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The Melbourne University Bill.

MELBOURNE University early took high rank among the universities of the British Dominions by the special distinction of many of its staff, the high standard of its degrees, and the harmonious co-operation between it and its affiliated colleges. There has, however, been a feeling in recent years among educationists in Victoria that the university is not still of the same standing, as it had not kept pace with progress elsewhere. To remove the causes of any such decline the Government of Victoria has introduced a Bill raising the statutory grant to the university from 21,000*l.* per annum to 30,000*l.*, the amount stated as necessary by the university council. This Bill also proposes reforms in the constitution of the university.

The ultimate authority at present is the senate, which consists of all the graduates of the university holding the degree of doctor or master. This body has some legislative powers and elects practically the whole of the university council, which is the executive and administrative organ of the university. To give such authority to the senate was probably the soundest policy available at the foundation of the university, but it is no longer necessary. The new Bill therefore proposes to replace the senate by a convocation which would consist of all the graduates, would act through a committee, and would elect twelve out of the thirty members of the council. The Bill reconstitutes the council to make it more widely representative. The new council would consist of thirty members, seven appointed by the Government, two by the university staff, and one by the students, and would include the director of education and the president of the Professorial Board *ex officio*. These members and the twelve elected by convocation would co-opt the six remaining members.

The new Bill assigns to the university three additional branches of work, a school of commerce, research at the university in applied science, and a university extension department; and it allots for these purposes an extra grant of 7000*l.* per annum. The allocation to the university of the proposed educational extension work would seem to be to its advantage as well as to that of the State. There is a widespread reaction towards various forms of affiliation as a means of widening the influence of universities on national education; but this system often imposes a severe burden on a university, and is better not employed if some other way of organising higher provincial education be available. In the case of Victoria, failing the scheme proposed in the Bill, the alternatives are the organisation of super-secondary classes by the Education Department, or the award of university degrees to external students by examination, the course recently adopted in Western Australia and Queensland. The proposal in the Bill for the admission of fifty free students a year to the university would therefore seem to be to its ultimate benefit, by lessening any claim for affiliation that might be put forward in future by provincial institutions.

The lines of the new Bill follow the present general trend of university reform. The University Association of Teachers, of which Prof. W. A. Osborne, the president of the Professorial Board, is chairman, has, however, issued a statement expressing great anxiety and disappointment at some of its features. The criticisms complain especially of the inadequate representation of the university staff on the new council, and of the disregard of the principle that a university should not be called upon to undertake new duties until the old duties are properly provided for. The statement points out that the 9000*l.* added to the annual grant for general university purposes would be so reduced by new expenses and loss of revenue from fees and public examinations that the university would gain at the utmost only an extra 1200*l.* If these estimates be correct, this additional income is obviously quite insufficient to enable the university to cope with the inrush of new students, who increased in numbers from 1296 in 1914 to 2607 in 1921.

This criticism is less against the Government than against the university council, which, according to the Association of University Teachers, has failed to protect the interests of the university by not raising fees and by asking for an inadequate increase of the State grant. The Government has given the amount

said to be necessary, and has probably under-estimated the effects on the university income of some of the proposed changes. If these effects be demonstrated, the raising of the general university grant may be expected.

The discussion of the new Bill shows that university teachers in Australia are profoundly anxious as to the present conditions, are doubtful of the possibility of maintaining the university work at an appropriate level, and are alarmed at the discontent rife among all grades of the staff. It is impossible for any one not intimately acquainted with existing conditions in Australia to judge the financial estimates, but it is obvious that if a university staff is thoroughly discontented its efficiency is bound to suffer. Teachers who are not paid a living wage must supplement their income by outside work which, except perhaps in departments of applied science, inevitably detracts from their usefulness to the university.

Those interested in the progress of the universities of the British Empire will hope that the Victorian Government, before the new Bill is passed, will allay the distracting anxieties of the university staff by making sure that the nominal increase of 30 per cent. in the general purposes grant is an actual increase of this amount, and by amending the regulations relating to the council so as to guarantee a larger representation of university teachers. The provision that one of the six members to be co-opted by the council and two of the twelve to be elected by convocation must be university teachers would give a staff representation of one in five, which is the average in the younger British universities. If by such changes the new scheme gained the confidence of the staff the reforms would restrengthen the university, which has hitherto been a glory to the State of Victoria and an important asset in the development of Australia.

Greek Mathematics.

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, 1921.) 2 vols., 50*s.* net.

WERE this book only for the mathematician it would be no book for me; but it is a great deal more. It is for all who care for the historical aspect of science; it is for all lovers of Greek, for mathematics is a true "Legacy of Greece," and is interwoven through and through with Greek thought and philosophy.

A couple of accidents in boyhood (if I may be allowed the reminiscence) made this subject curiously attractive to me. George Johnston Allman, pioneer in this country of the renewed study of Greek geometry, belonged to the little band of scholarly professors who taught in those days in Galway College; he had more of mathematics and more of fine historic sense than of Greek letters, and here his colleagues—"Tom" Maguire the Platonist, Davies the editor of the *Eumenides*, and my father, who was his kinsman—combined to help him. In our quiet Galway life we heard for months together little else than of Allman's book and the long discussions which went to the making of it.

About the same time I had for schoolmaster in Edinburgh (and long after for a close friend) Dr. John Sturgeon Mackay, as deeply versed in Greek mathematics as Allman himself. In Edinburgh he was scarcely known save to his schoolboys, and lived a life as neglected as that still greater Hellenist Veitch (of the "Greek Verbs") had done; but he spent his vacations reading Greek MSS. in the great libraries, and in Paris he was intimate with Paul Tannery and the scholars of the day. Mackay's life-task was to edit Pappus, the one great Alexandrine omitted by the Oxford editors of the eighteenth century. After twenty years' work the thing was done, and lay in his desk with every diagram exquisitely drawn and every page and footnote written and rewritten. He went one day into Williams and Norgate's bookshop, then in Edinburgh, and the manager said: "I have something that will interest you to-day, Dr. Mackay"; and he handed him the first volume, fresh from Leipzig, of Hultsch's edition of Pappus. The two men must (as Mackay told me afterwards) have been following one another unawares from library to library, collating the same MSS., noting the same minute textual details, and Mackay's intimacy with the French had helped doubtless, in those long-ago post-war years, to keep him unacquainted with the German and his work. Anyway, there was an end of the matter. Some might have hurried into print, trusting to little points of their own, claiming something of the reward—but not Mackay. The work was done and well done. Pappus was edited. It was a scholar's tragedy—and nothing more!

Sir Thomas Heath has produced one important work after another, while living all the while a life of strenuous official toil and responsibility. His Diophantus, his Apollonius, and (greatest perhaps of all) his Euclid are part of the solid foundation of this "History of Greek Mathematics." He has had more to build on by a long way than Allman and Gow had fifty years ago; new texts have been edited, and men like Heiberg, Tannery, Zeuthen, Aldo Mieli, and (last but not least) Gino Loria have dealt with the matter in part and

whole; but the essential difficulty remains of piecing together the broken stones.

In our first glimpse of ancient mathematics two great figures, Pythagoras and Plato, stand out above all the rest: not as the greatest mathematicians, but as the greatest landmarks in history and tradition, much like Descartes and Leibniz in another age. From Plato on, the story runs fairly smooth; we leave tradition behind and enter upon history; mathematics becomes a science of its own and slowly disentangles itself from philosophy; the "polymath" is giving place to the specialist. With Euclid we enter on the "Golden Age" of geometry cradled in Plato's Academy, and though some of the minor men (like Nicomedes and Diocles) remain shadowy figures, we have a solid inheritance in Euclid and Apollonius and in Archimedes—"ordine quidem tertius" (as Torelli said), "dignitate facile princeps." On the physical side the astronomy of Eudoxus, the Optics of Euclid, the astronomy again of Aristarchus—the "Copernicus of antiquity"—may be taken as "nails in a sure place"; and when we come to the "Silver Age" of Diophantus, Pappus, Ptolemy and Theon, we have a wealth of historical material.

But up to Plato's time it is a very different story, for the simple reason that very few of the earlier philosophers and mathematicians (say down to Archytas) ever *wrote* at all. Their teaching was private or even secret, and only oral tradition carried it on. Two things men will continue to discuss but never know for sure—the debt the first Greek mathematicians owed to Egypt and the East, and the real, actual attainments in mathematics of men like Thales, Pythagoras, Archytas, Democritus and Plato. Pythagoras is the strangest case of all, for no wise man's name since Solomon's has so fascinated the world. Tradition, and tradition alone, tells us that he invented the forty-seventh proposition, and tells it no more confidently than the Dancing Dervishes of Constantinople tell you they are the descendants of his holy Brotherhood!

Where there is nothing but tradition to go upon, the historian is lost. The imaginative man begins putting two and two together, arguing what *must* have been known in order to know this or that, and what *must* have followed as soon as this or that was understood; and so the story grows. The construction of the Pentagon "must" have implied a knowledge of the Golden Section, and this and the "Theorem" itself must have involved the concept of the Irrational; the triangle of the Pentalpha and its gnomons must have led on to the logarithmic spiral—even to the Limaçon of Pascal! In some such way Naber, for instance, discourses on what Pythagoras "must" have known and what he may have known; it is pleasant, even suggestive, reading, but it is a long, long way from history. At the other end stand the sceptical critics, to be taken more seriously—like Eva Sachs, whose book, by the way, on "Die fünf platonischen Körper," Heath does not seem to quote. She, for example, holds that up to Philolaus we know nothing at all; that he and later Pythagoreans were chiefly bent on ascribing each new thing to the old master of their school; that there is no proof that Pythagoras knew anything of irrationals, little that he was acquainted with the regular solids, and none at all that he associated them, *more Platonico*, with a theory of the Elements. Between such opinions Sir Thomas Heath steers a careful middle course, and what he has to tell he attributes to "the Pythagoreans" rather than to Pythagoras.

Again, as to alien sources behind early Greek mathematics, one school will tell you that Greece had nothing or next to nothing to gain from the land-surveyors or "rope-stretchers" of Egypt, nor from Mesopotamian astronomers and calendar-makers. Others eagerly pick up little stray hints of a community or descent of ancient learning. They remind us that it was in Ionia that Greek philosophy arose and the special sciences, even medicine, began—in a "mélange de races d'émigrés, d'origine diverse," as Heiberg called the Ionians the other day; that Ionia was in close and constant touch with Lydia; and that Ionian science appeared after a clash of empires and fall of cities, as a later Renaissance followed the fall of Constantinople. Or they catch hold of straws which point, or seem to point, to Far Eastern intercourse, such (for instance) as that mode of reckoning by myriads and myriads of myriads which the Japanese are said to have used about the time (say) of Thales, which exists in China to this day, and seems identical with Archimedes' famous numeration of the *Arenarius*—where he began by supposing a myriad grains of sand in the space of a poppy-seed (or rather surely a poppy-*head*), and went on to myriad-myriads of units, and of orders, and of periods. Heath discusses the broad question briefly and fairly, and is content in the end to agree (as we all must) with Plato, that whatsoever the Greeks had borrowed, were it much or little, they it was who improved on it and carried it towards perfection. The Greeks at least knew well what not to borrow, and striking above all else is their choice of themes. It is they who best exemplify what Sir John Herschel laid down (perhaps rightly) as a general proposition—that men delight to escape from the trammels of earth: that not practical problems but "the abstractions of geometry, the properties of numbers, the movements of the celestial spheres, whatsoever is abstruse, remote and extramundane, become the first objects of infant

science." The useful applications, mechanical inventions, follow later on; and David Hume put it neatly when he remarked that "we cannot reasonably expect a piece of woollen cloth to be brought to perfection in a nation that is ignorant of astronomy."

Two things attract the general student, I think, more than any others connected with Greek mathematics—the Pythagorean arithmetic and the matter of the Platonic bodies. The former begins with the notion, characteristically Greek rather than peculiarly Pythagorean or Platonic, of arithmetic as something apart from mere calculation or the doing of sums—as, in short, a "theory of numbers"; and not the least curious thing about it is that that arithmetic was studied (or so it is said) for generations before the Greeks had signs, even alphabetic ones, for the numerals. We may go to Sir Thomas Heath for a clear and full account of all the curious sorts of numbers, figurate and other, odd and even, square, triangular, and pyramidal, friendly numbers, perfect numbers, and so forth, which fertile imagination along with true mathematical insight was able to discover. It is not without a deep meaning, I believe, that we find on the very threshold of Mathematics this instinct for the symmetry of numbers, this sense of the intrinsic beauty, the comparative perfection, of one number or another. It is the way the calculating boy begins; we had it exemplified in the highest degree, only the other day, in Ramanujan's extraordinary but too short-lived talent. The theme, in Greek hands, leads on and on by many roads. By way of the "means," it is at the root of the theory of music itself, of the "acousmatic" side of the Pythagorean philosophy; by the theory of "gnomons" it is close-linked with the "theorem" of Pythagoras; it carries us, though more in contrast than identity, to the Euclidean treatment of arithmetic; and at last it brings us straight to the Neo-pythagoreans, to the "Theologumena," and to later writers down even to Kircher, who dealt more and more extravagantly (much after the fashion of the Cabbala) "de abditis numerorum mysteriis"—with the physical, the "ethical" and the "theological" properties of numbers.

The other matter, that of the Platonic bodies, is a long story. We know that Plato did not discover them but we may still be curious to know whether Pythagoras did; and here we must distinguish the mathematical side of the question from the physico-philosophical one—from the deeper meaning which Plato and others found in these five symmetries. It has been amply shown, I think, that their association with the elements was not due to Pythagoras, and it is not likely that Pythagoras knew very much even about their construction and properties. To suppose him to have understood these is to credit him with too much; the main teaching of Euclid would have been already his: "Le cadre était déjà celui," as Tannery says, "que remplissait les Eléments [d'Euclide]." But who were the great mathematicians who investigated them? Theætetus was probably the outstanding man—he who "*described*," that is *constructed*, the five solids, according to Suidas—though Heath hesitates (curiously) over the meaning of ἔγραψε. Heath quotes also the Euclid-scholion that Theaetetus added the octahedron and icosahedron to the other three, but I do not think he mentions that this has (or so it might seem) a textual flaw; for surely the octahedron was as old as the Pyramids, while the *dodecahedron* would be one of the last, probably the last of all, to be constructed and explained. Plato, then, may have taken his mathematics in this matter from Theaetetus, partly (some would say) from Democritus, and something more straight from Leucippus. So with their help was built up Plato's theory, fanciful no doubt but very beautiful, of these five figures, all inscribable in spheres, not really solids but hollow shells with filmy surfaces, made out of tiny triangles—as the gold-beater begins with little three-sided patins of gold—the figures being, as it were, molecules with the facets for atoms, and the whole forming a sort of foamy, cellular structure, like a froth of soap-bubbles, out of which to build the material of an harmonious world. Indeed, one wonders whether Plato had not in his mind's eye the homely but exquisite configuration of a froth of soap-suds!

The theme is kindred to our last. For just as an arithmetic grew up regardless of practical reckoning and dealing only with the symmetrical properties of numbers, so did a geometry arise which thought nothing of practical mensuration, only of the abstract properties, the essential symmetries, of planes and solids. This geometry, which studied the triangle, the square, the pentagon, etc., then the "Platonic" and "Archimedean" bodies, the regular and semi-regular solids, the perfect, the less perfect and the imperfect geometrical forms, was own sister to that arithmetic which investigated the triangles, squares, polygons, pyramids and cubes, the "perfections and imperfections," which lie hidden among the mysterious properties of numbers. And all the while these theoretical studies of *configuration* were being applied along somewhat narrow but very important lines to music, to optics and to astronomy, as we should say to problems of sound, light and periodic motion—in short, to the three great recognised groups of harmonious natural phenomena. This, then, in a word, was the concept of Greek mathematics as it occupied the wit of man, the intellect of philosophers, for just a thousand years.

The Archimedean bodies, by the way, Heath deals with pretty fully, but he might perhaps have told us that one of these (Kepler's "truncated octahedron"), said to have been known to Plato, is no other than that tetrakaidekahedron which Lord Kelvin showed to be (with a slight modification) the typical "cell" of a homogeneous froth. He might even perhaps have told us a little of how Kepler (true disciple of Pythagoras and of Plato) used both Platonic and Archimedean bodies in that treasure-house of elegant geometry, the "Harmonice Mundi"; and how he showed that not only the five Platonic bodies (as Euclid knew) but also Archimedes' thirteen were all there are, the complete series of their respective families.

There is a vast deal of information in Heath's book, clearly set forth and orderly arranged; we have nothing to compare with it in English, and Gino Loria's "Scienze esatte" is its only serious rival abroad. I am inclined to think that Loria paints history with a broader brush, while Heath excels in his account of individual mathematicians; but I cannot help thinking that Heath, who has attained such complete and acknowledged success in his editions of Euclid and the rest, must have found that in this history he had struck a harder task than any he had tried before. We may know more of the history of mathematics than of any other science, but the lacunæ are immense, and tradition is poor material for the historian. Moreover the historical aspect is somewhat uncongenial to the mathematician, if only because (as Eva Sachs says) history deals with *das Werden*, and mathematics with *das Sein*!

