin, founder and former president of the General Electric Company, who was responsible for the organisation of the research laboratory at Schenectady, on July 14, aged eighty-one years.

Dr. Willis T. Lee, sometime professor of geology and biology in the University of Denver, and geologist since 1902 of the United States Geological Survey, who studied the stratigraphy of the south-western States with particular reference to ground water and coal investigations, on June 17, aged sixty-one years.

Mr. Frank M. Woodruff, for many years curator of the Academy of Sciences and Museum of Natural History in Lincoln Park, Chicago, and secretary of the ornithological section of the Chicago Academy of Sciences, on July 21, aged fifty-nine years.

News and Views.

THE German Dye Trust, the actual title of which is the Interessengemeinschaft Farbenindustrie Aktiengesellschaft, has long been in the limelight as the largest and most powerful combination of its kind. Only last year its constituent companies entered into a form of union that is indistinguishable from an amalgamation, and their combined capital was increased to 646 million marks (say, 32,300,000*l.*) ; now it is announced that the capital is to be raised to the enormous figure of 1100 million marks (55,000,000*l.*). It is well known in chemical circles that dyestuff-manufacture now represents only a very small part of the activities of the I.G. Before 1914, Germany supplied 75-80 per cent. of the world's requirements in dyes ; to-day its export trade is relatively very small, and except for a marked revival in exports of zinc oxide and 'lithopone,' it is continually diminishing, whilst importations are steadily increasing. In the opinion of many German industrialists, the practical monopoly enjoyed before the War is unlikely ever to be regained. Manufacture of dyestuffs and pharmaceutical products has now become of inferior importance to that of fertilisers, such as synthetic ammonium compounds and urea, and these materials are responsible for most of the profits made. Nothing is more astonishing than the development of the nitrogen-fixation industry, and the long-threatened competition between it and the Chilean nitrate industry has materialised, to the great discomfiture of the latter. The most fundamental factor in the nitrogen-fixation industry is the cost of hydrogen, and every effort is being made to reduce this cost by extending its uses. This accounts for the interest which the I.G. is taking in the hydrogenation of coal and peat, and in the artificial production of light motor-fuels.

THE ramifications of the German Dye Trust are too intricate and deep-seated to be divined by those outside the inner ring ; and they are probably very numerous, if one may take a line from the activities of some of our own large chemical undertakings, the interests of which are known to extend far beyond the sphere of industrial chemistry. A letter from the Frankfurt correspondent of the *Times*, printed in its issue for August 27, throws a little light upon the ever-extending interests of the I.G. and upon the uses to which the new capital may conceivably be put. It may be taken as fairly certain that a good proportion of it is earmarked for developing and extending the nitrogen plants and for financing the rapidly increasing trade in nitrogenous products. The fact that compound fertilisers are in chief demand to-day in Germany, necessitates abundant supplies of phosphates and potash, and it is confidently asserted that the I.G. is contemplating some arrangement with the powerful Potash Syndicate. By absorbing the important Köln-Rottweil explosives company, the Dye Trust has obtained a dominant position in the German artificial-silk industry. That industry has already come to terms with certain foreign producers—including, it is stated, Messrs. Courtaulds—and rumour now says that an understanding with French and Italian manufacturers is in prospect. The Dye Trust, through one of its subsidiaries, is the largest producer of raw films in Europe ; co-operation or fusion with its two chief competitors, the Eastman Kodak Co. and Pathé Frères, is said to be maturing. Rumour is also busy with the industrial exploitation of the Bergius process, although its commercial success is by no means assured. The board of the I.G. has officially announced its intention to erect a large plant "for the liquefaction of coal," but it has not stated which process is to be adopted. In many quarters it is believed that the statement refers to the manufacture of light motor-fuel by a process other than the Bergius, and that it is this other process which is the subject of negotiations with British, Dutch, and American petroleum companies.

ALL who are interested in bibliography and in scientific organisations, particularly from the international point of view, will welcome the appearance of the first issue of the *Bulletin for Scientific Relations*, dated July 1926, which has just been published by the International Institute of Intellectual Co-operation of the League of Nations (price per annum, 24 francs, France; 2 dollars for other countries). Written mainly in French, partly in English, the journal deals with many phases of scientific activity, including the results of inquiries initiated by the Institute itself. In the first section, which is devoted to bibliography, general and special, and to libraries and research centres, nothing strikes one more than the interest which Russia is showing in these matters. Soviet Russia is stated to possess 28 libraries containing 50,000 volumes or more, and in these are located more than 16 million volumes, the public library in Leningrad alone containing 4,134,000—the largest library in the world. Moscow has 140 scientific libraries, about 100 of which have been established since 1917, and in May 1925 a bibliographical library containing more than 10,000 volumes was opened to the public. The library of the University of Amsterdam has been enriched by a gift of 10,000 French scientific books. Berlin possesses an information bureau for books and monographs that informs scientific workers where any desired book may be found, as well as a Government central office for scientific information, which co-ordinates bibliographies relating to natural science and procures either original or photostatic copies of the publications mentioned therein. Athens can now boast of a new library, housed in a fine building presented by the Carnegie Institute, and named "Bibliothèque gennadienne," after Gennadios, a former Greek minister in London, whose gift of books to the Greek Government is located in the library.

UNDER the heading "International Scientific Organization," the *Bulletin for Scientific Relations* records that in answer to a *questionnaire* sent out by the International Union of Academies concerning an international language, nine academies replied that they would prefer a living language to an artificial one ; Italy asked for Latin, and Japan for Esperanto. This section contains a long report from the International Bureau of Meteorology, also references to the

establishment of microbiological institutes at Moscow and Buenos Ayres, and to the projected opening of a branch of the Pasteur Institute at Montreal. Uuder "National Scientific Organizations" mention is made of the proposal to remove the anthropological, prehistoric, and ethnographic collections from the Museum of History at Vienna, and to use them for the nucleus of a new "Kulturhistorisches Museum." A Kaiser-Wilhelm Institute for silicate chemistry has recently been founded in Berlin, with Prof. W. Eitel as director. In France a Petroleum Institute has been opened at Strasbourg. In Greece the Academy of Athens has been founded and inaugurated in a building which was intended for this purpose forty years ago. The Academy has three classes of members: pure and applied sciences, literature and fine arts, and moral and political sciences, the number of members in them being restricted to 25, 20, and 15 respectively. In Germany an institute for Chinese students studying in the University of Frankfort was opened at the end of last year.

MR. ERNEST MACKAY'S summary of the results of the Oxford University and Field Museum Expedition to Kish during the past season, in the *Times* of August 25, affords striking evidence of the importance of this site for the early history of civilisation in Mesopotamia. No less than three considerable buildings have been brought to light this year. Of these, one, a temple of Nebuchadnezzar, with walls standing 18 feet high, which is one of the best preserved in Mesopotamia, has another large building of the period of Hammurabi (2100 B.C.) beneath it, and possibly earlier buildings at a still lower level. A ziggurat of Sargonic date (2752 B.C.) is of unusually large proportions, while another building adjoining the Nebuchadnezzar temple is constructed of mud bricks of a size which points to the age of Dungi (2250 B.C.). The discovery of the greatest significance, if the interpretation offered be correct, comes from Jemdet Nasr, a mound on which were discovered fragments of painted pottery, both monochrome and polychrome, and the inscribed signs emerging from the pictographic state, to which attention was directed at the time of their discovery in their relation to the evolution of writing from pictographic signs to the later cuneiform writing. The excavation of this mound showed that it belonged entirely to one period (*circ.* 4000–3500 B.C.), but a building discovered there proved to be built, not of the characteristic plano-convex bricks hitherto thought to be the earliest in date in Babylonia, but of a well-made rectangular brick, differing in size and shape from the later rectangular brick which ousted the plano-convex brick. It is thought, therefore, that the latter—an obviously inferior type—must have been introduced by a race of invaders and have entirely superseded the earlier form in Northern and Southern Sumeria, as there is no evidence that the two types were ever in use at the same time.

THE August number of the *Review* issued by the British Brown-Boveri Co. gives an excellent illustration of the trend of electrical development. We learn that Messrs. Brown-Boveri, the famous Swiss firm, is constructing for the New York Edison Co. a turbo-alternator set of 160,000 kilowatt capacity suitable for continuous running. As only a few stations in Great Britain have an output so large as this, it will be seen that it is a bold undertaking. The high steam pressure part, 265 lb. per sq. in., is to drive an alternator of 75,000 kilowatts at 1800 revolutions per minute, whilst the low pressure part drives an alternator of 85,000 kilowatts at 1200 revolutions per minute. This will be the world's largest turbine.

ANOTHER direction in which the Brown-Boveri Co. is specialising is in the manufacture of automatically controlled sub-stations. The importance of these stations in railway work has been long recognised. They are more expensive to build than hand-controlled stations, but the great saving in wages almost invariably makes their adoption advisable. There is no need to consider problems relating to the housing of the staff, and so the most economical site can be chosen. In a recently constructed sub-station for a Swiss railway they have installed a 300-kilowatt rectifier set which converts 8000 volts alternating pressure into 800 volts direct pressure. There is in addition a 300-kilowatt rotary converter for performing the same function. A time switch in the morning sets the rectifier into operation. If a long period of overload occurs a thermal relay operates and the rotary converter operates in parallel with the rectifier. If for any reason the converter failed to act and the rectifier was excessively overloaded, safety devices would act and an alarum would be sounded. In the event of a sudden serious disturbance, the relay tests whether the cause is permanent or not. It operates three times at intervals of ten seconds, and if the disturbance persists it shuts down the whole set. Even when the load is only one-third of the full load, the efficiency of the conversion at the sub-station is 92·5 per cent.

