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Britain's Food Supply Basis.

THE papers read at the successful International Potato Conference held in London last week indicated the many points of interest which the potato presents for plant pathologists, breeders, and cultivators; but there was no topic discussed by the experts, who dealt with the technical problems presented by the crop, which has so much interest for the general public as the place which the potato should take in our national food economy. To this subject close attention has recently been directed in connection with the uses of the potato in time of war.

In a paper read before the Agricultural Section of the British Association at the Edinburgh meeting last September and now published in pamphlet form,[1] Lord Bledisloe remarked:—

"During the late war it was assumed by practically the whole British population . . . that bread made of wheat flour was the unalterable staff of life. . . . I desire to propound the view that, in a like emergency, potatoes, supplemented by pig-meat and a larger output of milk, would probably afford a less precarious basis for Britain's food supply than wheat, and a better insurance against national starvation."

Lord Bledisloe marshals his points with much ability and industry, and he sets them out in a series which, if the public's right to self-determination in the matter of diet had been admitted, would have numbered exactly fourteen! In an emergency, however, there can be no self-determination, and so we have the whole case for potatoes and pigs; but there is little regard for the counter-claims of wheat, and none at all for the merits of oatmeal, an omission one would not have expected in an address delivered so close to the Heart of Midlothian!

Let us first take the case stated for potatoes. The crop is far more productive than wheat, yielding twice as much energy per unit of area. It can be grown successfully in every part of the United Kingdom, whereas wheat is suited to the dry eastern and southern counties. Potato cultivation is simple—every farmer and every allotment holder has grown this crop; with wheat cultivation many farmers are "wholly unfamiliar." Home-grown potatoes would be safe from the risks of marine transport; there were heavy losses in sea-borne wheat in 1917. Potatoes, grown everywhere, could be used locally, thus reducing transport; in preparation for long journeys "desiccation of the tubers" might be resorted to. Wheat is exposed to the incendiary bomb of the airman and to the pitiless rain of the British climate; the potato is safe underground, and though blight may appear its effects may be minimised by spraying. (But is the potato a safer crop than wheat? Have we already forgotten 1916? Was it the Corn Law only that was "rained away" in the middle of the 'forties? What was William Cobbett thinking about when he "resolved, fire or fire not, that working men should not live upon potatoes in my country"?)

With potatoes the pig is naturally associated; it may be fed on spoiled or sound tubers; it makes meat more economically than any other domestic animal, its flesh supplies the protein and the fat required to supplement the starchy potato.

The pig and potato policy was, of course, the outstanding pre-war feature of German agriculture, and Lord Bledisloe makes a conservative estimate of its effect on the endurance of that nation when he expresses the opinion that, but for its potato crop, German resistance would have broken down a year before November, 1918.

It is not quite clear how far Lord Bledisloe would propose to carry the substitution of potatoes for wheat. He would not reduce the British corn area, but, from the estimates which he presents, he appears to think that, by extending potato cultivation, our wheat importation during war might be reduced by at least 50 per cent., and even be abandoned altogether, for he states that 1,280,000 acres under potatoes would provide food equivalent to half our wheat imports, and that by

[1] "Potatoes and Pigs with Milk as the Basis of Britain's Food Supply." By Lord Bledisloe. (With some Hints as to the Production of Each.) Pp. 59. (London: Hugh Rees, Ltd., 1921.) 1s. net.

doubling this area and making some increase in pigs we could do without any importation of wheat.

There is much to be said in favour of a potato and pig programme in war, as German experience proves. We ourselves did everything possible to increase the potato area during the war, and though Lord Bledisloe suggests that we vacillated in the matter of pigs, this was inevitable. Every belligerent European nation vacillated in its pig policy, the Germans included. This class of live stock requires extraordinarily close watching; it easily becomes a danger, and in some stages of the war it may be questioned if there was any animal in Europe that served the Allied cause better than the German pig. The management of swine led to violent controversies between the agrarian and the urban population; eventually a pig holocaust was necessary to save the lives of the unfortunate city dwellers. German experience, indeed, does not wholly support Lord Bledisloe's proposition, for even their enormous potato crop —which before the war was three or four times greater than was necessary for human use—played them false. The storage and transport difficulties were immense, there were great losses from frost, and we cannot have forgotten the tales of woe caused by the indigestible kohlrabis which were used to supplement the scanty potato supply. Potatoes may be productive and highly valuable to nations at war, but no crop is more difficult to deal with; the echoes of the German Food Controller's language, when he discussed his potato problems in public, reached us here; and attentive listeners might have discovered that the perplexities presented by the potato excited even our own Food Controllers!

In the course of a great war it might be possible to stimulate potato cultivation to an extent that would reduce corn imports by 25 or 30 per cent., but to achieve the results proposed by Lord Bledisloe it would be necessary to follow the German example and in peace time learn to cultivate and use three or four times as large a quantity as our markets now call for. But it is certain that the farmer would find potato growing for such industries as distilling or starch making very much less profitable than corn growing. Pig feeding would pay better than alcohol or farina, but when the human consumer can barely afford the price necessary to maintain the existing acreage, what prospect is there of a threefold extension of potato growing for pigs?

The present position suggests a decrease rather than an increase in the area of potatoes grown for market. Since the Armistice a change has come over the prospects of the crop. The great rise in the cost of transport and of fuel makes this foodstuff no longer cheap to the urban consumer. In London potatoes are now being sold retail at from 1*s*. 9*d*. to 3*s*. per 14 lb. At 2*s*. the cost of energy would be about 225 Calories per penny; in the 4-lb. loaf at 10*d*. energy can be bought at about 400 Calories per penny, and potatoes must be cooked. There has therefore been a decline in consumption. The large drop in the percentage of the retail price of potatoes and other vegetables now received by the farmer, because of the increase in transport and marketing costs, is a serious matter for the consumer, as well as for the farmer. It means that the market demand has become much less effective than formerly in providing a supply. Until we can greatly reduce the cost of bringing the potato from the farm to the urban consumer the prospect of increasing the area under potatoes as desired by Lord Bledisloe is not encouraging.

Pigs form a more hopeful subject; there is great scope for their increase in peace time. Their place in war is less certain. In any long war we should probably have to ask ourselves whether fat pigs could be allowed to exist alongside a nation of lean people. There would always be advocates for both, but ultimately, as in Germany, the lean people would prevail.

Priestley in America.

Priestley in America, 1794–1804. By Prof. Edgar F. Smith. Pp. v+173. (Philadelphia: P. Blakiston's Son and Co., 1920.) 1.50 dollars net.

PROF. EDGAR SMITH, of the University of Pennsylvania, in studying the lives of early American chemists, naturally encountered the name of Priestley, who, as is well known, left this country for America in 1794. The odium and insult he had met with as a Dissenter culminated in the Birmingham Riots of 1791, when, to the cry of "Church and King," his house was wrecked and set on fire "with the most savage and determined fury," and the books and apparatus which it had been the business of his life to collect and use were utterly destroyed. What Pitt termed "the effervescence of the public mind" was kept alive by the implacable resentment of the great body of the clergy of the Established Church, aided by the speeches in Parliament of Burke, and by what were then known as "Treasury newspapers," controlled by the political party in power. Priestley's position in this country became so insecure that eventually he determined to leave it and to join his sons, who with certain other persons, mainly Englishmen, were projecting a settlement near Northumberland at the confluence of the north-east and west branches of the Susquehanna. On April 8, 1794, he and his wife sailed from London, and arrived at the Old Battery, New York, on the evening of June 4.

The good ship *Sansom,* under Captain Smith, was not a very speedy craft to require fifty-seven days to cross the Atlantic, and her hundred passengers, with scant provision for their comfort, must have had a weary time of it. Priestley, however, in spite of occasional sea-sickness, occupied himself, as was his wont, with books. He relates that he read the whole of the Greek Testament and the Hebrew Bible as far as the first Book of Samuel; also Ovid's Metamorphoses, Buchanan's Poems, Erasmus's Dialogues, Peter Pindar's Poems, etc. To amuse himself he tried the temperature of the water at different depths, and made other observations which suggested experiments to be prosecuted whenever he should be able to re-establish his laboratory. To solace him he had received sundry parting gifts, among them "an elegant silver inkstand" from "three young gentlemen of the University of Cambridge," who regretted that such an "expression of their esteem should be occasioned by the ingratitude of their country." Also a characteristically florid and highly rhetorical valedictory address from the Society of United Irishmen of Dublin, enjoining him to pray for the patriots who, like him, were about to cross the bleak Ocean to a barbarous land—victims of "purblind statesmen" like Mr. Pitt.

Priestley was well received in America. His fame as a man of science had preceded him, and his well-known warm friendship for Franklin was in his favour. Indeed, it was generally acknowledged that this friendship reacted powerfully upon Priestley's work as a political thinker and as a natural philosopher. The *American Daily Advertiser*, in an editorial article of welcome, declared that it afforded

"the most sincere gratification to every well-wisher to the rights of man, that the United States of America, the land of freedom and independence, has become the asylum of the greatest characters of the present age who have been persecuted in Europe, merely because they have defended the rights of the enslaved nations. . . . The citizens of United America know well the honourable distinction that is due to virtue and talents; and while they cherish in their hearts the memory of Dr. Franklin, as a philosopher, they will be proud to rank among the list of their illustrious fellow-citizens, the name of Dr. Priestley."

For some days after their arrival the travel-worn voyagers were busily occupied in receiving visits from the principal inhabitants of New York and in replying to addresses of welcome from corporate bodies and societies in the State. These addresses, together with Priestley's replies, occupy a considerable section of Prof. Smith's book. The general character of the addresses is very similar. There is much about the arm of tyranny, corrupt Governments, venal Courts, an imperious and uncharitable priesthood, etc., all contrasted with liberty and equality and the system of beauty and excellence and "of virtuous simplicity" which characterised the happy Republican Government of America, where Reason had triumphed over the artificial distinctions of European policy and bigotry, and "where Providence had unfolded a scene as new as it is august, as felicitating as it is unexampled." Priestley's replies were couched, as might be expected, in less turgid rhetoric; but it is obvious from their terms that he was much affected by and grateful for the warmth of his welcome.

Amidst the general chorus there was, however, one dissonant note. It came from William Cobbett, and was sounded with characteristic violence. His pamphlet, "Observations on the Emigration of a Martyr to the Cause of Liberty," was a scurrilous attack on Priestley. It was the first of a series of lampoons signed "Peter Porcupine," mainly directed against American statesmen, which resulted in convictions for libel, and Cobbett was forced to leave the country.

After a fortnight's stay in New York Priestley moved to Philadelphia, then the seat of Government, where he was welcomed by the American Philosophical Society, which had been founded in 1727 by his friend Franklin. But Philadelphia had few attractions for him. He found it "unpleasant, unhealthy and intolerably expensive"—"only a place for business and to get money in," and he soon moved to Northumberland, where, with the exception of an occasional visit to Philadelphia either to lecture or to preach, he remained to the end of his days. He was invited to accept a professorship of chemistry in the Medical College of Philadelphia, but as this would require his residence for at least four months of the year in that city he declined it.

At Northumberland he occupied himself in helping his youngest son, Henry, to clear the land, in planning his new house, working at his "Church History," and occasional experimenting. Towards the end of 1795 he sent papers to the American Philosophical Society on the analysis of atmospherical air and on the generation of air from water, which filled twenty quarto pages of vol. 4 of the Transactions of that learned body. These papers have little or no scientific value: their main interest consists in the fact that they were the first contributions he made in America to the literature of chemistry. As was the case with all his papers, they were written in the language of phlogistonism, and Stahl's doctrine was already on the wane, even in Young America. In the same year Priestley lost his favourite son, Henry. It was a bitter blow, from which neither he nor his wife ever wholly recovered. Indeed, from this time Mrs. Priestley's health steadily declined, and nine months later she, too, passed away. She was a woman of remarkable fortitude and strength of character, generous and affectionate, and a true helpmate to her husband. Her great-granddaughter, Madame Belloc, has paid a worthy tribute to her memory.

There were now rumours that Priestley intended to return to England, or at least to Europe, and he actually contemplated taking up his residence in France. It is doubtful whether he was ever wholly reconciled to his life in America. He said himself: "Here, though I am as happy as this country can make me . . . I do not feel as I did in England." He had occasional fits of depression—all the more remarkable for a man of his usually serene and equable temperament. He felt, too, that his "character as a philosopher was under a cloud." Phlogistonism was a lost cause, and, in spite of his efforts to keep it alive, he understood quite well, as Prof. Smith says, that "the entire chemical world was against him." Experimenting was now irksome to him, and, as he states, he became "quite averse to having his hands so much in water"; moreover, Priestley was an eminently sociable being, and he had little congenial society in Northumberland.

He simply hungered for letters from his friends in England. He wrote to Lindsey: "I cannot express what I feel when I receive and read your letters. I generally shed many tears over them." He turned more and more to theology, interested himself in the politics of the country, although he took no active part in them, wrote on public education and on the organisation of the college which President Jefferson contemplated for the State of Virginia. He was still, at times, drawn to science, for he had fitted up a small laboratory adjacent to his house, and the experimental work he did in it was embodied in "Six Chemical Essays," which were communicated to the American Philosophical Society and are printed in their Transactions. The essays consist of miscellaneous observations of no special scientific value. Indeed, it must be admitted that Priestley's chemical work in America added little to his scientific reputation. The laboratory, a small wooden building, remains much as he left it. It will shortly be removed to the Campus of Pennsylvania State College, where it will be preserved as a memorial to the famous chemist. Much of the apparatus is, however, in the possession of Dickinson College (Pa.). It is to be hoped that it will be ultimately deposited in the laboratory—surely the most fitting place for it. It would add greatly to the historic interest of the memorial.

It was on the piazza of Priestley's dwelling-house that the men who assembled on August 1, 1874, to celebrate the centenary of the discovery of oxygen, then and there founded the American Chemical Society.

The opening year of the new century found Priestley suffering from the infirmities of age. He was now nearly toothless, which, together with his incurable stutter, added to his difficulties of speaking. Moreover, his sense of hearing became impaired, and he was obliged to use an ear-trumpet. He was, however, thankful that his eyes did not fail him. During one of his visits to Philadelphia he had an attack of pleurisy, and for a time his life was in danger, while occasionally he suffered from ague. He said of himself:

"Tho' I was never robust, I hardly knew what sickness was before my seizure in Philadelphia, but the old building has since that had so many shocks, that I am apprehensive it will ere long give way. But I have abundant reason to be satisfied, and shall retire from life *conviva satur.*"

His apprehensions were soon to be realised. In the spring of 1803 he had a dangerous fall, and strained the muscles of the thigh, and for a time was obliged to use crutches. He suffered from the cold of the winter of 1804, and again contracted pleurisy, from which he died on February 6, in the seventy-first year of his age, breathing his last in the act of correcting a proof-sheet.

Prof. Edgar Smith gives the fullest and best account of Priestley's life in America which has yet appeared. He seems to have tapped every available source of information, and has had access to many letters and memoranda hitherto unpublished. The book serves to complete the life-history of one who has been styled a "hero and type of the intellectual energy of the eighteenth century," and whose name, in spite of his errors and his misguided loyalty to a false philosophy, is imperishably fixed in the annals of science.

T. E. THORPE.

The Actinomycetes.

Morphologie und Biologie der Strahlenpilze. (Actinomyceten.) By Prof. Rudolf Lieske. Pp. ix + 292 + Tafel 4. (Leipzig: Gebrüder Borntraeger, 1921.) 108 marks.

THIS volume by Prof. Rudolf Lieske, of the Botanical Institute at Heidelberg, on the morphology and biology of the Actinomycetes, forms a valuable addition to the literature of this subject. In a general introductory chapter there are an account of the occurrence of Actinomycetes in Nature and an annotated list of recorded species, references being given to original descriptions. This section also contains a discussion of the relation of Actinomycetes to Bacteria, Mycobacteria, Hyphomycetes, etc., the conclusion—from which many of us would dissent—being that the former are a primitive stem from which the latter have been derived.

The second section, dealing with the morphology of Actinomycetes, suffers from the lack of a thorough comparative study of growth forms under different standardised conditions. Still, Prof. Lieske approaches his subject with a more experimental and dynamic attitude of mind than that of a recent American investigator of Actinomycete morphology, and his results are correspondingly enlightened. In the study of higher organisms there has been developed a physiological anatomy; in the study of lower organisms perhaps our greatest need is a physiological morphology. When we abandon teleology and learn to interpret shape and structure in terms of physico-chemical relationships we shall begin to build a true micro-organismal morphology. The Actinomycetes would be a good group on which to commence. Prof. Lieske finds that they possess a true mycelium with typical monopodial branching, and "Luftsporen" are formed endogenously. The questions of cell nuclei and a possible primitive sexuality are left open, but it is disappointing to find "involution forms" dismissed as merely teratological growths—surely mycologists and bacteriologists have too long been content with this futile label.

The third section, dealing with the physiology of Actinomycetes, is perhaps the best, but again suffers from a too timid and unimaginative viewpoint. There is the usual consideration of the relation of the organisms to carbon, nitrogen, etc. —all useful data; but the very important enzymic relations of Actinomycetes, their antagonistic or additive reactions with other micro-organisms and their function in the soil economy, the very interesting pigments produced—these and other vital issues are treated too summarily. The fourth section deals with animal and human diseases such as "Madura foot," "lumpy jaw," etc. There is also a useful summary of methods of staining and the preparation of specimens. The last section of eight pages concerns the Actinomycetes in their relation to higher plants, and is merely a very inadequate account of potato scab and the root nodules of the alder. The work closes with a bibliography of 378 titles, of which 322 are German, while important works such as Poncet's comprehensive monograph are omitted.

The most serious difficulty in the study of Actinomycetes is the specific determination of the organisms isolated, and here Prof. Lieske's work gives no help. It needs to be supplemented by Drechsler's beautiful drawings in the *Botanical Gazette* and Waksman's cultural data in the *Journal of Bacteriology*. The book is finely produced with 114 text illustrations and four beautifully coloured plates, and in spite of its defects is a very valuable addition indeed to the literature of this important and obscure group of organisms.

W. B. BRIERLEY.

Emin Pasha's Last Collections.

Die Tagebücher von Dr. Emin Pascha. Herausgegeben mit Unterstützung des Hamburgischen Staates und der Hamburgischen Wissenschaftlichen Stiftung von Dr. Franz Stuhlmann. Band 6, *Zoologische Aufzeichnungen Emin's und seine Briefe an Dr. G. Hartlaub bearbeitet von Prof. Dr. H. Schubotz.* Pp. viii + 301. (Hamburg und Braunschweig: Georg Westermann, 1921.) 200 marks.

THE volume under review gives us notes, mainly ornithological, on the last collections made by this remarkable German-Jewish explorer in the equatorial Egyptian Sudan, including the south-eastern part of the Bahr-al-ghazal region, the Latuka-Lango district, and the north-west coast of the Albert Nyanza; but the author treats also of birds and mammals which have come under his observation in the countries between the south shores of the Victoria Lake and the Zanzibar coast. His correspondence ceases with the middle of 1890. It contains interesting allusions to Dr. Sclater and other English ornithologists, to Dr. Junker, and to members of Stanley's expedition, and a rather pathetic touch in his own assumption of the *rôle* of the Wandering Jew.

Though this volume deals mainly with the birds of equatorial East Africa, it has some very interesting notes on the mammals. Emin had become aware of the presence in East Africa proper of a striped form of hyena, unknown to him in any survey of the Upper Nile regions. More than this—he has noted hints as to the existence in the Mangbettu or Mabode country, within the north-eastern limits of the Congo basin, of some type of "zebra." There is no zebra—so far as we are advised—within the limits of the Congo basin, or west of Tanganyika, or even of the main stream of the Nile. No type of equine—zebra or wild ass—has been seen west of the Nile within the Bahr-al-ghazal basin. It is clear that these scraps of information reaching Emin indicated not any zebra, straying beyond the habitat of this striped horse, but the okapi.