When Sir Thomas Heath deals with Euclid, Apollonius, Archimedes, Diophantus, Hero or Pappus, he gives us in a few pages all we could expect by way of epitome of the trend, the method and the results of their labours. But his book pursues its steady, instructive course with little digression, allusion or anecdote, and with curiously little bibliographical information such as he puts abundantly into his other books. Surely one of the objects of a text-book is to guide the student to what it does not and cannot contain! Some of us, I think, would have liked a little more digression or even gossip. When Sir Thomas has told us that the Pentalpha was the Pythagorean symbol of Health he is well-nigh done; but Chasles gives us a dozen pages of learned gossip upon it, traces it through Boetius and Thomas Bradwardine and the Margarita Philosophica and Father Kircher to Kepler himself, and ends with Poinssot's "Mémoire sur les Polygones"! The Shoemaker's Knife is a beautiful and simple construction in easy geometry, of great antiquity—an ancient proposition, Pappus calls it—and Heath tells us doubtless all that is essential for us to know; but a short footnote might have told us how Jacob Steiner investigated and elaborated it, or how J. S. Mackay epitomised its many properties, or how Sir Thomas Muir added a pretty corollary.

Again (as a random instance) Heath discusses at length the simple but important rule of Thymaridas (simplicity itself in our notation) for solving certain simultaneous equations, where the sum of $x_1+x_2+\ \ldots\ x_n$ is known, and also the successive sums of x_1+x_2, x_1+x_3, etc.; but of Thymaridas he only tells us that he was "an ancient Pythagorean, probably not later than Plato's time." If we be limited to a phrase I do not know that we could say a safer thing; but why should we not have some little sign-post, even a footnote, to Tannery's discussion (in "L'Arithmétique pythagorienne") on who Thymaridas was and when he lived, or to the many discussions by Cantor, Martin, Nesselmann, and even Fabricius; for "il y a un assez grand intérêt historique à déterminer l'âge où vivait Thymaridas." Heath tells us that this rule of his was called by the special name of ἐπάνθημα, and he translates it "the 'flower' or 'bloom' of Thymaridas." He qualifies this by a parenthetic remark that the name was not, after all, confined to this particular proposition, but what it really means he does not explain; Tannery, I think, has shown fairly clearly that it was a name ("pour ainsi dire") "pour les matières non exigées du programme de l'arithmétique pour les étudiants en philosophie."

It was again Thymaridas who defined (as Heath tells us) "a unit as 'limiting quantity,'" περαίνουσα ποσότης. It was a very important definition, but was it not a definition of "unity" rather than of "a unit," and is a limiting *quantity* a fair and full translation of ποσότης? Turn towards the other end of the volume, to ground that is peculiarly Heath's own, and see Euclid's famous definition (V. 3) of *ratio*, which Heath renders "a sort of relation in respect of *size* (πηλικότης) between two magnitudes of the same kind." I cannot help thinking that, between the two, we lose the fine and even crucial distinction between ποσότης and πηλικότης. The one mathematician was talking of a relation between numbers, the other of a ratio between any two magnitudes; I think they both picked their words accordingly, and I should like at least to give them the benefit of the doubt. Of Euclid's definition Heath tells us that "it was probably inserted for completeness' sake, and in order merely to aid the conception of a ratio." All the same, I should rather like to hear what Barrow had to say of its metaphysical character; or what an older school meant when they translated

πηλικότης by *quantuplicity*; or even to be referred to that very curious imaginary discussion of this very point, by Euclid, Eutocius, Theon and the rest, in the pages of Meibom's "De Proportionibus." The simple fact is that Sir Thomas Heath has given us so much, and it is all so good, that he makes us ask for more.

D'ARCY W. THOMPSON.

Entomology and Malaria.

The Prevention of Malaria in the Federated Malay States: A Record of Twenty Years' Progress. By Dr. Malcolm Watson, with contributions by P. S. Hunter and A. R. Wellington. Second edition, revised and enlarged. Pp. xxviii + 381. (London: John Murray, 1921.) 36*s.* net.

DR. WATSON'S book shows clearly the wide range of scientific knowledge which is required by those who work in the tropics either as physicians or as sanitarians. It is unnecessary nowadays to insist upon the importance of the control of malaria in the development of those vast areas from which is derived so much of the food supplies and raw materials of manufacture of all civilised countries, but only those who have had practical experience of the methods used to deal with the disease can appreciate how many and how varied these must be.

Until about the middle of the nineteenth century medical men were almost always naturalists as well, and it is regrettable that the old traditional association of medicine and natural science has been so largely broken off. In modern times the older teaching of natural history has been replaced by an inadequate course of so-called biology which may, indeed, enable the student to recognise the appendages of the cockroach, or a section of the rhizome of a fern, but scarcely qualifies him to name correctly the commonest insect or plant when he sees it in the field. The need for a more practical knowledge of the forms and bionomics of animals, and especially of insects, is brought home to one again and again during the perusal of Dr. Watson's very interesting and readable book.

It was indeed no light task which confronted the author when in 1901 he began his service in the Malay States. The new knowledge of the mode of transmission of malaria by certain mosquitoes had to find a practical application in a country where physical conditions are very diversified and little or nothing was known about the insect carriers. Large commercial interests, too, were involved, and no doubt there were many interested persons ready to criticise adversely any failure, and reluctant to spend money on what they regarded as the doctor's theories. Here were the most favourable conditions imaginable for mosquitoes—an equable, warm, and moist climate; a large rainfall almost equally distributed throughout the year; abundance of pools, swamps, and hill-streams. As to the prevalence of mosquitoes, Dr. Watson relates that, in a small patch of jungle in the town of Klang, *Anopheles umbrosus*, a natural carrier of malaria, was present in such large numbers that three persons caught about two hundred in a quarter of an hour "and simply could not stand the biting any longer." At the same time, three other species of mosquitoes were present "in considerably greater numbers than the anopheline, so it can be imagined a quarter of an hour in that jungle was unpleasant."

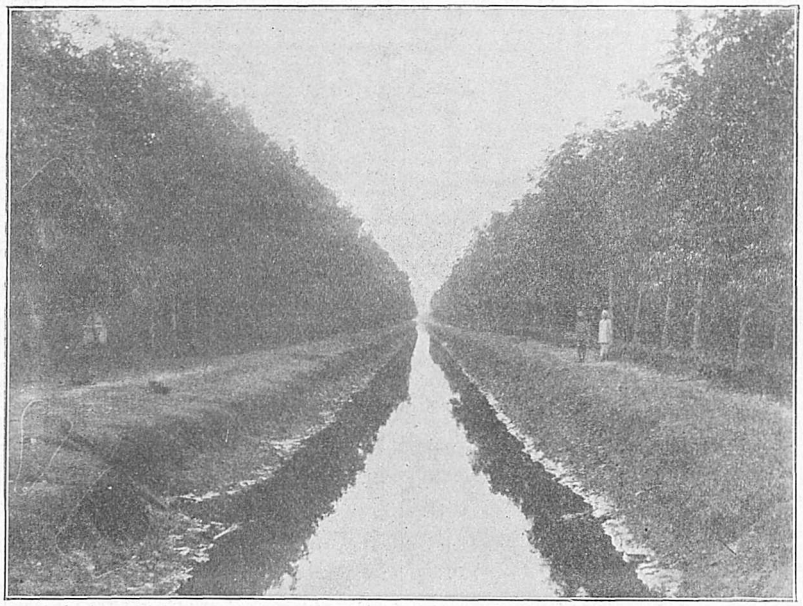

FIG. 1.—Kapar Drainage Scheme. One of the main drains, with rubber-trees on both sides. From "The Prevention of Malaria in the Federated Malay States."

The book abounds with interesting details concerning the natural history of various mosquitoes, and shows how necessary such knowledge is before any attempt can be made to mitigate the malarial scourge. The case of *Anopheles Ludlowi* is a good vindication—if any were needed—of the practical importance of the taxonomic work of the systematic entomologist. There are three species, *A. Ludlowi*, *A. Rossii*, and *A. indefinitus*, so similar to one another that the experience of an expert is required to distinguish between them. Yet of these three only one, *A. Ludlowi*, is known to be a natural carrier of malaria. Moreover, it differs entirely from the others in its habits, breeding mainly along the coast and often in brackish water. In connection with this mosquito Dr. Watson gives a good account of the mangrove-swamps, and explains how engineering works on the coast may cause an increase of malaria by interference with the tidal flushing of the swamps.

As the prevalent mosquitoes vary in the plains and in the hills, so the methods of dealing with malaria differ in each locality. As the jungle is cleared and drained in the plains malaria disappears; whilst in the hills drainage and the opening up of the jungle alone fail to influence the prevalence of the disease. The explanation of this is that in the plains the mosquito which carries malaria is *Anopheles umbrosus*, which breeds in pools in the jungle; in the hills the mosquito chiefly concerned is *A. maculatus*, the breeding-place of which is the running water of springs and hill-streams. A method which may be quite successful in diminishing the numbers of one species may yet fail to lessen the incidence of malaria, since it may lead to conditions suitable for the breeding of another species. How all these different problems were dealt with satisfactorily will be found in the volume under review.

The book appeals to other than medical men. Many interesting sidelights are thrown on the inhabitants, on life in the Malay States, and on the development of rubber planting; a good account also is given of the physical features of the country, with its mangrove-swamps, "flat land," coastal and inland hills.

The book is written in an attractive style, and such a large amount of knowledge is so pleasantly and modestly displayed that it will certainly add much to the high reputation of the authors; and, since the methods for the prevention of malaria, which were used so successfully in the Malay States, are of general application, this lucid account will be of the utmost value to all medical men practising in tropical and subtropical regions. The book is well printed and illustrated by a large number of excellent photographs, two of which are here reproduced.

H. J. WALTON.

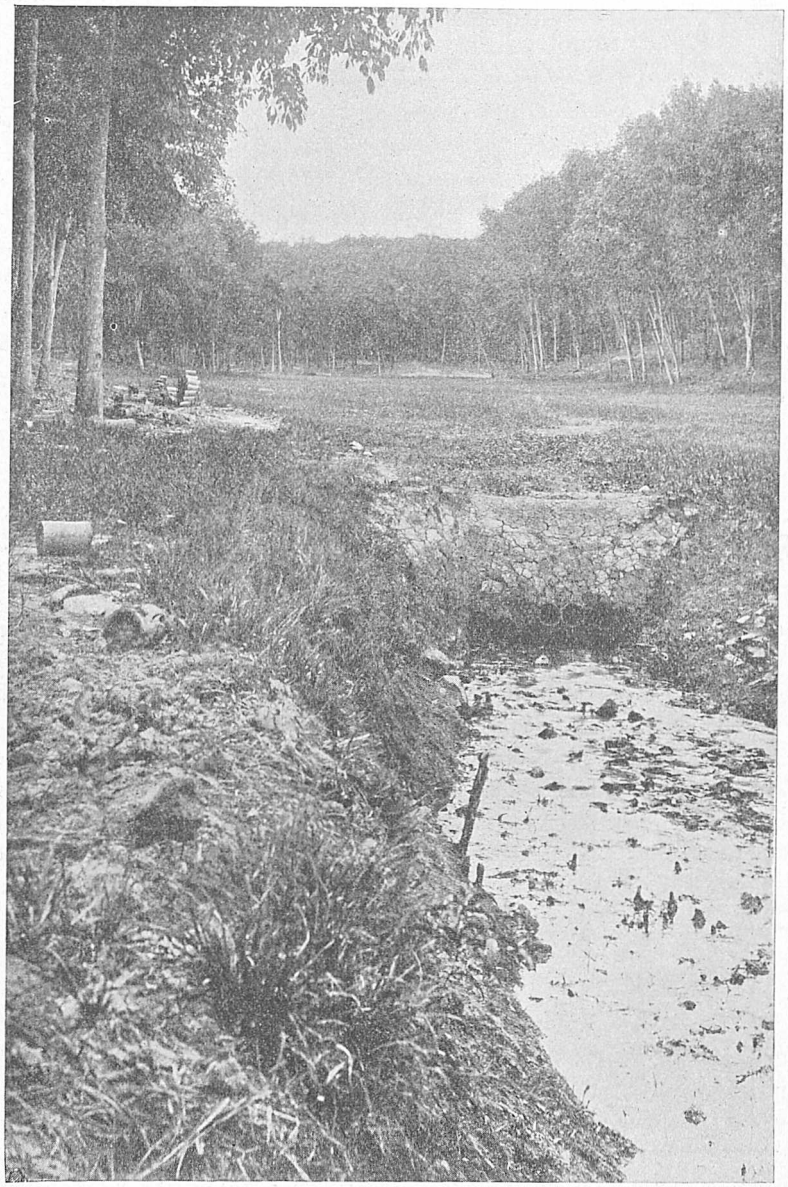

FIG. 2.—The end of the subsoil pipes in a ravine on the Seafield Estate; from this point the water continues in an open drain. Photograph taken in dry weather. From "The Prevention of Malaria in the Federated Malay States."

Berber Surgery and Sport in the Aurès Mountains.

(1) *Among the Hill Folk of Algeria: Journeys among the Shawia of the Aurès Mountains.* By M. W. Hilton-Simpson. Pp. 248. (London: T. Fisher Unwin, Ltd., 1921.) 21*s.* net.

(2) *Shooting Trips in Europe and Algeria: Being a Record of Sport in the Alps, Pyrenees, Norway, Sweden, Corsica, and Algeria.* By H. P. Highton. Pp. 237. (London: H. F. and G. Witherby, 1921.) 16*s.*

(1) THE gregarious nature of the British tourist is illustrated by Captain Hilton-Simpson's claim that during his excursions among the Algerian hills near Biskra, which he describes as one of the most popular tourist resorts of the whole world, his wife was the first European woman to be seen by many of the people of the adjacent hills. His journeys in the mountains of Aurès, the Mons Aurasius of the Romans, were conducted mainly to study the native surgery and make a collection of the instruments used for the Pitt-Rivers Museum, Oxford. The most valuable chapter in his book is the account of Berber surgery, which is not easily studied, as the French apply to the Northern Sahara the law that a fatal operation conducted by a man who is not medically qualified is manslaughter. Captain Hilton-Simpson, by gifts of drugs and surgical instruments, was able to gain the confidence of some of the native practitioners. He secured admission to some operations, and has collected much interesting information as to the methods of treatment. The most remarkable success is in trepanning.

The author has made seventeen visits to Algeria, so he knows the country well, and his book is a valuable record of contemporary native life in the remoter villages of the Southern Atlas. He refers to indications of a greater rainfall at the time of the Roman occupation, though the general evidence given in the book indicates that the climate in Roman times was much the same as it is to-day.

(2) The same district has been described from a very different point of view by Mr. H. P. Highton, a science master at Rugby. He, also, discarding the ways of the ordinary tourist, has devoted many of the generous holidays allowed at the public schools to shooting trips, in one of which he visited the mountains of Southern Algeria in quest of the Barbary sheep and the Dorcas gazelle. Other journeys were in chase of chamois in the Alps and the Pyrenees, of elk and reindeer in Norway and Sweden, and of moufflon in Corsica. Chamois-hunting he calls the prince of sport. His narratives are brightly written. He concludes with a defence of shooting based on the nature-red-in-tooth-and-claw principle, and the claim that, though animals suffer greatly from mental anguish when chased, as presumably in fox-hunting, they feel little physical pain. This line of argument is almost the opposite to that adopted by Roosevelt, based on the quickness with which wild animals forget sudden alarm.

The War and the Royal Engineers.

The Work of the Royal Engineers in the European War, 1914–19.

(1) *Water Supply.* Part I.: *General Development of Organization, Plant, and Works.* Pp. 54+32 pls.+2 maps. Part II.: *Operations.* Pp. 55-92+9 pls.+8 maps.

(2) *Bridging.* Pp. 87+33 pls.+3 maps.

(3) *Supply of Engineer Stores and Equipment.* Pp. 109.

(4) *The Signal Service in the European War of* 1914 *to* 1918. (*France.*) By R. E. Priestley. Pp. xvi+359+20 pls.

(Chatham: Secretary, R.E. Institute; W. and J. Mackay and Co., Ltd., 1921.)

(1) IN the last year of the war operations involving "concentrations of unexampled density could be successfully undertaken at short notice in any areas, and at the points most desirable for strategical or tactical reasons, without reference to the presence of water in or near the surface." The ways and means by which this result was achieved are well set forth in the work under review. Amongst them may be mentioned the erection of semi-permanent and extensive supply systems with head works and pipe-lines, such as those at Roosbrugghe, the free use of mechanical transport, and the extensive use of boring plant. Drills were used on a small scale in the chalk area in 1915, the air-lift pump soon giving a great impetus to boring operations. Portable air-compressor plants mounted on lorries visited a borehole and worked so long as was necessary to fill the local storage plants.

Scarcely less important than the supply of water was the purification of it, and full details of the methods used are given. Large purification plants did excellent work of a pioneer nature in supplying potable water from canals—in some cases through pipe-lines several miles in length.

(2) The need for heavy bridges was first experienced on the Aisne. From that time the history of bridging during the war was determined largely by the increasingly important rôle played by the heavy artillery and tanks, the maximum axle load to be carried rising from thirteen to thirty tons. With the aid of drawings and some excellent photographs, the various standard

types of bridges evolved in the campaign are passed under review. One of the most remarkable types, from the point of view of lightness and ease of erection, was the Inglis bridge of identical bays of weldless steel tubes.

The chapter on temporary bridges is a really stirring account of typical bridging operations during the final advance of August to November, 1918. A succession of waterways had to be forced before each serious engagement. In one case a field company erected a trestle bridge of 80-ft. span within 500 yds. of the enemy line, completing it four hours before the attack was launched. No fewer than 539 heavy bridges were erected between August and November, 1918.