WE have received from Mr. Arthur MacDonald of Washington, D.C., a statement of proposals which he has put before the United States Senate advocating the extension of anthropological studies in certain directions. Among other matters he stresses the importance of the study of man after death, especially in the case of those who have been prominent in the political and scientific world. It is interesting to note that since the beginning of the last century the brains of quite a large number of prominent Americans, including Abraham Lincoln, Lewis Aggasiz, and Walt Whitman, have been studied after death. Mr. Macdonald has also opened up a new line of inquiry in studying the political activities of American senators. In the sixty-second Congress, which lasted over three sessions, he found that the attendance was better in the first and third sessions than in the second, while Progressive Republicans showed a higher percentage of voting than Conservative Republicans. Business men attended quorum calls more and "yea and nay" calls less than professional men, but professional men averaged higher than business men in their frequency of remarks on the

Senate floor. Curiously enough, success in both public and private legislation varied inversely with education; that is, the better educated the senator, the less his success in legislative activity. Mr. MacDonald maintains that continuous study on these lines and a comparison with similar studies of legislatures in other countries should prove valuable, and probably lead to modifications of legislative procedure. It must be confessed that the utility of these studies is not immediately apparent. Abstract studies on statistical lines of political activities, such as frequency of voting in division, introduction of legislation, public and private, and the like, can have little scientific value when considered *in vacuo* and apart from attendant conditions which, from the nature of the case, it is almost impossible to ascertain.

PROF. A. F. C. POLLARD has prepared a Subject Index to volumes 1-25 of the *Transactions of the Optical Society* on the lines set out in his manual on the Decimal Bibliographical Classification of the Brussels Institut International de Bibliographie recently published by the Optical Society. It is printed on one side of the paper only, so as to be suitable for gumming to the ordinary 5 in. × 3 in. catalogue cards. A paper appears under each subject with which it deals, and to each subject is assigned a number, as in the original Dewey decimal system of 1876. This number appears at the right-hand top corner. At the left on the line below is the name of the author. Next below is the date in the order 1923.05.24 and the descriptive title. On the next line the reference in the order-title of publication, volume, year, pages. The manual explains the system of notation, which from 535 = Light gives 535·5 = Polarisation, 535·54 = Chromatic Polarisation, and 535·543 = Colours of thin Plates, and with (02) for Treatises gives 535(02) = Treatises on Light. The system was adopted at Brussels in 1899, but was not used in the International Catalogue of Scientific Literature, where Light had the range 2990–4470 assigned to it. As a system it appears both concise and comprehensive, but it has not yet been accepted as international, although it has been in existence more than a quarter of a century.

PROF. POLLARD'S Subject Index introduces an innovation into the method of indexing individual scientific journals, and it will be interesting to see with what favour the scheme is received and how far the movement will extend to other learned societies and journals and lead to some uniform and standard method of indexing. For, although the Dewey system has been adopted extensively in the libraries of Great Britain for their book classification, the Brussels scheme for indexing periodicals has not so far found much practical application. A few, notably French journals, habitually arrange their monthly abstracts of current literature in this order, and some, including certainly one English, even label the original articles in each issue with the appropriate Brussels notation, but none as yet, we believe, has extended the system to annual or consolidated indexes.

IN the June issue of *Medical Life* (vol. 33, p. 261), Prof. Tenney L. Davis has a short note on Boerhaave's attitude toward alchemy. A remarkable feature of the "Elementa chemiae," a book which did much to establish its author's reputation, is that it does not discuss the phlogiston doctrine of Stahl, and Prof. Davis interprets this silence to mean that Boerhaave thought the doctrine unimportant. Boerhaave, in short, was interested in facts, and was always ready to weigh and consider. This trait made him extremely tolerant and sympathetic in his treatment of the alchemists, whose habits of wide experimentation and careful observation did not, however, prevent him from doubting "whether these skilful persons, after they had discovered so many extraordinary things by naked observations, might not by a too great quickness of apprehension anticipate, and relate things for facts, which they conclude might be done; or even must of necessity have been done, if they had persisted in the pursuit. . . . Credulity is hurtful, so is incredulity: the business, therefore, of a wise man is to try all things, hold fast what is approv'd, never limit the power of God, nor assign bounds to nature."

SOME American museums are accustomed to publish reports of the explorations and travels on which members of the staff have been engaged, while reserving the scientific results for more weighty publications. This has the advantage of encouraging the traveller to observe and note facts subsidiary to his main object, and of preserving a record of details interesting in themselves but not important enough to warrant a formal paper. Thus the Yearbook of the Academy of Natural Sciences of Philadelphia for 1925 contains well-written and well-illustrated accounts of such journeys. Francis W. Pennell describes "Botanical Travel in Peru and Chile," his main objective being the Scrophulariaceæ of the central and southern Andes. Witmer Stone writes on "Past and Present Bird Life of the Southern New Jersey Coast," and publishes some good photographs of terns and skimmers. Samuel G. Gordon reports on a mineralogical expedition to Bolivia and Chile, but manages to introduce photographs of glaciers and mountain lakes.

ANOTHER such volume is "Explorations and Field-work of the Smithsonian Institution in 1925." This contains an account of Dr. Hrdlička's seven months' journey to some of the chief palæo-anthropological sites in the world. The photographs of the locality from which the Pithecanthropus remains were obtained, of the finder of the Rhodesian skull, and of the quarry that yielded Australopithecus, are of particular interest. Dr. C. D. Walcott's geological explorations in the Canadian Rockies, Dr. Bassler's field-work in Tennessee geology, and Mr. C. W. Gilmore's collecting fossil foot-prints in Arizona are among the numerous articles that show the value to the museum of detailing members of the staff for field-work. There are twenty-six such reports in this volume, ranging from field-work in astrophysics

by Dr. C. G. Abbot, to experimental breeding of the mollusc Cerion at the Tortugas, by Dr. Paul Bartsch.

THE thirty-eighth Congress and Health Exhibition of the Royal Sanitary Institute will, at the invitation of the Town Council, be held at Hastings on July 11-16, 1927. The Right Hon. Sir William Joynson-Hicks, Bart., Home Secretary, has consented to act as president of the Congress.

THE eighth International Congress of Psychology will be held at Groningen, Holland, on September 6-11. Sections will be formed for the discussion of eidetic imagery, psychogalvanic reflex, higher psychic processes, animal psychology, psychopathology, and applied psychology. Papers will be read by the following British psychologists: Mr. F. C. Bartlett (Cambridge), Dr. Wynn Jones (Leeds), Dr. Thouless (Manchester), Dr. Aveling, Dr. Ernest Jones, Dr. C. S. Myers, and Prof. Spearman (London). Altogether nearly a hundred papers will be read.

THE issue of *The Fight against Disease*, the journal of the Research Defence Society, for July, contains an obituary notice with an excellent plate of the late Mr. Stephen Paget, who died in May. He was the founder of the Society and of its journal. Dr. J. A. Murray's address at the annual meeting of the Society on "The Experimental Attack on Cancer" is also printed; it gives a good summary of the subject, and tells just how far we have advanced in the knowledge of cancer by experimental methods.

THE Department of Glass Technology of the University of Sheffield has recently published vol. 8, 1925, of its experimental researches and reports, consisting of papers collected from the *Journal of the Society of Glass Technology*, the *Journal of the Royal Society of Arts*, and the handbook to the annual meeting of the Society of Chemical Industry, Leeds, May 1925. Most of the papers describe the work which has been carried out by Prof. W. E. S. Turner, Dr. S. English, and Mr. A. Cousen on the physical properties and the chemical constitution of various glasses. In addition, the publication contains articles on the glass industry and the modern production of sheet glass.

MESSRS. Isenthal and Co., Ltd., inform us that their address now is Ducon Works, Victoria Road, North Acton, W.3, where all communications and inquiries should be sent. The change of address has been necessitated by the expansion of the business, chiefly in connexion with the manufacture of overhead high-tension switchgear, protection apparatus, automatic voltage regulators, etc., all of which now demand more spacious premises than it has hitherto been found possible to devote to them. The manufacture of resistances and the development of some important new lines will also benefit by the greater facilities now at Messrs. Isenthal's disposal.

UNDER the direction of Prof. Doello-Jurado, the Museo Nacional de Historia Natural of Buenos Aires has resumed its custom of distributing a fairly comprehensive "Memoria Anual." That for 1924 (dated 1925) has just been received. It records the celebration of the centenary of the Museum on December 31, 1923, gives an account of the activities of the staff and of the chief accessions, illustrated by 44 half-tone plates, and discusses the proposed new building. Among numerous expeditions, the most noteworthy was that to South Georgia to obtain examples of cetaceans, pinnipedes, and birds. Chief stress, however, is laid on the renewal of collections in vertebrate palæontology. Rich though the museum is in this department, the older material is not always furnished with those precise details of horizon and locality now esteemed indispensable. Among the fossils collected are crania of Scelidodon, bones of Promacrauchenia and Protohydrochœrus from Monte Hermoso, skull and bones of Lestodon and other mammals from the later deposits of Playa de Barco. Apparently the enforcement of the law forbidding the export of palæontological, archæological, and anthropological material before it has been passed by a commission, has proved a difficult and laborious task. It resulted, however, in the retention for the Museum of a fine mandibular ramus of Pyrotherium and a few other desiderata from the collection made by Dr. Elmer S. Riggs for the Field Museum, Chicago.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A European science master at the Agricultural School at Moor Plantation, Ibadan, Nigeria—qualified to teach mathematics, chemistry, physics, and botany to about Junior Local standard—The Secretary, C.A. (N.), Board of Education, Whitehall, S.W.1. Scottish candidates should apply to the Secretary, Scottish Education Department, S.E.D. (N.), Whitehall, S.W.1 (September 27). A professor of economics in the University of New Zealand—The High Commissioner for New Zealand, 415 Strand, W.C.2 (September 30). A head of the Department of Chemistry of the Witwatersrand Technical Institute—The Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (September 30). A museum assistant at the Royal Botanic Gardens, Kew—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (October 4). A whole-time research worker at the Calcutta School of Tropical Medicine for the investigation of hookworm disease from the point of view of its effect on the health on labour forces—The Director, School of Tropical Medicine and Hygiene, Calcutta (November 30). A laboratory assistant for the Veterinary Research Division of the Agricultural Department of the Government of Kenya—The Crown Agents for the Colonies, 4 Millbank, Westminster, S.W.1 (quoting M/14661). A visiting lecturer on engineering quantities and estimates at the Borough Polytechnic Institute—The Principal of the Institute, Borough Road, S.E.1. A director of the National Institute of Poultry Husbandry—The Principal, Harper Adams Agricultural College, Newport, Shropshire.

Research Items.