Dr. Junker, about 1886, wrote a note or two about a large antelope which was found in the southern part of the Mangbettu country, and which had a portion of its hide curiously striped. He seems to have been aware that the creature had cloven hoofs, and therefore did not style it a zebra; but he had evidently seen the strips of striped skin on the limbs of the okapi with which the forest negroes decorated their bodies. Stanley in 1889 heard stories of the okapi from the pigmies, and styled it "a large donkey." This volume will be of very great interest to ornithologists.

H. H. JOHNSTON.

Our Bookshelf.

The Clayworker's Handbook. By A. B. Searle. Third edition, revised, enlarged, and largely rewritten. Pp. viii+381. (London: C. Griffin and Co., Ltd., 1921.) 21*s.*

THIS handbook is a useful compilation from catalogues, journals, year-books, etc. There is little or no attempt to show the original sources, and special work like that due to Mr. Bernard Moore is incorporated without reference to the discoverer. For the protection of the author himself, it would have been better had he given the authorities for some of the extraordinary statements made. There are so many of these that the book wants using with some caution. For example, it is said that "ball clay should not leave any residue on a sieve of 120 holes per linear inch." Anyone familiar with ball clays knows that this is wrong, and anyone not familiar with those clays would appear foolish if he rejected a delivery on this authority. We are also told that "enamels are always opaque," and there are several other misleading statements of like calibre. The table of common chemicals and their scientific names and formulæ would be much improved if it was revised by a chemist, for some of the scientific names are hopeless, likewise the formulæ. For example, "sodalite" (common term) is "a felspar" (scientific term); gypsum and plaster are both given the formula $CaSO_4 \cdot 2H_2O$, and the same mistake is made higher up the page, while flint is given as amorphous silica. Some of the names of defects are translated literally from the German, instead of into the terms generally employed in this country.

The book serves a useful purpose; the data are handy for reference, and they are skilfully arranged. It is with the object of getting it seriously overhauled that the unpleasant task of emphasising some of the mistakes has been undertaken.

Liverpool Marine Biology Committee: L.M.B.C. Memoirs on Typical British Marine Plants and Animals. Edited by Prof. W. A. Herdman and Prof. J. Johnstone. No. 24, *Aplysia.* By Nellie B. Eales. Pp. viii+84+7 plates. (Liverpool: University Press, 1921.) 4*s.* 6*d.*

THE present is the twenty-fourth Memoir, published after a considerable interval, of the well-known L.M.B.C. series. The animal with which it deals is a member of the Opisthobranchiata, one of the two orders of Euthyneura, to the other of which, the Pulmonata, belong the ordinary land snails. Though one of these latter animals is very usually studied in the laboratory as an example of Gastropoda, Aplysia presents several advantages as a type for dissection. It is the largest British Gastropod. It exemplifies a number of morphological tendencies, and exhibits intermediate characters between the primitive and more specialised forms. Its internal organs "afford numerous links in the chain of evidence that detorsion has taken place." The pallio-visceral nerve cords are long (as in Streptoneura), but uncrossed (as in Euthyneura in general); the nervous system is less markedly concentrated than in many other Euthyneura, and the animal exemplifies the tendency to disappearance of the shell and mantle-cavity.

The present account will be useful as a laboratory guide; directions for dissection are given, intercalated in brackets at the necessary places in the anatomical description, and the plates are adequate in number and clearly drawn. An interesting section on the history of our knowledge of the animal is prefixed.

The first line of the book contains a curious inversion ("The Mollusc of which the present Memoir is the subject"); and the word "factors" on p. 41 (for "tributaries") reads awkwardly.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Metaphysics and Materialism.

IN his article in NATURE of October 20 Prof. Carr maintains that the principle of relativity has "reformed" the concept of physical reality, and has finally made untenable the doctrine that matter is real. I dissent most strongly from his conclusion. If "real" is used in the only sense in which a belief in the reality of matter ever has been part of physics, that belief is entirely unaffected by the principle of relativity, which involves the belief as much as any other physical proposition. There may be senses of the word "real" in which the doctrine that matter is real is affected by the acceptance of the principle of relativity, but they are either repugnant to physics or irrelevant to it. I have explained my reasons for this opinion at length elsewhere, but at such length that nobody seems inclined to read them. May I be allowed to set them out rather more concisely?

First, then, Prof. Carr will admit that "real" is used in at least two senses. He presumably smiled when first he heard the old story of the mongoose which was as unreal as the snakes it was kept to kill. If he could understand "real" only in the metaphysician's sense, he would not, being an idealist, see any point in the story, for he would assert that every mongoose and every snake was unreal. The reality which the traveller denied to his mongoose was the reality of common sense, not the reality of metaphysics. The criterion of this common-sense reality is universality of experience. The snakes were not real because the experience of them was limited to the intemperate friend; other people could not experience them. The mongoose was unreal because if the box were opened nobody would experience it. If Prof. Carr were to say that he does not know what I mean by "universality of experience" in this connection, I fear I should simply disbelieve him; for the whole of his normal life shows that he recognises and applies the criterion like anybody else, materialist, idealist, or physicist.

The "real" of common sense is the fundamental "real" of science. A belief that there are real things in this sense (which might be, but is not usually, expressed by the assertion that matter is real) is necessary to science. It is necessary not so much in order that science should be true as in order that there should be any science. For real things in this sense are the subject-matter of science. Science selects the material it will study by applying the criterion of universal experience. It rejects from its subject-matter the snakes which only the traveller's friend could see; it accepts only such snakes as everybody can see. It is as absurd to ask whether students of science are right to employ this criterion as to ask whether Greek scholars are right to accept the universal practice of Greek writers; if we applied any other criterion our study would not be experimental or natural science.

In so far as the principle of relativity leads to any conclusions relevant to experimental science, it depends on this criterion as much as other scientific theory; the only observations with which its conclusions must be in accordance, if the principle is to be accepted as true, are observations concerning which everyone agrees. Sir Oliver Lodge does not differ from Prof. Eddington concerning the distribution of the spots on the Principe plates, and both of them would agree that, if they did differ as to that distribution (say, because the spots were very diffuse), the plates would not afford any evidence on which to base any scientific conclusion whatever. They agree that the plates must satisfy the criterion of scientific reality before they can proceed to differ in their interpretation of the plates. Nor would any difference between them in the matter of scientific reality arise even if the hypothetical experiments of which Prof. Eddington is so fond could actually be tried (I hold that it is most important to insist that they cannot be tried), and if it were found that two observers travelling with great relative velocity differed concerning the simultaneity of events. They would both agree that the observers did differ; and they would agree that, because of this difference, the judgment of neither could be accepted as a valid basis for scientific argument unless one or both could be "corrected" in some manner so as to remove the discrepancy. The position which would arise would be precisely similar to that which arose when first it was noticed that observers at different distances from a gun differed concerning the simultaneity of flash and report. Some observations which had been expected to be "real" would have turned out to be "unreal," but enough real observations, concerning which agreement could be obtained, would remain (if anything can be predicted about an event which cannot occur) to make science possible, even as applied to the discrepant observations (*cf. Phys. Zeit.*, vol. 13, p. 126, 1912).

So much for "real" in its fundamental sense. But physicists also use the word in another sense when they speak of electrons or atoms or the æther being real. This sense is not the fundamental sense, because nobody has perceived or could perceive an electron, and because people do actually differ about the reality of some of these things (*e.g.* the æther). Fortunately, there is no need to discuss in detail here the significance of this kind of "reality," for no physicist would assert in this sense that "matter is real." If matter is something different from, but common to, electrons, atoms, and æther, then science does not assert, but most strenuously denies, that such matter has any "reality." And that conclusion, again, is perfectly independent of the principle of relativity.

On the other hand, the principle of relativity might have a bearing upon reality in this sense, though not on the reality of matter. For to assert that something is real in this sense is to say that some theory is believed to be true; if we believe the theory of relativity to be true, we may assert that some things are real which we shall assert are not real if we do not believe the theory. But it is not certain that we shall do so, for not all ideas of true theories are asserted to be real. For example, I do not think that anyone, speaking carefully, would assert that the frequency of light is real; he would not say it was unreal; he would say that the conception of reality was inapplicable to a frequency, just as is the conception of triangularity. Personally, I should adopt that attitude towards the ideas of the theory of relativity; others might possibly differ.

But it must be noted that any influence the theory of relativity may have on our views of reality in this sense is shared by other theories. Prof. Carr is quite right when he suggests that the theory establishes some rather special relation between mathematics and physics; it gives reality, in the second sense, to ideas which derive their attractiveness, not from analogy with material laws, but from connection with mathematical form. But so does the Bohr-Sommerfeld theory of the atom; the basis of the fundamental hypothesis $\int pdq=nh$ is purely mathematical, and cannot be stated apart from mathematical conceptions. So also, I think, does the Maxwellian theory of the electromagnetic field, but to discuss this matter would lead us too far. All that I am concerned to assert is that there is no sense of the word "real," relevant to experimental physics, in which the principle of relativity has a different kind of influence on our views of what is real from any other theory. In particular, it has no influence whatever on the belief that matter is real in any scientific sense. It may have some bearing on that doctrine in the metaphysical sense; but since, after considerable philosophic reading, I am still unable to discover what metaphysicians mean by "real," I clearly cannot discuss that question. But since, again, I can understand science without understanding metaphysics, I am naturally convinced that the two are completely independent.

NORMAN R. CAMPBELL.

DR. NORMAN CAMPBELL has not understood me. Probably thinking that I am an idealist philosopher, he has supposed that I must be arguing that there is no scientific reality in the accepted meaning—that is, no scientific criterion of reality—and that the naturalist's mongoose, for example, has just as much or just as little reality as the drunkard's. What I was pointing out was the fact that the principle of relativity *is* the rejection of materialism. Materialism is a causal theory of scientific reality. It is the argument that when we pronounce anything in our sense-experience to be real we imply an independent cause of it. According to the principle of relativity, the inference is entirely unnecessary and to insist on it unscientific. Instead of this causal theory relativity offers a simple correspondence theory. The Minkowski-Einstein universe consists of events co-ordinated by observers in their different systems of reference. What is essential to constitute the "real event" of any observer is that there should be point-to-point correspondence between his co-ordination of it and the different co-ordinations of other observers. The co-ordination of an event by any observer—that is, his perspective of the event—is not an effect which is the appearance to him of a "causal" reality, but an actual case in point of the reality itself. The "event" in the four-dimensional continuum, and its track the "world-line," in re-forming the notion of scientific reality has relegated scientific materialism to its right place in the limbo of scholasticism. Whatever his disagreement, at least Dr. Campbell need not be alarmed for the basis of scientific research.

November 9. H. WILDON CARR.

Hybridity and the Evolution of Species.

I AM sorry to say that the postscript of "The Writer of the Article" to my letter on p. 274 in NATURE of October 27 is not according to facts. It was he who used Trillium, Dirca, and Scoliopus as evidence against "bad pollen" being an indication of hybridity; this evidence appeared to me to be insufficient, and I stated the reason why. In his postscript "The Writer of the Article" makes no attempt to refute my arguments against his view, but says: "In such cases as Trillium, Dirca, and Scoliopus it is not sufficient for him [meaning me] to suggest that they must be hybrids merely because they have bad pollen," though I have never suggested this, or referred to Trillium, Dirca, and Scoliopus in any of my previous writings.

Perhaps I may be allowed to make use of this occasion to state my point of view shortly with regard to the question of bad pollen. I do not think that bad pollen is proof of a hybrid origin, but consider it as "suspect"; neither do I share Jeffrey's view that absence of bad pollen is a sign of a non-hybrid origin; as a fact, I know that it is not. Some of my segregates of the cross *Antirrhinum glutinosum* × *majus* have bad pollen, while others have not. I further think that "The Writer of the Article" is mistaken in his view that the theory of mutation *requires* the occurrence of a certain proportion of defective germ-cells. The facts are these:—When de Vries found bad pollen in *Oenothera Lamarckiana* he accounted for its presence on the *assumption* that this defect was caused by mutations; we now know that *O. Lamarckiana* is a hybrid, so that it is much more probable that hybridity is the cause of the presence of bad pollen; recent cytological work seems even to prove this.

May I beg zoologists to answer a question I should like to put to them, namely: Is there any evidence that the presence of oligopyrene and apyrene sperms in some insects and molluscs is due to hybridity?

I might finish my remarks here were it not that "The Writer of the Article" reproaches me with "begging the question" at issue. Nothing is farther removed from my intentions, so that I desire to deal shortly with all the points mentioned by him. He argues that it militates against the general applicability of the origin of species by hybridisation that not all British roses are hybrids. I fail to see the force of this argument, as it is well known that homozygotes can arise from a cross without showing any sign whatever of their hybrid origin; consequently, the fact of specific purity can never be used as an argument against a hybrid origin.

Nor does the fact that pollen sterility and fertility behave as a pair of characters in the sweet pea and the velvet bean tell against the origin of that bad pollen by hybridisation, as "The Writer of the Article" seems to think, unless he can bring forward arguments in favour of his contention which are unknown to me. Until then I must acknowledge I fail to see how behaviour of a character already existing can reveal its mode of origin; the idea that specific characters do not segregate while varietal characters do is, of course, obsolete.

"The Writer of the Article" finishes his remarks by pointing out that it will be necessary to bring some more convincing argument in support of hybridisation as a constructive evolutionary factor before it is likely to receive much serious consideration from biologists. If he means some more convincing argument than the suggested hybrid nature of Trillium, Dirca, and Scoliopus—a suggestion which is not mine—I cordially agree with him. I wonder whether the following will assist him in taking a kinder view of my theory than he evidently does?

It is a generally acknowledged fact that new breeds of animals and plants can arise by crossing, while no other mode of origin of them has ever been proved, although various other modes have been suggested. We all know that Darwin explained the origin of new forms in Nature largely on the mode of origin of domesticated races, so that it is of considerable importance to know the real nature of the "variations" among plants and animals under domestication which play so important a *rôle* in Darwin's writings.

Some time ago I happened to come across a letter of Darwin himself in his "Life and Letters," which seems to thrown important light on this momentous question. The letter is printed in full on p. 342 of the third volume of the "Life and Letters"; it was addressed to Dr. J. H. Gilbert, and dated "Down, February 16, 1876." The following passage is the one which interests us here :—

"It is admitted by all naturalists that no problem is so perplexing as what causes every cultivated plant to vary, and no experiments as yet tried have thrown any light on the subject. Now for the last ten years I have been experimenting in crossing and self-fertilising plants; and one indirect result has surprised me much, namely, that by taking pains to cultivate plants in pots under glass during several successive generations, under nearly similar conditions, and by self-fertilising them in each generation the colour of the flower often changes, and, what is very remarkable, they became in some of the most variable species, such as Mimulus, Carnation, etc., quite constant, like those of a wild species."

We now know that the colour changes and the becoming constant to which Darwin refers were the results of the repeated self-fertilisation of heterozygous material, so that the supposed variability evidently was nothing but segregation after a cross.

Velp, Holland, November 2. J. P. LOTSY.

IT would take too much space to reply in detail to all of Dr. Lotsy's statements, for which I have great respect. They go far outside the original point at issue, but it is necessary to refer to the more important of them, and it will then probably be seen that the others are immaterial. In his original letter (NATURE, October 27, p. 274), which commented on an article of mine on "British Roses and Hybridity" (NATURE, September 15, p. 99), he states that Jeffrey's work tends "to show that the presence of 'bad pollen' is *proof* [my italics] of a hybrid origin," and goes on to say that this view is "much strengthened" by other work. He correctly states that I took exception to that view, my own view being that "bad pollen" is unsafe as a criterion of hybridity, in support of which I cited various facts. As some of these facts were from a paper of which I was joint author, the original article was unsigned, but since this controversy, which was not of my seeking, has arisen, I prefer to sign my own name. In his present letter Dr. Lotsy seems to forget that the burden of proof rests upon those who assume that bad pollen is a proof of hybridity. He says that my postscript to his article is "not according to facts," and that he did not suggest the hybrid nature of Trillium, Dirca, and Scoliopus. I can only ask, if that is the case, why did he refer to them in his original article? Cytological work, which is by no means all "recent," proves that hybridity is *a* cause of bad pollen, but by no means proves that it is the only cause.

Dr. Lotsy has apparently omitted a consideration of lethal factors from his views. This is a more recent discovery which is of much significance in the interpretation of sterility, not only in Drosophila, but in various Œnothera forms, and it may apply either to gametes or zygotes. The conception has already been fruitfully applied, not only to various plants and animals, but also to man himself. When I said that the theory of mutation requires the occurrence of a certain proportion of defective germ-cells I had similar cases in mind, and did not mean to imply that mutations were necessarily *always* accompanied by germ-cell sterility. But clearly, if lethal factors account for germ-cell sterility in some cases, it is inadmissible to assume that bad pollen is in itself a proof of hybridity. We must apply the conception of multiple causes.

It follows that in any given case, such as that of *Oenothera Lamarckiana*, bad pollen *may* have originated from crossing, from lethal factors, or from some other cause, unless one or more of these possible causes can be eliminated. Dr. Lotsy says, "We now know that *O. Lamarckiana* is a hybrid." One can only ask how we know, and in what sense he is using the term hybrid. So far as the theory of mutation in Œnothera is concerned, it no longer matters whether *O. Lamarckiana* is a garden hybrid or not, since the work of Bartlett has proved that various close-pollinated wild American species of Œnothera show the same mutation behaviour.

Finally, I would say that if by his theory of evolution by hybridisation Dr. Lotsy means merely that the intercrossing of related races is the condition in which evolution has frequently taken place, I, for one, would heartily agree with him. For I have long advocated the view that among open-pollinated plants and most animals the evolutionary unit is an interbreeding population of closely related forms. I fancy many biologists adhere to a similar point of view. But I take it that Dr. Lotsy means much more than that by his theory, and if I understand him correctly, that is his reason for tacitly denying the existence of germinal changes. One can only ask how two visibly similar homozygous organisms when crossed can give rise to new germinal characters if they have not during the previous period of their isolation undergone germinal changes. R. RUGGLES GATES.

King's College, Strand, November 11.

Biological Terminology.

(*a*) "VARIATION is the sole cause of non-inheritance"; (*b*) "Apart from variations like exactly begets like, when parent and child develop under like conditions"; (*c*) "The development of the individual is a recapitulation (with additions and subtractions due to variations) of the evolution of the race." Here are three statements which seem to me "*in effect*" identical. To Dr. Bather the first two seem identical, but not the third. But if the child in his own development step by step recapitulates (with variations) the development of the parent, and the parent in the same way recapitulated that of the grandparent, and so on to the beginning, how, in the world, can the development of the individual be anything other than a recapitulation (with the accumulated variations) of the evolution of the race? If that be so, does not (*b*) necessarily involve (*c*)? (*c*) is merely (*b*) applied to a succession of parents and children. Dr. Bather says (NATURE, October 27, p. 271) that this is not what biologists mean. Then what do they mean? "Recapitulation" must be one of those terrible words which, like "inherit," are used, quite unconsciously, with a number of diverse and even contradictory meanings.