(3) The supply of stores necessarily developed not only in quantity, but also in variety, for "it came about that the R.E. were early regarded as the universal providers of everything that was not authorised equipment." By March 1919, more than 1,800,000 tons of R.E. stores of the most diverse nature had been sent over to the Western front. Road metal, camouflage, electric-light installations, and propaganda balloons, all figured in the lists. Constantly increasing experimental work on new devices was also carried out, and the statement of the results achieved is of considerable interest.

(4) This study of the nervous system of the Army in the recent war is the story of a service constantly "struggling with ever fresh developments and responsibilities: sometimes failing, more often succeeding, and always improving and learning." The need for continual adjustment of ideas and nimbleness of thought on the part of those directing the policy of signals has not ended with the war. Just as "the discovery of the magneto telephone by the General Staff was probably responsible for a revolution in staff methods as great as any that has ever occurred in the history of war," so may the developments of wireless telegraphy and telephony bring many new problems for the signal officer of the future. While recognising fully the strangle-hold that code and cipher exercised on the use of wireless during the greater part of the war, Major Priestley points out how, as shelling and bombing became more intense, wireless forced its way more and more into use and recognition. It is clearly his view that the signals of the future will be mainly wireless supported by line telegraphy and visual work.

Few remarks throw more light on the extent to which signals grew in complexity during the war and technical qualifications came to be required by front-line troops than the statement that at the end of the war, the battalion and battery signaller was expected to have more qualifications than those possessed by the line telegraphists of the Royal Engineers at the commencement of the war.

For its system of hastily improvising a large army this country paid the penalty that must needs accompany such a process. Had we been better organised to make full use of man-power and brain-power on a national emergency, Moseley could scarcely have been allowed to go to his gallant death at Gallipoli. He could have been so much more profitably employed in his corps either in developing wireless or in examining and combating the overhearing of telephone signals. Our slowness in the recognition of enemy overhearing, with all the unnecessary loss of life that it involved, is a natural sequel to our general unpreparedness for the great emergency of 1914.

Granted that we were not always first in the field in the early days of the war, we can, however, recognise fairly that lost time was well made up before the end. The close of the war found the Signal Service "efficient in its day and generation, as the *personnel* of the highly trained units of the original Expeditionary Force had been in theirs."

Our Bookshelf.

Nut Growing. By R. T. Morris. Pp. x+236. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1921.) 13*s.* net.

THERE is little of the dry manual about this useful volume. The author has a "message" to give to a world seeking new foodstuffs, and though he occupies forty pages in introducing the subject, his preliminary remarks are to the point and well worth reading by those interested. Briefly, the book is a practical guide to the commercial cultivation of trees bearing edible nuts, and is addressed to growers in America, where in recent years much attention has been given to this industry. The nuts dealt with include hickories, walnuts, hazels, chestnuts, pine nuts, and almonds. Reference is made to the devastation caused in the forests of American chestnut (*Castanea dentata*) by the fungus *Endothia parasitica*, which threatens to destroy the species unless resistant stocks can be discovered and successfully propagated. The author claims to have produced hybrids between this tree and the chinkapin (*Castanea pumila*) which are highly resistant to the fungus, and bear nuts of good size and quality. An important section on propagation deals with the practical aspects of nut cultivation, and has been written mainly with the object of describing a special system of grafting, which is clearly illustrated in a series of excellent plates.

A Handbook on Cotton and Tobacco Cultivation in Nyasaland: A Guide to Prospective Settlers. By J. S. J. McCall. Pp. 85. (Zomba, Nyasaland: The Government Printer, 1920.)

IT is greatly to be regretted that the late Mr. McCall did not long survive his promotion from the post of

Director of Agriculture in Nyasaland to the corresponding directorship in the newly acquired Tanganyika Territory. His little book is a useful summary of practical information on cotton and tobacco growing in Nyasaland, and contains just those particulars which experience shows are required by would-be planters with little or no previous knowledge of these crops.

The greater part of the book is devoted to cotton, a crop of which Mr. McCall had much experience. Nyasaland long-staple cotton has gained a high reputation and finds a ready market. A controlling factor in production is transport, and on this point the author expresses the view that "the progress of cotton growing in Africa to-day depends more than ever on railways and mechanical transport. The cultivation of tobacco has become one of the most important planting industries of the Protectorate, and the leaf (Virginian type) is well known in this country. The information given regarding the growing and curing of this crop forms a useful first guide to a subject requiring careful study.

A Popular Chemical Dictionary: A Compendious Encyclopaedia. By C. T. Kingzett. Second edition. Pp. viii+539. (London: Baillière, Tindall and Cox, 1921.) 21*s.* net.

THE first edition of this useful book has been exhausted in less than one year, thus proving that it filled a vacancy in chemical literature. A careful perusal of the new edition shows that much new material has been added which enhances considerably the utility of the book. In particular the chief constants of most of the chemicals named have been added, and the work now forms a handy and popular book of reference embracing in one moderately sized volume a mass of up-to-date information on practically every branch of chemistry and allied sciences.

The information is imparted in a clear and interesting manner, freed so far as possible from technicalities. Consequently any one wishing to ascertain the meaning of a term or definition, or the nature of any material or subject in the scope of chemistry or mineralogy, will find without difficulty and within a few seconds the information required—information which is often difficult to lay hands on immediately when embedded in the pages of a large text-book.

G. M.

The Adjustment and Testing of Telescope Objectives. Third edition. Pp. 123+3 plates. (York and London: T. Cooke and Sons, Ltd., 1921.)

THIS volume is the third edition of a book first published in 1891. The favourable reception accorded to the earlier editions, and the extent of their circulation, have encouraged the publishers to re-issue the work with the amplifications necessary to bring it up to date.

The book deals with the simplest and most effective means of detecting flaws in telescope objectives, as well as the various maladjustments and imperfections of mounting, which may prevent an observer from obtaining the best results from his telescope. Different types of objective are treated separately, a special section being devoted to the Cooke triple photo-visual objective. The points to which attention is given include squaring-on, achromatism, astigmatism, spherical and zonal aberration, mechanical strains, and other smaller, but equally important, matters. There is also a short chapter on the general treatment of objectives. The volume concludes with reprints of three papers by Mr. H. Dennis Taylor, originally presented to the Royal Astronomical Society, dealing with achromatism and the secondary colour aberrations of refractors.

The book is very clearly written, and should prove of great use, not only in detecting faults in imperfect objectives, but also in enabling an observer to determine whether defects in star images are due to the objective or to the manner of its setting. It should appeal especially to the amateur astronomer possessing a small refractor. The directions for testing and adjustment are of the simplest possible character, and involve keen observation rather than mechanical skill.

The publishers have done a great service to astronomy in preparing such a useful little book.

Bibliographia Agrogeologica: Essay of a Systematic Bibliography of Agro-Geology. By Adolf Wulff. (Mededeelingen van de Landbouwhoogeschool en van de Daaraan Verbonden Instituten, Deel 20.) Pp. iv+285. (Wageningen: H. Veenman, 1921.) 4·50 florins.

THE study of the soil has developed so rapidly in recent years that no student can keep pace with the output of papers, nor can the best card index of an individual worker be relied upon as being complete. The necessity for such adventitious aid as is afforded by a bibliography has long become pressing, and this is now supplied by Dr. Adolf Wulff. No fewer than 3300 titles are given, the papers being drawn from more than 600 journals, and the list goes up to November 1, 1919. A satisfactory classification is adopted, so that the student will have no difficulty in finding his way through the bibliography even if he has to consult it only occasionally.

Although the title suggests to English ears only the geological or mineralogical side, the index covers the whole ground dealt with in this country by soil investigators, including soil organisms, soil organic matter, and the relations of soil to the growing plant. The English is remarkably free from errors, and the few misprints will cause no difficulty.

Prof. J. van Baren contributes an interesting discussion on soil problems, bringing together a considerable amount of work which is little known, and forming a useful introduction to the whole volume. Altogether the book is one which can safely be recommended to students and investigators in the subject.

E. J. R.

Patents and Chemical Research. By H. E. Potts. Pp. x+198. (Liverpool: University Press, 1921.) 8*s.* 6*d.* net.

A PATENT, like any other form of contract, depends very largely for its value upon the skill with which it has been drawn up. The form of wording, in fact, may be quite as important as the subject-matter.

Particularly is this so in the case of a patent for a chemical invention, where the scope of the monopoly must be defined in chemical terms and generally without reference to drawings. Clearly, then, it is to the advantage of the patentee to obtain the fullest legal co-operation in drafting the specification for a chemical invention.

Mr. Potts makes this his theme, and in the major portion of his book he develops it by laying down the principles upon which to construct a chemical patent that will procure maximum protection consistent with security against possible infringement or invalidation. His observations should be distinctly helpful both to the research worker in industrial chemistry and to the patent agent, though they tend perhaps to exaggerate a little the function of the latter. Whether, for instance, the patent expert would be capable of diagnosing chemical problems to the extent indicated in chap. 3 is rather open to doubt.

But there can be no question of the author's grasp of the fundamentals of patent law; the discrimination with which he has selected his leading cases when discussing the validity of patents demonstrates this. On the business aspect of patents, too, the author's views are well worthy of attention, especially as regards their value, individually and collectively, in commercial warfare. E. J.

Astronomical Photography for Amateurs. By H. H. Waters. Pp. iv + 93 + v plates. (London: Gall and Inglis, n.d.) 6*s*. net.

AMATEURS possessing small telescopes may, with the means at their disposal, secure good astronomical photographs, and the volume under notice is an elementary handbook intended to explain in a simple manner how good results may be achieved. The book does not go beyond this stage, so that none of the many uses to which astronomical photographs may be put are touched upon.

It is to be regretted that the amateur's share in photographic methods of observation should be regarded as being confined solely to obtaining pictorial records. But, even accepting this limitation, there is much that the amateur may do with telescopes of small aperture. As an instance of what can be accomplished with a small instrument in the hands of a skilled observer, it may be mentioned that many of Prof. Barnard's superb photographs of the Milky Way were secured with a small lens of less than 2-in. aperture. To amateurs desirous of attempting something in this direction, but hesitating through lack of experience and for want of a guide, this book can be recommended. It is written by one who has had some success in this field, and is full of practical hints and directions as to the methods of working, the type of camera necessary, and the exposures and apertures most suitable for photographing various objects. This is just the sort of book which a beginner requires. It includes five plates with reproductions of astronomical photographs obtained by the author. These are printed on a paper of poor quality, with the result that they are practically useless as indications to the beginner of the results which he should be able to obtain. H. S. J.

Philosophy and the New Physics: An Essay on the Relativity Theory and the Theory of Quanta. By Prof. L. Rougier. Authorised translation from the author's corrected text of "La Matérialisation de l'Energie" by Prof. M. Masius. Pp. vi + 159. (Philadelphia: P. Blakiston's Son and Co., 1921.)

La Matière et l'Energie: Selon la Théorie de la Relativité et la Théorie des Quanta. Par Prof. L. Rougier. Nouvelle édition, revue et augmentée. Pp. xii + 112. (Paris: Gauthier-Villars et Cie, 1921.) 9.50 francs.

THE French title is a better indication than the English of the contents of this little book. The only philosophical question discussed at any length is that of the relation between matter and energy, regarded as an extreme example of the fundamental problem of a substance and its properties. By far the greater part of the space is devoted to a simple exposition of the theory of relativity and the quantum theory, which is as well suited for those whose interests are primarily scientific as for philosophers. The exposition is quite adequate, but it is not superior to all others of the same scope. The author has not solved the insoluble problem of giving a true account of mathematical theories without assuming familiarity with the mathematical ideas from which they derive their value and meaning; but he has succeeded in avoiding the distortion of meaning that is frequently a result of such attempts. We can recommend the book to any one with philosophical inclinations who wants to make one more attempt to "understand Einstein," but we are not sure that it was worth translation. However, the translator has done his work, except in the title, with unusual competence.

Personal Beauty and Racial Betterment. By Prof. Knight Dunlap. Pp. 95. (London: Henry Kimpton, 1920.) 6*s*. net.

PROF. DUNLAP'S essay on racial betterment consists of two parts. In the first he analyses the elements which go to make up the ideal of personal beauty as a basis of sexual selection; in the second he deals with its conservation as a means to the improvement of the race. Personal beauty, he maintains, on the negative side is the absence of deformity and of deviation from the accepted type towards that of an inferior race, while on the positive side it is the sign and expression of the *potentiality* of the individual, not in his own interests, but in the interests of the species. Prof. Dunlap meets possible objections that his view of the factors making for racial betterment is entirely physical by maintaining that that is the primary ideal essential for "the attainment of ultimate ideals." This is somewhat vague, but apparently he means that mental and moral qualities may be neglected in sexual selection without detriment—a somewhat large assumption. He discusses the question of the unfit and the desirability in their case of sterilisation, as well as the various causes operative in checking the fertility of those who are best fitted to perpetuate the race. Though he maintains that some fundamental reform is necessary and cannot long be delayed, he himself has no practical programme to propose.

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.*]

A Magnetic Model of Atomic Constitution.

THE following preliminary description of a new magnetic model atom is given on account of the remarkable coincidence between the results we have obtained experimentally and the views which Dr. Aston has put forward with regard to the atomic constitution of certain of the lower elements.

An attempt has already been made by Sir J. J. Thomson to draw a parallel between atomic structure and the arrangements into which Mayer's magnets group themselves; but this parallelism suffered from the fundamental flaw that there was no numerical relationship between the strength of the central pole and the united strengths of the floating magnets. In order to have a true parallel, it is essential that the strength of the central pole should increase *pari passu* with the number of magnets afloat at one time; for only in this way can a "magnetic neutrality" be obtained which will represent the electrical neutrality of the atom.

In our preliminary work we achieved a close approximation to this state of affairs by using a series of equal magnets. A single magnet was fixed vertically at the bottom of a lead tank filled with water, above the surface of which a second vertical magnet was held in a glass tube. On the water surface, a third vertical magnet was floated by means of a cork disk. All the magnets had their north poles upward. Since both poles of a floating magnet repel those of another floating magnet, it is necessary to have two fixed magnets for each floating one, in order to establish neutrality. When two floats are in the dish, two magnets are placed at the bottom and two magnets in the glass tube, and so on. In this way, the strength of the central pole is always exactly equal and opposite to the combined powers of the floating magnets.

When this arrangement is tested with numbers of floating magnets corresponding to units of atomic weight in the various elements, the following results are obtained. The magnets arrange themselves into two sharply defined and clearly separated groups, the central one of which may for convenience be termed the nucleus, whilst the second group may be named the ring. In the table below are the experimental results showing the distribution of the magnets into the two groups :—

Magnets.	In Nucleus.	Total minus Nucleus.	Corresponds to
1	1	0	Hydrogen.
4	2	2	Helium.
6	3	3	Lithium-6.
7	4	3	Lithium-7.
9	5	4	Beryllium.
10	5	5	Boron-10.
11	6	5	Boron-11.
12	6	6	Carbon.
14	7	7	Nitrogen.
16	8	8	Oxygen.
19	10	9	Fluorine.
20	10	10	Neon.

Inspection will show that this series of groupings corresponds exactly to the suggestions put forward by Dr. Aston. He regards each unit of atomic weight as a proton carrying one positive charge; and the atomic number of the element is, as Prof. Soddy suggested, the algebraic sum of the positive and negative charges in the atomic nucleus. In the new atomic model, it will be seen, the systems arrange themselves spontaneously so as to form a perfect analogy to the hypothetical atomic structures. Thus in the case of Boron-10 the central pole contains ten magnets; five of these are "neutralised" by the five floating magnets of the nucleus, leaving a net "charge" of five, which is the atomic number of boron. In the case of Boron-11 there are eleven magnets in the central pole; six floating magnets "neutralise" six of them, leaving free five—the atomic number of both isotopic forms of boron.

All the known elements and isotopes in the series find their exact parallel in these magnetic models; and the coincidence, if it be merely coincidence, is certainly surprising.

It should be pointed out that hydrogen is anomalous, since obviously a single magnet cannot simultaneously form part of two groupings, nucleus and ring. If the floating magnet in this case be reckoned as a ring magnet instead of a nuclear one, then hydrogen would have the atomic number 1.

It seems worth while to point out that the number of magnets in the ring is always equal to the maximum valency of the element plus two units; and the occurrence of two magnets in the ring of the system corresponding to helium suggests that all the eight elements up to fluorine are built up with two residual non-detachable electrons in the ring. In the case of neon, the non-detachables evidently number 10; and this suggests a connection with the Rydberg series $2(1^2+2^2+2^2+3^2\ \ldots)$, which evidently has some connection with atomic structure.

It appeared of interest to examine the cases of the atomic weights 2, 3, 5, and 8, which have at present no corresponding elements. With two floating magnets, one forms the nucleus and the other the ring group, which gives an atomic number 1. This substance would therefore by analogy be an isotope of hydrogen with an atomic weight 2. With three magnets, one again forms the nucleus, with two others in the ring: this corresponds to the atomic number 2, so that the element, if it exists at all, may be an isotope of helium. Five magnets give a system of two in the nucleus and three in the ring—an isotope of lithium. In the case of eight magnets there are two possible groupings, almost equally stable. Four in the nucleus and four in the ring would correspond to an isotope of beryllium. Five in the nucleus and three outside is the analogue of a fourth lithium isotope. These two groupings would be isobaric systems.