PRE-HISPANIC JEWELRY IN COLOMBIA.—Among the contributions to the session at The Hague of the thirty-first International Congress of Americanists which have recently been published is a description by Dr. Paul Rivet of two collections of pre-hispanic jewelry in gold and gold and copper—one of Chibcha manufacture, the other Antioquian. Although they represent two entirely distinct industries, they have a common technique which is identical on general lines and is also related to the technique of the gold ware of Chiriqui, Panama. The Colombian gold industry was carried by the Chibcha far beyond the bounds of Colombia, and the whole of Ecuador and the Peruvian coastal areas appear to have come under its influence. In the same region an entirely different industry, originating on the Peruvian-Bolivian plateau, has been superimposed. Unlike the Chibcha industry, which is confined to gold and gold-copper, this superimposed industry works in copper, gold, tin, silver, exceptionally lead, and the alloys of these metals. The Chibcha industry, notwithstanding its high development, is probably not indigenous. It may be derived from the industry in an alloy of copper and gold, which the Spaniards found on their arrival among the inhabitants of the Antilles and the area north of the Amazon-Venezuela and the Guianas. This alloy is identical with that of Colombia, and the industry may have been introduced into that area by a Carib invasion. The centre of its origin lay possibly in the hinterland of the Guianas, the legendary site of El Dorado, and may have given rise to that tradition. The antiquity of the Carib invasion must be considerable, as the Chibcha technique appears on the Peruvian coast so early as the proto-Chimu period of Uhle.

VITAL STATISTICS OF SOUTHERN INDIA.—A study of the vital statistics of southern India, by Major A. J. H. Russell, which appears in the *Scientific Monthly* for July, brings out some interesting points bearing upon the question of the conservation and promotion of the population. Of a population of 41,002,696 (1921), the Hindus form 89·48 per cent., Mohammedans 6·95 per cent., and native Christians 3·2 per cent.; other classes 0·04 per cent. A study of the population curve since the census was initiated in 1871, shows that southern India has very nearly reached an asymptotic population under present conditions. Indeed it has been necessary to import food stuffs during the last few years and, in spite of serious famine years and epidemics, the population is still too large for the methods of cultivation employed. The registered birth-rate is 30·0 per 1000, but there is reason to believe that the birth-rate is really so high as 42·5 per 1000. In Madras City, where registration is more accurate, in 1922 it was so high as 41·2, and of 215 towns, 13 registered a rate of 40 to 50. The registered death-rate for the same period was only 21 per 1000, but actually it was probably 33 to 36 per 1000. In Madras City it was 43·1 per 1000. Infantile mortality was very high, although there has been a distinct downward tendency. In several of the largest towns this was so high as 311·6 to 352·8 per 1000, as against the English rate of 80 per 1000. Nearly 50 per cent. occur within the first month. This is attributed largely to the Hindu employment of 'barber' midwives, and it is significant that in the towns, 13·7 mothers die for 1000 births, the rate for the whole presidency probably being much higher.

ROGER BACON AND GUNPOWDER.—In a recent issue of *Archivio di storia della scienza* (vol. 7, 1926, p. 34), Adolf Clément of Copenhagen offers a new and convincing solution of the famous cipher in Bacon's "Epistola de secretis operibus artis et naturae et de nullitate magiae." The passage in question, which it is only right to say has been regarded as of doubtful authenticity, reads: "Item pondus totum 30. Sed tamen salis petrae LURU VOPO VIR CAN UTRIET sulphuris; et sic facies tonitruum et coruscationem, si scias artificium." Lieut.-Colonel H. W. L. Hime interpreted the words in cipher by omitting *et* and rearranging the remaining letters into R. VII. PART. V. NOV. CORUL. V., which he translated "take seven parts (of saltpetre), 5 of young hazelwood (charcoal) and 5 (of sulphur)." Hime's solution (for a detailed account of which see "Roger Bacon Memorial Essays," Oxford, 1914, chap. xii.) has, however, been severely criticised by Lynn Thorndike, and is far less convincing than Clément's. Clément points out that the letters of the words in cipher can be rearranged into "pulveri carvonu tritov," the letters *s*, *m*, and a syllable *rum* at the end of *tritov* instead of *v*, apparently being lacking. It must, however, be remembered, he says, that the cipher was written at an epoch when abbreviations were in common use, and the three final letters of the words as rearranged are really signs of abbreviation, namely, *i* for *ĩ*, *i.e. is*; *v* for *ṽ*, signifying *um*; and *v*, in *tritov*, for *ꝝ*, *i.e. rum*. The sentence would then read: Sed tamen salis petrae, pulveris carvonum tritorum, sulphuris, etc.

ARABIC ASTRONOMY.—In a recent number of the *Sitzungsberichte der physikalisch-medizinischen Sozietät zu Erlangen* (Band 58, 1926, pp. 33-88) O. Schirmer continues the Erlangen tradition of the study of Islamic science. Inspired by Prof. Wiedemann, Schirmer has investigated some problems of Arabic astronomy, the most interesting being concerned with Arabic determinations of the inclination of the ecliptic. Two pages of figures of these determinations are given, chiefly, as might be expected, for Bagdad, Damascus, etc., though one was made at Toledo by Al-Zarqali. Al-Chugendi's description of his determination at Ray (near Teheran) in 994, for which he obtained the figures 23° 32′ 21″, is very clear. Prof. Wiedemann provides an appendix in which he translates the introduction of an astronomical work by Al-Nasawi; this contains a good deal of noteworthy historical information referring, *inter alia*, to the Aristotle of Islam, Avicenna.

TABULA SMARAGDINA.—Prof. Julius Ruska, of Heidelberg, whose work on the history of chemistry in Islam is well known, has recently published an exhaustive study of the "Emerald Table" of Hermes ("Tabula Smaragdina," Carl Winter's Universitätsbuchhandlung, 1926). He deals first with the ancient Hermetic literature, and discusses the conception of the god Thoth among the Egyptians. Passing in review Scott's "Hermetica," he rightly remarks that in sweeping aside all the alchemical books ascribed to Hermes as masses of rubbish, Scott was acting in a high-handed fashion, since "weder der Inhalt noch die Geschichte des ganzen Literaturkomplexes, der unter des Hermes Trismegistos Namen geht, gibt uns ein Recht auf solche grundsätzliche Scheidung und ungleiche Bewertung." A detailed study follows of Hermes and Hermetic literature among the Syrians, Arabs, and Persians, and Prof. Ruska shows that the attribution of the "Tabula" to Greek sources is probably not justified. He gives the Arabic text as found in a work of Jâbir ibn Ḥayyân, and also as it occurs in a collectaneous

MS. in a private library in Germany. He does not give credence to Jâbir's statement that he found the text of the "Table" in a work of Apollonius of Tyana, remarking that all we can be sure of is that by Jâbir's time (eighth century A.D.) a magical, astrological, and alchemical literature ascribed to Apollonius had grown up, but how much of it was genuine, or even from Greek sources at all, it is impossible to say. Prof. Ruska then deals with the "Emerald Table" in its Latin dress, exhibiting a wide and deep knowledge of medieval alchemical literature, but remaining interesting in spite of erudition—or perhaps because of it. The commentary of that enigmatical person Hortulanus is considered, and references to the "Tabula" and other Hermetic writings in Albertus Magnus, Arnold de Villanova, Trithemius, Paracelsus, and others are described. With one or two exceptions, such as the omission of any mention of the work on the "Table" published by Steele and Fulton, the book is extraordinarily complete, and contains everything that is of importance on the subject with which it deals.

HERRING AND PLANKTON.—The correlation of abundant plankton food with large catches of herring, if it can be successfully proved, should point to a means of great value for enabling fishermen to shoot their nets in areas most likely to be profitable, when the herring are actively feeding. In this connexion, Mr. R. E. Savage ("The Plankton of a Herring Ground." Min. Agric. Fish. Fishery Invest. Series 2, Vol. 9, No. 1, 1926) records the results of a cruise of the fisheries research vessel to study the plankton in the North Sea, in July 1922, off the mouth of the Tyne, where the herring fishery was very poor at the time. The catches of plankton on the fishing grounds, which consisted mainly of copepods, chiefly *Temora longicornis*, are stated to have been poor; while the region in which the plankton was most abundant did not coincide with the centre of the area in which the herring boats were fishing, but was some 20 miles south-east of it. Interesting observations are given on the vertical distribution of the different plankton organisms, together with a comparison of the distributions shown by day and by night collecting. It was found, by a series of hauls at each 5 fathom depth, that the deeper layers were generally richer in plankton animals as a whole in the daytime, and that the poverty of the surface layers extended to a depth of at least 10 fathoms.

VERTEBRATE DEVELOPMENT.—Volume 17 of the Carnegie Institution's Contributions to Embryology contains a paper on the origin of the rete ovarii and rete testis by Dr. K. M. Wilson, a description of the vessels of the sow's ovary by Miss D. H. Anderson, a physiological study of cortical motor areas in kittens and adult cats by Messrs. L. H. Weed and O. R. Langworthy, and a paper on the relations between the onset of decerebrate rigidity and the time of myelinisation of tracts in the brain and spinal cord of young animals by Dr. Langworthy. Dr. Wilson's most important conclusion is that the rete cords arise from deeply lying undifferentiated cells in the early sex gland and so indirectly from the cœlomic epithelium; thus they do not have a Wolffian origin. Miss Anderson's paper deals with the cyclic changes in the blood-vessels and lymphatics of the ovaries, and shows that both of these form double wreaths around the follicle, the capillaries growing inwards at ovulation and the lymphatics following two days later when the corpus luteum is becoming organised. Messrs. Weed and Langworthy determined the responses to electrical stimulation of the cerebral cortex in cats of all ages from birth, and found that in the newly-born ones movements of the contralateral fore-leg only were obtained, but in older ones not only these but also movements of the hind leg and of the facial-masticatory muscles were observed. The areas made out for the young kitten corresponded topographically to the same areas in the adult. In the paper by Dr. Langworthy, strong experimental evidence is presented of a correlation between the myelinization of the rubro-spinal tract and the occurrence of decerebrate rigidity. All the memoirs are illustrated by plates.