It is pleasant to find that Dr. Bather approves of Prof. Goodrich's address, for probably it has set the heather alight at last. In my humble way I also am enormously pleased. Still, Dr. Bather should bear in mind the history of this matter, some of which Prof. Goodrich indicates. As long ago as the 'eighties Weismann declared that "an organism cannot acquire anything unless it already possesses the predisposition to acquire it." At that time, too, doctors were beginning to insist that not actual diseases, but only predispositions to acquire them, were inheritable. Weismann failed to perceive the necessary consequences of his own idea—predisposition is all that can be inherited in the case of any character; all characters, therefore, are equally and in exactly the same sense innate, acquired, and inheritable. Instead he assumed, with Lamarck, that some characters are innate and others acquired, and so started the famous—or infamous—Lamarckian controversy. Sandeman did, however, very definitely follow out the idea in 1896, as did Adam Sedgwick in 1899. If authority be necessary, here is authority in plenty. I also tried in my very humble way, beginning as long ago as 1906. I daresay each man in turn thought he was propounding something new. Dr. Cunningham perceives, I hope, that Prof. Goodrich is spared the disgrace of being my pupil, and that even the most self-respecting biologist may, in this instance, follow the truth without qualms of conscience. Dr. Bather knows with what reception I met. I was told that I was doing harm, that biologists could manage their affairs quite well without my help, and so forth. Then the worm turned. So far as I am able to judge, Dr. Bather objects to my letters because they are tediously long and because they are impudent. Certainly they are long, and doubtless they are tedious. But I could state, or assume, in half a dozen words a fallacy which Dr. Bather could not refute in less than half a dozen columns. Moreover, as Dr. Bather courteously indicates, it has been holiday time, during which one does unusual things; therefore I have used his letters —with all reverence, as a parson might—as texts whereon to hang admonitory discourses. Certainly these letters have been impudent—most impudent. But here, again, we have the trodden worm.

Dr. Bather thinks I ought not to discuss variations unless I first account for them, which is like saying I ought not to eat my dinner unless I first cook it. Must I not accept the given fact? I am at once accused of being tediously long and not long enough. What is a poor man to do? Besides, I have tried elsewhere ("The Laws of Heredity," chap. 5) to do this very thing. Primarily variations can arise only in two ways. Either they are impressed on the germ-plasm by its environment, or they occur because the germ-plasm is a living, growing, changing thing which, like other living things, tends to revert to the normal from impressed change, especially injury. There exists ample crucial evidence to enable us to reach a decision, but much of it lies, outside the high roads followed by biologists, in the realms of disease and bacteriology.

Dr. Cunningham's letter (NATURE, November 17, p. 368) is addressed especially to Prof. Goodrich, who may deal with it if he desires; but one passage refers to my particular hobby. Lamarck called the changes which result from use "acquired"; but, thinking only of trifling changes which occur at the end of the development, he did not realise that the growth of the higher animals, especially man, is due mainly to that functional activity which begins to act immediately after birth. His successors employed the word "acquired" as indicating any character which develops under any very glaring influence. Now Dr. Cunningham defines an acquired character as a "change" (from the person's antecedent self, from the parent, from the race—which?) due to "environment or modification." In that case the English language is not "acquired," but is "innate" in an Englishman. If learned by a Frenchman, it is acquired. Heaven knows what it is if learned in Jersey. He accuses Prof. Goodrich and me of a "misuse of words" and of obscuring "a *perfectly clear* distinction"! The italics are mine!

G. ARCHDALL REID.

9 Victoria Road, Southsea, November 19.

The Softening of Secondary X-rays.

DR. A. H. COMPTON in a letter on this subject in NATURE of November 17, p. 366, described an experiment in which he reflected the $K\alpha$ rays from a molybdenum Coolidge tube on to a slab of paraffin, and measured the absorption coefficient of the secondary scattered rays at different angles with respect to the direction of the primary beam. The absorption coefficient of the secondary rays was found to be 29 per cent. greater than that of the primary $K\alpha$ beam at $\theta=90°$, and 6 per cent. greater at $\theta=20°$. This softening of the rays on being scattered was still more pronounced when the K lines of tungsten were used.

Dr. Compton referred to this work as a repetition of measurements which I had previously reported (*Phil. Mag.*, September, 1921), in which no such increase in absorption after scattering was observed, and he attributed my negative result to an unfavourable choice of wave-length and angle. Apparently he did not understand the purpose of my experiment. It was to settle a question regarding the interpretation of energy measurements made with the Bragg spectrometer. We were not sure that the atom in a scattering substance does not always absorb energy from the incident rays and re-emit this energy in a manner characteristic of the atom and independent of θ. My problem was to find out if such an effect need be considered in ordinary spectrometer measurements. The wave theory of scattering predicts a certain amount of softening due to the finite size of the atom and to a sort of Doppler effect, but not nearly the observed amount, especially at large angles.

As Dr. Compton suggests, there is probably an additional somewhat softer radiation due to collisions of electrons released within the scattering substance by the primary rays. Such a "fluorescent" radiation should diminish with θ, as observed. The softening due to the finite size of the atom should also, in general, diminish with θ and be negligible in the characteristic radiation, which is believed to consist of relatively sustained wave-trains. Softening due to these recognised causes can thus be minimised by using the sustained characteristic rays, large wavelengths, and θ as small as possible. I chose these conditions, which were unfavourable to the Compton effect, because I wanted to eliminate it so far as possible. The negative result simply indicates that with light atoms the indirect unpolarised radiation sought is not great enough to require consideration in ordinary crystal measurements. S. J. PLIMPTON.

Worcester Polytechnic Institute, Worcester, Massachusetts, November 8.

The Molecular Scattering of Light in Liquids and Solids.

As was pointed out by the late Lord Rayleigh, the basis of his theory of the blue sky, namely, that the molecules scatter the incident energy independently of each other's presence, is only true for gases in consequence of the freedom of movement the molecules possess in this state of matter. In connection with the problem of the colour of the sea and of deep waters generally it is necessary to know the scattering power of ordinary liquids, such as water, and I find this can be very simply accomplished by application of the theory of local fluctuations of density arising from molecular movement, originated by Einstein and Smoluchowski and utilised by the latter to elucidate the phenomena occurring near the critical state. The general formula for the scattering power of a fluid is

$$\frac{\pi^2}{18}\frac{RT\beta}{N\lambda^4}\left(\mu^2-1\right)^2\left(\mu^2+2\right)^2,$$

where β is the compressibility of the substance, μ its refractive index, R, T, N being the usual constants of the kinetic theory. The scattering power of water comes out from this formula as about 160 times that of air. Not only is this in agreement with observation, but I find the coefficient of extinction of light due to scattering

$$\frac{8\pi^3}{27}\frac{RT\beta}{N\lambda^4}\left(\mu^2-1\right)^2\left(\mu^2+2\right)^2$$

closely represents the observed transparency of pure water in the region of the spectrum where there is no selective absorption. Work is now in progress testing the formula in the case of other liquids.

It is clear that an application of the same idea of local fluctuations of optical density and of Debye's theory of the thermal movements in solids would give the theoretical scattering power of transparent crystals for ordinary light. This is also being tested.

C. V. RAMAN.

210 Bowbazaar Street, Calcutta, October 15.

The Tendency of Elongated Bodies to Set in the North and South Direction.

THE letter from Sir Arthur Schuster in NATURE of October 20 last requires amplification and amendment in one particular. The setting tendency of an elongated body depends upon its method of support. If suspended, with the centre of gravity not free to rise and fall, it is at its "lowest" position when lying on the equipotential section of maximum radius of curvature, *i.e.* tends to set east and west. A floating body, on the other hand, where the centre of gravity is free to rise and fall, is at its lowest when lying on the equipotential of minimum radius of curvature, *i.e.* north and south. The whole matter is fully discussed in an article by Mr. W. D. Lambert, of the United States Coast and Geodetic Survey in the *American Journal of Science* for September last.

The tendency of the rod of a torsion balance to set east and west was pointed out by Baron Eötvös in one of his early papers, probably one of those presented to the International Geodetic Conference, but I am not able to lay my hands on the exact reference.

E. H. GROVE-HILLS.

Ophion luteus.

IT is a quite common experience to see *Ophion luteus* fly into houses at night attracted by light. I have myself captured at least half a dozen specimens that had in a single hour flown into a room in that way. Not long ago Dr. James Waterston, at my request, dissected a fresh female specimen, and found in it a poison gland, reservoir, and duct similar in character to those recorded as being present in certain other species of Ichneumonidæ.

M. R. du Buysson, in a paper (*Rev. d'Entomologie*, vol. 11, p. 257, 1892) which I have only recently seen, states that he had often been stung by Ichneumonidæ of the Ichneumon, Pimpla, and Ophion groups; but however much poison may have been injected, the pain and inflammation produced by the sting, he says, lasted only a short time. He dissected a large number of specimens belonging to all the groups of Ichneumonidæ, and always found one or several poison glands present.

The larvæ of *Ophion luteus* appear to be parasitic in the caterpillars of many different species of Lepidoptera; but it would appear to be the case also that the female does not pierce the skin of the caterpillar to lay her eggs inside. She is said to lay them on the skin. That point probably needs confirmation. But however that may be, it seems to me incredible that the female would mistake the arm of a young lady for a caterpillar. In M. du Buysson's case, the insect had always been held in the hand or otherwise irritated before it attempted to sting, and this seems to be the general experience. He was never puzzled to divine the purpose of the sting, regarding it, no doubt, simply as an act of self-defence; and that is the explanation which I would venture to suggest in reply to Sir Herbert Maxwell's letter in NATURE of November 10.

C. J. GAHAN.

Natural History Museum, S.W.7, November 14.

IN respect of Sir Herbert Maxwell's letter in NATURE of November 10 on *Ophion luteus*, Linn., may we hope that the insect caught *flagrante delicto* was preserved in order that the species might be placed beyond a doubt, these large red Ophionidæ being almost impossible to differentiate at a glance?

Ophion luteus is apparently a nocturnal insect. I have observed it at night hunting for Dianthœcia larvæ. The species is credited with a long list of hosts, chiefly Noctuid moth caterpillars.

Almost all Ichneumonidæ will "sting" or attempt to if handled, the males included (though, of course, morphologically incapable), but that any member should make an attack unprovoked is most unusual. *O. luteus* and allied species are extremely bad-tempered—a fact which hampers work with them in confinement, as they repeatedly "sting" potential hosts to death without attempting to parasitise them. Perhaps this irritability was the cause of the unusual attack.

R. STENTON.

Pathological Laboratory, Ministry of Agriculture, Harpenden, November 19.

Sex-manifestation and Motion in Molluscs.

I DO not wish to prolong the discussion upon sex-differentiation and mode of life, though I venture to think that Dr. Orton's reply in NATURE of November 3 to my letter in the issue of October 13 leaves several questions very much as they were before.

On many points I find myself in agreement with Dr. Orton, though I consider that the incidence of sex-differentiation in the Mollusca does not exhibit that general correlation with an active habit demanded by Dr. Orton's hypothesis. I quite agree, as I said in my previous letter, that many forms originally considered diœcious *may* be monœcious; but I think it is for Dr. Orton to prove this, and I shall await his demonstration with interest. I would like to point out, however, that it will not be enough to show *sex-change* (a turnover from maleness to femaleness, or *vice versa*). The implications of Dr. Orton's hypothesis entitle me to demand from him something in the nature of *permanent* hermaphrodite forms.

G. C. ROBSON.

Natural History Museum, S.W.7, November 14.

Sinistral Limnaea peregra.

LAST year I started a breeding experiment with two pairs of sinistral *Limnaea peregra* given me by Mr. J. W. Taylor, of Leeds. The first two generations have not come out on any plain plan, and it is necessary to carry them further if the mode of inheritance of this very rare form of one of our commonest freshwater snails is to be worked out. But the young have now quite outgrown the possibilities of my establishment, and if anyone would take over some of them and breed them out (which is quite simple, as they want little attention) they would be doing me a service.

A. E. BOYCOTT.

University College Hospital Medical School, University Street, Gower Street, W.C.1, November 7.

Some Problems in Evolution.[1]

By PROF. EDWIN S. GOODRICH, F.R.S.

IT was nearly one hundred years ago that Charles Darwin began his scientific studies in the University of Edinburgh. No more fitting subject, I think, could be found for an address than certain problems relating to his doctrine of evolution. Perhaps the best way of treating these general subjects is by trying to answer some definite questions. For instance, we may ask: "Why are some characters inherited and others not?" By characters we mean all those qualities and properties possessed by the organism, and by the enumeration of which we describe it: its weight, size, shape, colour, its structure, composition, and activities. Next, what do we mean by "inherited"? It is most important, if possible, clearly to define this term, since much of the controversy in writings on evolution is due to its use by various authors with a very different significance—sometimes as mere reappearance, at other times as actual transmission or transference from one generation to the next. Now, I propose to use the word inheritance merely to signify the reappearance in the offspring of a character possessed by the ancestor—a fact which may be observed and described, regardless of any theory as to its cause. Our question, then, is: "Why do some characters reappear in the offspring and others not?"

It is sometimes asserted that old-established characters are inherited, and that newly-begotten ones are not, or are less constant, in their reappearance. This statement will not bear critical examination. For, on one hand, it has been conclusively shown by experimental breeding that the newest characters may be inherited as constantly as the most ancient, provided they are possessed by both parents.[2] While, on the other hand, few characters in plants can be older than the green colour due to chlorophyll, yet it is sufficient to cut off the light from a germinating seed for the greenness to fail to appear. Again, ever since Devonian times vertebrates have inherited paired eyes; yet, as Prof. Stockard has shown, if a little magnesium chloride is added to the sea-water in which the eggs of the fish Fundulus are developing, they will give rise to embryos with one median Cyclopean eye! Nor is the suggestion any happier that the, so to speak, more deep-seated and fundamental characters are more constantly inherited than the trivial or superficial. A glance at organisms around us, or the slightest experimental trial, soon convinces us that the apparently least-important character may reappear as constantly as the most fundamental. But while an organism may live without some trivial character, it can rarely do so when a fundamental character is absent, hence such incomplete individuals are seldom met in Nature.

Yet undoubtedly some characters reappear without fail and others do not. If it is neither age nor importance, what is it that determines their inheritance? The answer is that for a character to reappear in the offspring it is essential that the germinal factors and the environmental conditions which co-operated in its formation in the ancestor should both be present. Inheritance depends on this condition being fulfilled. For all characters are of the nature of responses to environment[3]; they are the products or results of the interaction between the factors of inheritance (germinal factors) and the surrounding conditions or stimuli. This power of response or reaction is no mysterious property of organisms—it is the effect produced, the disturbance brought about by the application of a stimulus. All the special properties and activities of living organisms utimately depend on their metabolism, of which growth and reproduction are the chief manifestations. The course of metabolism, and, consequently, the development in the individual of a character, is moulded or conditioned by the environmental stimuli under which it takes place. On the other hand, the living substance, protoplasm, which is undergoing metabolism is the material basis of the organism. It has a specific composition and structure peculiar to the particular kind of organism concerned, and this is handed on to the offspring in the germ-cells from which starts the new generation. The inheritance of a character is due, then, not only to the actual transmission or transference of this specific "germ-plasm" containing the same factors of inheritance (germinal factors) as those from which the parent developed, but also to this factorial complex developing under the same conditions (environmental stimuli), as those under which the parent developed. Any alteration either in the effective environmental stimuli or in the germinal factors will produce a new result, will give rise to a new character, will cause the old character to appear no longer.

Now what is actually transmitted from one generation to the next is the complex of germinal factors. Hence we should carefully distinguish between transmission and inheritance. Much of the endless confusion and interminable controversies about the inheritance of so-called "acquired characters" is due to the neglect of this important distinction. For it is quite clear that whereas factors may be transmitted, characters as such never are. The characters of the adult, being responses, are not present as such

[1] Abridged from the presidential address delivered to Section D (Zoology) of the British Association at Edinburgh on September 8.

[2] We purposely set aside complications due to hybridisation and Mendelian segregation, which do not directly bear on the questions at issue.

[3] In a letter to NATURE Sir Ray Lankester long ago directed attention to the importance of this consideration when discussing inheritance. He also pointed out that Lamarck's first law, that a new stimulus alters the characters of an organism, contradicts his second law, that the effects of previous stimuli are fixed by inheritance. (NATURE, vol. 51, 1894.)

in the fertilised ovum from which it develops, they are produced anew at every generation.[4] No distinction in kind or value can be drawn between characters.

If some are inherited regularly and others are not, the distinction lies not in the nature or mode of production of the characters themselves, but in the constancy of the factors and conditions which give rise to them. Thus, although there is only one kind of character, there are two kinds of variation.

Much of the confusion in evolutionary literature is, I think, due to the use of the word variation in a loose manner. Sometimes it is taken to mean the degree of divergence between two individuals; sometimes the character itself in which they differ, such as a colour or spot on a butterfly's wing; at other times a variety or race differing from the normal form of the species. If clearness of thought and expression is to be attained, the word variation should mean the extent or degree of difference between two individuals or between an individual and the average of the species, the divergence of the new form from the old; not a new character or assemblage of characters, but a difference which can be measured or at least estimated. We shall then find that a variation is of one of two kinds (which may, of course, be combined): the first kind is due to some change in the complex of effective environmental stimuli, the second to some change in the complex of germinal factors.

The second kind, to which the name mutation has been applied, will, under constant conditions, be inherited since the new complex of factors will be transmitted to subsequent generations. The first kind of variation, which has been called a modification, will also be inherited, provided, of course, the change of stimulus persists. In either case, new characters will result. But here, again, we must be careful not to apply the terms mutation and modification to the characters themselves, as is so often done[5]; for we then reintroduce the confusion already exposed in the popular but misleading distinction between "acquired" and "non-acquired" characters. The characters due to mutation or modification are, of course, indistinguishable by mere inspection, and can only be separated by experiment. A mutation once established should give rise, under uniform conditions, to a new heritable character, and may be detected by crossing with normal members of the species.

So far observations and tests have shown that new characters due to modification only reappear so long as the new stimulus persists. The difference lies not in the value or permanence of the new character, but in the causes which give rise to it.[6]

It is little more than a platitude to state that for the production of an organism or of any of its characters both germinal factors and environmental stimuli are necessary, and that if evolution is to take place there must be change in one or both. Yet the changes in the factors may be held to be the more important. In an environment which on the whole alters but little, evolution progresses by the cumulation along diverging lines of adaptation of new characters due to mutation. Thus natural selection indirectly preserves those factorial complexes which respond in a favourable manner. In other words, an organism, to survive in the struggle for existence, must present that assemblage of factors of inheritance which, under the existing environmental conditions, will give rise to advantageous characters.

In answer to a further question, let us now try to explain what we mean when we contrast the organism with its environment. In its simplest and most abstract form a living organism may be likened to a vortex. That mixture of highly complex proteins we call protoplasm, the physical basis of life, is perpetually undergoing transformations of matter and energy, so long as life persists. Towards the centre of the vortex the highest compounds are continually being built up and continually being broken down; new material (food, water, oxygen) and energy are brought in at the periphery, and old material and energy (work and heat) thrown out. The principle of the conservation of energy and matter holds good in organised living processes as it does in the inorganic world outside. This is the process we call metabolism, and it is at the base of all the manifestations of life. From the point of view of biological science life is founded on a complex and continuous physico-chemical process of endless duration so long as conditions are favourable; just as a fire will continue to burn so long as fuel is at hand. No one step, no single substance, can be said to be living: the whole chain of substances and reactions, every link of which is essential, constitutes the life-process. A stream of non-living matter with stored-up energy is built up into the living vortex, and again passes out as dead matter, having yielded up the energy necessary for the performance of the various activities of the organism. If more is taken in than is given out it will grow and sub-divide. The complexity of the organism may increase by the formation of subsidiary, more or less interdependent, vortices within it. The perpetual growth and transmission of factors of inheritance, the continuity of the germ-plasm, is but another aspect of the continuity of the metabolic process forming the basis of the continuity of life in evolution.

But all environmental stimuli are not external

[4] In other words, all characters are "acquired during the lifetime of the individual," and "inherited" in the sense here defined has just the same meaning. Much the same view was advocated by Prof. A. Sedgwick in his address to this Section at Dover in 1899, and it has also been developed by Sir Archdall Reid and others.

[5] The name "mutation" might be given to the alteration in the factors instead of the variation due to it. The latter might then be termed a mutational variation and would be opposed to a modificational variation. At present the term "mutation" is applied to three different things: the actorial change, the variation or difference, and the new product, response for character.