It would occupy too much space to discuss the regularities of the magnetic groupings within the nucleus, but one point of interest may be mentioned. In the case of Boron-11 and carbon, both nuclei contain six magnets arranged in two pairs of concentric triangles. In view of the general resemblance in physical characteristics between boron and carbon, and especially of the fact that in its hydrides boron is quadrivalent like carbon (yielding B_2H_6 like C_2H_6 and not BH_3 as might be expected from its position in Group III.), this peculiarity seems not without meaning.

We propose to extend this investigation immediately with improved apparatus which we hope will surmount some of the obvious experimental difficulties in the case of more complex systems.

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A. W. STEWART.

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Nature of Vowel Sounds.

THE following observations as to the nature of the vowel sounds of a single voice (my own)—details of which form the subject of a separate communication to the journal of the International Phonetic Association—may be of interest.

The sounds were observed by ear, first, for the whispered vowels, and afterwards with a larynx note superimposed. In the whispered series it was found that each of the separate vowels was characterised by *two* resonant notes, an upper component ranging from about ♯d″ (608~) to e‴ (2579~), and a lower component ranging from ♯d′ (304~) to ♯a″ (912~).

The upper components are produced in a manner analogous to that of whistled notes, and their pitch is mainly controlled by the distance of the tongue from the palate and teeth. The same note may be produced with almost any degree of opening of the mouth; about one octave of the scale can be produced—through the nose—with the mouth closed altogether. These notes, for convenience, are referred to as "whistle notes."

The lower components appear to depend, like the pitch of a Helmholtz resonator, largely on the area of the mouth opening—they are referred to as resonator notes.

The two series are independent of each other, so that, for example, an ascending scale of resonator notes and a descending scale of whistle notes may be produced (whispered) simultaneously.

The characteristic whistle and resonator notes for each vowel sound are not absolutely fixed (for an individual voice), but may vary in some cases over as much as 5 semitones without loss of the vowel characteristic.

The ranges of "neighbouring" vowels often overlap, so that two different vowels may have the same whistle or resonator note, but in such cases the other component will be substantially different.

In one or two cases, such as "ii" (eat) and "i" (it) the ranges of *both* components overlap, and the difference between these vowels may be produced in some cases mainly by difference of stress.

When a larynx note is added—as in singing or talking—the pitch of the resonator note does not appear to be affected at all by variations of pitch of the larynx note.

The whistle notes generally are not affected, so long as the pitch of the whistle note in question differs sufficiently widely—say by 2 to 3 octaves—from that of the larynx note.

As the pitch of the larynx note is further raised towards that of the whistle note, the latter tends to adjust itself or "draw" towards the nearest harmonic of the larynx note which lies within its characteristic range for the vowel in question.

Thus, if a chromatic scale be sung to a given vowel sound, the resonator note will remain constant, but when the note sung approaches within say 2 octaves of the whistle note, this latter may be heard to alternate between or jump from one to another of 3 or 4 neighbouring semitones at each change of pitch of the larynx note.

This last phenomenon has, I find, been already observed by Mr. Perrett.

From these observations it would appear to be possible to make an exclusively acoustic classification of the vowel sounds depending on the range of their whistle and resonator notes respectively.

R. A. S. PAGET.
East India House, 74 Strand, London, W.C.2,
March 3, 1922.

Protective Colloids—A Pretty Lecture Experiment.

As the result of a large number of experiments carried out in the Chemistry Department of this School by Messrs. Vallance, Dennett, Trobridge, Hammond, and Tidmus in conjunction with the writer, it appears to be a general law that protective colloids or organic emulsoids tend to retard the velocities of such reactions, whether chemical or physical, as involve a change of state in one or more of the components.

Thus it is found that the rates of solution of metals in acids, of corrosion in neutral media, of solution and precipitation of salts, of replacement of one metal by another, as, for example, in the familiar lead-tree experiments, etc., are all retarded by protective colloids. In many cases the rate of retardation conforms to the requirements of the adsorption law. Details of these experiments will be published in due course elsewhere.

A very pretty lecture experiment illustrating this retardation is afforded by the precipitation of mercuric iodide on addition of the chloride to potassium iodide. If this is effected in fairly dilute aqueous solution, the unstable yellow form is first precipitated and rapidly turns from orange to red as it becomes converted to the more stable variety.

If, however, the reaction is carried out in the presence of gelatin, say one per cent., the liquid first turns momentarily yellow, due to the formation of colloidal mercuric iodide, then becomes turbid, and a beautiful canary colour develops, which remains practically unchanged for half an hour or more, according to circumstances. Only very slowly does it change to the red polymorph. The protective colloid retards the growth of the yellow particles. Sunlight accelerates the change markedly. With the aid of the ultramicroscope ($\frac{1}{12}$th inch oil immersion) these changes may be seen beautifully. Drops of gelatin and dilute potassium iodide are mixed under the coverglass and the ultramicroscope focussed as usual. A drop of mercuric chloride solution is brought to the edge of the coverglass and is drawn under by capillary action. The field of the ultramicroscope becomes swept with a stream of luminous particles moving with dazzling velocity—the Brownian movement of the colloidal mercuric iodide. The velocity slows down as the particles increase in size, until the colloid range has been passed, and in a few minutes a fine precipitate is obtained evincing scarcely any movement.

J. NEWTON FRIEND.
The Municipal Technical School, Birmingham,
February 27, 1922.

A Problem in Economics.

MANY economic applications of meteorology depend upon the use of forecasts in deciding whether or not to incur expense by taking precautions against some particular phenomenon which would cause damage. A good example is provided by forecasts of ground temperature in deciding whether to pay men to spread sacking over newly-laid concrete road surfaces which would be injured by frost. In the simplest form of such problems the three possible lines of action are (1) to take precautions only on occasions when the phenomenon is forecasted, (2) to take precautions on all occasions, (3) to take no precautions at all. It is of interest to examine the circumstances under which (1) is the most economical line of action.

Let a be the cost of precautions against an event whose probability is P and which will cause damage b if it occurs in the absence of precautions. Suppose the forecast to take the form of a plain "Yes" or "No," and let p be the probability that an occurrence of the event will be preceded by a forecast of "Yes."

With an unbiassed and experienced forecaster it may be assumed that in the long run "Yes" occurs among the forecasts about as frequently as the event occurs. In a large number n of trials, "Yes" will therefore be forecasted on Pn occasions and the expenditure on precautions will be a . Pn.

The event will occur on Pn occasions of which p . Pn will have been forecasted. The remaining unforecasted occasions will number P$n(1-p)$ and will entail an expenditure of b . P$n(1-p)$ by damage. The total expenditure will therefore be

$$a \,.\, \mathrm{P}n + b \,.\, \mathrm{P}n(1-p). \quad . \quad . \quad \text{(I.)}$$

The cost of the forecasts is assumed to be negligible in comparison with a and b.

If precautions are always taken the expenditure will be

$$a \,.\, n. \quad . \quad . \quad . \quad . \quad \text{(II.)}$$

If precautions are never taken the expenditure will be

$$b \,.\, \mathrm{P}n. \quad . \quad . \quad . \quad \text{(III.)}$$

We have now to compare the amounts involved by I., II., and III. and see which is the least.

I. may be written $b \,.\, \mathrm{P}n - (b \,.\, \mathrm{P}n \,.\, p - a \,.\, \mathrm{P}n)$.

The condition for I. to be more economical than III. is therefore

$$b \,.\, \mathrm{P}n p - a \,.\, \mathrm{P}n > 0$$

or

$$p > a/b.$$

That is to say, the probability of a correct forecast must be greater than the ratio of precautionary expenditure to possible damage. Unless forecasts are very bad or precautions very expensive this condition will be very easily fulfilled.

The condition for I. to be more economical than II. is

$$b \,.\, \mathrm{P}n(1-p) < a \,.\, n(1-\mathrm{P}),$$

which expresses the fact that the loss due to possible damage must be less than the saving through omission of precautions. This may be written

$$1 - p < (1/\mathrm{P} - 1) \,.\, a/b. \quad . \quad . \quad . \quad \text{(IV.)}$$

With given values of P, a, and b, IV. sets a limit to the allowable error in forecasting. For example, suppose the chances of the event are even, that is P$=0{\cdot}5$, the following results are obtained for the limiting values:

$a/b=$	0·01	0·05	0·10	0·20
$p=$	0·99	0·95	0·90	0·80

If the probability of a correct forecast is not above 0·90 it is therefore disadvantageous to base precautionary action on the forecasts unless it costs more than 1*l.* to save 10*l.* worth of damage.

With lower probability of the event things become much more favourable for (1). Thus suppose P$=0{\cdot}25$ (chances 3 to 1 against the event) we obtain the following results:

$a/b=$	0·01	0·05	0·10	0·20
$p=$	0·97	0·85	0·70	0·40

If in this case the probability of a correct forecast is 0·90 and $a/b=0{\cdot}10$, the expenditure involved per 100 trials, 1*l.* being the precautionary expenditure, works out as follows:

Taking no precautions . . .	250*l.*
Taking precautions on all occasions .	100*l.*
Taking precautions only when the event is forecasted	50*l.*

In practice, the forecaster, being aware that the object of the forecast is to avoid loss by damage, would be biassed in favour of forecasting the event and would only forecast "No" when the odds were considerably against an occurrence. Such a bias would tend to increase p, which was defined as the probability that an occurrence of the event would be successfully forecasted. Against this we would have to set an increased expenditure through needless precautions, and if the forecaster were too cautious this might outweigh the gain resulting from a decrease in unforecasted occurrences. A moderate degree of bias would, however, obviously result in a gain in most cases.

In practice, therefore, the financial results of utilising weather forecasts are likely to be even better than those calculated above.

There is reason to believe that the commercial possibilities of weather forecasts are not fully appreciated. These calculations will serve to show that considerable gain may result from their utilisation, allowing a reasonable margin of error in the forecasts.

E. G. BILHAM.

Age Incidence of Influenza.

THE explanation given by Miss A. D. Betts (NATURE, February 23, p. 240) has always seemed to me an obvious and adequate one. The reply of "The Writer of the Article," that follows it, is admirably clear, and therefore helpful; but I think it really supports the explanation it ostensibly opposes.

Influenza is clearly a disease the incidence and severity of which depend more on the man than on the germ. Some people (apart from the intensive infection and exhaustion of overcrowding and nursing) seem practically immune to it. But all such immunity is probably partial and relative. The successive milder attacks, sometimes not called influenza, that follow a well-marked attack show that the patient is not immune; and any relative immunity is probably largely due to these later successive attacks being treated in time.

In the same way the degree of immunity induced by preventive inoculation is, like other immunity, partial and relative. The inoculated may hope, at least for a time, for substantially increased resistance to infection (but not absolute immunity no matter how intense the infection), and for slighter and briefer attacks if they catch it.

Further, all such relative immunity, if originally present, tends to be destroyed and the severity of the disease and its associated complications increased by exhaustion, whether due to virtuous and patriotic overwork or to vicious dissipation. I do not therefore oppose point (4) of "The Writer of the Article," which is not, however, in dispute here.

But as regards his other three points—

(1) Under end-of-war conditions our young people with unselfish patriotism worked to exhaustion, and largely under conditions involving intensive infection; and as a secondary factor had inadequate food in health and when ill. Again, working as they did largely away from home, the dangerous work of nursing them fell largely on those of their own age, and not, as in normal times, on their parents and elders.

The latter, on the other hand, were not only spared the exhaustion and intensive infection of nursing them, but the "rationing," so trying for the young, was good for us older people, to whom habitual over-eating and drinking is apt to be one of the chief causes of exhaustion and consequent liability to disease, at an age when we should be most immune.

Doubtless the aged were hard hit by the sorrows of the war, which in the end shortened the lives of many; but I take it that, except in the countries actually invaded and ravaged by the enemy, war conditions did not make them more liable to influenza.

(2) Observations on influenza in boarding schools show that those boys who do not readily catch it, and, under normal home conditions, would escape probably entirely, if exposed long enough to the intensive infection of crowded rooms at school, succumb in the

end. This explains the attacks on older people in the later phases of the waves of the war-end epidemic. Their immunity was relative, not absolute.

(3) All European countries, neutral as well as belligerent, were greatly upset and tried by the war; and N. America (Canada and U.S.A.) was belligerent.

GERARD W. BUTLER.

Candahar, Yorke Road, Reigate, Surrey.

Calcium Carbide and the Board of Trade.

THE decision of the Board of Trade Referee that calcium carbide is not a synthetic organic chemical is characterised by "H. E. A." (NATURE, February 23, p. 230) as an offence against both chemical tradition and our chemical conscience. "H. E. A." no doubt may claim to be the keeper of the chemical tradition and conscience of organic chemists, but I should like to dissociate myself personally from his custodianship. How any one can regard calcium carbide, a substance that gives calcium oxide as its sole solid product when moistened with water, as an organic chemical, or an electric furnace operation as the fundamental synthesis of organic chemistry, I cannot understand. What do they know of organic chemical synthesis who only the syntheses of organic chemists know?

FREDERICK SODDY.

PROF. SODDY is a trifle impetuous: my reference to Hazlitt was not out of place, it seems. If I follow my critic, as only a small heap of solid phosphate of lime will be left of me when I am burnt, I am not organic. Granted that calcium acetylide (carbide) gives lime when wetted, it is a little surprising that the putative father of *Emanation* and the first to make clear the significance of helium should attach no importance to the escaping gas. If a man have a wooden leg, he is none the less counted a man, I believe. Now, when zinc ethide is started swimming in water, it leaves behind it its leg, as it were, in the form of zinc oxide, just as carbide does, though in the form of lime; yet the ethide ranks as one of the most honourable of synthetic organic chemicals: why discard the carbide?

One purpose of my article was to direct attention to our lack of logic when using words. Prof. Soddy's comments are but proof that the need to put considered meaning into our words *is* with us. I was led to respect Trench before reading science: in consequence, I have all my life had my attention drawn to words. The term organic has never had any "organic" or vital significance, in chemistry, in Prof. Soddy's lifetime. Thinking chemists have long and logically attached an entirely conventional meaning to it. Before Prof. Soddy was born, I wrote a text-book entitled an "Introduction to the Study of Organic Chemistry," which had as subsidiary title "The Chemistry of Carbon and its Components." I was but adopting a definition put into my hands by my chemical grandfathers. Both carbon and carbonic acid were considered. I would class not only coal but even limestone among "organic compounds."

In conclusion, let me say that the proceedings under the Act are becoming more of a scandal every week. The latest riddle asked is, "When is a chemical not a chemical?" "When it is used as a foodstuff," being the suggested answer. The position of disputants is that defined centuries ago in "Hudibras":

> They're catched in knotted law, like nets;
> In which when once they are imbrangled,
> The more they stir, the more they're tangled,
> And while their purses can dispute,
> There's no end of th' immortal suit.

From beginning to end, every proceeding connected with the Act has been "unscientific." H. E. A.

The Hormone Theory of Heredity.

I SHOULD be much obliged if you would allow me to correct in NATURE, which is, I believe, widely read in the U.S.A. as well as in this country, the erroneous account of my hormone theory of heredity given by Prof. T. H. Morgan in his memoir on Secondary Sexual Characters, Carnegie Institution, No. 285, 1919. At that date Prof. Morgan could only have known the account of my theory in my paper in the *Arch. f. Entwicklungsmechanik*, 1908. His description of my views is contained in the following two quotations from his memoir: (1) "He imagines these hormones to be collected in the germ cells and transmitted to the next generation, where their presence contributes to the further development of the special region (when it develops) that corresponds to the region in its parent in which the hormone was made." (2) "His special appeal to the hormone theory makes use of that theory in a way to which it was never intended to be put, by assuming that an internal secretion formed in one organ can be stored up in another organ, egg or sperm, an assumption not only unsupported by any evidence, but, as I have stated, quite foreign to the hormone theory."

The theory suggested by me in 1908, and put forward in my recent book, "Hormones and Heredity," is that the increased amount of hormones or waste products given out by a structure in which hypertrophy has been caused by external stimulation, may stimulate the determinants or factors corresponding to that structure in the gametes, and so cause some degree of inherited hypertrophy in the next generation. One quotation from my 1908 paper will prove this:

"At the same time the hormone from the incipient antler stimulates the determinants in the gametes. . . . If the stimulation of the determinants is repeated for an indefinite number of generations the congenital tendency to the hypertrophy will become very strong."

The idea of stimulation of a determinant or factor, which may be as Prof. Morgan maintains a part of a chromosome, is very different from the storing up in the gametes of hormones derived from parts of the soma, and for this latter idea I disclaim all responsibility.

J. T. CUNNINGHAM.

East London College, March 6, 1922.

Neon Lamps.

IT does not seem to be generally known that neon lamps, for which many applications can be found in a physical laboratory, are now obtainable very cheaply. They are made to fit an ordinary holder, and contain moderately pure neon (usually somewhat contaminated with mercury) at low pressure. The electrodes are of nickel and are made in various shapes according to the purpose for which the lamp is intended, but they are sufficiently close together for the lamp to run at ordinary supply voltages (down to 100 v.). They are particularly useful for stroboscopic measurements; in this case the lamp is used to illuminate the disc, and may be run from the secondary of an induction coil the primary of which is in series with an electrically maintained tuning-fork.

Another application is to the detection of oscillating P.D.'s in connection with a Fleming cymometer and similar experiments. Possibly, too, they may be of service in spectroscopic work where the dispersion is small or the exposure long, as the lines are not too numerous and their wave-lengths are in many cases very accurately known. Their great advantage over the ordinary neon vacuum tube is of course their cheapness; the last one I purchased cost 3*s*. 9*d*.