A DINOCEPHALIAN FROM SOUTH AFRICA.—Prof. W. K. Gregory has published in the *Bulletin of the American Museum of Natural History* (Vol. 61, article 3) a very detailed account, illustrated by 21 plates and 29 text figures, of *Moschops capensis*, a dinocephalian reptile. This study is based on very complete material, some seven or eight skeletons being represented, and, as a result, Prof. Gregory is able not only to describe the osteology but also to discuss the relations of this animal, its probable food and habits, and to make a restoration of it as it appeared when alive. Moschops, a semi-aquatic animal, had advanced from the primitive reptilian condition in that its body was raised well off the ground. In the author's opinion it was derived from some Pelycosaurian ancestor.

JAPANESE EXTINCT MAMMALS.—Prof. Matsumoto describes in *Science Reports of the Tôhoku Imperial University*, Vol. 10, No. 1, various extinct mammals discovered in Japan, many of them being described for the first time. The paper is in three sections, the first dealing with Proboscidea. The chief interest of this account is the description of a new species of the genus Hemimastodon. This genus was first described by Dr. Pilgrim from Baluchistan from rather scanty material, and its existence was doubted by some authorities. Matsumoto's further evidence goes to support Pilgrim's determination of the genus as being a connecting link between the genus Phiomia (Palaeomastodon in part) and the later mastodons. Altogether fourteen species of Proboscidea are listed as occurring in Japan. The second section describes two pinnipeds, one an extinct form *Eumetopias watasei*, the other a specimen of *Odobaenus obesus*, the walrus, possibly of Pleistocene age. The third section deals with four new species of fossil cetaceans.

HYDROGRAPHY OF THE IRISH SEA.—An account of hydrographic observations made in the Irish Sea between Holyhead and Dublin, by Mr. R. J. Daniel in 1925, is published in the annual report of the Lancashire Sea-Fisheries Laboratory (Liverpool University Press). In this area the water is of practically the same temperature and salinity from surface to bottom, which greatly facilitates the survey of these two physical conditions which are being carried out regularly every month. A slow drift of ocean water passing north through the Irish Channel, strongest in some months and weakest in others, has been known for some time, our knowledge being based on inferences drawn from changes in salinity of the water. Mr. Daniel's observations at regular intervals of one month may be expected to give a record of the fluctuations in this drift of water from year to year. A point of interest, recorded in this report, is the considerable differences in surface salinity readings at near-by stations which occur sometimes, and the small differences, at each station, between the surface and deeper samples.

BOTTOM CURRENTS IN THE NORTH SEA.—Under the title "The Water Movements in the Southern North Sea, Part 2, The Bottom Currents," Mr. J. N. Carruthers publishes an account of an extensive experiment conducted by the Ministry of Agriculture and Fisheries, by means of 'bottom trailers,' of which some ten thousand were set free from a number of selected positions throughout a year (Fishery Investigations Series 2, Vol. 9, No. 3, London: H.M. Stationery Office, 1926). This ingenious method of observing the drift of the water close to the bottom, by means of bottles so weighted that they remain lightly poised upon their tails of wire, which are about two feet long, was devised by Dr. G. P. Bidder more than twenty years ago, and has been used successfully in several areas of the sea around the coast of Britain. The bottles trip along lightly with any horizontal movement of the water and escape the danger of becoming arrested by mud and rough ground to a much greater extent than any body resting directly on the bottom, until such time as they are caught in the trawl of a fishing vessel or go ashore on the coast. The number of days each has been out and the distance travelled gives an indication of the currents experienced in the course of its wanderings. An idea of the intensity of the trawl fishing in the southern part of the North Sea is given by the fact that 24 per cent of the trailers put out were recaptured by trawlers. Besides these a number were found on the coast, particularly in the case of those liberated from the Sandettie, Galloper and Outer Dowsing Light vessels, from the positions of which there is an onshore set of the deep water. The results of this extensive experiment show that current of bottom water flows in to the North Sea from the English Channel, spreads out fan-wise towards the East Anglia and Dutch shores and proceeds north-easterly. A current also flows south-east off the coast of Scotland and north-east England until it reaches the latitude of Flamborough Head, when it turns easterly and finally north-easterly, forming a counter clockwise swirl system in the vicinity of the South Dogger Light vessel. Water from the two currents mingle and proceed north towards the Danish coast. The speed of the residual drift or current at each of the chosen positions approximates to a mile a day.

A CURRENT METER FOR DEEP WATER.—Much ingenuity has been exercised in the design of meters for measuring currents in the sea during recent years, and considerable headway has been made with a difficult practical problem. The apparatus devised by Prof. V. W. Ekman more than twenty years ago has been used extensively and is probably the best known type. In *Publication de Circonstance* No. 91 (June 1926) of the Conseil International pour l'Exploration de la Mer, he describes "a new repeating current meter" which is a development of the original model for use in deep water. The aim has been to provide an instrument to be used in several hundred fathoms from a vessel riding to a single anchor, which does not provide a fixed point of suspension for the meter owing to the veering of the ship. With this instrument a number of 'messenger weights' are slid down the wire to which the meter is attached, one after another at noted times, and the meter registers the direction of the current at the moment when each 'messenger' hits it, together with the distance the current has travelled between successive hits.

THE COMPRESSIBILITY OF ROCKS.—To test the rival hypotheses that beneath the earth's outer shell the material consists of peridotite or basaltic glass, L. H. Adams and R. E. Gibson, of the Geophysical Laboratory of Washington, have made direct measurements of the compressibilities of dunite and tachylyte (*Proc. Nat. Acad. Sci.*, May 1926). The results show that at a pressure of 17,000 megabars, corresponding to a depth of 60 km., the velocity of longitudinal earthquake waves in dunite would be 8·4 km. per sec. In basaltic glass the corresponding velocity would be 6·45 km. per sec., and in gabbro from 6·9 km. to 7·3 km. per sec. The actual velocity of such waves at a depth of 60 km. is about 8 km. per sec. It is concluded that this gives a very definite indication "that at depths greater than 60 km. we have a material more basic than gabbro and approaching dunite in composition." The new measurements show quite conclusively that Daly's conception of a substratum of basaltic glass meets with no support, but neither can the author's deduction be completely justified. Eclogite would probably satisfy the evidence equally as well as peridotite. It is to be hoped that similar work on this high-pressure facies of basalt may soon be carried out.

RADIATION WITHOUT QUANTA.—The Montreal *Mercury* has issued as a pamphlet of 28 pages the two addresses given in April by Prof. L. V. King to the Physical Society of McGill University on the properties of a rotating electron in translatory motion. If the shortening of the axis of the electron in the direction of translation is taken into account, the equations of motion of the electron are shown to give a precessional motion of frequency ν which is connected with the translational velocity v by an equation of the form $h\nu = \frac{1}{2}mv^2$, where m is the mass of the electron when at rest and h is a constant for all electrons. Thus the quantity h of the quantum theory is introduced by classical dynamics as a property of the rotating electron. The extension of the idea to spinning protons and to atoms leads to the series formulæ for the hydrogen and helium spectra and to the *S*, *P*, *D*, and *F* series for other elements with the correct value for the Rydberg constant. The fine structure of lines, the Zeeman and Stark effects are explained as due to perturbations of orbits brought about by external fields. The radiation formula in terms of temperature and wave-length follow from a Maxwellian distribution of electron velocities.

COAL CARBONISATION TESTS.—The Department of Scientific and Industrial Research has issued a Fuel Research Technical Paper, No. 15, on the Carbonisation of Durham 'Holmside' Coal in Continuous Vertical Retorts (London, H.M. Stationery Office, 1926). The continuous vertical retort has gained its popularity largely because it lends itself to the production of the lower-grade gas which is usually distributed to-day. The tests recorded were made at the Fuel Research Station, Greenwich, at the request of the South Metropolitan Gas Company, which distributes a coal gas of calorific value somewhat greater than is customary in England, and it is of considerable interest to ascertain how far the continuous vertical retort can be applied to the production, from a typical Durham coal, of gas of the quality used in South London. It was found that the settings required certain modifications both in construction and operation, after which it was possible to produce the carbonisation results desired. The tests were extended to study the effect of steaming the charge, so as to obtain results comparable with those previously obtained on other coals.

Phytopathology and Private Enterprise.

IN most of the European countries, as is the case in England, the insect pests and fungus diseases of agricultural plants are dealt with by one phytopathological service, and in spite of the opposition to such a practice in America this union has been found to work satisfactorily, for if at times one branch may seem to be profiting at the expense of the other, the two have so much in common that it is probably the most logical system to adopt. As we in Great Britain are more or less interested in what is happening in the corresponding service on the continent, it may perhaps be opportune to give an account of the National French Phytopathological Congress held at Lyons on June 28-30, which we had the pleasure of attending through the kindness of the promoters, the P.L.M. Railway.

The meetings, on account of the heavy programme, began at the somewhat early hour—for an Englishman—of 8.30 A.M. and continued until after 6 P.M. M. Mangin, the director of the Natural History Museum, Paris, acted as president, and M. Boret, the ex-Minister of Agriculture, and several other deputies honoured the Congress with their presence. Some five hundred persons accepted invitations, and most of the surrounding countries were represented. The subjects discussed comprised papers on various entomological and mycological problems, the disinfection of the soil, the value of colloids in spraying, the relation of birds and field-mice to agriculture, and proposals for the establishment of regional committees to assist in the war against what may be termed shortly the enemies of plants. In view of the large quantities of certain chemicals employed in this fight—on an average 50,000 tons of copper sulphate are used, for example, in a year, and about one-third of that is imported—and the consequent increase in price which such a demand creates, the need for finding fresh insecticides and fungicides was also discussed, while motions were passed dealing with the necessity of obtaining nicotine plentifully and readily and the need for some sort of guarantee of purity in those chemical preparations used by the grower. The latter question, it may be said in passing, has been receiving of late some consideration in this country. The exhibits of the various research stations—Paris, St. Genis-Laval, Montargis, Mentone, etc.—and of various firms, notably those of Vermorel and Truffaut, were very fine, while a practical demonstration of spraying apparatus at Ampuis completed the work of the Congress.