[6] We might perhaps distinguish the two cases by calling them constant and inconstant characters, or "natural" and "acquired," as is commonly done when describing immunity. It should be meant thereby that one is acquired usually (under normal conditions), the other occasionally (when infection occurs). Error creeps in when the term "acquired" is opposed to "non-acquired" or to "inherited."

to the organism. Just as the various steps in the metabolic process are dependent on those which preceded them, so when an organism becomes differentiated into parts, when the main process becomes sub-divided into subsidiary ones, these react on each other. What is internal to the whole becomes external to the part. An external stimulus may set up an internal metabolic change, giving rise to a response the extent and nature of which depend on the structure of the mechanism and its state when stimulated, that is to say, on the effect of previous responses. Such a response may act as an internal stimulus giving rise to a further response, which may modify the first, and so on. Parts thus become marvellously fitted to set going, inhibit, or regulate each other's action; and thus arises that power of individual adaptation, or self-regulation, so characteristic of living organisms. The processes of temperature regulation, of respiration, of excretion are examples of such delicate self-regulating mechanisms in ourselves. But one of the great advantages thereby gained by organisms is that they can regulate their own growth and ensure their own "right" development. Whereas the simplest plants and animals are to a great extent, so to speak, at the mercy of their external environment, except in so far as they can move from unfavourable to more favourable surroundings; whereas their characters appear in response to external stimuli which may or may not be present, and over which they have little or no control—the higher organisms (more especially the higher animals), as it were, gradually substitute internal for external stimuli. Food material is provided in the ovum, and the size, structure, and time of appearance of various characters are regulated to a great extent by use and by the secretions of various endocrinal glands, the action of which has been so successfully studied, among others, by Sir E. Sharpey Schafer in this university. Thus, as is well shown in man, the higher animals acquire considerable independence, and are little affected in their development by minor changes of environment. Inheritance is thus made secure by ensuring that the necessary conditions are always present.

We may seem to have wandered far from our original question; but the answer now appears to be that only those characters can be regularly inherited which depend for their appearance on conditions always fulfilled in the normal environment (external or internal); and those characters will not be regularly inherited which depend on stimuli that may or may not be present.

Now it will be said, and not without some truth, that all this is mere commonplace admitted by all; but, if so, it is, I think, often ignored or misunderstood in discussions on heredity, more especially in semi-popular writings, and sometimes even in scientific works. However, I quite willingly admit that the real problems Darwin left to be solved by the evolutionist are the nature of the germinal factors themselves, and more especially the origin of the differences between them, the origin of those changes which give rise to mutations.

That these factors[7] must at least be self-propagating substances, subsidiary vortices in the main stream of metabolising living protoplasm, is certain, since they grow and multiply repeatedly, to be distributed to new generations of germ-cells. That they may be relatively constant and remain unaltered for generations seems also certain, since organisms or their parts can continue almost unchanged for untold ages. That they can act independently, can be separately distributed into different germ-cells, and can be re-combined seems likewise to have been proved by the brilliant work of Mendel and his followers. So independent and constant do they appear to be that modern students of heredity tend to treat them as so many beads in a row, as separate particles themselves endowed with all the properties of independent living organisms, the very properties we wish to explain. While not prepared to accept these views without qualification, it seems to me that it can scarcely be doubted that some such units must exist whether in the form of discrete particles or merely of separable substances. But not until these factors have been brought into relation with the general metabolism of the organism, as links in the chain of processes, will the problem of inheritance approach solution. If the theory is to be completed it must attempt to explain how they come to differ, how their orderly behaviour is regulated, in what functional relation they stand to each other, what is the metabolic bond between them. That harmonious processes may be carried out by discrete elements in cooperation is shown in cases of symbiotic combinations such as the lichens, or the green algæ in such animals as Hydra and Convoluta. Here an originally independent organism takes its place and does its work regularly in another organism, and may even be propagated and transmitted from one generation to the next in the germ-cell! Most instructive, also, are the recently studied cases of bacteria and yeasts living regularly in certain special tissues of various species of insects, where they exert a definite influence on the metabolism (see the works of Pierantoni, Buchner, Glaser). These no doubt are mere analogies, but they serve.

In all probability, then, factors of inheritance exist, and the fundamental problem of biology is how are the factors of an organism changed, or how does it acquire new factors? In spite of its vast importance, it must be confessed that little advance has been made towards the solution of this problem since the time of Darwin, who considered that variation must ultimately be due to the action of the environment. This conclusion is inevitable, since any closed system will reach

[7] Herbert Spencer's "physiological units," Darwin's "pangens," Weismann's "determinants," are all terms denoting factors, but with somewhat different meanings. More recently Prof. W. Johannsen ("Elemente der exakten Erblichkeitslehre," 1909) has proposed the term "gene" for a factor, "genotype" for the whole assemblage of factors transmitted by a species, and "phenotype" for the characters developed from them. This clear system of nomenclature, although much used in America, has not been generally adopted in this country.

a state of equilibrium and continue unchanged, unless affected from without. To say that mutations are due to the mixture or re-shuffling of pre-existing factors is merely to push the problem a step farther back, for we must still account for their origin and diversity. The same objection applies to the suggestion that the complex of factors alters by the loss of certain of them. To account for the progressive change in the course of evolution of the factors of inheritance and for the building up of the complex it must be supposed that from time to time new factors have been added; it must further be supposed that new substances have entered into the cycle of metabolism, and have been permanently incorporated as self-propagating ingredients entering into lasting relation with pre-existing factors. We are well aware that living protoplasm contains molecules of large size and extraordinary complexity, and that it may be urged that by their combination in different ways, or by the mere re-grouping of the atoms within them, an almost infinite number of changes may result, more than sufficient to account for the mutations which appear. But this does not account for the building up of the original complex. If it must be admitted that such a building process once occurred, what right have we to suppose that it ceased at a certain period? We are driven, then, to the conclusion that in the course of evolution new material has been swept from the banks into the stream of germ-plasm.

Let it not be thought for a moment that the admission that factors are alterable opens the door to a Lamarckian interpretation of evolution! According to the Lamarckian doctrine, at all events in its modern form, a character would be inherited after the removal of the stimulus which called it forth in the parent. Now of course, a response once made, a character once formed, may persist for longer or shorter time according as it is stable or not; but that it should continue to be produced when the conditions necessary for its production are no longer present is unthinkable. It may, however, be said that this is to misrepresent the doctrine, and that what is really meant is that the response may so react on and alter the factor as to render it capable of producing the new character under the old conditions. But is this interpretation any more credible than the first?

Let us return to the possible alteration of factors by the environment. Unfortunately there is little evidence as yet on this point. In the course of breeding experiments the occurrence of mutations has repeatedly been observed, but what led to their appearance seems never to have been so clearly established as to satisfy exacting critics. Quite lately, however, Prof. M. F. Guyer, of Wisconsin, has brought forward a most interesting case of the apparent alteration at will of a factor or set of factors under definite well-controlled conditions.[8] You will remember that if a tissue substance, blood-serum for instance, of one animal be injected into the circulation of another, this second individual will tend to react by producing an anti-body in its blood to antagonise or neutralise the effect of the foreign serum. Now Prof. Guyer's ingenious experiments and results may be briefly summarised as follows. By repeatedly injecting a fowl with the substance of the lens of the eye of a rabbit he obtained anti-lens serum. On injecting this "sensitised" serum into a pregnant female rabbit it was found that, while the mother's eyes remained apparently unaffected, some of her offspring developed defective lenses. The defects varied from a slight abnormality to almost complete disappearance. No defects appeared in untreated controls; no defects appeared with non-sensitised sera. On breeding the defective offspring for many generations these defects were found to be inherited, even to tend to increase and to appear more often. When a defective rabbit is crossed with a normal one the defect seems to behave as a Mendelian recessive character, the first generation having normal eyes and the defect reappearing in the second. Further, Prof. Guyer claims to have shown that the defect may be inherited through the male as well as the female parent, and is not due to the direct transmission of anti-lens from mother to embryo *in utero*.

If these remarkable results are verified, it is clear that an environmental stimulus, the anti-lens substance, will have been proved to affect not only the development of the lens in the embryo, but also the corresponding factors in the germ cells of that embryo; and that it causes, by originating some destructive process, a lasting transmissible effect giving rise to a heritable mutation.

Prof. Guyer, however, goes farther, and argues that, since a rabbit can also produce anti-lens when injected with lens substance, and since individual animals can even produce anti-bodies when treated with their own tissues, therefore the products of the tissues of an individual may permanently affect the factors carried by its own germ-cells. Moreover he asks, pointing to the well-known stimulative action of internal secretions (hormones and the like), if destructive bodies can be produced, why not constructive bodies also? And so he would have us adopt a sort of modern version of Darwin's theory of pangenesis, and a Lamarckian view of evolutionary change.

But surely there is a wide difference between such a poisonous or destructive action as he describes and any constructive process. The latter must entail, as I tried to show above, the drawing of new substances into the metabolic vortex. Internal secretions are themselves but characters, products (perhaps of the nature of ferments) behaving as environmental conditions, not as self-propagating factors, moulding the responses, but not permanently altering the fundamental structure and composition of the factors of inheritance.

[8] *American Naturalist*, vol. 55, 1921; *Jour. of Exper. Zoology*, vol. 31, 1920.

Moreover, the early fossil vertebrates had, in fact, lenses neither larger nor smaller on the average than those of the present day. If destructive anti-lens had been continually produced and had acted, its effect would have been cumulative. A constructive substance must, then, have also been continually produced to counteract it. Such a theory might perhaps be defended; but would it bring us any nearer to the solution of the problem?

The real weakness of the theory is that it does not escape from the fundamental objections we have already put forward as fatal to Lamarckism. If an effect has been produced, either the supposed constructive substance was present from the first, as an ordinary internal environmental condition necessary for the normal development of the character, or it must have been introduced from without by the application of a new stimulus. The same objection does not apply to the destructive effect. No one doubts that if a factor could be destroyed by a hot needle or picked out with fine forceps the effects of the operation would persist throughout subsequent generations. Nevertheless, these results are of the greatest interest and importance.

There remains another question we must try to answer before we close, namely, "What share has the mind taken in evolution?" From the point of view of the biologist, describing and generalising on what he can observe, evolution may be represented as a series of metabolic changes in living matter moulded by the environment. It will naturally be objected that such a description of life and its manifestations as a physico-chemical mechanism takes no account of mind. Surely, it will be said, mind must have affected the course of evolution, and may indeed be considered as the most important factor in the process. Now, without in the least wishing to deny the importance of the mind, I would maintain that there is no justification for the belief that it has acted or could act as something guiding or interfering with the course of metabolism. This is not the place to enter into a philosophical discussion on the ultimate nature of our experience and its contents, nor would I be competent to do so; nevertheless, a scientific explanation of evolution cannot ignore the problem of mind if it is to satisfy the average man.

Let me put the matter as briefly as possible at the risk of seeming somewhat dogmatic. It will be admitted that all the manifestations of living organisms depend, as mentioned above, on series of physico-chemical changes continuing without break, each step determining that which follows; also that the so-called general laws of physics and of chemistry hold good in living processes. Since, so far as living processes are known and understood, they can be fully explained in accordance with these laws, there is no need and no justification for calling in the help of any special vital force or other directive influence to account for them. Such crude vitalistic theories are now discredited, but tend to return in a more subtle form as the doctrine of the interaction of body and mind, of the influence of the mind on the activities of the body. But, try as we may, we cannot conceive how a physical process can be interrupted or supplemented by non-physical agencies. Rather do we believe that to the continuous physico-chemical series of events there corresponds a continuous series of mental events inevitably connected with it; that the two series are but partial views or abstractions, two aspects of some more complete whole, the one seen from without, the other from within, the one observed, the other felt. One is capable of being described in scientific language as a consistent series of events in an outside world, the other is ascertained by introspection, and is describable as a series of mental events in psychical terms. There is no possibility of the one affecting or controlling the other, since they are not independent of each other. Indissolubly connected, any change in the one is necessarily accompanied by a corresponding change in the other. The mind is not a product of metabolism as materialism would imply, still less an epiphenomenon or meaningless by-product as some have held. I am well aware that the view just put forward is rejected by many philosophers, nevertheless it seems to me to be the best and indeed the only working hypothesis the biologist can use in the present state of knowledge. The student of biology, however, is not concerned with the building up of systems of philosophy, though he should realise that the mental series of events lies outside the sphere of natural science.

The question, then, which is the more important in evolution, the mental or the physical series, has no meaning, since one cannot happen without the other. The two have evolved together *pari passu*. We know of no mind apart from body, and have no right to assume that metabolic processes can occur without corresponding mental processes, however simple they may be.

Simple response to stimulus is the basis of all behaviour. Responses may be linked together in chains, each acting as a stimulus to start the next; they can be modified by other simultaneous responses, or by the effects left behind by previous responses, and so may be built up into the most complicated behaviour. But, owing to our very incomplete knowledge of the physico-chemical events concerned, we constantly, when describing the behaviour of living organisms, pass, so to speak, from the physical to the mental series, filling up the gaps in our knowledge of the one from the other. We thus complete our description of behaviour in terms of mental processes we know only in ourselves (such as feeling, emotion, will) but infer from external evidence to take place in other animals.

In describing a simple reflex action, for instance, the physico-chemical chain of events may appear to be so completely known that the corresponding mental events are usually not mentioned at all, their existence may even be denied. On the contrary, when describing complex behaviour when impulses from external or internal stimuli modify each other before the final result is translated into action, it is the intervening physico-chemical processes which are unknown and perhaps ignored, and the action is said to be voluntary or prompted by emotion or the will.

The point I wish to make, however, is that the actions and behaviour of organisms are responses, are characters in the sense described in the earlier part of this address. They are inherited, they vary, they are selected, and evolve like other characters. The distinction so often drawn by psychologists between instinctive behaviour said to be inherited and intelligent behaviour said to be acquired is as misleading and as little justified in this case as in that of structural characters. Time will not allow me to develop this point of view, but I will only mention that instinctive behaviour is carried out by a mechanism developed under the influence of stimuli, chiefly internal, which are constantly present in the normal environmental conditions, while intelligent behaviour depends on responses called forth by stimuli which may or may not be present. Hence, the former is, but the latter may or may not be inherited. As in other cases, the distinction lies in the factors and conditions which produce the results. Instinctive and intelligent behaviour are usually, perhaps always, combined, and one is not more primitive or lower than the other.

It would be a mistake to think that these problems concerning factors and environment, heredity and evolution, are merely matters of academic interest. Knowledge is power, and in the long run it is always the most abstruse researches that yield the most practical results. Already, in the effort to keep up and increase our supply of food, in the constant fight against disease, in education, and in the progress of civilisation generally, we are beginning to appreciate the value of knowledge pursued for its own sake. Could we acquire the power to control and alter at will the factors of inheritance in domesticated animals and plants, and even in man himself, such vast results might be achieved that the past triumphs of the science would fade into insignificance.

Mount Everest.

By LIEUT.-COL. H. H. GODWIN-AUSTEN, F.R.S.

IN the issue of NATURE of March 31 last, p. 137, I offered some remarks on the Mount Everest Expedition. I have now been asked to give some account of the progress made by the recent expedition, and to point out some facts of interest to men of science. I have some hesitation in doing this, as so much has been written by able officers, such as Brig.-Gen. the Hon. C. G. Bruce (*Geographical Journal*, January, 1921) and Major H. T. Morshead (Survey of India, March, 1921), who have done more and been at greater heights than myself.

The news which has come regularly and rapidly through the *Times* reports tells of signal success; fine work has been done, and a difficult task faced with all the enthusiasm such an expedition can create. Enthusiasm for mountain reconnaissance was displayed on the lamentable death of Dr. A. M. Kellas on June 5 at Kampa Dzong, one of the first to join the expedition; in truth, he was already worn out by previous exposure. He gave his life, but not before his knowledge of Himalayan travel and what the native porter can do must have been of inestimable value. Now the expedition has completed its first season's work with the object of reaching next year a point as high as possible on its flank, I can better attempt to show what there is of interest not generally known, what the great height of Everest indicates, and how much it is bound up with the physical features of a vast area and with the geology of the same. There is something more than Mount Everest being the highest peak in the world which is bringing it rather suddenly into notice and proving of interest to the general public. This something I hope to bring before the reader and increase his interest.

I am envious of the good fortune of those who may stand on the flank of Mount Everest. They will, indeed, be fortunate men, for, with a clear horizon, they will look over the world laid out before them; still more fortunate they will be if they can ponder on the many problems it presents. Would that we could recall Sir Joseph Hooker with his knowledge and power of observation. We must not forget what he accomplished with limited means—his mapping and botanical record; indeed, few books of travel are on a level with his "Himalayan Journals."

I would ask the reader first of all to look at a good map of India, noting particularly the scale of miles to an inch on which it is compiled. First, I would direct attention to the peak's association with a gigantic geodetical undertaking, the measurement of an arc of the meridian or the great arc series of triangulation which, starting at Cape Comorin, was carried for 1500 miles to Banog at the base of the Himalaya—systematic work too technical to explain here. It was the conception of Col. Sir George Everest, R.E., when Surveyor General of India, assisted by his successor, Col. Sir Andrew Waugh, R.E. Exact triangulation gives us the true latitude, longitude, and height of the many lofty peaks on the far-off Himalayan chain, with the names and position of which the public are becoming familiar. Among them Everest is the culminating point, 29,202 ft. above sea-level. The great geodesist, George Everest, introduced compensation bars in the measurement of base lines, and measured many with marvellous exactitude; he perfected instruments and produced a theodolite with a circle of 36 in. diameter; he invented also the heliotrope to supersede the pole when observing angles. The Survey of India owes everything to his creative genius, and Mount Everest is the finest monument to his memory. More than this, the survey now in progress in Thibet under Col. D. Ryder, R.E., the present Surveyor General of India, is extending the triangulation to the north, so that of the great arc may follow and be continued many miles further. Pendulum observations will also be feasible, and all will combine to give us a greater knowledge of the figure of the earth's crust and of those irregularities which cause the deviation of the plumb line from its normal direction.

Mount Everest, in common with all lofty points, looks over many thousand square miles of the earth's surface, which has seen enormous changes with which the height of the mountain itself is closely connected. For instance, the Garo Hills are seen from it, 250 miles distant on the south-east. They mark the western extremity of the Assam Range, one which is geologically recent and of elevation corresponding with that of the Sivaliks in Nepal which Everest overlooks. The view will embrace the great deltas of the Ganges and Brahmaputra; the courses of the main rivers will be followed by their wide, sandy beds as they issue from the mountains and flow to the sea, displayed as on a map—and what a changing map it has been—how affected by seismic action—a map of absorbing interest. Mount Everest is close upon the southern face or scarp of what may be termed an ancient plateau of denudation, well shown in Photograph 5 reproduced in the *Geographical Journal* for October, which depicts what we see at the present day, a surface configuration after thousands of years of wear and tear. The high plateau type of country of great elevation, none of it below 14,000 ft., can be said to commence in Rupshu, is continued on the Pangkong Lake, and widens out rapidly in Rudok. It is fairly well populated by a hardy race having many good qualities; crops are raised with difficulty, but enormous flocks and herds are reared. Denudation began with the very earliest Sivalik deposits, and continued until a quite recent Glacial period, one of extreme conditions. Even here, in latitude 28°, the glaciers were of great extent, though nothing compared with the lengths they attained in the north-west Himalaya when the Indus valley at Skardo was filled with ice and moraines, and even in the valley of Kashmir, latitude 34°, the Sind valley glacier extended to the valley itself not far from Srinagar, and was some forty miles long. Although hundreds of travellers pass up and down this beautiful valley, how very few of them know of this, yet the rocks, ground by the ice and striated by the stones which were embedded in it, are clearly to be seen.

During the Glacial period a great ice cap covered all the country here; and the work it performed is shown in the rounded outline of the spurs given off from Mount Everest.