W. E. CURTIS.

Wheatstone Laboratory, King's College, W.C.2, March 6.

Photosynthesis.

By PROF. E. C. C. BALY, F.R.S.

PHOTOCHEMICAL reactions, more particularly those in which highly endothermic syntheses take place, have generally been considered as something apart from the ordinary chemical reactions of the laboratory, and, indeed, have at times savoured of the mysterious for the reason that they seemed to be impossible of realisation *in vitro*. Recent work, however, on the energy changes involved in chemical reaction has shown that there is no inherent mystery in photosynthesis, and that all reactions, including those of photochemistry and catalysis, are completely analogous and obey the same laws. Every complete reaction consists of three separate stages, with each of which is associated its characteristic energy change. In general, molecules in the free state exist in a phase which is non-reactive, and in order to carry out any reaction it is first of all necessary to bring them into a reactive phase. This, which is the first stage of the reaction, requires that a definite amount of energy should be supplied to each molecule, the amount necessary being the difference in energy contents of the initial phase and the particular phase necessary for the reaction in question. Each phase of a given molecule differs in energy content by a fixed quantity of energy characteristic of that molecule, which is called the molecular quantum of energy. It follows, therefore, that the amount of energy necessary to activate each molecule in the first stage of the reaction is exactly one or more molecular quanta.

The second stage of the reaction is the atomic rearrangement whereby new molecules are produced, and it is this stage, and this stage alone, which is represented by the equation of the reaction.

The third and final stage is the change in phase of the newly synthesised molecules, whereby they pass into their normal and non-reactive phases. These last two stages are both accompanied by an escape of energy, and in each of them the amount of energy lost per molecule is exactly one or more molecular quanta characteristic of the new molecules. If the sum of the amounts of energy evolved in the second and third stages is greater than that absorbed in the first stage, the reaction is exothermic; whilst an endothermic reaction is one in which the energy necessary for the first stage is greater than the total amount evolved in the second and third stages.

There are three methods by which the energy necessary for the first stage may be supplied. It may be supplied by a material catalyst, or as radiant energy in the form of heat or light. The action of a catalyst does not arise here, and need only be mentioned in order to guard against any misconception. Many reactions take place in solution without the apparent intervention of the first stage, but in such cases the molecules have been activated by the solvent which functions as a catalyst.

In general, it is a matter of little consequence whether a molecule is activated by heat or light—that is, by infra-red or ultra-violet rays—in view of the known integral relationships that exist between the frequencies at which a molecule can absorb energy. It is a matter of cardinal importance, however, in the case of highly endothermic reactions, in which the increment of energy required for the initial phase change is obviously a large number of molecular quanta. When a molecule absorbs energy at its principal frequency in the infra-red, it absorbs it in terms of its molecular quantum; but if it absorbs ultra-violet light the unit of energy absorbed is a quantum which is an integral multiple of the molecular quantum, the multiple depending on the phase in which the molecule exists. One single quantum of energy absorbed at the characteristic frequency in the ultra-violet is always sufficient to activate a single molecule for any reaction, however endothermic this may be.

An endothermic reaction, in the first stage of which each molecule requires a large number of molecular quanta to activate it, will obviously be very much easier to carry out by exposing the molecules to energy of their characteristic frequency in the ultra-violet, when the absorption of one quantum per molecule is sufficient, than by exposing them to infra-red radiation, when the reaction will not proceed until a specific number of quanta have been absorbed by each molecule. When, as is frequently the case, this specific number is ten or more, it is not surprising that the realisation of the reaction by means of heat becomes impossible from the practical point of view. Such a reaction, however, is readily brought about by the absorption of a single quantum by each molecule at its characteristic frequency in the ultra-violet.

This may be understood more clearly from a specific instance, namely, the decomposition of hydrogen chloride into hydrogen and chlorine. The molecular quantum of HCl is about $5{\cdot}7 \times 10^{-13}$ erg, whilst the quantum absorbed at the ultra-violet frequency is about $9{\cdot}7 \times 10^{-12}$ erg, which is seventeen times as large. The activation of an HCl molecule so that it may decompose requires seventeen molecular quanta, and this may readily be brought about by exposing the gas to radiant energy of the wave-length 203 $\mu\mu$, when the absorption of a single quantum per molecule is sufficient. In order to bring about this reaction by heat, it will be necessary for each molecule consecutively to absorb seventeen molecular quanta, without losing any by radiation during the process, before it can decompose. The preparation of hydrogen and chlorine from hydrogen chloride is therefore very difficult to carry out by the aid of heat, but is readily induced by light. Another highly endothermic reaction which may be realised photochemically is the synthesis of formaldehyde from carbon dioxide and water, for it has been shown that under the influence of light of wave-length 200 $\mu\mu$ the reaction takes place according to the equation $CO_2 + H_2O = CH_2O + O_2$. These two examples are sufficient to show that whilst there is no essential difference between any two chemical reactions, those that are highly endothermic can be realised in practice only by photochemical stimulation.

The photosynthesis of formaldehyde from carbonic acid is of great importance, because it undoubtedly forms the first step in the formation of the many complex substances produced in the living plant. Some recent work in Liverpool on this reaction has thrown

light on the mechanism utilised by the living plant in carrying it out, and also on the general problem of the photosynthesis of vegetable products. Although the synthesis of formaldehyde has been carried out photochemically in the laboratory with light of wave-length 200 $\mu\mu$, this is certainly not the case in the plant, for there is present in sunlight no radiation of this wave-length. The plant must in some way carry out the reaction with the absorption of visible light, for it is well known that visible light only is necessary for the photo-assimilation of carbon dioxide. It has been shown experimentally that, if a visibly coloured basic substance be added to the aqueous solution of carbon dioxide, formaldehyde is produced on exposing the mixture to visible light. The coloured substance, being basic, forms a complex with the carbonic acid, and within such a complex the components possess an identical infra-red frequency; that is to say, the molecular quanta of the two are identical. The energy absorbed by the coloured component is radiated at this common infra-red frequency and re-absorbed by the carbonate component. The necessary increment of energy is thus gained by the carbonate component, which is converted into a molecule of formaldehyde and a molecule of oxygen. This type of reaction has been named photocatalysis, the coloured substance acting as photocatalyst. It has been proved that malachite-green, methyl-orange, and *p*-nitrosodimethylaniline act as photocatalysts in this reaction, and in the presence of carbon dioxide give formaldehyde on exposure to visible light.

It has been shown by Willstätter that chlorophyll as it occurs in the plant combines with carbonic acid, and hence there is little doubt that it functions as a photocatalyst. The green-coloured complex absorbs visible light, and the energy so absorbed is transferred to the carbonic acid through the identity of infra-red frequency, with the result that formaldehyde and oxygen are produced. Although this gives a satisfactory explanation of the mechanism by means of which the living plant is able to produce formaldehyde with the aid of visible light alone, the story is far from complete, for there are yet to be considered the formation of carbohydrates from the formaldehyde, and the details of the process whereby the oxygen set free in the photosynthesis is transpired by the plant as gaseous oxygen.

It was shown by Moore and Webster that aqueous solutions of formaldehyde on exposure to ultra-violet light are polymerised to reducing sugars, but no evidence was given of the nature of these sugars or of the wave-length of the light required. It has been shown more recently in Liverpool that the necessary wave-length of the light is 290$\mu\mu$, which at once establishes the fact that the polymerisation is photochemically distinct from the synthesis of formaldehyde. It has also been shown indirectly that the polymerisation of formaldehyde can be photocatalysed; but this is of scientific interest only, since there is no need to postulate such a mechanism in the plant. On exposure to ultra-violet light the formaldehyde molecules are activated, and it is these activated molecules which undergo polymerisation to sugars, since it is well known that ordinary formaldehyde does not polymerise in this way. When the formaldehyde molecules are first produced by photosynthesis they are in the activated form, and may therefore lose energy in one of two ways, either by change of phase to produce ordinary formaldehyde or by polymerisation to give sugar molecules. But it has been proved that the photochemically activated molecules at once polymerise to sugar, and therefore the photochemically synthesised molecules do the same. There is thus no need to consider the activation of the formaldehyde in the plant, for it is already activated when produced. The absence, therefore, of free formaldehyde in the growing leaf is explained by the fact that the photosynthetic process from carbonic acid to sugar takes place without a break. (Baly, Heilbron, and Barker, *Trans. Chem. Soc.*, vol. 119, p. 1025, 1921.)

The mechanism of the process whereby the oxygen, which is produced with the formaldehyde in the photosynthesis, is transpired as gaseous oxygen is one of great importance in view of the energy changes involved. Willstätter has shown that chlorophyll is in reality a mixture of two substances, chlorophyll A and chlorophyll B, and that a molecule of chlorophyll B contains one atom of oxygen more and two atoms of hydrogen less than a molecule of chlorophyll A. Two atoms of oxygen, therefore, are required to convert a molecule of chlorophyll A into a molecule of chlorophyll B, and since this is the exact relation required in the photosynthetic operation it is impossible to believe that it is not utilised. It is in the highest degree probable that a molecule of chlorophyll A combines with a molecule of carbonic acid, and that this complex on exposure to light gives a molecule of activated formaldehyde and a molecule of chlorophyll B. Willstätter hesitates to accept this view, because he found that the ratio of chlorophyll B to A is not altered during photosynthesis; but since he also proved that the velocity of transpiration of the oxygen is equal to that of the absorption of carbon dioxide, this cannot be accepted as evidence. It means only that there is present in the leaf some mechanism whereby the chlorophyll B is deoxidised and reconverted into chlorophyll A. Willstätter has further proved that an aqueous solution of chlorophyll, saturated with carbon dioxide, decomposes on exposure to light, no measurable photo-assimilation of carbon dioxide taking place. This affords an additional proof that there is present in the living plant a mechanism for maintaining the chlorophyll equilibrium.

In the living photosynthetic cell there exist, along with the chlorophylls, two more pigments, carotin, $C_{40}H_{56}$, and xanthophyll, $C_{40}H_{56}O_2$, the relation between the two as regards oxygen being the same as that between chlorophyll A and B. It may therefore be suggested that carotin has the power of reducing chlorophyll B to chlorophyll A, itself being oxidised to xanthophyll. This is supported by Willstätter's observation that the ratio of xanthophyll to carotin is increased during the photosynthetic operation. This increase, though perfectly definite, is not large enough to decrease materially the amount of oxygen transpired.

The complete reaction, $H_2O + CO_2 = CH_2O + O_2$, is highly endothermic, and is accompanied by the absorption of about 150,000 calories per gram-molecule of formaldehyde produced; and it is interesting to note that one quantum of energy absorbed in the

visible region by chlorophyll is not sufficient to induce the complete reaction, since 150,000 calories per gram-molecule is almost exactly one quantum per molecule at $\lambda = 200\mu\mu$. Certain quantitative experiments have shown that a possible explanation of this is to be found in the fact that the carbonic acid is partly activated by combination with the chlorophyll. Alternatively, it is possible that, whilst one quantum of energy at $\lambda = 200\mu\mu$ is required for the complete reaction with the escape of free oxygen, one quantum of visible light as absorbed by the chlorophyll is sufficient to induce the reaction

$$\text{Chlorophyll A} + H_2CO_3 = \text{chlorophyll B} + CH_2O.$$

It is scarcely necessary to point out that either of these alternatives amplifies the principle of photocatalysis as previously defined. In either case the completion of the reaction, whereby the oxygen is abstracted from the chlorophyll B and transpired into the atmosphere, must require a further supply of energy. This second amount of energy is doubtless absorbed by the carotin and xanthophyll, the absorption bands of which lie in the visible region and between those of chlorophyll, so that each can absorb visible light simultaneously and independently. This suggested explanation is now being investigated.

Reference may be made to some other work now in progress at Liverpool which has already given most promising and suggestive results. By the action of ultra-violet light on aqueous solutions of formaldehyde, several hundred grams of concentrated sugar syrup have been prepared. Analysis of this syrup has shown that the sole products of the polymerisation are hexoses, no trace of a triose or pentose having been found. This result is very striking in view of the greater possibility on the kinetic theory of the formation of sugars containing fewer than six carbon atoms. There can therefore be no possible doubt that the sole products of the polymerisation of the activated formaldehyde as photosynthetically produced in the living plant are also hexoses. Not only does this afford a ready explanation of the storage of starch in the chloroplast during the period of photosynthetic activity and its subsequent hydrolysis to hexoses, which are utilised by the plant in later syntheses, but it also establishes the fact that pentoses must be formed from hexoses, possibly through furane compounds; further, it opens the door to most promising theories of the synthesis of other plant products, every stage of which is attractive in its simplicity.

Then, again, there is the question of the production of the various nitrogen compounds in the plant, which is one of considerable interest, since it would seem that the principal source from which the plant derives its nitrogen is potassium nitrate. It is well known that metallic nitrates are readily converted to nitrites by material catalysts as well as by ultra-violet light. Baudisch has shown that an aqueous solution of potassium nitrite and methyl alcohol, on exposure to ultra-violet light, gives formhydroxamic acid, the alcohol first being converted to formaldehyde. This has been confirmed at Liverpool by investigation of the action of ultra-violet light on aqueous solutions of potassium nitrate or nitrite containing formaldehyde, and it has been proved that an activated molecule of formaldehyde combines with a molecule of potassium nitrite according to the equation $CH_2O + KNO_2 = CH(OH):NOK + O$, since the reaction takes place only in the light. It has also been found that if the activated formaldehyde is in excess formhydroxamic acid and hexoses are simultaneously and independently produced. This condition is doubtless that which obtains in the plant, and it may be concluded that the two syntheses take place in the leaf without mutual influence. It is worthy of note that the photosynthesis of formaldehyde and the synthesis of formhydroxamic acid are both accompanied by the setting free of oxygen.

Experiments are also in progress on the reaction between activated formaldehyde and ammonia, and although these are not yet complete, they have already established the great reactivity of activated formaldehyde towards ammonia. Whatever, therefore, may be the starting point on the nitrogen side, potassium nitrate or ammonia, there is no question that, in the presence of activated formaldehyde such as is produced photosynthetically in the plant, compounds are formed in which carbon and nitrogen are united, thus securing the first step towards protein, pyrrole, and alkaloid synthesis.

Finally, one very important deduction may be made. The sole photosynthetic process in the living plant would seem to be the production of activated formaldehyde from carbon dioxide and water. These activated molecules either polymerise to hexoses or react with potassium nitrite or ammonia. Any further reactions are not photochemical except in so far that the first synthesised nitrogen compounds combine with more molecules of activated formaldehyde to give complex nitrogen derivatives.

The Migration of British Swallows.

By Dr. A. LANDSBOROUGH THOMSON, O.B.E.

"Sister, my sister, O fleet sweet swallow,
Thy way is long to the sun and the south."
SWINBURNE.

FROM time immemorial the Swallow (*Hirundo rustica*, Linn.) has been a proverbial type of summer visitor to our northern lands, but age-long familiarity with the fact of its seasonal appearance and disappearance has not served to bring us complete knowledge or understanding: there are many secrets, both matters of fact and questions of interpretation, to which we have as yet no clue. Nevertheless we are in a better position to appreciate the problem than were Gilbert White and his contemporaries, who were obsessed with the idea that hibernation, particularly in regard to this species, might play an important part as an alternative to migration. White was particularly influenced by the frequent phenomenon of the few "early swallows" which appear some time before the main contingents arrive, and are no more seen if wintry weather should recur in the meantime. The theory of hibernation dies hard even to-day, and every now and then some imperfect piece of evidence in its

favour is recorded—cases, for instance, of birds lingering in autumn being overtaken by hard weather and being found in a comatose condition, really moribund rather than dormant. The further idea that the place of hibernation was in the mud at the bottom of reedy ponds was regarded with sufficient seriousness in the time of John Hunter, the famous anatomist, for him to examine it scientifically; with a truly modern appreciation of experimental methods, he confined swallows in a conservatory one autumn, providing them with water, reeds, and mud, and the result naturally confirmed his scepticism.

Nowadays we know enough of migration to have no need to explore alternative theories, but it still remains true that we see migration actually in progress comparatively seldom, although perhaps we do so more often in the case of swallows than in that of most small birds. The writer recalls one fortunate occasion, for example, when he spent the morning of a bright autumn day sitting at the extreme northern apex of the isle of Heligoland watching the swallows coming in over the sea in the teeth of a southerly gale. For hours there was a steady succession of small bands of from half-a-dozen to a score of swallows, all flying low over the sea and coming into sight as they rose to the level of the cliff-tops. All the birds kept to the same course, the stream following the line of the western cliffs and quitting the island again at its south-western corner. Only an occasional bird circled round for a few minutes, and none seemed inclined to break its journey so early in the day in spite of the adverse conditions. But a glimpse of this kind is only seeing in momentary cross-section, so to speak, one tiny rivulet of the great emigratory stream of swallows from Northern Europe.

Much has been learnt, however, by the careful piecing together of observations collected from many different places, notably from the lighthouses and lightships round the British coasts. From these data Dr. Eagle Clarke was able to give us some years ago, in the report of the special committee appointed by the British Association, an elaborate summary of the movements which usually take place in the British area, and more recently this has been supplemented by the labours of a committee of the British Ornithologists' Club. A few early birds may appear in March, but the average times for the arrival of the vanguard of our summer visitant swallows are:—for south-western England the beginning of the first week in April, for Ireland the end of that week, for south-eastern England early in the second week, for south-western Scotland the end of the same, for south-eastern Scotland the middle of the third week, for northern Scotland the fourth week, and for the Orkney Isles the second week of the following month; the main influx usually begins some ten or twelve days later in each case. The earlier dates for the western regions, latitude being equal, are noteworthy, and it appears that the immigratory waves arrive along the whole length of the south coast of England, but first and chiefly on its western half. Before this immigration of our native birds has been completed—at the very end of April—there begin the passage movements of swallows traversing the eastern seaboard of Great Britain *en route* for northern Europe, and these movements may be prolonged until almost the middle of June.