Hitherto it has been left to a government to maintain a phytopathological service, either directly or indirectly, though there are notable examples of the enterprise of private associations in establishing and running laboratories for the study of diseases of the particular crops in which they are interested. Amongst these the Hawaiian Sugar Planters' Association, the Colonial Sugar Refining Company, the Assam Tea Planters' Association, and the recently founded Ceylon Tea Planters' Research Institute may be mentioned, while on a smaller scale we have seen the establishment of works' laboratories by several private firms in Great Britain for the study of certain problems affecting their businesses, but this is a side of which people are in the main ignorant, and indeed there is little reason why they should be enlightened. The fostering of the agricultural industry by the P.L.M. Railway in the area covered by their system dates fairly far back. It has to be remembered that in northern France the carrying trade of the railways consists largely of coal, wheat, and beet, but in mid and southern France the railway derives most of its revenue from flowers, fruit, and vegetables. In 1877, when Phylloxera threatened to wipe out the wine industry, the P.L.M. Railway recognised that its revenue was closely bound up in the prosperity of the vineyards and did its utmost to assist in the stamping out of this dread disease. The service instituted then served as a nucleus out of which has grown the present magnificent organisation, which as it exists to-day is almost entirely of post-war origin. It is quite distinct from the service maintained by the state, but in actual practice it works in conjunction with and is really supplementary to it.

That disease may seriously affect the returns of an industry we all know, though it is difficult to obtain definite figures. M. Raybaud, the chief inspector to the company, estimates the injury caused by insects and fungi throughout the globe at 10 milliards of francs per annum, of which one milliard's worth is done in France. That the former figure is probably a very fair estimate the following data collected haphazardly from literature and reduced to a par value will show; the estimates are for limited areas in most cases and for prices prevailing before or during the War. The Hessian Fly is said to cost the U.S.A. 20,000,000*l.* every year; in the State of Washington the Codling Moth injures apples to the tune of 800,000*l.*, and in another State 400,000*l.*; *Conotrachelus nenuphar*, one of the British "scheduled" pests, injures peaches worth 400,000*l.* in Georgia; leaf injury by insects to tobacco in Sumatra on 80 estates amounts to 750,000*l.*; Helopeltis causes about 200,000*l.* loss every year in the Dutch East Indies; *Phytalus smithi* 33,400*l.* to sugar-cane in Barbados, and figures are not available for the loss it causes in Mauritius, where it is a much more serious pest; *Bruchus pisorum* causes damage of more than 200,000*l.* in one province of Canada alone; *Thrips tabaci*, to those crops it attacks in the U.S.A., 600,000*l.*; Frit-fly in Britain in 1912 damaged 12,126,198 bushels of wheat which, if we allow 1*l.* per quarter, is equivalent to more than 1,515,000*l.*; the Brown and Gold Tail Moths have cost Pennsylvania and the neighbouring States 6,000,000*l.* loss annually; *Prosagrotis orthogonia* caused injury valued at 600,000*l.* in Montana in 1920; *Cylas formicarius*, where it is established in the U.S.A., causes a loss of about 1,500,000*l.*; *Sitotroga cerealella* in Pennsylvania alone 200,000*l.*; one scale insect (*Saissetia oleae*) takes an annual toll of 400,000*l.* from the Californian Citrus industry; and if we include grain pests, Ohio loses 200,000*l.*, Alabama from 800,000*l.* to 2,000,000*l.*, while *Calandra oryzae* alone caused a loss of about 2,000,000*l.* in the U.S.A. in 1918, but this was a particularly bad year. Damage on the grand scale is seen in the case of the Cotton Boll Weevil, which costs the cotton growers of the U.S.A. 35,000,000*l.* in lint and 5,000,000*l.* in seed, and the Pink Boll Worm, which is said to cause a loss of 10,000,000*l.* in Egypt. Then we have the more general estimates of 20,000,000*l.* for the injury to the forest and shade trees of the U.S.A., 1,000,000*l.* to the agricultural products of British Guiana, 1,350,000*l.* to the maize industry in South Africa, 25,000,000*l.* annual loss to the field crops in Canada, and a similar amount in Germany. A mycologist would probably be able to supply as astounding figures for the losses caused by fungi.

Satisfied as to the need, therefore, of keeping a watchful eye on the diseases of plants, the P.L.M. Railway maintains a central agricultural service bureau which carries on a progressive educative policy amongst the growers in the region covered by

its lines, providing them with the latest literature on every subject which may be of interest to them, arranges conferences and demonstrations at convenient centres to which large attendances are assured through free travelling facilities, visits to other countries to study the conditions prevailing there, and also provides free carriage on their system for chemicals and spraying apparatus. The conferences are not confined to university professors and researchers in phytopathology, but the chemist and physicist, the manufacturer and the engineer take their place beside the practical man. Lively discussions result from such a gathering of experts, and not unusually the grower is able to hold his own. We were particularly struck by the keenness of the grower in everything pertaining to spraying, and whatever may be the opinion prevailing in Great Britain as to its value, there can be no doubt that the French agriculturalist is a firm adherent to the practice.

The phytopathological is but one side of the work carried out by the P.L.M. Railway. Since 1912 it has founded 138 experimental nurseries for the training of the peasants, and also many school gardens, subsidised largely the research station at St. Genis-Laval and the Insectary at Mentone, experimented with many varieties of strawberries, established a nursery for growing cypress for hedging, and distributed hundreds of thousands of plants free, fruit trees, vines, black currants, asparagus, artichokes, tomatoes, and osiers being the chief, but potatoes and winter vegetables have also received their share of attention. In addition pisciculture, viticulture, and sericulture owe much to the liberality and the encouragement of the Company. A huge organisation and a well-filled purse have always been behind these movements. What is the result to the Company? In 1910 it carried 190,000 tons of fruit and vegetables, in 1925 this had grown to 488,850 tons, so that the results of its labours are reflected in the balance-sheet at the end of the year in such a way as to encourage the Company to continue in the work which they are doing with such conspicuous success. L.

A British Expedition to the Sepik River, New Guinea.

AN expedition has been planned and is now being organised by Mr. V. A. C. Findlay, the object of which is to penetrate to the central mountain chain of New Guinea and locate the head-waters of the Sepik River. There is at present a theory that a large lake lies between the Victor Emmanuel Range to the north and the Müller Range to the south, which feeds both the Sepik and the Fly Rivers. In 1891 Sir William MacGregor reached a point on the Fly River in the territory of Papua at lat. 8° 11′ S., long. 141° 54′ E., and of recent years a number of explorations of the head-waters of the Fly River have been carried out by officers in the Papuan service. In 1913–14 Dr. Behrman's expedition proceeded up the Sepik River in what is now mandated territory and the advance party reached lat. 8° 11′ S., long. 141° 36′ E. in the Victor Emmanuel Range, but failed to attain the objective of the expedition, the source of the river. A survey was made up to the point reached by the advance party.

The object of the present expedition will be not only to locate the source of the Sepik, but also to cross and survey the country lying between the head-waters of this river and those of the Fly. Geological, anthropological, zoological, and botanical observations will be made on the way, and if the objective is attained, should lead to results of great importance, as the higher and hitherto unexplored parts of the central mountain chain should produce much new and valuable material in each of these branches of science.

The expedition will proceed by launch to the highest possible point on the Sepik, where a base will be formed. From this the main party will proceed into the hills. Should they succeed in reaching the Fly, they will return down this river, the base party returning down the Sepik independently. The base party will be in communication with the authorities at Rabal by radio, and the main party will keep in touch with the base by means of a small transmitting set. A kinematograph outfit will also be carried.

The personnel of the expedition so far as arranged at present consists of Mr. V. A. C. Findlay, leader and agricultural and topographical surveyor; Mrs. Findlay, engineer, radio operator and photographer; Mr. A. J. Hill, engineer and radio operator; Mr. K. H. Henderson, zoological and botanical collector; Mr. W. S. Malcolm, anthropologist; and Mr. C. T. Teychenné, geological surveyor.

The expedition has received the approval of the Royal Geographical Society, the Royal Anthropological Institute, and the Committee for Anthropology of the University of Oxford. The expedition is being organised under the direction of a council of which Lord St. John of Bletso is president, and Mr. Henry Balfour, The Hon. Mr. H. A. Casson, and Dr. A. F. R. Wollaston, are members. At the recent meeting of the British Association at Oxford a committee was appointed to co-operate in the work of organisation. The estimated cost of the expedition is 6000*l.*, and contingently on that amount being raised, the expedition will leave England in the autumn of 1927.

The Pelagic Young of the Cod.[1]

MR. MICHAEL GRAHAM and Mr. J. N. Carruthers have attempted to correlate the known distribution of the pelagic young of the cod with the theoretical distribution deduced from three factors—market statistics, wind records, and experiments with drift-bottles. The theoretical part is undertaken by Mr. Carruthers, the practical part, dealing with the actual catches of the young fishes, by Mr. Graham. In addition Mr. H. H. Goodchild investigated the food of the fry from the same samples. Three questions are involved in the present paper: First, to what extent the drift affects the pelagic fry in the North Sea; secondly, what is the distribution of the fry; and thirdly, what is the food of the young in the pelagic stage? To answer these questions the market statistics were used to ascertain the spawning-grounds and times, the methods being justified by previous work of one of the authors in 1924. A system of cruises was undertaken to fish for the larvæ and post-larvæ from these spawning-grounds outwards; experiments with drift-bottles were made and wind statistics consulted. The ascertained distribution was then compared with the theoretical distribution, and the results were found to be so much in agreement that the authors seem to be justified in their con-

[1] "The Distribution of Pelagic Stages of the Cod in the North Sea in 1924 in Relation to the System of Currents," by Michael Graham and J. N. Carruthers. With a section on "The Food of Pelagic Young Cod" by H. H. Goodchild, Fisheries Laboratory, Lowestoft. Ministry of Agriculture and Fisheries. Fishery Investigations, Series 2, vol. 8, No. 6, 1925. London: H.M.S.O.

clusion that the pelagic young of the cod are to a large extent carried by currents.

The method of fishing was by taking oblique hauls with Petersen's young fish-trawl, at first as close to the bottom as possible for ten minutes; then to shorten the warp to half the length used in fishing near the bottom, and tow for a further ten minutes; finally, to tow for ten minutes at the surface. It was not intended to investigate the distribution by depth but to obtain representative hauls from near the bottom to the surface. Thus the fishes from all three depths were mixed together in the sample. In the drift-bottle experiments those at the surface only were taken into account. Information as to the vertical distribution of the pelagic young and the vertical extent of the drift would be extremely interesting.