In the letter of October 2 from Kharta, published in the *Times* of October 21, we have the first record of the geological structure of the Everest mass. It is short but worthy of notice. Col. Howard Bury says: "Immediately to our left towered up Makalu's great cliffs of white granite, so steep as to be snow free; it is a most imposing and marvellous mountain, looking incredibly thin, so perpendicular are its sides." Is this granite intrusive? Judging by analogy, it is. What Everest is composed of we have yet to learn. We have some data to guide us in Sir Joseph Hooker's diary of the Tambar valley at its southern end, where, on the Pemmi River, at about 2260 ft., he recorded ("Himalayan Journals," vol. 1, p. 192, 1854): "The rocks above 5000 feet were gneiss; below this cliffs of very micaceous schists were met with, having a north-west strike and being often vertical; the boulders again were always of gneiss." This strike (the prevailing one in this area) would extend towards Everest, and indicates what may be expected there.

The valley of Nepal came into existence with the great movements in late Tertiary times, when the Sivaliks were compressed and elevated on a belt of 1500 miles. A roll in the strata formed the Dun through which the waters of the Kosi and Gandak, keeping pace with the elevation, slowly cut their exit to flow into the ancient depression of the Bay of Bengal. The Nepal valley is therefore, in its physical features, similar to that of Assam on a very much smaller scale; that of the Deyra Dun is on a still smaller one. Looking to the Sikkim side, situated only fifteen miles from the plains, and towering above them, is the conspicuous point Gyepmochi, 14,418 ft. high. I know it well; it is of intrusive granite. It is connected with Kangchenjunga by the high, parting range, crossed at the Jalap La. Chamalarhi, 23,930 ft., which is seen from this direction on the north, has been said to be of an intrusive rock.

Going back to the Glacial period, it is worthy of notice, as not generally known, that from Gyepmochi deposits of morainic type extend to the plain of the Bhutan Dooars. A stream of large blocks of granite (one 10 ft. long) can be followed for eight miles, and is a conspicuous feature. A similar extension of ice action may be looked for south of Mount Everest, but not at so low a level, in the Nepal valley.

The next main valley beyond Gyepmochi, having its sources in Thibet, is the Am-mochu. The scarp lies south of Chumbi, as is shown in the steep fall in the bed of the river to Tsangbe. As it nears the plains it flows directly on to them; there is no Dun, but a massive limestone of unknown age brought up by a great fault occurs at

Balla, and thence, by the name of the Bura Torsa in the plains, the stream goes to join the Brahmaputra opposite the Garo Hills. Curiously enough, the Sivalik or Tertiary formation is absent at Balla, but it may be hidden beneath the recent alluvium. For twenty-five miles it is not visible, but at Buxar the Sivaliks suddenly reappear in considerable thickness, and contain abundant fossilised boughs of trees, indicating a forest-clad country on the north when they were laid down. These sandstones continue without a break and with varying breadth to far-distant Eastern Assam at the base of the Abor Hills.

To see the Tertiaries again as exemplifying the extent of Himalayan denudation one has to cross the broad alluvial valley of the Brahmaputra some 100 miles south, where they lie up against the Assam Range and contiguous to the intrusive granite there. They can be followed to Sylhet, to Jaintia, and the Naga Hills, rising in altitude until they reach in the latter country a height of 10,000 ft., the whole thickness being exposed from base upwards. The geological evidence goes to show that this late elevation of the Assam Range diverted the direct courses of the Subansiri and Tsanspu of Thibet which originally flowed through Burma to the sea into the present less direct route into the Bay of Bengal, and completely altered the ancient geography, and particularly the features of the Gangetic Delta.

I have mentioned granite intrusion. This leads me to refer to a very recent contribution in the Journal of the Geographical Society, September, 1921, p. 199, by Col. Sir Sydney Burrard, "On the Origin of Mountain Ranges." He asks: "Have they been elevated by horizontal compression of the surface, or by vertical uplift from below?" Further on: "It is difficult to be satisfied with the theory that mountains have arisen from horizontal compression, and we have to face the question: What is the force that has raised mountains?" (in this case the Himalaya). Again, on p. 200: "The highest summits are generally composed of granite, and the granite masses are believed to have risen out of the crust." I follow and agree with him, adding that actual observation is better than the many theories that have been put forward, such as that of Col. E. A. Tandy, R.E., "that falling stones sink by their own weight into the crust as though the latter were molten."

In Baltistan I was first struck by the evidence that the granite was intrusive, and I had the support of Gen. McMahon (*Geological Magazine*, 1897, p. 304), and discussed it with him. I came to the conclusion that granite intrusion has done more to elevate the Himalayas than any other force. It penetrates the metamorphic rocks, and has carried them up with it, and it can be followed for an enormous distance on the outer face of the great range, though always in the same relative zone.

In Nepal we have no data to go by, but at the Kali River, in longitude 80°, the granite—evidently intrusive—mapped by Capt. Herbert in 1815, after the Nepal War, is a conspicuous feature at Nynee Tal. The well-known Chor Peak near Simla extends it, while at Dharmsala is the most remarkable out-pouring forming the Dhauladhar, where, as the late Gen. C. A. McMahon points out, it is twelve miles broad. The Chatadhar extension, where I have seen and mapped it myself, is seven miles broad—where it has carried up the Nummulitic formation to the crest of the range—and in its plastic-looking state appears to lie above the Eocene and Pleistocene formations, compressing them and turning them over to a high, reversed dip. With such breadths of intrusion we have not far to go to find a cause for the folding and faulting of the Sivaliks rocks. In Kashmir similar granite intrusion is met with on the Pir Panjal and on the Kajnag Range west of Baramulla, up to Mozufferabad, with inversion of the Eocene on the south.

In the *Times* report of October 21 are the truly sensational headlines, "Wild Hairy Men," "Human Footprints." I fear the missing link has not yet been found; nevertheless, the observation has interest, and can be explained by the fact that a large species of monkey, probably of the genus Semnopithecus, the Hannman, or Lungur, has found its way from the Nepal side into Thibet, and has been reported to extend north of the Tsanspu. The late Capt. C. G. Rawling, R.E., in his excellent book, "The Great Plateau" (pp. 222, 223), tells how Capt. H. Wood, R.E., saw a troop of monkeys in November at Sangsang, which is nearly due north of Mount Everest; unfortunately, it was too late in the day to follow them and secure a specimen. These animals live there all the year round—a very interesting fact—and to be visible at 500 yards it must be a large species. Even on the slopes of Everest this monkey, which is omnivorous, would find plenty to live on, for the hare found everywhere in this region is abundant and easily caught in its forme after a cold night. A Lungur could in a few hours be down in warmth on the Nepal side, and in all probability the footprints were those of one retiring before the advent of the expedition camp. Mr. Briant H. Hodgson, who was for so many years resident at Katmandoo, brought together a splendid collection of mammals and birds, and he is not likely to have missed the existence of a new monkey in the valley of Nepal. I find that in August, 1834, he exhibited his extensive series of skins of mammalia at a meeting of the Zoological Society of London. An abstract of the species shown is given (Proc. Zool. Soc., p. 95, 1834), and it is stated that *Semnopithecus entellus* of F. Cuvier "has been introduced by religion into the central district (*i.e.* of Nepal), where it flourishes, half-domesticated, in the neighbourhood of temples." What more likely than that it has met the same happy protection in Thibet, the only part of the world where all living creatures can live in peace?

Obituary.

SIR CHARLES DOUGLAS FOX.

ONE of the last representatives of a generation of distinguished engineers, Sir Douglas Fox died on November 13 in his eighty-second year. His father, Sir Charles Fox, had assisted Ericsson in building the "Novelty," one of the three locomotives which competed at Rainhill in 1829, and as a member of the firm of Messrs. Fox, Henderson and Co. constructed the Crystal Palace in Hyde Park in 1850–51.

Articled to his father at the age of seventeen, Sir Douglas Fox acted as resident engineer of the Witney and Ramsey railways. In 1863 he was taken into his father's firm, which still subsists with the title Sir Douglas Fox and Partners. In this relation he was responsible for the construction of the London, Chatham, and Dover, and the London, Brighton, and South Coast Railways. He became consulting engineer to the Queensland Government Railways and to various railways in South Africa. Amongst the latter may be mentioned the Beira Port and Railway, and the Rhodesian railways, and the remarkable bridge over the Zambesi river at the gorge below the Victoria Falls. With Mr. Brunlees Sir Douglas was engineer for the Mersey Tunnel, and with Mr. Greathead for the Liverpool overhead railway, a new type of construction in this country. In the Argentine he was consulting engineer for several railways. When the Manchester, Sheffield and Lincolnshire Railway became the Great Central, Sir Douglas's firm was responsible for the works on the Southern and Metropolitan divisions and the Marylebone terminus. Sir Douglas was interested in the London traffic problem, and constructed the Great Northern and Hampstead tube railways. His firm are consulting engineers to the Channel Tunnel Co.

Sir Douglas Fox was president of the Institution of Civil Engineers in 1899–1900, and received the large party of American civil and mechanical engineers who came to England in that year. He contributed papers to that institution (in collaboration with his brother, Sir Francis Fox, and some of his chief assistants), and took part in important discussions on excavating machines; long-span bridges; broad-gauge, narrow-gauge, and light railways; Indian tramways; break of gauge; resistances on railways; and other subjects.

Sir Douglas Fox took an active part in the foundation of the British Standards Committee (now Association). This is doing an immense work in preventing waste of effort and facilitating production in engineering manufacture.

W. C. U.

PROF. A. S. DELÉPINE.

PROF. AUGUSTE SHERIDAN DELÉPINE, whose death was announced in NATURE last week, was educated in Paris, Geneva, and Lausanne, graduating in science at the last-named. He then proceeded to the University of Edinburgh, where he pursued medical studies, graduating with first-class honours in 1882. His interest from the first centred in pathology and in the then new science of bacteriology, and after acting for a time as demonstrator in these subjects at Edinburgh he settled in London, and soon afterwards was appointed demonstrator of pathology and curator of the museum at St. George's Hospital, where he did excellent work. In 1891 Delépine was appointed the first Procter professor of pathology and morbid anatomy in the University of Manchester. Here he organised the pathological department and designed the new buildings of the department. During his tenure of this professorship he carried out many investigations of a public health character, so that when, twenty years later, a department of public health was established at the University, he resigned the chair of pathology and was appointed to the new chair of public health and bacteriology and to be director of the public health laboratory, posts which he retained until his death.

At the laboratory Prof. Delépine gave instruction to a large number of graduates proceeding to the diploma of public health, some of whom assisted in conducting research work, while others surveyed the health of the district by inquiries and reports upon the incidence and spread of preventable disease. In this way close co-operation was maintained between the laboratory and the public health department of the city.

Among his researches may be mentioned his report to the Local Government Board in 1908 on the prevalence and sources of tubercle bacilli in milk, the connection between summer diarrhœa and food-poisoning (1902), and his report to the Manchester City Council on the conditions necessary to obtain a clean milk supply (1918).

During the war Prof. Delépine did good work in a consultative capacity as sanatarian and bacteriologist, and in particular investigated the nature and prevention of trench-foot, a malady which in the early days of the war was costing the Allied Armies many lives and an enormous amount of disability, and which he showed was due to a combination of damp, cold, and constriction.

Prof. Delépine was a warm and genial friend, and his place will be hard to fill. The tragedy of the loss of his only son during the war doubtless conduced to the ill-health from which he suffered of late.

R. T. H.

M. HENRY BOURGET.

WE regret to announce the death last September, after a long illness, at the age of fifty-seven years, of M. Henry Bourget, director of the Marseilles Observatory. After taking his degree, in which he gained distinction both for literary and mathematical studies, M. Bourget was at Toulouse Observatory for twelve years under M. Baillaud, and carried out a successful programme of stellar photography with the large reflector. He also continued his mathematical researches, obtaining the doctor's degree for a thesis on hyperabelian groups, and helping in the editing of the works of Hermite. He took a large share in the photography of the Toulouse zone of the astrographic catalogue, in the Eros programme of 1900, and observed the total solar eclipses of 1900 and 1905 from Elche and Guelma.

In 1907 M. Bourget became director of the Marseilles Observatory, when he introduced the seismograph, the prism-astrolabe for time determination, and the reception of wireless signals from the Eiffel Tower. He also studied with MM. Fabry and Buisson the internal movements in the Orion nebula. He later introduced the Marseilles Circulars and the *Journal des Observateurs*, which have proved very serviceable for the distribution of information concerning comets and minor planets. A. C. D. C.

THE death of Lieut.-Col. P. G. VON DONOP, which occurred on November 7, at the age of seventy years, is recorded in *Engineering* of November 11. He obtained a commission in the Royal Engineers in 1871, and in 1899 was appointed Inspecting Officer of Railways under the Board of Trade. His name was well known in connection with inquiries into railway accidents.

THE death of Prof. CARLTON JOHN LAMBERT on November 6 is announced in *Engineering* of November 11. Prof. Lambert was seventy-seven years of age, and for several years was professor of mathematics, physics, and mechanics at the Royal Naval College, Greenwich. He was elected an associate member of the Institution of Naval Architects in 1896.

WE regret to see the announcement of the death on November 16 of PROF. P. THOMPSON, professor of anatomy at Birmingham University, at the age of fifty years.

IT is with much regret that we see the announcement of the death, on November 22, at seventy-six years of age, of the distinguished philosopher, M. EMILE BOUTROUX, member of the Institute of France.

Notes.

THE new skull from Rhodesia described by Dr. A. Smith Woodward in last week's NATURE was exhibited by him at a meeting of the Zoological Society on November 22. The skull, which was found in the Broken Hill Mine at a depth of 60 ft. below water-level and 90 ft. below ground-level, is in a remarkably fresh state of preservation. It is much broken on the right side and the lower jaw is missing. The brain-case is of modern human type, and the bone not thicker than that of the ordinary European; the capacity, though not yet accurately determined, is clearly above the lower human limit. The orbits are large and square, with pronounced overhanging ridges much extended laterally. The forward position of the foramen magnum indicates that the skull was poised on an upright trunk. The palate is large, but typically human, and adapted to perfect speech. It is remarkable that the teeth are much affected by caries. The lower jaw must have been massive and larger than the Heidelberg jaw. The appearance of flatness of the frontal area suggests a comparison with *Pithecanthropus erectus*. Dr. Smith Woodward was inclined to find the nearest approach to the Rhodesian skull in the Neanderthal type from La Chapelle aux Saints in France. Though markedly modern in regard to the brain-case, in its facial characters, while it is essentially human, it appears to hold a position between the gorilla and Neanderthal man. Fragments of the long bones, both femur and tibia, which have been found indicate that, unlike Neanderthal man, Rhodesian man walked in a perfectly upright posture. Dr. Smith Woodward regarded Rhodesian man as possibly a later development than Neanderthal man, but Prof. Elliot Smith suggested that he might represent a primitive type of which Neanderthal man might be a highly specialised form.

THE Council of the Institution of Electrical Engineers has elected Lord Southborough to be an honorary member of the institution. Lord Southborough, who is probably better known to men of science as Sir Francis Hopwood, has long been associated with electrical progress in this country, and rendered valuable services to the Institution of Electrical Engineers in connection with the obtaining of a Royal Charter and Royal Patronage, by his enthusiastic help and counsel, and by active co-operation with the charter committee. He is a member of the Board of Control of the National Physical Laboratory, and has been for many years closely associated with the problem of railway electrification.

THE inaugural meeting of the Empire Forestry Association was held in the Guildhall, London, on November 16. The object of the association is to federate in one central organisation societies and individuals interested in the growth, marketing, and utilisation of timber throughout the Empire. The association will publish a Journal, advocating a constructive policy of conservation and development in the various Dominions, Colonies, and India. It will collect and publish facts as to existing forestry conditions and timber requirements of the Empire. A room in the Imperial Institute will be at the disposal of the association for the display of the commercial timbers which are produced in countries under British rule. A Royal charter has been granted to the association. The secretary is Mr. T. S. Corbett, 17 Victoria Street, London, S.W.

THROUGH an advertisement in the *Times*, Prof. F. Soddy issues a warning "against the fraudulent use of a letter written by him referring to tests made by him of a process alleged to make gold."

MR. R. G. BARKER, of the British Dyestuffs Corporation, has been appointed scientific director of the British Launderers' Research Association.

THE *British Medical Journal* announces that the Swedish prize entitled the Berzelius medal has been conferred on Prof. E. Abderhalden, of Halle, for his researches on biochemistry.

AT the ordinary scientific meeting of the Chemical Society to be held in the lecture hall of the Institution of Mechanical Engineers, Storey's Gate, on Thursday, December 8, at 8 p.m., Prof. J. W. Gregory will deliver a lecture entitled "The Genesis of Ores."

THE Molteno Institute for Research in Parasitology is to be opened by Earl Buxton at Cambridge on Monday next, November 28, at 3 p.m. The new institute is a gift to the University from Mr. and Mrs. Percy A. Molteno.

THE council of the Royal Meteorological Society has awarded the Symons memorial gold medal for 1922 to Col. Henry George Lyons, F.R.S., for distinguished work in connection with meteorological science. The medal, which is awarded biennially, will be presented at the annual general meeting on January 18 next.

NOTICE is given that applications for the Government grant for scientific investigations for 1922 must be received by, at latest, January 1. They must be made upon forms obtainable from the Clerk to the Government Grant Committee, Royal Society, Burlington House, W.1.

APPLICATIONS for grants from the Andrew Carnegie Research Fund in aid of research work on the metallurgy of iron and steel are now receivable by the council of the Iron and Steel Institute. Application forms may be obtained from the secretary of the institute. They should be completed and sent in before the end of February.

AT the meeting of the London Mathematical Society to be held at 5 p.m. on Thursday, December 15, in the rooms of the Royal Astronomical Society, Burlington House, W.1., Mr. J. H. Jeans will deliver a lecture on "The New Dynamics of the Quantum Theory." Members of other societies will be welcome.

THE following were elected officers and members of council of the London Mathematical Society at the annual general meeting held on November 17:—*President:* Mr. H. W. Richmond. *Vice-Presidents:* Mr. J. E. Campbell, Mr. A. L. Dixon, Dr. W. H. Young. *Treasurer:* Dr. A. E. Western. *Secretaries:* Mr. G. H. Hardy, Dr. G. N. Watson. *Other Members of the Council:* Dr. T. J. I'A. Bromwich, Dr. L. N. G. Filon, Dr. H. Hilton, Miss H. P. Hudson, Mr. A. E. Jolliffe, Mr. J. E. Littlewood, Mr. E. A. Milne, Dr. J. W. Nicholson, and Mr. F. B. Pidduck.

AT the meeting of the Royal Geographical Society on Monday, November 21, the president announced that Brig.-Gen. the Hon. Charles Bruce has been offered the post of chief of the Mount Everest Expedition for next year, and has accepted the invitation. From an account just received by the society from Mr. Mallory of his final and successful effort to reach the North Col, 23,000 ft., it is understood that the way from there to the crest of the north-east arête is easy. Whether men suffering from the increasing lassitude which the ascent will produce can prevail against the wind and snow on the last 6000 ft. of that exposed arête is what next year's expedition will have to determine.

THE *Times* announces that the advance party of Mr. V. Stefansson's new Arctic expedition has arrived at its base on Wrangell Island, some 160 miles north of North Cape, Eastern Siberia. The main party of the expedition is expected to leave Nome, Alaska, next March or April. Its chief object is to explore the Beaufort Sea in order to discover if any land exists in that uncharted area. Mr. Stefansson believes that this can best be accomplished by small parties travelling over the ice, depending on seals for food, and thus able to remain for long periods away from the base. Wrangell Island itself has been imperfectly explored by Americans and, in 1914, by the survivors of the *Karluk,* the ship of Mr. Stefansson's former expedition. No further details of the present expedition are yet available.