Decided southerly movements within the British area begin towards the end of August, and early in September actual cross-channel emigration sets in and continues for nearly two months, after which only stragglers are as a rule recorded. From the middle of September onwards there is also the return passage of swallows from Northern Europe, and the two sets of movements are not easily distinguishable. There is also a passage movement from Central Europe, first observed by Dr. Eagle Clarke from the Kentish Knock Lightship, the line of flight being roughly from east to west; the existence of a corresponding spring passage on this line has not been definitely established. A very few instances are on record of swallows surviving in this country throughout exceptionally mild winters.

Within the last few years the method of marking birds with numbered aluminium rings has been widely employed in this country, under the auspices both of the magazine *British Birds*, edited by Mr. H. F. Witherby, and of the University of Aberdeen. The proportion of marked swallows recovered is unfortunately very small, for out of 1198 marked during the Aberdeen scheme only five, or 0.4 per cent., were recovered. The *British Birds* scheme, which is still actively in progress, has nevertheless yielded a very interesting series of records for the species, representing a vast amount of energy in marking; 7597 had been marked up to the end of 1920, and 60 (or 0.7 per cent.) have been recovered. A brief summary of the results of this work, taking the published data of the two schemes together, may accordingly be given with advantage.

There are, to begin with, various records of swallows marked as nestlings and recovered within a few miles a little later in the same season, but these are without special significance. The European stages of migration are indicated by records of birds marked as nestlings and reported in their first year, as follows: one marked in Lancashire from the Isle of Wight late in October; one marked in Lancashire from Indre-et-Loire, in the centre of France, in September; one marked in Staffordshire from Charente-Inférieur, south-western France, in October; and one marked in Staffordshire from Brittany in December, but without information as to how long it may have been lying dead before it was discovered. Further, a swallow marked as a nestling in Staffordshire was recovered at Bilbao, northern Spain, in March of the following year.

Four swallows marked as nestlings, all under the *British Birds* scheme, have been recovered in South Africa during their first winter: a Lancashire bird in Cape Province in February, an Ayrshire bird in the Orange Free State in March, a Yorkshire bird in East Griqualand in February, and a Stirlingshire bird in the Transvaal in January. A swallow marked in Staffordshire as an adult, also, was recovered in Natal in December of the second winter thereafter. Mr. Witherby has directed attention to the suggestive fact that all these five records of his are from the eastern portion of South Africa. A swallow marked in Schleswig-Holstein was obtained on migration at Bregenz, on the Lake of Constance; another, marked as a nestling in Overijsel, Holland, was recovered on October 1 of the same year at Tangier, Morocco.

Of great interest, also, are the records which indicate

the return of swallows to their native districts in subsequent summers. Seventeen marked as nestlings have been so recorded, sixteen in the following summer and one in summer two years after marking, the localities ranging from Hampshire to Kincardineshire. Six marked as adults have been similarly recorded, three after one year and three after two years, the localities ranging from Staffordshire to Peeblesshire.

In some of the foregoing cases the return to the same place was very exact—even to the self-same porch or outhouse. In others the place of recovery was a few miles from the place of marking; a swallow marked as a nestling at Beaulieu (Hampshire), for instance, was recovered in the following May at Ringwood, in the same county but 18 miles distant. There are other cases, still to be mentioned, in which swallows marked as nestlings returned in the following summer to parts of the country rather more widely separated from their respective birthplaces, the distances being from Hampshire to Sussex (30 miles), from Hampshire to Middlesex (70 miles), from Stirlingshire to Yorkshire (170 miles), and from County Kildare to County Armagh (75 miles).

Migration of swallows from Great Britain to South Africa is thus clearly established, and it is also now certain that the birds commonly return to the same summer quarters, often with great exactness, in subsequent years. Much still remains to be learnt, and some of this the marking method may give us in time. What route is followed between Great Britain and South Africa, for example, and are the identical winter quarters repeatedly sought out in the same way as breeding-places? Further, how do the migrations of British swallows compare with those of swallows native to other countries: can we, for instance, confirm Dr. Hartert's suggestion that "the most northerly dwellers migrate furthest south, while the breeding birds of the Atlas Mountains probably go only to the oases of the Sahara for the winter"? These questions strike at the very roots of the nature of the migratory instinct, one of the great wonders of the animate world.

Obituary.

PROF. BENJAMIN MOORE, F.R.S.

BY the death of Prof. Benjamin Moore, at fifty-five years of age, science has suffered the loss of an original and daring thinker. Moore was born, and studied, in Belfast, and the first degree he took was Bachelor of Engineering. At one time he thought of following that profession. He received a travelling research scholarship, and studied physical chemistry under Ostwald in Germany, and then came to London and studied physiology under Sharpey Schafer. From thence he went to fill a chair at Yale Medical College, but returned a few years later to be lecturer in physiology at Charing Cross Medical School, and at the same time to qualify himself as a medical man—a double task requiring much nerve, energy and courage. Moore was then elected to the newly-founded Johnston chair of biochemistry at Liverpool—the first chair in that subject to be founded in this country. He took a most active share in the development of the Medical School at Liverpool University, and jointly with Mr. Whitley founded the *Biochemical Journal*. He was elected a Fellow of the Royal Society in 1912. In 1914 he accepted an invitation to join the Department of Applied Physiology under the Medical Research Council, and after rendering valuable services to industrial medicine during the War, was elected, in 1918, to the newly-founded Whitley chair of biochemistry at Oxford. There he quickly inspired several of his honour school students to carry out pieces of research work, and all too soon he has passed from thence, the victim of influenza. He took the greatest interest in Public Health, and a State Medical Service, as shown by his book "The Dawn of the Health Age."

Moore was a man of impetuous imagination, conceiving brilliant ideas, and stimulating others by these and his enthusiasm; he was impatient under the necessarily slow accumulation of results required for confirming his ideas—an impatience which sometimes led him to be too hasty in publication, and to subject himself to criticism whereby his spirit was vexed and his energy wasted in controversy. He was perhaps sometimes wild, sometimes wrong, but often the pioneer in visions of great value. To him we owe the first attempts in this country to apply the results of physical chemistry to the intricate problems of biology. The article by Moore published in "Recent Advances in Physiology," edited by L. Hill, and last year elaborated and republished in book form, did much to found the British school of physico-chemical physiology.

Moore was fascinated by the problem of the origin of life, and formed conceptions of the first steps in the evolution of life by the synthesis of inorganic compounds. He was able to show the formation of formaldehyde from CO_2 and H_2O under the influence of sunlight on a commonly occurring substance like iron oxide. This was the beginning of a series of papers on photosynthesis, on which a value higher than at present will probably be set in future time. He recently demonstrated the production in the air of oxides of nitrogen by the action of sunlight, and conceived the assimilation of these when dissolved in rain and dew by the green leaf. He was a pioneer in the work which is now given so much attention among physiologists, namely, on the normal reaction of body fluids and the maintenance of this normality, acidosis, etc.

Tackling the problem of trinitrotoluene poisoning, which was working havoc in munition factories during the War, Moore found that the chief danger was due to the absorption of this material through the skin—a view which met with considerable opposition, and led to controversial strain upon his sensitive nature. This discovery, when fully accepted, enabled thousands of workers to be preserved from poisoning during the War, and saved the country paying out hundreds of thousands of pounds in the settlement of employers' liabilities.

The sudden death, from appendicitis, of Moore's wife, who was devoted to his care, was an irreparable loss to him, and made a vast difference to the happiness and health of his last years. He leaves one son—a chemist in training—and two daughters. L. H.

DR. A. D. WALLER.

WE record with much regret the death on March 11, at fifty-five years of age, of Dr. A. D. Waller, director of the physiological laboratory and professor of physiology in the University of London.

M. CAMILLE JORDAN.

BY the recently announced death of Camille Jordan the mathematical world has sustained the loss of one of its greater modern analysts. Born in 1838 Jordan succeeded Chasles (1881) in the geometrical section of the Paris Academy of Sciences. Later he was given the chair of mathematical analysis at the École Polytechnique, from which he retired a few years ago.

In the earlier part of his career Jordan's mathematical work was mainly geometrical. An important memoir is concerned with polyhedra and the attendant geometry of position. In another paper he obtained the condition that two flexible and extensible surfaces should be applicable to one another without tearing or doubling over. His work on symmetry and displacement-groups anticipated later research on transformation-groups, and has been used in theoretical crystallography.

Jordan left his deepest impression, however, by his work on substitutions and algebraic equations. In his "Traité des Substitutions" he followed up Galois' ideas, obtaining fundamental results on primitive, transitive, and composite groups, and on the composition-factors of a group. These investigations enabled him to settle a question proposed by Abel, *viz.* to decide whether a given algebraic equation is soluble by radicals or not. Other work of Jordan's is concerned with algebraic forms and linear groups of finite order, with their applications to algebraic integrals of linear differential equations.

Some of Jordan's more recent work was on the theory of functions of a real variable. His name will be remembered as the discoverer of *Jordan curves*, the most general curves which cut a plane into two distinct portions. W. E. H. B.

Current Topics and Events.

THE call for economy in the Civil Service has produced a number of letters in the correspondence columns of *State Technology*, the journal of the Institution of Professional Civil Servants, from members who do not belong to the administrative section of the service or to the clerical section from which the administrative is recruited. The object of these letters is to show that great saving might be effected by making better use of the professional, scientific, and technical officers of the service. At present it often happens that progressive scientific development is hampered by the existence of a control without knowledge of the scientific work on which the professional members are engaged. Such a control tends towards a stereotyped system in which each member of the service becomes a mere machine without inspiration or initiative, and to the promotion of clerks into secretaries, deputy secretaries, assistant secretaries, etc., at salaries out of all proportion to the value of their services to the State. From letters in the February number of the journal it appears probable that some of these facts are to be discussed in the daily press in the near future.

THE Field Museum of Natural History, Chicago, announces several collecting expeditions. Mineralogists will visit the gem-producing and the gold- and copper-producing districts of Brazil, the silver- and copper-producing districts of Peru and Bolivia, and the nitrate and vanadium deposits of Chile. Fossil vertebrates will be sought in Patagonia, northern Argentine, and Brazil. Zoologists and botanists will be associated in the Sierras of Central Peru and round the sources of the Amazon. Archaeologists will visit the Isthmus of Panama, the State of Colombia, and the Colorado Desert. Dr. Fay-Cooper Cole is to study the races of the Malay Peninsula and to explore the interior of Borneo. Dr. Berthold Laufer proposes to study the aboriginals of Hai-nan, and to make archaeological collections in Fu-kien and Manchuria.

A VIOLENT gale traversed the southern portion of England during the night of March 7 and the forenoon of March 8. The storm arrived from the Atlantic and was first experienced on our south-west coasts, whence it travelled across the south and east of England to the North Sea. In the English Channel and at the southern English stations the south-westerly and westerly winds attained hurricane force. At Scilly the wind blew with the velocity of 108 miles an hour at 4 A.M., a speed which has only once previously been exceeded in the United Kingdom, the wind in a gale on January 27, 1920, registering 110 miles an hour in Co. Clare, Ireland. The storm was accompanied in most parts by heavy rains, and the violence of the wind occasioned a large amount of damage.

UNDER the title "Research Laboratories in Industrial Establishments of the United States, including Consulting Research Laboratories," a Bulletin of the U.S. National Research Council (1921, vol. 3, Part I., pp. 135) has recently been issued. The report gives an alphabetical list of 526 industrial establishments in the U.S.A. having research laboratories, the name of the chief worker, the number of the staff, the nature of the work, and the special equipment, together with a subject classification and index, and a list of the directors of research with addresses. It is a most interesting compilation, furnishing useful details not only of the enormous staffs of such companies as E.I. du Pont de Nemours, Eastman Kodak, Goodyear Tyre, General Electric, and Western Electric, but even of the small laboratories with only one or two workers. It is very plain, however, that the term "Research" has been generously applied, for the vast majority of the laboratories would be modestly referred to in this country as "works laboratories." The equipment catalogued is also quite conventional in most cases, but it is amusing to read that the Edison laboratory has a "large scrap heap from which to rob to build

other apparatus," and some scientific workers may envy the lot of the two members of the staff of a sugar company who have a "candy kitchen" at their disposal. It is flattering to the chemist to find how largely he preponderates in the various staffs, but many an industry would be better served by the co-operation of other scientific workers, especially physicists.

AMONG the pioneers of the locomotive a high place is deservedly given to Timothy Hackworth, who was born December 22, 1786, and died July 7, 1850. No complete biography of Hackworth has yet been written, and his merits apparently escaped the notice of the compilers of the "Dictionary of National Biography." This rendered all the more welcome the interesting review of his work which Mr. Robert Young, a grandson of Hackworth, gave to the Newcomen Society at the meeting held on March 1. Hackworth's youth was spent at Wylam Colliery, where Hedley built his "Puffing Billy." By 1824 he was sufficiently well-known to take charge of Stephenson's works at Newcastle, and the following year he became engineer and manager of the famous Stockton and Darlington Railway. For this line he built the "Royal George," which definitely asserted the superiority of steam over horse traction, and a year or two later the "Sans Pareil," a powerful competitor with Robert Stephenson's "Rocket" in the Rainhill trial of October 1829. If for nothing else Hackworth deserves recognition for his discovery of the proper manner of discharging the exhaust steam up the funnel so as to create a powerful draught through the furnace. He was, however, far more than a successful inventor. For fifteen years he managed the Stockton and Darlington Railway, and his workshops at Shildon became a training ground for locomotive engineers. He was also a great captain of industry and set an example in his treatment of his workmen. All these matters were touched upon in Mr. Young's paper, and information was given about many of the engines Hackworth constructed, among them being the first locomotive to be sent to Russia, and also the first to be run in British North America.

PROF. B. BRAUNER, professor of chemistry and director of the chemical laboratory, Bohemian University, Prague, has sent us an article, which we hope to publish in a week or two, on work done by Bohemian men of science during the war and after. He has been a reader of NATURE for forty-two years, and has on a number of occasions made original communications to its columns. We particularly appreciate, therefore, the following reference to this journal in an article contributed by him to the leading Bohemian periodical, *Národní Listy*, of December 21 last:—"My favourite reading is the London journal NATURE, circulating over the whole world and bringing articles about all acquisitions of the human spirit, from bacteria to the Egyptian 'Book of the Dead,' from the structure of atoms to the structure of the universe. The magnificent work of my teacher Bunsen and of Kirchhoff on spectrum analysis, together with the principle of our Doppler (who lived in Prague), which led us to understand of what and how the stars are formed and how they move; the work of Kekule ze Stradovic, a descendant of the Protestant exiles of Bohemia three hundred years ago, on the structure of matter; photography, Darwinism, theory of evolution, Mendeléeff's periodic system, Röntgen's discovery, Becquerel's discovery of radioactivity and the great chemical and electrical discoveries connected with it, which led to our knowledge of the innermost constitution of the atoms—of all these discoveries and their evolution and progress NATURE brings each week the most recent information. Everything described is connected together as a whole and yields a magnificent picture of Nature on the earth and in the universe. It is our religion—reverence to the One Who all this, and also ourselves, created of the original nebula, *i.e.* almost of nothing, and at the same time admiration of the human spirit which investigated and conceived it."

ON Wednesday, March 1, there was opened at the British Museum a special exhibition of Greek and Latin papyri presented at various dates by the Egypt Exploration Society. This body (formerly the Egypt Exploration Fund) is celebrating the twenty-fifth anniversary of the foundation of its Græco-Roman Branch, the excavations of which at Behnesa (Oxyrhynchus) and elsewhere have made so many additions to our stock of Greek literature and to our knowledge of the political, economic, and social history of Græco-Roman Egypt; and it is in honour of the anniversary that the Museum is arranging its exhibition. A guide-book to the exhibition, with introduction, detailed descriptions of the papyri shown, a preface by Sir Frederic Kenyon, and one photographic facsimile, is being published by the Society, and will be on sale at the Museum, price 1*s*. The exhibition, which will be found in the MSS. Saloon, Case A, includes many interesting papyri of various kinds, selected to illustrate the wide range of papyrological discovery. There are examples of famous additions to Greek literature, like the Pæans of Pindar, the poems of Cercidas, and the Oxyrhynchus historian; theology is represented by the Sayings of Jesus; and the economic and social life of Egypt finds illustration in many non-literary documents, several of them rich in human interest.

IN the middle of January the first issue of a new technical publication appeared entitled *Oil Engineering and Finance*, a journal intended for the producer and user of petroleum and also for the investor. A feature of the enterprise is the division of the paper into sections, each dealing with a particular phase of the industry, such as oilfield development, oil refining, fuel and lubricating oils, oil fuel, heavy oil engines, and the home oil industry, each section being under the editorship of a specialist in the particular branch under discussion. The first issue is almost entirely devoted to a comprehensive review of the petroleum industry in 1921 under the above headings, and, as such, is a most useful number. It is well put together, carefully printed, and the illustrations are good, and we can only express the hope

that future issues will conform to the standard aimed at by the promoters, and certainly achieved at the outset. The entire absence of an endeavour to influence the purchase of particular oil shares—an unfortunate feature of so many petroleum publications—is a sound policy which, if adhered to rigidly, will go far to establish this journal on a firm basis.