More than a thousand of these pelagic stages were investigated for food; the result, as was entirely to be expected, showing that from the time when it begins to feed the young cod's main food is copepods. Copepods are pre-eminently the food of the larva and post-larva at least up to the time of its settling down to demersal life. Mr. Goodchild finds that diatoms are practically of no importance as food, which also is not surprising, judging from our knowledge of the food of other baby gadoids. The presence of the few specimens he mentions is in all probability accidental.

The Haslemere Educational Museum.

NEW buildings for the Haslemere Educational Museum, founded a generation ago by the late Sir Jonathan Hutchinson, were inaugurated and opened to the public on August 27. He was an original and powerful influence in many ways; in his hobby of making and directing a museum he became a popular benefactor to the beautiful Surrey district where he had his home, and in the development of which into one of the best known areas for scenery, residence and holiday in the radius of fifty miles from London. The Museum, which was formed and arranged with the educational aim predominant of making every exhibit tell its tale to the average person who came to look at it, has until recently been the property of the Hutchinson family. They have now handed it over to a trust under a scheme by which the collection is placed in new buildings, a maintenance endowment fund is being formed, and the committee becomes representative of local and other institutions, which ensure it being widely popular and therefore educational to many.

The scheme owes much in inception and carrying out to the chairman, Dr. Arnold Lyndon, who presided at the ceremony on August 27, when Earl Midleton formally opened the buildings, and Dr. F. A. Bather, keeper of the Department of Geology in the British Museum, unveiled a memorial tablet to the late Sir Jonathan Hutchinson. A large and distinguished company assembled in the beautiful grounds behind the roomy old mansion in the High Street, which with large additions has been most happily transformed into an admirable Museum. These grounds, with the spacious verandah and lecture hall, make the Museum well suited for education gatherings, whether for instruction of classes or by special demonstrations, etc., or (what may be well looked for) to visits from scientific societies, field clubs, and perhaps summer schools and conferences.

An additional interest is added by the fine collection of so-called Peant Arts, the property for some years of the Peasant Arts Guild, having been donated to the Museum and arranged in a special section. From an anthropological and ethnographical point of view, as well as from that of art and handicraft, this collection is important; there is no other in Great Britain made and arranged on the lines familiar to those who have visited Scandinavia and various continental cities where there are folk-museums. This Peasant Arts Section is entirely sympathetic to the aims and ideas of the late Sir Jonathan Hutchinson; a number of objects which he had collected have come into fitting spaces in this new phase. A great deal is due to Mr. E. W. Swanton, whom Sir Jonathan many years ago appointed as the curator of his Museum, and who, with the aid of Mrs. Swanton, has become a real educational influence in Surrey. This is recognised by the annual grant of the County Council (as Education Authority) to the Museum. Mr. Swanton is a many-sided man, as was the original founder of the Museum, and he may be trusted to carry the Museum on in the fine tradition which it has established.

University and Educational Intelligence.

A USEFUL guide-book to the universities of Germany has been published by the Akademische Auskunftsamt an der Universität Berlin. This has been compiled by Prof. Karl Remme, Director of the Central Office for Foreign Students in Prussia. It is an attractive volume of 290 pages, profusely illustrated and well arranged, and will be most useful to students proposing to visit Germany. It comprises an historical introduction, a general description of the higher educational system, statistical summaries, and chapters devoted to facilities available for foreign students, the distribution of subjects of study as between the different institutions, conditions for obtaining degrees and diplomas, and very readable descriptions of the university towns.

RESEARCH in progress at the University of Minnesota, July 1924–July 1925, is described in a three-hundred-page pamphlet issued by the University's Graduate School. It contains the titles of about a thousand papers published or in the press and short abstracts of a large proportion of them. In addition it contains brief notes on the subjects and purposes of researches, the methods and materials used, and the results so far as available, in cases in which publication of papers has not been decided on. The index is not very satisfactory, names of researchers and classification headings of subjects of research being mixed in one series. If universities would co-operate in the production of annual lists of titles of subjects of research in progress, such lists could scarcely fail to be of considerable utility.

THE National University of Ireland's Calendar for 1926 exemplifies the tendency of such annuals to become unwieldy. It contains more than 900 pages, chiefly lists of graduates and university honours. A list of published works and theses submitted for doctorate degrees from 1911 onwards contains about 200 titles and is followed by a footnote requesting professors, lecturers, and graduates to forward to the registrar "full details of publications and research work carried out by them." Of the six travelling studentships, each 200*l.* per annum for two years, announced for competition in 1925, only one was awarded, namely, in pathology. The subjects notified for travelling fellowships to be offered for competition in 1927 are: mathematical science, Irish together with English or French or German, philosophy, one of the three sciences, botany, zoology and geology, and anatomy.

Contemporary Birthdays.

September 4, 1845. Sir Thomas Barlow, Bart., K.C.V.O., F.R.S.
September 6, 1870. Prof. Frederick G. Donnan, C.B.E., F.R.S.
September 6, 1876. Prof. J. J. R. MacLeod, F.R.S.
September 7, 1877. Sir John Cadman, K.C.M.G.
September 9, 1867. Mr. Robert Ludwig Mond.
September 10, 1859. Prof. J. Norman Collie, F.R.S.
September 11, 1877. Dr. J. H. Jeans, Sec. R.S.

Sir THOMAS BARLOW, to whom congratulations are due on the anniversary of his eighty-first birthday, is Physician Extraordinary to H.M. the King. President of the Royal College of Physicians, 1910–15, he was also president of the International Medical Congress of 1913.

Prof. DONNAN, occupant of the chair of general chemistry in the University of London, was educated at Queen's University, Belfast, and at Leipzig and Berlin. From 1904 until 1913 he was professor (the first to be elected) of physical chemistry in the Muspratt Laboratory of the University of Liverpool. Prof. Donnan is a Longstaff medallist of the Chemical Society.

Prof. MACLEOD, Nobel laureate in physiology and medicine in 1923 (jointly with Dr. F. G. Banting), was born at Cluny, Perthshire. He was educated at the Grammar School of Aberdeen and the University there. Six and twenty years ago he was demonstrator in physiology, and afterwards lecturer in bio-chemistry, at the London Hospital, and for a time he was working with Dr. Leonard Hill on the physiological effects produced on animals by compressed air. From 1901 until 1903 he was Mackinnon research student under the Royal Society, taking up afterwards the chair of physiology in the Western Reserve University, Cleveland, Ohio. In 1918 he was elected to a similar post in the University of Toronto. The Nobel prize was awarded for the discovery of insulin.

Sir JOHN CADMAN was born at Silverdale, Staffordshire. He was educated at the High School, Newcastle-under-Lyme, and Armstrong College. Formerly a mining engineer and colliery manager, he established a practical acquaintance with all branches of the mining industry. Sir John is professor of mining and petroleum technology in the University of Birmingham, and technical adviser to the Anglo-Persian Oil Company. He is an Officer of the Legion of Honour.

Mr. ROBERT L. MOND was born at Farnworth, Lancashire, and educated at Cheltenham and Peterhouse, Cambridge. He is honorary secretary of the Davy-Faraday Laboratory. In recent years Mr. Mond has rendered signal service as a student of Egyptology and conductor of excavations.

Dr. NORMAN COLLIE has been, since 1902, professor of organic chemistry in the University of London. A past president of the Alpine Club, he is an ardent mountaineer.

Dr. JEANS, one of the secretaries of the Royal Society, was educated at Merchant Taylors' School and Trinity College, Cambridge. Second wrangler in 1898, he was Smith's prizeman in 1900, and sometime Isaac Newton student. From 1905 until 1909 he was professor of applied mathematics in the University of Princeton. In 1919 the Royal Society allotted him a Royal medal for researches in applied mathematics; in 1922 the Royal Astronomical Society awarded him its medal for his contributions to the theories of cosmogony.

Societies and Academies.

PARIS.

Academy of Sciences, July 12.—Charles **Moureu**, Charles **Dufraisse**, and C. L. **Butler**: Rubrene peroxide: new experiments. Rubrene peroxide, when dissociated by rise of temperature, emits light. In an earlier note it was shown that light was essential to the combination of oxygen with rubrene.—Miécislas **Biernacki**: The theorem of Lucas and its generalisations.—J. **Neyman**: A property of the law of probability which obeys the coefficient of variation.—Jules **Drach**: The integration of partial differential equations of the second order and the explicit use of the characteristic variables of Ampère.—**Decros**, **Rebuffet**, and J. **Villey**: An electrometric recording dynamometer.—N. **Gunther**: The movement of a liquid filling a domain with multiple connexion which is displaced.—Ernest **Esclangon**: The asymmetry of sidereal space and the phenomenon of tides.—Marcel **Laporte**: The measurement of the mobility of ions in gases.—R. **Forrer**: The structure of the atomic magnet. Its normal position with respect to the network and residual magnetisation.—A. **Bogros**: The resonance of lithium vapour. The resonance line of the alkali metals is known to be the first doublet of the principal series. Direct experimental proof of this has been given for sodium and cæsium (Wood): the author now gives experiments proving it for lithium.—J. **Heyrovský** and B. **Souček**: The electrolytic potential of iron amalgam. From measurement of the electrolytic potentials of iron amalgam, it is concluded that this amalgam should be metastable and decompose spontaneously, with liberation of energy, into a mixture of solid iron and mercury.—J. **Consigny**: The stopping power of some metals for α rays.—A. **Hamy**: The absorption of iodine by precipitated magnesia. Studies in the amount of iodine absorbed as a function of time, concentrations of iodine and of potassium iodide.—J. **Dumont**: The separation of the finer particles and colloidal constituents of the soil by centrifugation. The solid matter remaining in a clay suspension in water after standing for a day can be separated into two portions by a high velocity centrifuge, the portion remaining in suspension being considered as a true colloid.—Marcel **Bouis**: The synthesis of allene hydrocarbons. In an earlier communication a method was given for preparing ethylallene starting from vinylethyl carbinol. It is now shown that the method is generally applicable, the vinylalkyl carbinol, $CH_2:CH.CH(OH).R$, leading to the allene $R.CH=C=CH_2$.—Charles **Prévost**: A new erythrite. The glycols (*cis* and *trans*) $CH_2.OH.CH:CH.CH(OH).CH_3$ were converted into the ether oxides