IN a paper read before the Royal Society of Arts on November 9 Mr. D. R. Wilson gave a summary of the work of the Industrial Fatigue Research Board, the activities of which have, unfortunately, been curtailed owing to the demands in the interests of "national economy." The study of industrial fatigue is of quite recent origin. Its effects can be judged in various ways, notably by the rate of output, which follows a well-identified change throughout the working day. In some cases diagrams for hourly output throughout the week also reveal cumulative fatigue, *i.e.* a distinct diminution of efficiency as the week proceeds, and a corresponding improvement after the recuperative pause at the week-end. The effects of climatic conditions, giving rise to seasonal variations in output in certain industries owing to alterations in conditions of temperature, humidity, etc., are also interesting. A noteworthy fact is that, according to researches in the silk-weaving industry, output suffers a 10 per cent. diminution under artificial light as compared with daylight. Such work has a direct bearing on national efficiency and productive power. It is probable that much assumed "slackness" is due to causes outside of the control of the worker. It is a pity that these researches should be limited by lack of support.

AT the opening meeting of the Illuminating Engineering Society on November 15 an account of recent progress in connection with illumination was presented by Mr. L. Gaster, who referred to various recent official reports dealing with factory lighting, the effect of kinema lights on the eyesight of actors in studios, and motor headlights, as illustrating the interest now taken by Government Departments in various aspects of illumination. Afterwards a series of short demonstrations of novel applications of artificial light was given. This included several new forms of motor-car headlights, systems of "artificial daylight," new neon electric lamps used for letter-signs, etc. The last-named exhibit was of considerable scientific interest in view of the novel principle of using neon gas as a luminous medium instead of a filament within a lamp-bulb of the ordinary standard size. Another striking demonstration illustrated the application of ultra-violet rays for the purpose of distinguishing genuine precious stones from spurious ones. Most gems fluoresce under strong ultra-violet light. Not only is the effect different in a genuine gem from that met with in imitations, but it is even possible to discriminate, by means of the difference in the colour of the fluorescence, between gems of the same kind from different districts. It was shown that Indian pearls can be readily distinguished from Japanese pearls by the aid of ultra-violet light, although by ordinary light they can be detected only with great difficulty. Ultra-violet light does not, however, enable "cultured" to be distinguished from ordinary Japanese pearls.

"SCIENTIFIC Men as Citizens" was the subject of an address by Sir Richard Gregory to an open meeting of the Cambridge branch of the National Union of Scientific Workers on November 16. In the address the theme was developed that modern civilisation differs from civilisations of the past, especially in wealth and power, almost entirely as the result of science and its application to human affairs. How comes it that the scientific man, as such, does not occupy a position in the community in any way commensurate with what he has done for modern civilisation? The reason appears to lie in the failure of scientific men as a body to grasp their own significance in the social complex, their failure to take any interest in the relation of their work and its application to the life of the community, their failure to impress their own importance and the importance of their work upon the imagination of the public, upon Governments, and upon leaders in industry. Broadly speaking, modern wealth and industrial expansion are directly due to scientific men, but men of science as such have taken little part in trying as citizens to control the proper uses of the riches with which they have helped to endow the nation. Scientific men should now exert direct influence in the State, and the motto of any organisation or union they may form should be, "The interests of science are the interests of the community, and the interests of the community are the interests of science." Sir Ernest Rutherford, who followed Sir Richard Gregory, said that the difficulty was that scientific men, both by temperament and training, were unfitted for the so-called political world. The remedy was for scientific men to be represented by men educated and trained in science, but who also possessed ability for public affairs or journalism. Prof. A. C. Seward emphasised the need for, and the value of, increased scientific education in schools. Prof. J. Stanley Gardiner, president of the Cambridge branch of the union, occupied the chair at the meeting.

A VERY remarkable kinematograph film, illustrating the method by which the cuckoo disposes of its eggs, and the subsequent behaviour of the young, was exhibited at the scientific meeting of the Zoological Society on November 8. For some years these matters have formed the subject of very patient and methodical study by Mr. Edgar Chance, and this summer he contrived, after an elaborately worked out plan, to summarise his results with the aid of a kinematographer carefully concealed within a shelter of leaves and bracken. Hitherto it has been the accepted belief that the cuckoo deposited her egg upon the ground and then conveyed it to the nest of her dupe in her beak. This film showed clearly enough that, as a matter of fact, the bird lays the egg within the nest, which, at any rate in the case of meadow-pipits' nests, she leaves tail foremost, apparently to avoid displacing the "run" made by the owners of the nest. As she leaves she takes in her beak one of the eggs of the pipit, and presently eats it. The "planing" down of the cuckoo from a high tree, and the alighting within a few feet of the nest, were most realistically shown. But the most wonderful of the whole series of pictures were those which showed the young cuckoo, though but two days old, blind, and naked, making the most determined efforts to raise its foster-brothers on to its back and up over the edge of the nest, thrusting its lean limbs backwards to assure itself by the sense of touch whether its efforts had succeeded. There was something indescribably diabolical and horrible about the whole of the proceedings. The first attempt failed, the downy, struggling body of the nestling to be ejected being saved from falling over the edge of the nest by a projecting twig. At this juncture the foster-mother returned and, unconcernedly feeding both her own youngster, gasping on the rim of the nest, and the young cuckoo, took both and brooded them. No sooner had she left them for more food than the work of eviction began afresh, and this time was accomplished successfully. Immediately after the only remaining rival was also thrown out.

AT a meeting of the Royal Statistical Society on November 15, Sir R. Henry Rew delivered his second presidential address, taking as his subject "The Progress of Agriculture." He pointed out that the total land area of Great Britain is now $56\frac{1}{4}$ million acres, and of the $52\frac{3}{4}$ million acres capable of productive use about 90 per cent. is so utilised in a greater or less degree. This area is not capable of any material extension. The proportion of arable land was 58 per cent. in 1869–78, and is now 48 per cent., but the prevalent belief that the output of British agriculture has declined overlooks the fact that the smaller arable area may, if devoted to other crops, produce a greater amount of food than the larger. By substituting potatoes for wheat, for instance, one-fifth the area would give about as much food. Fruit and vegetables have also largely replaced farm crops, while the extension of cultivation under glass has resulted in a great increase of output per acre. As regards livestock, comparing the ten years 1869–78 with 1912–21, there has been a net gain of about 750,000 beasts. There has also been a progressive and substantial increase in milk production during the past fifty years, the milking herd having increased by 32 per cent., while the yield per cow has also been greatly increased. At the outbreak of war a larger quantity of food was being produced than at any previous period. During the war there was a setback in food production, the amount of cereal food being increased, but other kinds of food being markedly reduced. Whether the pre-war standard of total output has been regained is regarded as doubtful, but such facts as are accessible point to the conclusion that the output of food has been increased. Indeed, the agricultural land of the country is capable of producing more food, for on a large proportion of it the output is undoubtedly lamentably deficient.

"STATE Aid and the Farmer" forms the subject of an interesting paper contributed by Mr. S. L. Bensusan to the *Fortnightly Review* for September last. At the end of the war agriculture was at the summit of expectation, and the machinery required for the big development foreshadowed by the Prime Minister was gradually assembled. The passing of the Agricultural Act left the farmers under certain obligations to the State and to his employees, and in receipt of guarantees to enable him to face foreign competition in wheat and oats. The general policy of the Minister of Agriculture was to further the development of research, to protect the industry from diseases, to organise the agriculture of each county, and at the same time to make conditions as free as possible to encourage enterprise. But the Agricultural Act is now in large part repealed, and the farmers' position is not an enviable one. Not only have all costs increased, but the farmers have also to contend with the grave difficulties introduced by the Labour Bill and the new hours of labour. Farmers have a deep sense of grievance against the Wages Board, and they tend to take up an attitude towards the farm labourer that will lead to widespread disturbance throughout the rural area. It is of the utmost importance that farmers and labourers should meet in a spirit of justice and right endeavour, and should seek by co-operation to fuse into one the great agricultural interests of the country. The author concludes that "to-day the whole fabric of reconstruction is in ruins," whereas it probably would have been better if the Agricultural Act could have been suspended rather than destroyed, for the Act itself was based on sound principles and carried a promise, not for agriculture alone, but for the whole country.

IN a paper in the October issue of the *Quarterly Journal of Forestry* Mr. H. J. Denham directs attention to the fact that in calculating the times of fall of seeds of forest trees it has been the custom to neglect the resistance of the air. In the case of small seeds this leads to results much less than the actual time of fall, which is determined mainly by what is known in physics as the "terminal" or "limiting" velocity when the gravitational acceleration is exactly counterbalanced by the air resistance. The seeds experimented on attained this velocity in the first three metres of fall, and the time taken to fall the next four metres was observed. For certain species of ash and sumach the limiting velocity was 1·5 metres per second, for a maple 1·25 metres, while for a great many species of pine and cedar it is only about 0·8 metre per second. Seeds provided with a thin lamina frequently spin in falling, and the centrifugal force brought into play flattens the lamina and increases the time of fall. The bearing of the limiting velocity on the dispersal of seeds is obvious, and further research is desirable in the interests of forestry.

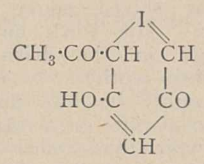
WE have received vol. 1, No. 1, issued on October 17, of the Bulletin of the Hill Museum, a newly instituted magazine devoted to Lepidoptera, and edited by Messrs. Joicey and Talbot. Great credit is due to Mr. Joicey for establishing this journal, and giving the results of studies carried out in his private museum at Witley to the entomological world. It is only a wealthy man or a public body that is in a position to amass collections on the scale carried out by Mr. Joicey. No apology is needed for this practice, since it is only by means of extensive collections that it is possible to carry out research into many of the problems concerning Lepidoptera. Work on variation and geographical distribution, for example, is very dependent upon access to large numbers of specimens. The appearance of an addition to the already long list of entomological periodicals may cause exclamation in some quarters, but it must be pointed out that most of the existing journals which usually accept papers on Lepidoptera are greatly taxed for space, and the high cost of publication has entailed an inevitable reduction in their pages. The sample issue before us is clearly printed and fully illustrated by twenty-four half-tone plates. Intending subscribers to this magazine should communicate with Mr. G. Talbot, curator, the Hill Museum, Witley, Surrey. The editors will be glad to hear from any societies or institutions desiring to exchange their publications. The subscription price is 30*s*. per annum post free.

MR. BAILEY WILLIS describes in *Science* (vol. 54, 1921) a new and interesting method of tracing the course of a great earthquake-rift by photography from an aeroplane. One of the most important rifts is that of San Andreas, along which the Californian earthquake of 1906 originated. It has been traced for a distance of about 600 miles, from Humboldt County in northern California to the Mohave Desert in the south of the same State. The fault is an ancient one, and has been the scene of innumerable movements which have given rise to pronounced topographic features. Mr. Willis's photographic survey was carried out during flights from San Francisco to Los Angeles and back, over a distance of about 400 miles. In the northern part, where rainfall is abundant and erosion efficient, there is not much to be seen after fifteen years. Farther south the rift can be traced by the linear arrangement, sometimes for 25 miles, of numerous landslide scars and small ponds. When it enters the desert country, in which the aridity of the climate limits erosion, the signs of the rift become more distinct and continuous.

From an altitude of 12,000 ft. it could be plainly seen like a large empty irrigation canal, stretching away for ten miles to the south until it was lost in the dust haze. Indeed, so permanent are the dislocation features in the desert regions that those produced during the earthquake of 1857 are still plainly visible. Mr. Willis thus concludes that the aeroplane can be used with advantage as a means of rapid geological reconnaissance in mapping large structural features.

In an article on rudder pressures and Airship R38, *Engineering* of November 11 it is pointed out that our information as to the actual forces operating on a ship when its rudder is in use is extremely limited and indefinite. In light structures such as those of airships it is therefore necessary to allow a more generous factor of safety for the structural portions which have to withstand these forces than for any other portion of the structure the straining action of which is more definitely known. It is possible to arrange the weights in an airship relative to the buoyancy, so that the shearing forces and bending moments operating on the structure as a whole may be reduced to very small amounts. If, however, more efficient control is required, and especially for movements in the horizontal plane, larger forces on the structure are involved, and the framing must of necessity be stronger. It is from airships that more definite information as to the actual pressures on rudders and other control surfaces can be obtained, since the actual pressure at various points can be measured simultaneously without much difficulty. Certain information on this point has already been obtained, but has not yet been published.

In the October issue of the Journal of the Chemical Society Prof. J. N. Collie and Miss A. Reilly describe the preparation of a new type of iodine compound. This is obtained by the action of iodine on the barium salt of diacetylacetone, and appears to contain iodine in the ring. The formula attributed to the compound is



On solution in water the iodine atom takes up the elements of water and becomes quinquevalent.

"The Legacy of Greece," edited by R. W. Livingstone, which is shortly to be published by the Oxford University Press, aims at giving an idea of the debt of the world to Greece in various realms of the spirit and intellect, and of what may still be learned from her. The chapters most likely to appeal to readers of Nature are Biology, by Prof. D'Arcy W. Thompson, Mathematics and Astronomy, by Sir Thomas Heath, Medicine, by Dr. C. Singer, and Philosophy, by Prof. J. Burnet.

Our Astronomical Column.

The Leonid Meteor Shower.—Mr. W. H. Denning records that this display proved rather a feeble one this year, and that very few of the meteors were seen. Miss A. Grace Cook, of Stowmarket, watched the sky for $3\frac{1}{4}$ hours on the very clear, frosty morning of November 11, and recognised six Leonids out of a total number of twenty-five meteors seen. The radiant point was in the usual position at $150+22°$. Several other observers maintained a vigilant watch on the same date, but saw very few Leonids, though some brilliant objects were recorded from the minor showers of the period. There were radiant points in Taurus, Auriga, Cancer, and Ursa Major.

A New Suggestion to Explain Geological Climatic Changes.—Dr. Harlow Shapley contributes a paper on this subject to the *Journal of Geology*, vol. 29, No. 6. He has lately been observing the seventy variable stars in or near the Orion nebula, finding that they belong to various spectral types, and that their light-curves are peculiar, showing no regular periodicity, no extreme range of variation, and little resemblance to other known light-curves. He supposes that the changes are due to collision or friction with the nebulosity. He then notes that the motion of the sun is nearly straight away from the nebula, and that, assuming the distance as 600 light-years, the sun was in its neighbourhood some 9,000,000 years ago, in which case a variation of from 20 to 80 per cent. of the total light and heat may readily have taken place, more than enough to explain any of the changes postulated by geologists. He makes the further interesting notes that long-exposure spectrograms with the 100-in. reflector show the bright lines of hydrogen, nebulium, helium, carbon, and nitrogen; and that they also show a faint continuous spectrum in all parts of the nebula. This last fact makes the difference from the spectra of the spiral nebulæ one of degree rather than of kind.

Star Catalogues.—There have been extensive additions to published catalogues in recent months. Greenwich catalogues cover the zone 24–32° N. decl., and also the northern circumpolar region. The Astronomer Royal contributed a paper to the meeting of the R.A.S. on November 11, dealing with the proper motions of the latter catalogue. He showed that Drift I. was very strongly indicated, while Drift II. could be traced, but was much less conspicuous, as its apex was not far distant from the region of the catalogue. The Cape Observatory has issued a catalogue of the stars in the Backlund-Hough list, which was drawn up with the idea of covering the sky with a fairly uniform network of stars the places of which were to be well determined. Both Greenwich and Cape observations indicate a surprisingly large correction to the equinox previously employed; this correction has not yet been introduced into the Greenwich catalogues, but the Cape catalogue adopts the value $-0{\cdot}048$s., deduced from observations of the sun, Mercury, and Venus. The cause of the correction is obscure; some part of it may be due to the introduction of the travelling-wire method of observing transits.

Washington Observatory has also published a catalogue of fundamental and zodiacal stars. It is particularly desirable to have the latter well observed, since they are employed to fix the positions of the moon and planets.

British Research on Tides.

OF recent years tidal research in this country has resumed the vigour which it showed during the fruitful years of Sir George Darwin's work and influence. Among official bodies, the Admiralty and Ordnance Survey have shown renewed activity in promoting tidal observation and research; but the revival is perhaps most closely linked with the interest shown in tidal problems by Mr. G. I. Taylor and by Prof. J. Proudman. The former has made several brilliant incursions into the field of tidal research, and has solved some important outstanding problems. His work on the tidal dissipation of energy in the Irish Sea has already inspired other workers to researches of a similar kind. Recently he has published a solution of the problem of tides on a rotating rectangular basin, a subject which had foiled the attempts of many former workers, including the late Lord Rayleigh; also, by an elegant investigation of the waves in a tapering channel with a sloping bed, he has lately explained the special tidal features in the Bristol Channel.

Free-lance work of this kind is essential to the progress of tidal theory, but not less necessary is systematic work on the immediate practical problems of tidal analysis and prediction. The establishment of a centre where such work is carried on is due primarily to the second-named mathematician, Prof. Proudman, backed by the University of Liverpool, the docks and shipping interests in that city, and later by the Department of Scientific and Industrial Research. The second annual report of the Tidal Institute of the University of Liverpool has just been issued, and describes the work completed or begun, under the direction of Prof. Proudman, during the past year. A fuller account of some of the work is contained in the report of the British Association Committee appointed "to assist work on the tides"; this report is drawn up by Dr. Doodson, who is the secretary both of this committee and of the Tidal Institute.

The main part of the year's work has consisted in the analysis of tidal observations, partly from a Liverpool tide-gauge, but chiefly from the Newlyn gauge. Newlyn is one of the four new tidal stations instituted by the Ordnance Survey. The analysis indicates that the errors remaining in the predictions made by former methods of harmonic analysis may amount to more than a foot, apart from the errors arising from the use of predicting machines. About half of the error may be due to the inadequate treatment of shallow-water effects, while the rest is due to tidal constituents not included in Sir George Darwin's schedule. A re-examination of the astronomical and dynamical theory of the tides has also been made by Dr. Doodson, who has found a number of terms large enough to demand consideration which are absent from the Darwinian schedule.

The shallow-water effects have been isolated by successive elimination of known or determined astronomical constituents. They show themselves, as theory indicates, in the introduction of components having periods a half, a third, a quarter, and so on, of the primary astronomical components—mainly, of course, of the semidiurnal component. Partly on a basis of theory, and partly as a result of experience with the Newlyn records, Dr. Doodson has formulated a rule connecting the amplitude and phase of these secondary constituents with the resultant semidiurnal tide on any day. The rule is that the shallow-water constituent of frequency $2n$ ($n=2, 3, 4$) is proportional in amplitude to the corresponding component in the nth power of the resultant semidiurnal tide, while the phases of these two components differ by an amount characteristic (like the factor of proportionality in amplitude) of the station and of the value of n. This rule is valuable because its commercial application is easy; correction tables for the purpose are readily prepared, since the corrections are functions merely of the time and height of the semidiurnal tide on any given day.

Much attention has been paid to improved methods of tidal analysis and of prediction by the use of the results of such analysis. Computational methods are favoured as against mechanical methods; a test of the accuracy of the tide-predicting machines used by the Admiralty and the India Office has indicated some serious errors in their results, and it is concluded that the labour of reading the curves afforded by the machines, with any pretence to accuracy, is comparable with the labour of direct computation, while the value of the results is greater in the latter case.

The discussion has so far been confined to the tides of short period, and these still present many unsolved problems. The long-period tides and the meteorological effects also afford an important field for research, which has yet to engage the attention of the committee and institute.

The Influence of Egypt on African Death Ceremonies.