IN the Annual Report for 1921 of the Council of the Institution of Mechanical Engineers it is announced that the Thomas Hawksley Gold Medal for 1922 for the best paper published in the society's proceedings of the previous year has been awarded to Prof. E. G. Coker for a paper written in conjunction with Dr. K. C. Chakko and Mr. M. S. Ahmed on "Contact Pressures and Stresses." Other awards are grants of 20*l.* each to Mr. R. L. Smith and Mr. G. E. Sandland from the Sir Robert Hadfield prize fund for their communication entitled "An Accurate Method of determining the Hardness of Metals, with particular reference to those of a High Degree of Hardness." Prizes from this fund will not be offered again, and the unexpended balance of the capital sum will be used for assisting research. It is also announced that a scheme has been established in conjunction with the Board of Education for the award of National Certificates and Diplomas on the results of group part- and full-time courses at approved technical schools and colleges.

THE second annual report of the Industrial Fatigue Board to the Medical Research Council (pp. 65, H.M.S.O., 1922, 1*s.* 6*d.* net) is far more than a mere Report of the Board; only fourteen of its sixty-five pages are devoted thereto. The remainder consists in an instructive and valuable analysis of the published work of the Board, divided into the following five sections:—(i.) scope and method of its investigations; (ii.) hours of labour, spells, rest pauses, etc.; (iii.) other conditions of work, such as temperature, humidity, ventilation, and lighting; (iv.) methods of work, including vocational selection and guidance, and time and motion study; and (v.) miscellaneous points, *e.g.* organisation, human and technical factors in efficiency. The Secretary of the Board, Mr. D. R. Wilson, is to be congratulated most heartily on the report and on his successful organisation of its varied activities. Of these it is noteworthy that a large proportion (one half of the reports issued by the Board and of papers based on work done for it) have been contributed by investigators who have received special training in experimental psychology.

THERE has recently been issued "A List of Seismological Stations of the World" as vol. 11, No. 15, of the *Bulletin of the National Research Council* (U.S.A.). It was compiled under the auspices of the Section of Seismology of the American Geophysical Union, with the co-operation and assistance of the Research Information Service of the National Research Council. This list is incomplete owing to conditions prevailing generally after the world-war, and it is desired to correct and complete the information in the files of the Research Information Service in preparation for a revised edition of the publication. To that end a further revised *questionnaire* is being distributed with the printed list. Extra copies of the *questionnaire* are available, and will be sent to all who have additional information to contribute. It is requested that every one who notes errors or omissions in the list as issued should bring these to the notice of the Section of Seismology of the American Geophysical Union, addressing communications in care of the Research Information Service, National Research Council, 1701, Massachusetts Avenue, N.W., Washington, D.C., U.S.A. It is hoped, further, that complete as well as accurate information may be supplied concerning all stations not now fully described.

BRIEF statements on the position of the various research committees appointed by the Institution of Mechanical Engineers from time to time appear in the Report of the Council for the past year. The Committee on Alloys Research under the chairmanship of Sir John Dewrance has completed its work on aluminium alloys and is continuing that on the alloys of iron. Research work on the stresses in tools and material cut has been carried out by Prof. E. G. Coker, using polarised light and transparent models, for the Cutting Tools Research Committee, also under the chairmanship of Sir John Dewrance, and Col. Compton has experimented on the simplest form of cutting. Work for the Hardness Tests Research Committee, under the chairmanship of Dr. W. C. Unwin, has been carried out by Dr. T. E. Stanton at the National Physical Laboratory on the comparison of ball and cone tests and of scratch and indentation tests for very hard steels. The Steam-Nozzles Research Committee, under the direction of Capt. H. Riall Sankey, has investigated the efficiency of Parsons' nozzles; the expenditure of this committee during the year exceeded 900*l.*, and a balance of less than 200*l.* remains. Work for the Wire Ropes Research Committee, of which Mr. C. W. James is chairman, has been carried out by Dr. W. Scoble on repeated bending tests of wire ropes.

THE representative meeting at Glasgow of the British Medical Association will begin on July 21. The statutory annual general meeting commences on July 25, and the presidential address will be delivered by the president-elect, Sir William Macewen, during the same evening. Prof. J. Graham Kerr is to give a popular lecture on the evening of July 28. The following have been elected presidents of sections: Prof. T. K. Monro, medicine; Dr. G. M. Robertson, neurology and psychological medicine; Mr. A. S. Percival, ophthalmology; Prof. R. Muir, pathology; Prof. H. A. Thomson; Mr. R. MacN. Buchanan, microbiology (including bacteriology); Prof. J. A. McWilliam, physiology; Dr. A. K. Chalmers, public health; Prof. A. Macphail, anatomy; Prof. J. Glaister, industrial diseases and forensic medicine; Mr. L. A. Rowden, radiology; and Sir Robert W. Philip, tuberculosis. The honorary local general secretary is Dr. G. A. Allen, 22 Sandyford Place, Glasgow, W.

Our Astronomical Column.

THE PARTIAL SOLAR ECLIPSE OF MARCH 28.—This eclipse is a successor, after twelve lunations, of the large eclipse of last April. On this occasion the central line has moved southwards, crossing Brazil and the Sahara. The whole of the British Isles enjoy a partial eclipse, the magnitude of which diminishes from 0·20 at Greenwich to zero at the Shetlands. At Greenwich the eclipse begins at 1.19 P.M. at the lowest point of the disc, attains its greatest phase at 2.15, and ends at 3.8. The only observations of importance that can be made are the timing of the contacts and the watch for lunar mountains at the edge of the moon.

PHOTOGRAPHY OF THE ULTRA-VIOLET SOLAR SPECTRUM.—MM. Charles Fabry and H. Buisson give an account of their work in this field in the *Astrophys. Journ.* (December). They state that existing material on this region is unsatisfactory; Rowland's map is disturbed by a spectrum of another order; that of Higgs stops at λ3000; and Cornu's map was made by hand from Simony's photographs. Fabry and Buisson's photographs were taken at Marseilles in May and June 1920. They used two quartz spectrographs, the prism edges in them being perpendicular to each other, and state that they thus eliminated diffuse light of longer wave-length, which is one of the chief difficulties in this region. Another difficulty, due to the rapid increase in exposure-time as the wave-length grows shorter, was overcome by using an occulting screen, which was moved by hand at a calculated rate along the spectrum during exposure; the extreme exposures were in the ratio of 1 to 1000. They state that they were able to estimate the varying amount of ozone present in the air by its absorbing effect on these short waves. They give the mean amount of ozone in the air as 0·4 c.c. per cubic metre; as this is much larger than the amount near the ground, they conjecture that it is mainly at a great height (say 50 km.). Two reproductions are given of the spectrum from λ2898 to λ3150; the definition is good and numerous lines are shown, the wave-lengths of which are promised shortly; they include the lines designated *r*ST*t*U. The region λ2965 to λ3030 appears on both photographs, the agreement being good, but with differences in the relative intensities of lines.

The authors note that the intensity of spectrum at the sun's limb is about half that at the centre, this factor remaining nearly constant throughout the region studied. They conclude that the fairly abrupt termination of the spectrum at λ2898 is due to the terrestrial, not the solar, atmosphere.

A CRITICISM OF MAJORANA'S THEORY OF GRAVITATION.—The *Astrophys. Journ.* for December contains a criticism of this theory by Prof. H. N. Russell. It will be remembered that the theory, which was based on the apparent alteration in the weight of a mass of lead when surrounded by mercury, asserts that gravitation is subject to absorption by intervening matter. Prof. Russell shows that a sphere composed of homogeneous spherical layers would still attract external bodies according to the inverse square law; as though its mass were concentrated at the centre; thus it would not give rise to any motion of perihelia, as some have supposed. However, the apparent mass of the sphere, as measured by its attraction on external bodies, would be less than its true mass, the deficiency increasing as the central condensation of the matter in the sphere increases. It is then proved that a massive planet would be considerably nearer to the sun than a planet of small mass with identical period. Jupiter, in particular, would be nearer to the sun by 1 per cent. than the accepted distance; but this is inadmissible, since it would produce an error of 7′ in the geocentric place when the planet was in quadrature.

Another test applied is the difference between the heights of the tides when the sun and moon respectively are above and below the horizon. It is shown that the theory would give results totally at variance with observation. Lunar theory supplies a further test, since the attraction of the sun on the moon would produce an acceleration greater by 1·6 per cent. than that experienced by the earth. Prof. Russell concludes that Majorana's theory must be abandoned; he suggests tentatively that the phenomena observed by Majorana might be explained on the assumption that the presence of a large mass itself diminishes the masses of neighbouring bodies: "the space-curvature produced by one mass of matter might be modified by the superposition of that due to another." He admits, however, that this theory also gives rise to difficulties.

THE DEFINITION OF A NOVA.—The Rev. J. G. Hagen directs attention to the advisability of formulating a definition of a nova which takes into account our present knowledge of the nebulous material surrounding new stars, and also class O stars and planetary nebulæ (*Astrophysical Journal*, vol. 54, No. 4, p. 229). Seeliger, so long ago as 1886, put forward the idea that temporary or new stars originated from collisions between stars and cosmic nebulæ, and this theory is now generally adopted. Dr. Hagen's view is that by assuming that the nebulæ are cometary—that is, become luminous at the approach of stars—many facts of observation are explained. Thus the observations account for nearly all the peculiarities of new stars, especially the range of magnitude, shape of the light-curve, character of the spectrum, and the rarity of occurrence; they also show a physical similarity to the O stars and planetary nebulæ.

The collision between the star and the nebula is discussed and the possible results of four types of encounters are given. Then it is shown that a transit without contact might produce a nova with a relatively small range of variation. If the star grazed the nebula and the occurrence was repeated occasionally an irregular variable would be the result. The passage of the star through the nebula might result in a nova of the ordinary type and in a star with a nebulous envelope like an O star. If the star were captured by the nebula a variable of the δ Cepheid type or a planetary nebula would be evolved. The definition of a nova is thus given: "A cometary nebula brought temporarily into close proximity or contact with a bright star."

THE STELLAR MAGNITUDE OF THE RINGLESS SATURN.—Mr. J. van der Bilt investigates this subject in *Bull. Astron. Instit. of Netherlands*, No. 6. Capella, Vega, Procyon, Spica, Pollux, Regulus, and Polaris were used as comparison stars, their magnitudes being revised by the author's observations. The value obtained for Saturn in opposition (Ringless) is 0·84 mag., that given by Müller being 0·877. The chief value of this work lies in the deduced value of the planet's albedo. Similar determinations made when the rings are wide open will give a determination of their albedo, and may give a clue to the constitution of the ring-particles. Mr. van der Bilt has also investigated the effect of phase angle on magnitude, and found the change for 1° of Saturnicentric angle between sun and earth to be 0·050 magnitude, which is in good accord with the mean of other observers.

Research Items.

CLASSIFICATION OF NEMATODES.—Dr. H. H. Cobb sets forth in *Nematology* (8) a classification of nematodes "based on a study of several hundred genera" and depending chiefly on the characters of the mouth and related organs; and in the following part (9) gives systematic descriptions of about one hundred, mostly free-living, new species of nematodes, which form the type-species of nearly as many new genera. Among the morphological points may be noted the following: the large percentage of species with pointed setæ, the complex distal ends of the cephalic setæ in some species indicating their sensory nature, and the presence in a large group of nematodes of six well-developed pharyngeal onchia or spears having an outward stroke and adapted for digging.

FORESTRY IN SWEDEN.—The Forestry Research Institute (Skogsförsöksanstalt) of Sweden, with the view of making its scientific publications better known to the general public, has recently begun the free issue of a series entitled *Skogliga Rön*, which gives the main points of the larger memoirs, emphasising those of direct practical importance. No. 1, by Olof Tamm, deals with the constitution of the soil in the primæval forest of Northern Sweden. The Institute, in addition to its periodical *Skogen*, publishes leaflets, of which we have received *Flygblad* No. 23, by E. Wibeck, on some new forest-cultivating machines, such as root ploughs and sowing apparatus, and *Flygblad* No. 24, by O. Tamm, discussing the dependence of forest growth on the mineral constitution of the soil. Those interested can obtain these publications on application to the Institute at Experimentalfältet, Stockholm.

THE DOVE MARINE LABORATORY, CULLERCOATS.—The Report for the year ending June 30, 1921, of the Dove Marine Laboratory, Cullercoats, is devoted chiefly to an account of trawling investigations carried out in the inshore waters of the coast of Northumberland, which were suspended in 1913 and renewed in 1920. Prof. Meek concludes, from an examination of the rings on the otoliths of the plaice, that the spawning season of 1917, and probably also that of 1916, was a poor one, and that the fry resulting from it were subjected to unfavourable conditions. He thinks that this may perhaps be due to the flooding of the inshore waters with oil, which occurred in the war, during the pelagic period of the eggs and fry. The trawling investigations of 1920 are compared in detail, especially as regards plaice, with those carried out before the war, from 1892 to 1913, and an account is given of the results of marking experiments made with the same fish. An interesting discussion on the migrations of the plaice and other fishes in the area is added. The important feature of the remainder of the Report is Mr. Storrow's paper on herring shoals. Samples from shoals extending from Stornoway and the Shetlands in the north to Yarmouth in the south were analysed as regards age and maturity, and samples of Irish fish were treated in the same way. Attention is directed to the fact that herrings in their fourth year form the most important constituent of the summer fishery along the east coast of Britain, and the author concludes that the fluctuations in this fishery depend largely upon the success of the spawning and rearing of the season four years before that of fishing.

IRISH ESKERS.—Mr. J. de W. Hinch, in a paper on "The Eskers of Ireland" (*Irish Naturalist*, vol. xxx p. 137, 1921), criticises the recent memoir by Prof. J. W. Gregory (*Phil. Trans. Roy. Soc.*, Section B, vol. ccx.), in which it is maintained that a large part of Ireland was submerged under the sea during the formation of the boulder-clay that now occupies the plainland. Mr. Hinch points out that this revival of an old view, which was very natural in its day, ignores the work done in glacial geology in Ireland for the last thirty years. If it is necessary, as some writers think, to regard eskers as deposited in water, a lake must be postulated; but the problem of the marine shells found in abnormal positions has been successfully met without demanding a submergence, in accordance with the widening of our knowledge of the behaviour of "continental" ice-sheets.

THE POST-GLACIAL CLIMATIC OPTIMUM IN IRELAND.—Mr. J. de W. Hinch, of the Geological Survey of Ireland, has recently discussed "The Post-Glacial Climatic Optimum in Ireland" (*Irish Naturalist*, vol. xxx. p. 85, 1921). He regards the warm damp epoch when the Littorina sea prevailed in the Baltic area as representing an optimum which declined towards present-day conditions. The hazel, for instance, had then its most northern fossil boundary, and regions of high arctic vegetation became subarctic. The oak and the elm have now a more southerly limit than at this optimum. Mr. Hinch now shows that the marine fauna of the estuarine days, overlying submerged peat on so many parts of the Irish cost, contains a number of molluscan species that have similarly migrated southward, but which were formerly present in abundance in a more northern habitat. The improvement in climate at the epoch of the submergence which gave us the estuarine clays may thus be regarded as an optimum, or near an optimum, which has not been maintained in more recent times.

LABRADOR AND NEW QUEBEC.—Memoir 124 of the Geological Survey of Canada, by Prof. A. P. Coleman, deals concisely with the "North-eastern part of Labrador, and New Quebec," and will be useful to geographers who wish to gain an insight into a territory that embodies many late glacial features, though it lies on the latitude of the Orkneys. The landscapes in the Memoir are excellent, and among them there is an example of the most puzzling feature of solifluxion in cold tundra lands, where the polygonal areas of soil become surrounded by walls of stones coarser than the average in the soil. As the author remarks, the effect produced is "as if the finer materials, sandy or gravelly rather than muddy, ascended and spread out from the centre, crowding the coarser blocks to the edge." No stratæ intervene in N.E. Labrador between sediments that are probably Huronian and glacial deposits that are referable to an early stage of the Pleistocene ice-age. The later glaciations from the Labrador centre seem never to have reached the Atlantic coast. The raised beaches occur below the 400 ft. contour-line, and are attributed to the depression of the land by the continental ice, which here was probably only 2000 ft. in thickness. Prof. R. A. Daly's study of the post-glacial warping of the region immediately to the south, including Newfoundland, was published in the *American Journal of Science*, vol. cci. p. 381, 1921, and in it he corrects previous statements, referred to by Prof. Coleman, that raised beaches occur in Newfoundland above 500 ft. The famous

labradorite-rock of Paul Island comes within the area described by Prof. Coleman. For this, Sterry Hunt's unfortunate name anorthosite is retained; even so acute a recorder as Dr. A. Holmes has been led astray by this term, and has stated that anorthose is the French equivalent for plagioclase.