$$CH_2.CH.CH-CH-CH_3.$$
$$\quad\ O\quad\ O$$

Only from the *trans* glycol was sufficient ether oxide obtained to convert by hydration with water into the corresponding erythrite.—E. **Rothé**: The nature of the maxima inscribed in seismograms.—Albert **Baldit**: The periods of constancy of temperature at a station of medium altitude.—J. **Beauverie**: The modes of degenerescence of the chloroplasts, particularly in parasitism.—Mlle. H. **Popovici**: Contribution to the cytological study of the laticifers.—A. L. **Guyot**: Some parasitic fungi of the roots of Phanerogams.—A. **Rizzolo** and A. B. **Chouchard**: The quantitative study of the action of morphine on the cerebral cortex.—G. A. **Nadson** and N. **Meisl**: The mechanism of the action of chloroform on the protoplasm, the nucleus and the

chondriome of the cells of *Allium cepa*. The chondriome is the most sensitive to the action of chloroform; later, modifications are seen in the protoplasm, and last of all in the nucleus. The general character of the modifications produced by chloroform in the living substance is analogous with that of the changes provoked by X-rays.—Emile **André** and Henri **Canal**: Contribution to the study of the oils of marine animals. Researches on the oil of *Todarus sagittatus*.—Robert **Weill**: The problem of the cleptocnids. The nematocysts of *Hermœa bifida*.—André **Lwoff** and Mlle. Nadia **Roukhelman**: The variations of some forms of nitrogen in a pure culture of infusoria. From the point of view of the chemical transformations of the culture medium, and more especially from the point of view of the excretion of nitrogen in the form of ammonia and amides, *Glaucoma piriformis* (and perhaps all Infusoria) resemble bacteria.—A. **Vandel**: Triploïdia and parthenogenesis in the isopod *Trichoniscus* (*Spiloniscus*) *provisorius*.—M. **Lemoigne** and P. L. **Dopter**: The nitrogen losses caused by soil bacteria in pure cultures.—M. **Javillier** and H. **Alliare**: The existence of a nucleic phosphorus index of tissues.

July 19.—H. **Deslandres**: The law of distribution of terrestrial magnetic storms, and the corresponding law of distribution of the active regions of the sun. These are due to corpuscular radiation, which is subject to considerable periodic change.—G. **Bigourdan**: A means of improving the lunar co-ordinates deduced from the occultations of stars. The errors due to the irregularities of the edge of the moon's surface may cause an error of 1″, whereas the error of observation gives the lunar longitude to about 0″·1. The application of lunar photographs is suggested as a means of reducing the error caused by the surface irregularities.—Charles **Moureu** and Adolphe **Lepape**: The determination of krypton and xenon in atmospheric air. An application of the spectrophotometric method previously described. The results (by volume) are: krypton, 1×10^{-6}, and xenon, 9×10^{-8}. These are about twenty times those obtained by Ramsay in 1903, but nearly identical with the figures obtained by Ramsay and Travers in 1900.—Charles **Richet** and P. **Lassablière**: The protective effects of chloralose in chloroform anæsthesia. From experiments on dogs it is shown that the administration of chloralose (which must be free from parachloralose) by the mouth prevents cardiac syncope by the action of chloroform.—Rolin **Wavvre**: The reduction of domains by a substitution with m complex variables, and the existence of a single invariant point.—Luigi **Fantappié**: A class of analytical functionals.—H. **Mineur**: Waves of discontinuity of the second order in an Einstein universe.—Henri **Bénard**: The limit of the laminar regime and the turbulent regime, revealed by the appearance of clear alternating vortices.—Farid **Boulad Bey**: The calculation of a continuous beam of any form when given vertical elastic deformations.—Da **Costa Lobo**: Correlation between the solar prominences and the filaments. The agitation of the surface of the faculæ. Results obtained with a large spectroheliograph set up at the astronomical observatory of the University of Coïmbra. This instrument is identical in dimensions and characteristics with the instrument installed by M. Deslandres at Meudon Observatory, and the results from one station will serve to fill up gaps caused by bad weather at the other.—W. H. **Keesom**: The curve of fusion of helium. Data are given for pressures and temperatures ranging from 77·09 cm. of mercury on the helium bath (T. 4°·21) to 0·057 cm. (T. 1°·13).—G. **Darrieus**: A relation between the gravitation constant and other fundamental constants.—Henri **Malet**: The mathematical synthesis of the laws of electrodynamics.—A. **Dauvillier**: The spectrography of X-rays of large wave-length.—Mlle. J. **Liquier**. The variation of the rotatory power of solutions of quinine salts as a function of the hydrogen-ion concentration. The rotatory power of asparagine and the salt effect.—Salomon **Rosenblum**: The retardation of the X-rays by matter.—Georges **Fournier**: The absorption of the β-rays by matter.—Henri **Belliot**: Experiments on photographic solarisation.—A. **Boutaric** and Mlle. G. **Perreau**: The existence of two zones of instability in the flocculation of certain suspensions by electrolytes with trivalent and tetravalent cations.—P. **Brun**: The miscibility of quaternary water-alcohol mixtures. Details of the study of miscibility of mixtures of ethyl alcohol and water with two other alcohols not miscible with water, isobutyl and isoamyl alcohols.—**Pariselle**: The tartrates of pyridine and quinoline.—A. P. **Rollet**: A new colorimetric determination of nickel. The colour reaction utilised is produced by the oxidation of nickel dimethylglyoxime and will show 0·0005 mgm. nickel in 1 c.c.—René **Girard**: The action of saline solutions on the ferrous metals.—Mlle. **Bardon** and Mme. **Ramart**: The action of organo-magnesium derivatives on the glycidic ethers.—Mlle. **Marthe Montagne**: Researches concerning the action of organo-magnesium derivatives on some fatty dialkylamides.—E. E. **Blaise** and Jean **Miliotis**: Researches on the transposition of functional groups.—Jacques **Bourcart**: The stratigraphy of the Bouches de Cattaro (Jugoslavia).—Paul **Caubet**: Eruption of the peak of La Fournaise, December 1925 to April 1926.—V. **Agafonoff**: The genesis of the black earth and other soils in the neighbourhood of Clermont-Ferrand.—Ch. **Jacquet**: Researches on the radio-active springs of the Puy-de-Dôme.—Henry **Hubert**: The general movements of the air in western Africa.—M. **Bridel** and C. **Béguin**: Biochemical researches on the composition of *Salix triandra*. Preparation of rutoxide, asparagine, and a new glucoside hydrolysable by emulsion, salidroxide. The leaves of this plant contain glucoside, which can be hydrolysed by rhamnodiastase and a glucoside which under the action of emulsion gives an essential oil smelling of rose.—René **Souèges**: The embryogeny of the Liliaceæ. The development of the embryo in *Muscari comosum*.—Jules **Amar**: Observations on the cellular pigments.—G. **Lafon**: The intimate mechanism of muscular contraction.—Charles **Perez**: The sexual characters of the caudal fin in the Galatheideæ.—René **Fabre** and Henri **Simonnet**: Study of the photo-sensitising action of hæmatoporphyrine.—F. **Vlès** and A. de **Coulon**: The receptivity of the organism for grafts of tumours, in relation with the iseolectric points of the tissues.—L. **Lutz**: The soluble ferments secreted by the Hymenomycetes fungi. Reducing actions.—E. **Fauré-Fremiet** and Mlle. Laura **Kaufman**: Remarks concerning the curve of annual decrease of eggs laid by the domestic fowl.—Constantino **Gorini**: The stimulation of the bacterial activities in milk.—A. **Paillot**: The etiology and epidemiology of the *Gattine* of the silkworm, or the transparent head disease.—H. **Bordier**: The action of diathermic d'Arsonvalisation on synovia.

Official Publications Received.

Bulletin of the National Research Council. Vol. 10, Part 4, No. 54: Quantum Principles and Line Spectra. By Prof. J. H. Van Vleck. Pp. 316. 3 dollars. Vol. 11, Part 1, No. 55: The Determination of the Protein Requirements of Animals and of the Protein Values of Farm Feeds and Rations. Report of the Sub-committee on Animal Nutrition. By H. H. Mitchell. Pp. 44. 75 cents. (Washington, D.C.: National Academy of Sciences.)

Aeronautical Research Committee: Reports and Memoranda. No. 985 (Ae. 197): The Reduction of Aircraft Performance Tests. By R. S. Capon; with an Appendix by W. G. Jennings and F/O. Falkner. (A.4.a. Full Scale Work. Aeroplanes General, 124—T. 2090 and a.) Pp. 20+13 plates. 1s. 3d. net. No. 998 (E. 16): Gaseous Combustion at Medium Pressures. Part 1: Carbon Monoxide-Air Explosions in a Closed Vessel; Part 2: Methane-Air Explosions in a Closed Vessel. By R. W. Fenning. (I.C.E. 471; I.C.E. 479.) Pp. 25. 1s. net. No. 999 (Ae. 206): Step-by-Step Calculations upon the Asymmetric Movements of Stalled Aeroplanes. By Prof. B. M. Jones and Miss A. Trevelyan. (A.2.a. Stability Calculations and Model Experiments, 97—T. 2126.) Pp. 22+25 plates. 1s. 9d. net. No. 1010 (Ae. 216): On the Effect of the Walls of an Experimental Tank on the Resistance of a Model. By H. Lamb. (D.2. Misc. Committee Papers, 274—T. 2209.) Pp. 6+1 plate. 6d. net. No. 1020 (Ae. 221): The Behaviour of certain Aeroplanes when the Controls are Abandoned in Stalled Flight. By H. L. Stevens. (A.2.b. Stability Full-scale Experiments, 35—T. 2160.) Pp. 9. 9d. net. (London: H.M. Stationery Office.)

Department of Agriculture, New South Wales. Science Bulletin, No. 26: Veterinary Research Report, No. 2. By Dr. H. R. Seddon. Pp. 48. (Sydney, N.S.W.: Alfred James Kent.)

Reprint and Circular Series of the National Research Council. No. 69: The Service of State-Supported Agricultural Research. By Sidney B. Haskell. Pp. 10. 20 cents. No. 70: Forest Research under State Auspices. By F. W. Besley. Pp. 10. 20 cents. No. 71: Science and Engineering; a Visualization of the Material Elements of our Civilization as Complex Products of Manifold Studies, Fundamental and Applied, that Interlock and Trace Back to the Broad, Basic Concepts through which we attempt to interpret the Phenomena of Nature. By William F. Durand. Pp. 13. 20 cents. (Washington, D.C.: National Academy of Sciences.)