AT a meeting of the Royal Anthropological Institute held on October 25, Dr. W. H. R. Rivers, president, in the chair, Mr. T. F. McIlwraith read a paper on "The Influence of Egypt on African Death Ceremonies." He said that there was strong evidence of Egyptian influence in modern Africa, particularly in the region south and west of the Sahara. In West Africa and the Congo preservation of the dead had a wide distribution. The methods employed included desiccation and pressure, frequently assisted by preservatives, such as honey, palm-wine, salt, and spices. Not only were these methods strikingly similar to those practised in Egypt, but there were also resemblances in arbitrary details, such as the plugging of the nostrils, sewing up the opening in the body, placing plates over the mouth and eyes, and wrapping the corpse in bandages. Equally important was the limitation of the preservation of the body to chiefs. Mummification had a slow growth in Egypt under favourable climatic conditions, but it was highly improbable that similar methods should have been evolved in the humid atmosphere of tropical Africa.

Coffins and anthropomorphic figures occur widely on the Guinea Coast and in the Congo, and are rare in East Africa. Coffins are usually the prerogatives of chiefs, and often occur in conjunction with some method of preservation of the body. Among the Baculé of the Ivory Coast a representation of the deceased is portrayed on the cover of the coffin, a feature highly suggestive of Egypt. Anthropomorphic figures are employed in a variety of ways in magical and religious ceremonies, and in a few cases are used to house the souls of the deceased, as was done in

Egypt. It is probable that the erection of a representation of the deceased over his grave belongs to the same complex.

The cumulative evidence of mummification, coffins, and anthropomorphic figures gives strong support to the belief that the resemblances between Ancient Egypt and Modern Africa are due to transmission of culture. Is this transmission of culture the result of direct influence from Egypt to Africa (or *vice versa*), or is it due to the common ancestry of Ancient Egyptians and Modern Hamites? This last possibility is untenable, since the history of mummification can be traced from its beginning in Egypt, whereas in Africa it appears to occur only in a fairly developed state. This further precludes the possibility of African influence on Egypt, leaving as the only solution that various Egyptian practices were transmitted to Africa, where they have survived, in a more or less degraded form, until the present day.

Why do these survivals occur in distant parts of the Continent rather than in the north and east? Two hypotheses are possible: (1) That elements of Egyptian culture were transmitted to various parts of Africa by land, but survive only in areas where pastoral peoples have not penetrated; (2) that seafarers established a centre of Egyptian civilisation on the Guinea Coast, whence their influence spread inland with ever-lessening intensity.

The presence in East Africa of a few isolated instances of the practices under consideration supports the first hypothesis. On the other hand, the evidence of Egyptian civilisation in West Africa raises the possibility of a settlement on the coast itself. It is probable that much of the culture of the Canary Islands was of Egyptian origin, and the islands may have served as a base for voyages further south.

In opening the discussion which followed the reading of the paper the president said that the question involved three distinct problems: (1) Was there any relation between burial customs in West Africa and those of Ancient Egypt? (2) Did the influence penetrate by land or sea, and why were these customs absent from the greater part of Africa? (3) What was the date of the movements by which they were introduced? Miss Murray said that regarding the evidence from the chronological, rather than from the geographical, point of view, she required further proof of connection. Similarity was no proof. For instance, the ceremonial of royal funerals in this country had been identical in many points with that of the royal funerals of Ancient Egypt; but it did not follow that they were connected. The types of mummification cited belonged to the earliest times.

Prof. Elliot Smith pointed out that the customs cited by the author, so far from being early in date, belonged to a small group of dynasties of the late Empire, ranging mainly from the nineteenth to the twenty-second dynasties. This gave the earliest date for the diffusion of these customs. They had spread by land across the Continent and down the Niger; but there was definite evidence of a later diffusion by sea in the sixth century B.C. The distribution should be compared with the occurrence of gold. Mr. Peake said that these customs must have been introduced at an early date, and clearly were not indigenous, as climatic conditions were not favourable to the independent development of mummification. The distribution was probably due, not to the occurrence of gold, but to the fact that an incoming people, arriving from the grasslands, would follow the line of least resistance along the open glades of the forest and the river valleys.

Mr. Torday suggested that the use of the coffin might be due to European influence, while the distribution was due not to gold—there was no forest gold —but to the fact that these customs had been reported by travellers who had followed the beaten track. Further, was there not more reason to believe that these customs had been introduced into Egypt from Africa rather than *vice versa*? Dr. Stannus said that the custom of plugging the nostrils of a corpse, on which stress had been laid, was widespread in Africa, and was intended to arrest the rapid setting in of decomposition through the agency of flies.

University and Educational Intelligence.

Bristol.—Prof. T. Loveday, principal of University College, Southampton, and formerly professor of philosophy at Armstrong College, Newcastle-upon-Tyne, has been appointed vice-chancellor of the University in succession to Sir Isambard Owen, recently retired.

Cambridge.—Mr. W. E. H. Berwick, University lecturer in mathematics at Leeds University, has been elected to a fellowship at Clare College.

The list of those who voted last month on the position of women at Cambridge has now been published. It shows a strong majority among the residents in favour of the compromise scheme. As had been generally surmised, this scheme was thrown out by the non-resident voter.

Leeds.—Mr. E. C. Williams has been selected for the post of research chemist to the Joint Benzole Research Committee of the University and the National Benzole Association, and he was officially appointed by the council on November 16 last. Mr. Williams graduated in 1914 at the University of Manchester with first-class honours in the School of Chemistry. He was awarded the Mercer and Dalton research scholarships for research theses, and a special University prize for physical chemistry. His M.Sc. was gained by research, and later he was appointed research chemist to British Dyes, Ltd., where for the past four and a half years he has been engaged, not only upon laboratory research, but also on large-scale work and administration, as head of the department at the Dalton Works, Huddersfield, for the manufacture of intermediate products. Mr. Williams's work will centre at the University of Leeds in the Department of Coal-gas and Fuel Industries, where laboratory facilities are provided, but will also be carried out so far as may be found desirable on the plants engaged in benzole production and laboratories attached thereto.

London.—The Senate has adopted a resolution that the recently erected inorganic and physical chemistry laboratories at University College should be named after the late Sir William Ramsay.

Mr. E. R. Weidlein has been appointed director of the Mellon Institute of Industrial Research, University of Pittsburgh.

The Hampshire Field Club and Archæological Society has organised a course of six public lectures on topics of local archæological interest which are being delivered at Southampton. Two lectures have already been given, and it is gratifying to learn that the attendance has in each case been between 350 and 400, of whom nearly 300 were persons who had obtained serial tickets. We note that the lecturers are giving their services free, and all the profits made will be devoted to publishing original research.

IT is announced that a course of instruction will be given in the summer of 1922 at the Official Seed Testing Station, Cambridge. The course will be limited to persons who are (*a*) nominated by seed firms who intend to offer employment to such nominees in their own seed-testing stations; or (*b*) recommended by universities, agricultural colleges, and institutions; or (*c*) approved by the council of the institute. An examination will be held at the conclusion of the course, and certificates will be issued to students who satisfy the examiners. The examination will also be open to practical seed analysts who have not attended the course of training. Applications for entrance forms should be made to the Chief Officer, Official Seed Testing Station, Cambridge, not later than May 1 next.

LEEDS University Calendar for 1921–22 is a compact volume of some 600 pages, containing particulars which prospective students of the University would do well to consult. Lists are given of the members of the University Court, Council, Senate, Faculties, and Boards of Faculties, and the professorial and teaching staff. Details follow of the degrees and diplomas conferred by the University, and in most cases a syllabus of the work required is appended. Evening courses and extension lectures are also dealt with, and brief accounts are given of the origin of, and regulations affecting, the various fellowships, scholarships, and prizes awarded by the University. A summary is given of the number of students who attended courses in the University during the last two sessions; for both day and evening students an increase of about 200 on the 1919–20 figures is recorded—a sure indication of progress justifying the recent appeals for increased grants and donations.

THE announcement of the intended retirement of Sir Philip Magnus from the Parliamentary representation of the University of London at the close of the present Parliament has been received with much regret. Sir Philip has represented the University of London since 1906, and he has been in intimate touch with it for upwards of fifty years, from the time when it was a mere examining body, however distinguished and serviceable, to the present day, when it is comprised of a closely co-ordinated variety of teaching institutions and incorporated colleges, yet still lacking a central home in which its activities as a teaching and examining body can be more efficiently concentrated and administered. Sir Philip will be much missed on his retirement from Parliament, where his great knowledge and experience of all educational matters were at the service of the House and of those engaged in their administration and promotion. He had been an active member of the School Board for London, but his most conspicuous service lay in his capacity of director of the technological examinations of the City and Guilds of London Institute, to which position he was appointed in 1880, followed by his selection in 1881 as a member of the Royal Commission on Technical Education. In his former capacity, by his wise measures and unfailing support, he greatly stimulated the development of technical instruction throughout the United Kingdom, and as a result of the latter the report of the Royal Commission created a deep and widespread interest which ultimately led to the enactment of the Bill for Technical Instruction of 1889, which has had such beneficent effects on our trade and industry. Sir Philip Magnus is a warm advocate of manual training in all schools, and he is no less concerned that all efficient private schools shall receive official recognition, believing that it is the only effective way of ensuring freedom and variety of subject and method.

Calendar of Scientific Pioneers.

November 24, 1864. Benjamin Silliman died.—The first professor of chemistry at Yale, and the founder and editor of the *American Journal of Science and Arts*, Silliman owed his reputation mainly to his lectures and writings on chemistry and geology. His son, also Benjamin Silliman (1816–85), was his successor at Yale.

November 25, 1884. Adolphe Wilhelm Herman Kolbe died.—A pupil of Wöhler, and, in 1851, the successor of Bunsen at Marburg, Kolbe effected the synthesis of acetic acid, the second organic compound to be produced artificially, and had an important share in the development of chemical theory.

November 25, 1913. Sir Robert Stawell Ball died.—Introduced to astronomy by reading Mitchell's "Orbs of Heaven," Ball, in 1874, became Royal Astronomer of Ireland, and in 1892 succeeded Adams as Lowndean professor at Cambridge. A most popular lecturer and writer, Ball was also a mathematician, and in 1910 published his great work on the theory of screws.

November 26, 1801. Déodat Guy Silvain Tancrède Gratet de Dolomieu died.—An indefatigable student of the volcanic regions of South Europe, Dolomieu is counted among the pioneers of geology, and his name is perpetuated by the word dolomite.

November 26, 1885. Thomas Andrews died.—Trained as a physician, Andrews held the chair of chemistry in the Queen's College, Belfast, where he carried out the researches in physical chemistry which led to his important discovery of the existence of a critical temperature above which a gas cannot be converted into a liquid by pressure alone.

November 26, 1896. Benjamin Apthorp Gould died.—The founder of the *Astronomical Journal*, Gould did valuable work for the United States Coast Survey, and organised the Argentine National Observatory at Cordoba. He was one of the first astronomers to use the camera as an instrument of precision.

November 28, 1876. Karl Ernst von Baer died.—One of the greatest Russian naturalists, von Baer, in 1827, discovered the mammalian ovum, and by his later work became the founder of comparative embryology. For many years he was librarian to the Imperial Academy of St. Petersburg.

November 28, 1914. Johann Wilhelm Hittorf died.—A student under Plücker at Bonn, Hittorf, in 1852, became professor of chemistry and physics in the University of Münster. He contributed to the study of spectrum analysis and electrolysis, and in 1869 discovered the nature of kathode rays.

November 29, 1694. Marcello Malpighi died.—Malpighi has been called the first of the histologists. A pioneer in microscopic anatomy, he was the first to see capillary circulation, and did important work on secreting glands and the anatomy of brain and vegetable tissue. Most of his life was spent at Bologna.

November 29, 1872. Mary Somerville died.—The first notable woman worker in science in Great Britain, Mary Somerville, in 1831, published her "Mechanism of the Heavens," based on the writings of Laplace, who said that she was the only woman who understood his works.

November 30, 1603. William Gilbert died.—Physician to Queen Elizabeth, Gilbert is the father of magnetic and electrical science. In 1600, the year he became president of the College of Physicians, he published his "De Magnete . . ." the first great physical work published in England. Of him Dryden remarked, "Gilbert shall live till loadstone cease to draw."

E. C. S.

Societies and Academies.

LONDON.

Royal Society, November 17.—Prof. C. S. Sherrington, president, in the chair.—P. A. **MacMahon** and W. P. D. **MacMahon**: The design of repeating patterns. The study and classification of repeating patterns in space of two dimensions is founded upon the simplest geometrical forms which happen to be repeats. These are employed as bases and are subjected to specified transformations which depend upon certain contact systems between the sides which are in contact in the assemblage. Repeats are of three varieties: the block, the "stencil," and the "archipelago." There is a further broad division into normal and abnormal repeats. A theory of "complementary repeats" is established. A contour can be drawn around every normal repeat in an infinite number of ways, such that the area within the contour, which does not belong to the repeat, is itself a repeat. The contour under specified conditions is itself the boundary of a repeat, which is therefore a combination of the original repeat and its complementary. Mr. G. T. Bennett finds that "every quadrilateral figure" is a repeat.—J. W. **Nicholson**: A problem in the theory of heat conduction. The temperature at any point in the external medium, and the rate of loss of heat from a cylinder, the surface of which is maintained, from some specified instant, at a constant temperature for all subsequent time, is found for any instant by the use of a generalised form of the Bessel-Fourier double integral. A solution can be obtained in a similar way when the temperature maintained on the cylindrical surface is not constant.—C. H. **Lees**: The thermal stresses in spherical shells concentrically heated. Thermal stresses in the material of a furnace of approximate spherical form due to differences of temperature, and the stresses due to pressures on the inside and outside surfaces, may be expressed in terms of the volume of the spherical surface through any point or of its reciprocal. The whole problem can be treated graphically. The increase of stress due to sudden changes of temperature of the inside surface is discussed.—R. A. **Fisher**: The mathematical foundations of theoretical statistics. The most efficient statistic has the least standard deviation; the efficiency of any other statistic is the ratio of number of observations required by the most efficient to that required by statistic under consideration in order to obtain a value of the same accuracy. The criterion of consistency applied to a method of estimation is a special case of criterion of sufficiency, which requires that the sufficient statistic shall include the whole relevant information provided by sample. Statistics obtained by the method of maximum likelihood are always sufficient statistics. Their standard deviation being easily calculated, the efficiency of any other statistic of known probable error may be found.—F. P. **White**: The diffraction of plane electromagnetic waves by a perfectly reflecting sphere. The series solution is transformed into a contour integral along a path of "steepest descents," and the value of this integral is determined approximately. The results obtained are in agreement with those obtained by other workers.—C. V. **Raman** and G. A. **Sutherland**: The Whispering Gallery phenomenon. Observations made in the Whispering Gallery at St. Paul's Cathedral and in laboratory experiments show that Rayleigh's theory of the phenomenon does not offer a complete explanation. The single belt of maximum intensity close to the wall contemplated by Rayleigh is obtained only in the limiting case when the radius of the reflecting circle is practically infinite in comparison with the wave-length. For more moderate values of the radius of curvature there is a succession of belts of alternately great and small intensity. The slight deviation from the condition of strictly circumferential wave-propagation postulated by Rayleigh gives rise to such effects.

Linnean Society, November 3.—Dr. A. Smith Woodward, president, in the chair.—J. **Groves**: Charophyta collected by Mr. T. B. Blow in Ceylon. The collection consisted of thirteen species, one of which was regarded as new; only one of them occurred in Europe. Many of the specimens were obtained from tanks which had been in use when large tracts of country, which are now lying waste, were in cultivation.

Zoological Society, November 8.—Dr. A. Smith Woodward, vice-president, in the chair.—R. I. **Pocock**: The external characters and classification of the Mustelidæ.—W. R. **Sherriff**: Evolution within the genus. Part 1. *Dendronephthya* (*Spongodes*), with descriptions of a number of species. Part 2. Description of species (Alcyonaria) taken by the *Siboga* expedition.—C. F. **Sonntag**: The comparative anatomy of the tongues of the mammalia.—V. Lemuroidea and Tarsoidea. VI. Summary and classification of the tongues of the Primates.—E. P. **Chance**: Investigation of the laying-habits of the cuckoo (*Cuculus canorus*) and the life of the young cuckoo. This communication was illustrated by a striking series of kinematograph films and photographs.

CAMBRIDGE.

Philosophical Society, October 31.—Prof. Seward, president, in the chair.—H. **Hartridge**: A new method of testing microscope objectives. The focussing points of rays from different zones, or the lateral displacements of an image formed by the rays from different zones, are determined. For the latter method either direct visual observation may be used or the displacements as recorded in a photographic plate can be afterwards measured.—J. E. P. **Wagstaff**: (1) Determination of the coefficient of viscosity of mercury. (2) A laboratory method of determining Young's modulus for a microscopic cover-slip.—J. L. **Glasson**: Some peculiarities of the Wilson ionisation tracks and a suggested explanation. The tracks of β-particles in the Wilson photographs form circular arcs of random radii length and direction. This may be due to magnetic fields produced by transient quasi-crystalline aggregations of water molecules. The existence of many cases in which two or more tracks have similar shapes supports these conclusions, as does the periodicity of the ionisation and the curvature of the α-ray tracks. Peculiar distributions of the α-rays emitted from radium emanation suggest that the atoms of emanation are polar, and that the field is polarised.—W. **Burnside**: (1) Convex solids in higher space. (2) Certain simply transitive permutation-groups.—G. H. **Hardy** and J. E. **Littlewood**: Some problems of diophantine approximation.—W. J. **Harrison**: The stability of the steady motion of viscous liquid contained between two rotating coaxial circular cylinders.—R. **Whiddington**: (1) Note on the velocity of X-ray electrons. (2) A laboratory valve-method for determining the specific inductive capacities of liquids.—Sir George **Greenhill**: Tides in the Bristol Channel.—M. J. M. **Hill**: The fifth book of Euclid's "Elements."—W. **Wirtinger**: A general infinitesimal geometry, in reference to the theory of relativity.

DUBLIN.

Royal Irish Academy, November 14.—Prof. Sydney Young, president, in the chair.—T. **Alexander** and J. T. **Jackson**: Polygons to generate diagrams of maximum stress. The blackboard model polygon, with the two end sides long, and four short sides, was rolled over on a lath fixed to the board, while the apex drew five circular arcs. The vertical ordinates gave the square roots of maximum bending moments on a 42-ft. girder due to the transit of a 30-ft. 42-ton locomotive. The short sides of the polygon doubled are the distances apart of its five wheels, while the five spaces into which the span is divided by perpendiculars from the intersecting points of the arcs give, numerically, the loads on the wheels. The cycloid is an extreme case, and an interesting curve modified from it was shown, and a new pair of conjugate load areas that balance the linear circular rib and lead to a geometrical solution of the equilibrium of the semi-circular masonry arch.

PARIS.