British Association Meeting, Oxford, 1926. Exhibition of Scientific MSS. and Printed Books at the Bodleian Library. Pp. 22. (Oxford: Bodleian Library.)

Société des Nations: League of Nations. Bulletins de l'Institut International de Co-operation Intellectuelle. Bulletin des Relations scientifiques. No. 1, Juillet. Pp. 52. (Paris: Les Presses Universitaires de France.) 8 francs.

Proceedings of the Royal Society of Edinburgh, Session 1925-1926. Vol. 46, Part 3, No. 22: Present Problems in Colour-Vision; the Laws of Visual Fatigue and of Resultant Sensation. By Prof. W. Peddie. Pp. 245-263. 1s. 6d. Vol. 46, Part 3, No. 23: A Geometry associated with the Double Binary (2,2) Form. By Wm. Saddler. Pp. 264-282. 1s. 6d. Vol. 46, Part 3, No. 24: On the Effects of Vasectomy and of Epididymodeferentectomy in the Mouse. By Y. Tamura and F. A. E. Crew. Pp. 283-288. 1s. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

East Africa. Report of the East African Guaranteed Loan Committee appointed by the Secretary of State for the Colonies. (Cmd. 2701.) Pp. 47. (London: H.M. Stationery Office.) 9d. net.

Newport Public Libraries, Museum and Art Gallery. Fifty-sixth Annual Report and Balance Sheet for 1925-26. Pp. 11. (Newport, Mon.)

Natural History Booklets. B101: Pine Marten. Pp. 4. B102: Harvest Mouse. Pp. 4. B103: Fallow Deer. Pp. 4. C99: Barn Owl. Pp. 4. (London: British Museum (Natural History).) 6d. each.

Falmouth Observatory. Meteorological Notes and Tables for the Year 1925, also additional Meteorological Tables for the Lustrum 1921-1925, with Mean Values for 55 Years (1871-1925). By Joshua Bath Phillips. Pp. 16. (Falmouth.)

Department of Agriculture, Ceylon. Bulletin No. 74: House Flies and their connection with Manuring Operations on Estates in Ceylon. By F. P. Jepson. Pp. 16+7 plates. 40 cents. Bulletin No. 75: A Preliminary Investigation on the Absorption of Fertilizers by Ceylon Soils. By A. W. R. Joachim. Pp. 19+3 plates. 40 cents. (Peradeniya.)

The Gardens' Bulletin, Straits Settlements. Vol. 4, No. 1: A List of the Mosses of the Malay Peninsula. By H. N. Dixon. Pp. 46. (Singapore: Botanic Gardens.) 50 cents.

Memoirs of the Geological Survey of India. Vol. 46, Part 2: The Cutch (Kachh) Earthquake of 16th June 1819, with a Revision of the Great Earthquake of 12th June 1897. By R. D. Oldham. Pp. iv+77+viii+4 plates. (Calcutta: Government of India Central Publication Branch.) 2 rupees; 3s. 6d.

U.S. Department of Agriculture. Farmers' Bulletin No. 1499: The Melon Aphid and its Control. By F. H. Chittenden and W. H. White. Pp. ii+17. (Washington, D.C.: Government Printing Office.) 5 cents.

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 527: Short Tests for Sets of Laboratory Weights. By A. T. Pienkowsky. Pp. 65-93. (Washington, D.C.: Government Printing Office.) 10 cents.

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 329: Manual of First-Order Triangulation. By C. V. Hodgson. (Special Publication No. 120.) Pp. vi + 185. (Washington, D.C.: Government Printing Office.) 40 cents.

Canada. Department of Mines: Victoria Memorial Museum. Museum Bulletin No. 43, Biological Series No. 11: List of Mushrooms and other Fleshy Fungi of the Ottawa District. By W. S. Odell. (No. 2089.) Pp. iv+15. (Ottawa: F. A. Acland.) 10 cents.

Scientific Papers of the Institute of Physical and Chemical Research. No. 63: Chemical Studies of Vitamin-B in Japan. By Umetaro Suzuki. Pp. 295-302. 25 sen. No. 64-65: On the Catalytic Hydrogenation of the Carbonyl Group in Aromatic Compounds under Pressure in the Presence of Copper. Parts 1 and 2. By Bennosuke Kubota and Taro Hayashi. Pp. 10. 20 sen. No. 66: Pleochroic Haloes in Biotite; Probable Existence of the Independent Origin of the Actinium Series. By Satoyasu Iimori and Jun Yoshimura. Pp. 11-24+plates 1-3. 50 sen. No. 67: On the Hardness of Different Structure in Steel. By Kanzi Tamaru. Pp. 25-44+plates 4-5. 50 sen. No. 68: Effect of Electric Field on the Spectral Lines of Zinc and Cadmium. By Yoshio Fujioka. Pp. 45-53+plates 6-9. 40 sen. No. 69: Spectroscopic Study on the Discharge in Helium. By Toshio Takamine. Pp. 55-61+plates 10-12. 40 sen. (Komagome, Hongo, Tokyo.)

Aeronautics. Report of the Aeronautical Research Committee for the Year 1925-26. Pp. 50. (London: H.M. Stationery Office.) 2s. net.

The Rockefeller Foundation: International Health Board. Twelfth Annual Report, January 1, 1925-December 31, 1925. Pp. xx+229+24 plates. (New York City.)

Union of South Africa: Department of Agriculture. Science Bulletin No. 48 (Division of Chemistry Series No. 66): Fumigation with Hydrocyanic Acid Gas; Concentration and Distribution as influenced by Fumigation Procedure. By B. J. Smit and Dr. T. J. Naude. Pp. 23. (Pretoria: Government Printing and Stationery Office.) 3d.

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 78. The Land Mollusks of the Republic of Panama and the Canal Zone, by H. A. Pilsbry; Costa Rican Land Shells collected by A. A. Olsson, by H. A. Pilsbry. Pp. 57-133+plates 9-11. (Philadelphia.)

Diary of Societies.

SATURDAY, SEPTEMBER 4.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South Wales District Meeting) (at Llantrysant), at 10.55 A.M.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (North-Eastern District Meeting) (at Blyth), at 12.30.

FRIDAY, SEPTEMBER 10.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (North-Eastern District Meeting) (at Middlesbrough), at 2.

CONGRESSES.

SEPTEMBER 6 TO 11.

INTERNATIONAL CONGRESS OF PSYCHOLOGY (at Groningen), with Sections on Eidetic Imagery, Psychogalvanic Reflex, Higher Psychic Processes, Animal Psychology, Psychopathology, and Applied Psychology. Papers by, among others, F. C. Bartlett, Dr. Wynn Jones, Dr. Thouless, Dr. Aveling, Dr. E. Jones, Dr. C. S. Myers, and Prof. Spearman.

AMERICAN CHEMICAL SOCIETY (at Philadelphia).—In eighteen Divisional Gatherings, dealing with various branches of Pure and Applied Chemistry.

SEPTEMBER 7 TO 10.

SMOKE ABATEMENT CONFERENCE (at Birmingham).

September 7.—Industry and Smoke Abatement, with Particular Reference to Boiler Smoke and embodying an Official Statement of Policy by the Smoke Abatement League.

September 8.—Papers on Housing and Smoke Abatement, by E. D. Simon, Marion Fitzgerald, Dr. R. Unwin, P. Taylor, Dr. L. Hill, and Mrs. C. S. Peel.

September 9.—Dr. Margaret Fishenden and A. S. E. Ackermann: Smokeless Production of Heat and Power.

September 10.—Combustion in Connexion with the Full Scale Model Boiler House which will be erected in the Conference Hall.

SEPTEMBER 9 AND 10.

CERAMIC SOCIETY (Refractory Materials Section Autumn Meeting) (at Queen's Hotel, Leeds), at 10.30 A.M.

September 9.—W. J. Rees: A Further Note on the Influence of Iron Oxide in Promoting the Inversion of Silica.—F. West and J. W. Fagan: Practical Results and Experience in the Drying and Burning of Refractory Materials.—Dr. G. Martin: Refractory Linings for Cement Kilns.

September 10, at 10 A.M.—Prof. J. W. Cobb, Dr. H. S. Houldsworth, and J. F. L. Wood: The Influence of Foreign Matter on the Thermal Expansion and Transformation of Silica.—W. T. Gardner: Refractories in the Gas Industry.—H. M. Ridge: Note on Modern Clay-working Machinery as used on the Continent.—C. E. Moore: Note on the Products obtained by Heating Stourbridge Fireclay with Potassium Chloride.

SEPTEMBER 12 TO 18.

INTERNATIONAL CONGRESS FOR APPLIED MECHANICS (at Federal Technical University, Zurich).—Lectures by Prof. P. W. Bridgman, Prof. P. Debye, Prof. T. Levi-Civita, Prof. L. Prandtl, and Prof. G. I. Taylor.

SEPTEMBER 13 TO 17.

INTERNATIONAL CONGRESS OF PHILOSOPHY (at Harvard University, Cambridge, Mass.).

SEPTEMBER 14 TO 16.

INSTITUTION OF PUBLIC LIGHTING ENGINEERS (Annual Meeting and Conference) (at Newcastle-upon-Tyne).

September 15, at 9.30 A.M.—R. Davison: Presidential Address.—J. F. Colquhoun: The Improved Lighting of a City.—Major S. Cooke: Motor Traffic in Relation to Lighting (*a*) on the Highway, (*b*) on the Vehicle.

September 16 (Morning).—R. Beveridge: Variations of Hours in Public Street Lighting.—H. Dickinson: Electric Street Lighting in Liverpool.

SEPTEMBER 19 TO 26.

GERMAN SCIENTIFIC AND MEDICAL ASSOCIATION (at Düsseldorf).

SEPTEMBER 22 TO 24.

GERMAN RÖNTGEN SOCIETY (at Düsseldorf).—Discussions on X-ray Treatment of Inflammation, the Compton Effect, and Irradiation of the Ovary and Offspring.

SEPTEMBER 26 TO 29.

INTERNATIONAL CONGRESS OF INDIVIDUAL PSYCHOLOGY (at Düsseldorf).