Academy of Sciences, November 7.—M. Georges Lemoine in the chair.—C. **Richet**: An optical illusion in the appreciation of velocity.—G. **Charpy** and G. **Decorps**: The determination of the degree of oxidation of coal. An empirical method based on the extraction of the constituents of the coal by 50 per cent. soda solution at 100° C., and measurement by permanganate of the amount of oxygen required for the oxidation of the organic matter.—G. **Julia**: A class of functional equations.—H. **Villat**: Certain integral equations possessing an infinity of solutions with an unlimited number of arbitrary parameters.—K. **Popoff**: The development of an arbitrary function in series according to a suite of given functions.—P. **Boutroux**: The functions associated with an "autogenous" group of substitutions.—M. **Riabouchinski**: The general equations of movement of solid bodies in a perfect incompressible fluid.—M. **Michkovitch**: The rectifications of the ephemerides of the minor planets.—M. **Salet**: Spectrophotometry of stars containing carbon.—A. **Buhl**: The *rôle* of analytical symmetries in the relativist theories.—P. **Langevin**: The theory of relativity and the experiment of M. Sagnac. A proof that the generalised theory of relativity gives a quantitative explanation of Sagnac's experiment.—M. **Décombe**: The theory of the galvanic battery.—M. **Travers**: A new method for the estimation of fluorine at the ordinary temperature. Fluorine is obtained in the state of soluble alkaline fluoride, potassium silicate and a little hydrochloric acid added, and precipitated as potassium fluosilicate by potassium chloride. The precipitate is estimated by titration.—M. **Grandmougin**: The homonuclear dibromoanthraquinones.—E. **Rothé**: The use of radiogoniometry in the study of storms and of atmospheric "parasite" currents. It is possible to predict the weather from the observation of the parasite currents.—J. **Lacoste**: The relation existing between the directions of depressions and the directions of the maxima of the atmospheric parasites.—Mlle. Yvonne **Boisse** and P. **Marty**: The plurality of the eruptive apparatus of the Cantal massif.—R. **Souèges**: The embryogeny of the Boragaceæ. The last stages of the development of the embryo in *Myosotis hispida*.—St. **Jonesco**: The formation of anthocyanine in the flowers of *Cobaea scandens* at the expense of the pre-existing glucosides. The experiments of E. Rosé, which gave negative results for glucosides in the non-coloured flowers are shown to be incorrect. Glucosides are always present, and the author holds that the colouring matters are produced at the expense of these pre-existing glucosides.—H. **Colin**: The graft of sunflower on the Jerusalem artichoke. Studies on the transformations of the carbohydrates.—A. **Kozlowski**: The formation of the red pigment of *Beta vulgaris* by oxidation of the chromogens. The chromogens extracted from the maritime beet and the white sugar-beet were white or light yellow. On oxidation these gave a red pigment spectroscopically identical with colouring matter from the red beet. The chromogens from the white beets have some properties in common with the saponins; they have a bitter taste, and produce froth and decolorisation of red-blood corpuscles.—P. **Dangeard**, jun.: The formation of aleurone grains in the albumen of the castor-oil plant. The observations described and illustrated lead to the conclusion that the formation of the aleurone grains is only a particular case of a more general phenomenon, the evolution of the vacuolar system.—E. **Chatton**: A new kinetic mechanism: syndinian mitosis in the plasmodial parasitic Peridinians.—M. **Baudouin**: A method for the determination of the minerals constituting prehistoric metallic axes: use of spectrum analysis. The presence or absence of tin is readily determined by the spark spectrum without mutilating the specimen.—F. H. **Quix**: The *rôle* of the otoliths in the spontaneous movements of animals during jumping and falling.—P. **Brodin** and P. **Huchet**: A new anti-anaphylactising substance, formaldehyde-sodium hydrosulphite.—G. **Truffaut** and M. **Bezssonnof**: The variations of energy of *Clostridium Pastorianum* as nitrogen-fixing organisms. The partial sterilisation of the soil by calcium sulphide increases, not only the number of *C. Pastorianum*, but also their capacity for fixing nitrogen.—C. **Levaditi** and S. **Nicolau**: Neurotropic affinity and the purification of the virus of vaccine.

CAPE TOWN.

Royal Society of South Africa, September 28.—Dr. J. D. F. Gilchrist, president, in the chair.—J. **Moir**: Colour and chemical constitution, pt. 15. A systematic study of fluorescein and resorcin-benzine. Colour-factors have been obtained by experiment whereby the colour of any halogenated fluorescein can be calculated. A preliminary investigation of resorcin-benzine derivatives follows.—J. D. F. **Gilchrist**: The origin of paired fins in fishes.

Books Received.

Australasian Antarctic Expedition, 1911–14. Under the Leadership of Sir D. Mawson. Scientific Reports. Series C: Zoology and Botany. Vol. 8, part 1: Echinodermata Asteroidea. By Prof. R. Koehler. Pp. 308+75 plates (Sydney: Government Printing Office.) 38*s*.

Stanford's New Map of the Pacific Ocean. 30 in. ×22½ in. (London: E. Stanford, Ltd.) Coloured sheet, 4*s*.

The Marketing of Whole Milk. By Dr. H. E. Erdman. (The Citizen's Library: Marketing series.) Pp. xvi+333. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 21*s*. net.

The Wisdom of the Beasts. By C. A. Strong. Pp. x+76. (London: Constable and Co., Ltd.) 5*s*. net.

Wisconsin Geological and Natural History Survey. Bulletin No. 55: Soil series, No. 27. Soil Survey of Northern Wisconsin. By A. R. Whitson and others. Pp. iv+46. Bulletin No. 58: Educational series, No. 6. The Geography and Economic Development of South-eastern Wisconsin. By Prof. R. H. Whitbeck. Pp. x+252. (Madison, Wis.)

Air Ministry: Meteorological Office. Geophysical Memoirs, No. 17: Simultaneous Values of Magnetic Declination at Different British Stations. By Dr. C. Chree. Pp. 175–200. 2*s*. net. Geophysical Memoirs, No. 18: Observations of Radiation from the Sky, and an Attempt to Determine the Atmospheric Constant of Radiation. By W. H. Dines. Pp. 201–212. 1s. 3d. net. (London: H.M. Stationery Office.)

Agricultural Directorate: Ministry of Interior, Mesopotamia. Memoir III: Dates and Date Cultivation of the 'Iraq. By V. H. W. Dowson. Part 1: The Cultivation of the Date Palm on the Shat Al 'Arab. Pp. viii+75. 10s. net. Part 2: The Results of an Investigation into the Yield of Date Palms on the Shat Al 'Arab. Pp. vi+26+tables. 5s. net. (Cambridge: W. Heffer and Sons, Ltd.)

Chemical Warfare. By Brig.-General A. A. Fries and Major C. J. West. Pp. xi+445. (New York and London: McGraw-Hill Publishing Co., Inc.) 21s. net.

Transactions of the Royal Society of Edinburgh. Vol. 53, part 1 (No. 2). Shackleton Antarctic Expedition, 1914–17. Geological Observations in the Weddell Sea Area. By J. M. Wordie. Pp. 17–28+4 plates. (Edinburgh: R. Grant and Son; London: Williams and Norgate.) 4s.

Biologische Gesetze in ihren Beziehungen zur Allgemeinen Gesetzlichkeit der Natur. By Prof. Dr. J. Reinke. Pp. 31. (Leipzig: J. A. Barth.) 7.50 marks.

Life: How It Comes. A Child's Book of Elementary Biology. By S. Reid-Hayman. Pp. xiii+174. (Oxford: B. Blackwell.) 5s. net.

A History of Greek Mathematics. By Sir Thomas Heath. Vol. 1: From Thales to Euclid. Pp. xv+446. Vol. 2: From Aristarchus to Diophantus. Pp. xi+586. (Oxford: Clarendon Press.) 50s. net.

Report on the Economic and Natural Features of British Honduras in relation to Agriculture, with Proposals for Development. By W. R. Dunlop. Pp. iv+32. (London: Crown Agents for the Colonies.)

Einstein the Searcher: His Work explained from Dialogues with Einstein. By A. Moszkowski. Translated by H. L. Brose. Pp. xii+246. (London: Methuen and Co., Ltd.) 12s. 6d. net.

Cours Complet de Mathématiques Spéciales. By Prof. J. Haag. Tome 2: Géométrie. Pp. viii+661. (Paris: Gauthier-Villars et Cie.) 65 francs.

Science Universelle de l'Energie. VI.: La Relativité et les Forces dans le Système Cellulaire des Mondes: Nouvelle Etude de Cosmogonie scientifique. By Capt. S. Christesco. Pp. 302. (Paris: F. Alcan.) 12 francs net.

Les Maîtres de la Pensée scientifique: Collection de Mémoires et Ouvrages. Mémoires sur l'Electromagnétisme et l'Electrodynamique. By André-Marie Ampère. Pp. xiv+111. (Paris: Gauthier-Villars et Cie.) 3 francs net.

Les Maîtres de la Pensée scientifique: Collection de Mémoires et Ouvrages. Essai Philosophique sur les Probabilités. By Pierre-Simon Laplace. I. Pp. xii+103. II. Pp. iv+108. (Paris: Gauthier-Villars et Cie.) 3 francs net each.

Selection in Cladocera on the Basis of a Physiological Character. By A. M. Banta. (Publication No. 305, Paper No. 33, of the Department of Genetics.) Pp. ii+170. (Washington Carnegie Institution.) 2.50 dollars.

The Distribution of Vegetation in the United States as related to Climatic Conditions. By B. E. Livingston and E. Shreve. (Publication No. 284.) Pp. xvi+590+plates. (Washington: Carnegie Institution.) 9 dollars.

Observations made at the Royal Magnetical and Meteorological Observatory at Batavia. Vol. 39, 1916, containing Meteorological and Magnetical Observations made in 1916. By Dr. C. Braak. Pp. xxviii+118+3 charts. (Batavia.)

Recalculated Monthly Values of the Vertical Component and Inclination of the Magnetic Force at Buitenzorg, 1902–1910. (Appendix to "Observations made at the Royal Magnetical and Meteorological Observatory at Bătavia," vol. 38, 1915.) Pp. iv+20. (Batavia.)

The Wheat Plant: A Monograph. By Prof. J. Percival. Pp. x+463. (London: Duckworth and Co.) 63s. net.

Virgil in Relation to the Place of Rome in the History of Civilisation. A Lecture given to Oxford University Extension Students. By Sir Herbert Warren. Pp. 36. (Oxford: B. Blackwell.) 2s. net.

Rural Organisation. By Prof. W. Burr. Pp. xiv+250. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 12s. net.

Nut Growing. By R. T. Morris. Pp. x+236. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 13s. net.

The Outline of Science: A Plain Story Simply Told. Edited by Prof. J. A. Thomson. Vol. 1, part 1. Pp. ii+40. (London: G. Newnes, Ltd.) 1s. 2d. net.

Morbid Fears and Compulsions: Their Psychology and Psychoanalytic Treatment. By Dr. H. W. Frink. Pp. xxiv+344. (London: Kegan Paul and Co., Ltd.) 21s. net.

Diary of Societies.

THURSDAY, NOVEMBER 24.

ROYAL SOCIETY, at 4.—Special General Meeting to consider the Annual Report of Council. At 4.30.—K. Sassa: (1) Observations on Reflex Responses to the Rhythmical Stimulation in the Frog. (2) The Effects of Constant Galvanic Currents upon the Mammalian Nerve-muscle and Reflex Preparations.—E. Ponder: The Hæmolytic Action of Sodium Glycholate.—Dorothy J. Lloyd and C. Mayes: The Titration Curve of Gelatine.—D. H. de Souza and J. A. Hewitt: Idio-Ventricular Periodicity.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. C. Hay-Murray: Phrenology as an Aid to Education.

INSTITUTION OF LOCOMOTIVE ENGINEERS (London) (at Caxton Hall), at 7.15.—A. E. Kyffin: Axleboxes and Hornblocks.

CONCRETE INSTITUTE, at 7.30.—E. F. Etchells: Presidential Address.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—Prof. F. J. Cheshire: Polarising Apparatus.

INTERNATIONAL COLLEGE OF CHROMATICS (at Caxton Hall), at 8.—Dr. A. C. D. Crommelin: Colour and the Stars.

CAMERA CLUB (at 17 John Street, W.C.2), at 8.15.—Miss Olive Eddis: A Colour Photography Trip in Canada.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—Discussion on Renal Function Tests.—*Short Opening Papers* by J. J. Everidge, J. S. Joly, J. B. Macalpine, Dr. MacLean and C. Nitch, Dr. M. Wallis and G. Ball. To be followed by Sir Cuthbert Wallace, Dr. L. Brown, F. Kidd, Dr. Marrack, G. E. Neligan, A. E. Webb-Johnson, and A. C. Morson.

SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, NOVEMBER 25.

ROYAL SOCIETY OF ARTS (Dominion and Colonies and Indian Sections, Joint Meeting), at 4.30.—A. H. Ashbolt: An Imperial Airship Service.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—Discussion on Hygrometry.—Dr. E. Griffiths: Some Modified Forms of Hygrometers.—F. J. W. Whipple: The Theory of the Hair Hygrometer.—F. J. W. Whipple: The Rationale of Glaisher's System of Hygrometry.—Principal Skinner: The Wet and Dry Bulb Hygrometer.—W. Watts: Determination of the Proper Constant in Apjohn's Formula for Use in Aeroplanes.—H. G. Mayo and Prof. A. M. Tyndall: A New Form of Absorption Hygrometer.—Prof. A. M. Tyndall and Prof. A. P. Chattock: A Thermal Hygrometer. To be followed by Sir Napier Shaw, Sir Richard Glazebrook, W. B. Hardy, Dr. G. C. Simpson, R. Corless, W. J. Hall, Dr. J. S. Anderson, Dr. G. Barr, W. H. Withey, and Dr. G. W. C. Kaye.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 5.—Miss Eva Morton: Report on a Fatal Case of Bullous Eruption.

ELECTRICAL POWER ENGINEERS' ASSOCIATION (Southern Division) (at Central Hall, Westminster), at 7.—A. W. Bennis: Some Notes on Boiler House Plant.

INSTITUTION OF PRODUCTION ENGINEERS (at Institution of Mechanical Engineers), at 7.30.—A. F. Guyler: Drawings and Production.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—G. F. Shotter: Electromagnetic Instruments: Problems in their Design and Construction.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.—Dr. J. P. Kinloch: Metabolism in Fevers.

MONDAY, NOVEMBER 28.

INSTITUTE OF ACTUARIES, at 5.—S. J. Perry: The Relation between the Course of Wholesale Prices of Commodities and the Market Value of Various Classes of Securities.
ROYAL SOCIETY OF MEDICINE, at 5.—Dr. Guelpa: The Treatment of Diabetes and Gout by Disintoxication.
FARADAY SOCIETY (at Chemical Society), at 8.—J. N. Greenwood: The Effect of Cold Work on Commercial Cadmium.—J. N. Pring and E. O. Ransome: Reaction between Cathodic Hydrogen and Nitrogen at High Pressures.—F. H. Jeffery: The Electrolysis of Aqueous Solutions of Alkaline Nitrites with a Lead Anode, and an Electromagnetic Determination of the Constitution of the Complex Anion Formed.—T. C. Nugent: An Inhibition Period in the Separation of an Emulsion.—N. R. Dhar and N. N. Mittra: Induced Reactions and Negative Catalysis.—Dr. S. J. Lewis and Miss F. M. Wood: Exhibition and Description of a New Adjustable Thermostat for all Temperatures between 0° and 100° C.
ROYAL SOCIETY OF ARTS, at 8.—A. M. Hind: Processes of Engraving and Etching (Cantor Lecture) (1).
ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—W. F. Broderick: The Endocrine Factor in the Production of Immunity or Susceptibility of the Teeth to Pain.—S. Mummery: A Case of Mandibular Sarcoma in an Infant.

TUESDAY, NOVEMBER 29.

ROYAL HORTICULTURAL SOCIETY, at 3.—Dr. A. B. Rendle: Plants of Interest in the Day's Exhibition.
MEDICAL OFFICERS OF SCHOOLS ASSOCIATION (at 11 Chandos Street, W.1), at 5.—R. C. Elmslie: Status of Physical Instructors in Schools.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—C. M. Williamson: Photography and Mechanics: Facts and Possibilities.
ROYAL ANTHROPOLOGICAL INSTITUTE (at Royal Society), at 8.30.—H. Balfour: The Archer's Bow in the Homeric Poems (Huxley Memorial Lecture).

WEDNESDAY, NOVEMBER 30.

ROYAL SOCIETY, at 4.—Anniversary.
ROYAL SOCIETY OF ARTS, at 8.—N. Heaton: The Preservation of Stone.

THURSDAY, DECEMBER 1.

LINNEAN SOCIETY OF LONDON, at 5.—Prof. W. N. Jones: Note on the Occurrence of Brachiomonas.—J. Burtt-Davy: The Distribution of Salix in South Africa.—Miller Christy: The Problem of the Pollination of the British Primulas.
ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Capt. G. de Havilland: Design of a Commercial Aeroplane.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—L. J. Steele and H. Martin: The Cyc-arc Process of Automatic Electric Welding.
ROYAL MICROSCOPICAL SOCIETY (Metallurgical Section), at 7.30.—The Practical Application of Vertical Illuminators in the Determination of the Structure of Metals and Alloys and in Metallographical Research Generally. Exhibition of Various Types of Vertical Illuminators by C. W. Hawksley and P. Swift.
CHEMICAL SOCIETY, at 8.—R. Mond and A. Wallis: Some Researches on the Metallic Carbonyls.—R. Mond and A. Wallis: The Action of Nitric Oxide on the Metallic Carbonyls.

FRIDAY, DECEMBER 2.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Geophysical Discussion: The Geological Effects of the Cooling of the Earth.
JUNIOR INSTITUTION OF ENGINEERS (at Caxton Hall), at 8.—B. L. Ladkin: Notes on Maintenance of Electrical Accumulators.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 8.—M. O. Dell: Ideals and Methods in Picture Making.

SATURDAY, DECEMBER 3.

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 3.—Prof. G. S. Boulger: The Sundews: Their Kindred and Neighbours.

PUBLIC LECTURES.

(A number in brackets indicates the number of a lecture in a series.)

THURSDAY, NOVEMBER 24.

UNIVERSITY COLLEGE, at 2.30.—Miss M. A. Murray: Ancient Survivals in Modern Egypt.
UNIVERSITY COLLEGE, at 5.—Prof. J. E. G. De Montmorency: Feudalism in India (4).
BARNES HALL (1 Wimpole Street, W.1), at 5.15.—Prof. E. C. Van Leersum: Dietetics and Public Health (Chadwick Lecture).
IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—W. Bateson: Recent Advances in Genetics (4).
KING'S COLLEGE, at 5.30.—H. W. Fitz-Simons: Bridge Construction (4).

FRIDAY, NOVEMBER 25.

UNIVERSITY COLLEGE, at 4.30.—Dr. J. C. Drummond: Nutrition (7).
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 5.—B. G. Goodhue and D. Barber: American Architecture.
IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Dr. J. D. Falconer: The Wonders of Geology (Swiney Lectures) (9).
UNIVERSITY COLLEGE, at 8.—Prof. G. Dawes Hicks: Our Knowledge of the Real World (4).

SATURDAY, NOVEMBER 26.

UNIVERSITY COLLEGE, at 10.30.—Prof. Karl Pearson: Fallacies (Lectures for Teachers).

MONDAY, NOVEMBER 28.

UNIVERSITY COLLEGE, at 5.—A. T. Walmisley: Geometry for Engineers.
IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Dr. J. D. Falconer: The Wonders of Geology (Swiney Lectures) (10).
KING'S COLLEGE, at 5.30.—H. Moore: Liquid Fuels (4).

TUESDAY, NOVEMBER 29.

KING'S COLLEGE, at 5.30.—Prof. H. Wildon Carr: The Modern Scientific Revolution and its Meaning for Philosophy (8); The Theory of Creative Evolution; Dr. W. Brown: Psychology and Psycho-therapy (7).
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 6.—R. Unwin: American Architecture and Town Planning.

WEDNESDAY, NOVEMBER 30.

UNIVERSITY COLLEGE, at 3.—Prof. E. G. Gardner: Nature in the *Divina Commedia* (3).
KING'S COLLEGE, at 4.30.—Dr. C. Da Fano: Histology of the Nervous System (8).
UNIVERSITY COLLEGE, at 5.—Prof. G. Elliot Smith: The Evolution of Man (2).
IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Dr. J. D. Falconer: The Wonders of Geology (Swiney Lectures) (11).

THURSDAY, DECEMBER 1.

UNIVERSITY COLLEGE, at 5.—Prof. J. E. G. De Montmorency: Feudalism in Western China and in Africa (5).
IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—W. Bateson: Recent Advances in Genetics (5).

FRIDAY, DECEMBER 2.

UNIVERSITY COLLEGE, at 4.30.—Dr. J. C. Drummond: Nutrition (8).
IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Dr. J. D. Falconer: The Wonders of Geology (Swiney Lectures) (12).
UNIVERSITY COLLEGE, at 8.—Prof. G. Dawes Hicks: Our Knowledge of the Real World (5).

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