SULPHUR IN ILLINOIS COAL-BEDS.—The University of Illinois Bulletin, vol. xviii. No. 36 (Bulletin No. 125) contains the results of an investigation by Messrs. H. F. Yancey and Thomas Fraser upon the mode of occurrence of sulphur in certain of the coal-beds of Illinois. It is shown that the sulphur is present partly in the form of pyrites and partly in certain organic compounds; the former may be either macroscopic or microscopic. The technical importance of these distinctions lies in the fact that it is practically only the sulphur present in macroscopic pyrites which can be separated by washing. In some cases a certain amount of sulphur is present as sulphates, but there were only traces of these present in the coals examined. Pyritic sulphur is characterised by extreme irregularity of distribution in the coal-bed, mainly due to the concentration of the pyrites in coarse bands or lenses. On the other hand the vertical distribution of organic sulphur is comparatively uniform at given points in the same bed, though in the mine as a whole the variations may be considerable; nevertheless it is more uniformly distributed than pyritic sulphur. There is no definite relation between the occurrence of organic and pyritic sulphur. The amount of the former is quite important, the percentages in three mines being :—

	I.	II.	III.
Pyritic Sulphur . . .	47·3	47·7	60·5
Organic Sulphur . .	52·7	52·3	39·5

In 104 face samples taken in the three beds, organic sulphur exceeded pyritic sulphur in 49 samples.

EVAPORATION FROM LARGE EXPANSES OF WATER.—This subject is dealt with in the *Meteorological Magazine* for January and February. In the January issue reference is made to Dr. H. Jeffreys, who submitted the problem to mathematical analysis in 1918, and who adopted the simple hypothesis that the rate of evaporation depended only on difference of vapour pressure. It is mentioned that Mr. M. A. Giblett in *Proc. Roy. Soc.* A, vol. 99, 1921, makes a further advance by allowing for the strength of the wind. Valuable information is given as to the total amount of evaporation under various circumstances. It is asserted that the same amount of air picks up less moisture if it crosses the ocean quickly than if it goes slowly; the more vigorous evaporation does not make up for the shorter time of passage. The February *Meteorological Magazine* deals with "The Evaporation from the Sea," by G. Wüst (Institut für Meereskunde, Berlin, Oct. 1920). This publication was taken for discussion at the Meteorological Office at the evening lecture on February 6 last. An estimate is given of the zonal distribution of evaporation, which is said to be most rapid between the latitudes 10° and 20° north and south. Comparison between the estimates of evaporation and the rainfall over the ocean indicates that evaporation exceeds precipitation between latitudes 40° N. and 40° S., except in the cloudy equatorial belt, whilst outside these limits precipitation is in excess of evaporation.

METEOROLOGY IN MEDICINE.—At a meeting of the Royal Meteorological Society in the University, Edinburgh, on September 7 last, a paper on Meteorology in Medicine, with especial reference to the occurrence of malaria in Scotland, was read by Dr. Angus G. Macdonald. The paper is printed in the Quarterly Journal of the Royal Meteorological Society for January. Meteorology is described as a science, and medicine as a consummate art—the practical exploitation of the data of all the sciences for the conservation of mankind. Referring to the reappearance of malaria indigenous in England in the years 1917, 1918, and 1919, temperature results are given for the months of June–September in each year. It is mentioned that it would appear to be safe to infer that any month having a mean temperature of 60° F. may suffice to produce malaria in England, given other conditions favourable. The conditions in the years mentioned were associated with the presence of a large mass of infection imported in soldiery from the East. The recent period of malaria is contrasted with the last previous recorded outbreak of malaria in England in the years 1856–59, when a period of abnormally high temperature is shown to have occurred. This period also coincided with the return of infected soldiery from Eastern Europe, this time from the Crimean War. An abnormally cold year followed in 1860 which brought the infection to an end. In relation to the maturation of the infection especial reference is made to the mosquito associated with high temperatures. These general considerations are applied to occurrences of malaria in Scotland, and much valuable information is given.

INDUSTRIAL LIGHTING.—In a paper read before the Illuminating Engineering Society on February 28, Mr. L. Gaster discussed "Ideal Requirements in Industrial Lighting and Practical Solutions." Ideal lighting conditions should enable work to proceed by night as safely and efficiently as by the best daylight. Practical possibilities were illustrated in the recommendations of the Home Office Departmental Committee on lighting in factories and workshops and the codes of industrial lighting adopted in various American states. The latter, while more detailed and elaborate, were based on the same general principles, namely, sufficient illumination, avoidance of glare, and elimination of inconvenient shadows. Mr. Gaster laid stress on the fact that sufficient illumination was only part of the problem. A distinction must be drawn between recommendations and legislative measures. Any form of code must be so framed as to prevent abuse of industrial lighting and yet impose no hardship on manufacturers. The Home Office in this country had proceeded wisely step by step, adopting the principle of "government by consent." Their first report, besides recommending general statutory provision requiring adequate lighting, proposed certain values of illumination, easily obtained, in the interests of safety and general convenience. Their second interim report proposed a simple rule for avoidance of glare, which could be met in various ways. In future it was intended to study values of illumination and conditions of lighting necessary for efficient work in various industrial processes, co-operation being invited from representatives of the industries concerned. This process might take some time, but would ensure decisions being taken on a sound and scientific basis. In conclusion Mr. Gaster mentioned that industrial illumination was becoming a subject for international treatment. It was being considered by an international committee appointed at the recent technical session of the International Illumination Commission, and it was also receiving attention from the International Labour Office operating under the League of Nations at Geneva.

Carbon Monoxide in Gas.

By PROF. JOHN W. COBB.

THE following paragraph appeared in *The Times* for February 11, under the heading "Carbon Monoxide Peril."

"The Board of Trade has drafted a special Order under the Gas Regulation Act, 1920, relating to carbon monoxide in gas used for domestic purposes. The Order provides that: No gas undertakers as defined by the Gas Regulation Act, 1920, shall supply any gas for domestic purposes containing carbon monoxide unless such gas possesses the distinctive pungent smell of coal gas. The Order requires the approval of both Houses of Parliament."

The announcement needs some explanation, as probably nobody in this country has ever come across a public gas supply without a very distinctive and pungent smell.

When Sir George Beilby and the Fuel Research Board were called upon by the Board of Trade, some time ago, to make recommendations for the future regulation of public gas supply, they recognised in effect that radical improvements and economies by the gas manufacturers could be secured by the gasification of the fixed carbon of the coal by some such process as that of the steaming of vertical gas retorts or the gasification of coke in external generators with steam—the so-called water-gas process.

The increase in the carbon monoxide content of the gas so involved depended upon the extent to which the fixed carbon was gasified. The recommendations then made form the basis of the Gas Regulation Act of 1920, but when the Act was passed it was decided that the Board of Trade should institute inquiries on two special points, one of which was "whether it is necessary or desirable to prescribe any limitations of the proportion of carbon monoxide which may be supplied for the gas used for domestic purposes." The inquiry was made and evidence taken by a Committee from witnesses who regarded this matter from different points of view, and set out their arguments at length. It became plain that the economic advantages offered by the new Act depended very largely on freedom to supply gas containing more carbon monoxide, and that even on the side of hygiene the position was not so simple as might appear at first sight. Any danger from carbon monoxide had to be placed against the improvement of public health which would result from the progressive abolition of smoke as gas replaced raw coal for heating purposes, and it had to be realised that in no circumstances would it be practicable to supply gas containing little or no carbon monoxide, since ordinary "straight" coal-gas might contain 10 per cent or more.

It is not surprising, therefore, that the Committee recommended against statutory limitation of carbon monoxide in public gas supply. It was, however, possible that the conditions of manufacture might at some time or place be changed to such an extent that the gas then supplied to the public would be nearly odourless unless some means were taken to confer a smell upon it, and to meet that possibility of the future it was recommended that the distribution of an odourless gas should be made an offence.

The Board of Trade Order, which has just been drafted, will carry that recommendation into effect. It is no doubt hoped that it will also have on the public mind the beneficial effect of a psychological antitoxin, which seems to be needed at the present time.

During the last two months of severe weather, the number of accidents from gas poisoning undoubtedly increased. Various factors have been operative in bringing this about, including the tendency to restrict ventilation owing to the cold, and to use gas heating appliances of all kinds, in all sorts of places, and particularly in bedrooms. Public attention, however, having been directed to the fact that carbon monoxide in public gas supply might increase considerably in the future owing to the Gas Regulation Act, people have arrived at the mistaken conclusion that such increase had already taken place and was solely responsible for these accidents. It would, as a matter of fact, greatly surprise the present writer to learn that the carbon monoxide content of gas responsible for any one of these accidents was above the permissible limit recommended by the advocates of restriction before the special Committee to which reference has been made above. In the gas supply of Leeds, which has come under the writer's own tests, the percentage of carbon monoxide has been actually considerably lower than it was during the summer months of the coal strike, and no higher than in the preceding winter. Nor is there any reason to suppose that the condition so described is exceptional.

The Brain of Rhodesian Man.

AT a meeting of the Royal Anthropological Institute held on February 14, Dr. W. H. R. Rivers, president, in the chair, Prof. G. Elliot Smith described the brain of Rhodesian man.

The excellent endocranial cast which Mr. Frank Barlow, of the Natural History Museum, has been able to obtain from the Rhodesian skull is of exceptional importance. In the first place, it affords evidence which settles once for all the position of *Homo rhodesiensis* in the human family and its varying degrees of affinity to the different members of the family; and, secondly, it provides very precise information concerning the size, shape, and stage of development of the brain of Rhodesian man, so that when the endocranial casts of Pithecanthropus, Eoanthropus, and *Homo Neanderthalensis* are compared with it and the whole series is considered in the light of the new information, a fuller understanding of the process of evolution of the human brain is attained. Moreover, the endocranial cast enables us definitely to settle the dispute as to the posture of Rhodesian man, or at any rate as to how he carried his head.

Prof. John Hunter, of the University of Sydney, has made a series of exact orthogonal projections of the endocranial casts of the extinct types of the human family and of the anthropoid apes, and has shown that Rhodesian man's head was thrust forward on his tremendously massive neck at an angle almost exactly intermediate between that of the gorilla and modern man—a degree of obliquity almost identical with that of Gibraltar man and probably a little more than that of the man of La Chapelle-aux-Saints. The peculiarly distinctive features of the base of the skull of Rhodesian man corroborate this interpretation. The cranial capacity is 1280 c.c., which is roughly equal to that of the Gibraltar skull, but much smaller than all the other members of the

Neanderthal species. It is definitely bigger than the Piltdown cast.

Like the endocranial casts of Pithecanthropus and Eoanthropus, that of the newly discovered skull reveals a marked deficiency in the prefrontal and inferior temporal areas. But as in all these primitive members of the human family, there is an obtrusive prominence in the auditory territory which suggests that the cultivation of the acoustic symbolism necessary for the acquisition of articulate speech was a very important, if not the dominant, factor in the attainment of the human status. This localised expansion in the superior temporal area is responsible for the peculiar form of all primitive human brains, *i.e.* their relatively great width and flatness. The expansion of the cortex has been carried a stage further than in the Piltdown brain and has led to a fuller development of the inferior parietal territory, but the superior parietal area is still ill-developed and flat.

Thus the Rhodesian cast reveals a stage definitely more primitive than that of Neanderthal man and helps us to understand the features of the latter. The significance of the peculiarities, so far as they shed light upon the evolution of the human brain, was discussed, and the speaker expressed his gratitude to Dr. Smith Woodward of the British Museum for affording him the opportunity for studying the Rhodesian skull and the endocranial cast obtained from it.

The president, in opening the discussion, said that he had been particularly struck by the demonstration of the development of those parts of the brain that are connected with mind, and it was interesting to note that those parts which were latest in development of the child were those in which Rhodesian man stood intermediate between the gorilla and modern man.

Dr. Smith Woodward regretted the absence of geological or palæontological data which might throw light upon the age of the skull. Any attempt to determine its age must depend upon the character of the skull itself. Prof. Elliot Smith had made a beginning of the scientific study of this evidence, and it should be possible to determine its position in the human series apart from geological evidence. Prof. W. Wright said that Prof. Elliot Smith had given a clear demonstration of the development of the brain from the lowest primates to Dean Swift. Would it not be possible to go a little further and prophesy that the future development of the brain would be in the direction of filling those parts of the cranial cavity which were at present ill-filled? He agreed that the author was justified in now placing Pithecanthropus definitely within the human family. Prof. Parsons said that the present communication indicated the value of the endocranial cast in ethnological investigation, and that this method of study should be applied to the investigation of the problems connected with modern races.

Evolutionary Faith and Modern Doubts.

IN a notable address on the above subject at the Toronto meeting of the American Association for the Advancement of Science, which is printed in *Science* for January 20, Dr. William Bateson discusses particularly the changes in point of view which have followed each other since the Darwinian period and the end of last century. The morphological school worked itself out, and was followed by the development of genetic experiments. It was seen that the gradual transformation of species over large areas was an unacceptable doctrine. From field studies of pairs of species it was concluded that both could not have come from an intermediate ancestor through gradual divergence by natural selection, nor could either have given rise to the other by such a process.

Then Mendelism seemed to furnish an explanation of the discontinuity of species—a discontinuity which had long been denied by those evolutionary philosophers who were not systematists. Nevertheless, the result has been disappointing, and the attempt to explain evolution in Mendelian terms has finally been dropped. This is because evolutionary conceptions have dealt with zygotes, or the bodies of plants and animals as we see them, while genetic research has revealed the interactions of an inner world of gametes upon which the zygotes depend for their origin. Dr. Bateson further records his full conversion to the belief that the chromosomes are directly associated with the characters of the zygote. "The transferable characters borne by the gametes have been successfully referred to the visible details of nuclear configuration."

Although we see variations in abundance on all hands, the origin of species is still obscure, and genetic analysis has not enabled us to account for certain phenomena, especially the origin of new dominant characters and of sterility. The question of species-origin is believed to be concerned with the base upon which transferable characters are implanted, but of this base we at present know nothing. Dr. Bateson concludes a remarkable survey with an appeal for closer co-operation between geneticists and systematists, and finally points out that the fact of evolution is not in doubt, although the manner of the origin of species remains a mystery.

R. R. G.

The Teeth of the Nation.[1]

THE lecturer began by directing attention to a series of skulls exhibited, kindly lent for the occasion by Sir Arthur Keith. Skulls of Neolithic date showed perfect dentition, though the teeth were worn a good deal by attrition; the skulls of to-day exemplified the ravages of dental caries, or of the equally prevalent disease of gums and jaws called pyorrhœa. One modern skull with a perfect set of teeth was the rarest specimen he could show. Caries was not unknown in past ages, and even the teeth in the Rhodesian skull exhibit it. The seriousness of the increase in dental decay in recent times is such that the Ministry of Health has appointed a special Committee to investigate its causes and prevention. Cleanliness is a necessary duty, and the tooth-brush, unless supplemented by antiseptic mouth-washes, is an imperfect instrument. The danger is the accumulation of food-débris in chinks and crevices and the formation of acids such as lactic acid by bacteria, especially if the food is soft and sticky and contains easily fermentable sugars of the glucose type. Such acid has a solvent action on the protective layer of enamel, and in time on the dentine which it covers.

The teeth, however, are not mere ornaments to be

[1] Abstract of a discourse delivered at the Royal Institution in February 10 by Prof. W. D. Halliburton, F.R.S.

kept clean locally. They are living structures, and their power of resistance varies with the general health, and this, like the health of the teeth, mainly depends on a supply of natural foods in proper quantity, especially in early life when tooth-formation occurs. Early life means especially embryonic life, and the proper feeding of expectant mothers is a *sine qua non*. Sophisticated and patent foods are specially harmful, for they, as a rule, lack the necessary "vitamins," which were then described in outline. Bad teeth in their turn undermine the general health, and, by forming foci of infection, lead to general ill-health, indigestion, blood-poisoning, rheumatoid affections, and the like, and so a vicious circle is produced, the abolition of which becomes a national duty.

After a general account of what is called "calcium metabolism," a series of lantern-slides was shown to illustrate not only the structure of the various parts of a tooth, but also the stages in their development, in which the cells responsible for the elaboration of the enamel prisms and the layers of dentine with its tubules and the nerves, etc., within them were seen. Occasion was taken to press home again the possibilities of injury and the necessity for care, especially in early stages and in early life, the word "early" including fœtal life. In conclusion, the lecturer looked forward to a time in the not far distant future when the teeth of the nation might be its pride, and not a source of lamentation and pain.

The Brown Bast Disease of the Para Rubber-tree.[1]

By DR. S. E. CHANDLER.

DURING the early years of rubber planting in the East considerable optimism prevailed in certain quarters as to the powers of the Para rubber-tree (*Hevea brasiliensis*) to resist disease in its new home. The planting of such great areas with a single crop plant, however, was practically certain to result sooner or later in fungal disease, to say nothing of insect attack; and, although little was (and still is) known as to the functions of latex in plants, it was safe to predict that the regular withdrawal of considerable quantities of latex from the trees would result in physiological disturbances which might become a factor of commercial importance. Events have proved these views to be well founded. As compared with many crops, rubber has been comparatively free from visitations, but several fungal diseases are now recognised and insect pests are not unknown; while a disease hitherto ascribed to physiological causes, and known as "brown bast," has attained such importance as to constitute the most dangerous cultural menace to the rubber-planting industry at the present day.

Brown bast is a disease of the bark[2] of tapped trees, but it does not involve the death of the tree, or even of the affected bark. The disease may be recognised by a difficulty in obtaining latex on tapping to the usual depth, followed ultimately by the cessation of latex flow (when the tree is said to be "dry"), and is further characterised by a brownish or olive-green discoloration of the middle and inner bark, which may show a definite brown line on the tapping cut near the cambium. External signs of the disease may be lacking, but in the more severe cases the outer bark often scales and splits longitudinally and an exudation of latex occurs. This condition sometimes results from the secondary development of woody "burrs," nodules, or plates within the diseased tissue, and, unless the case is dealt with, these bodies may cause the bark ultimately to become so knotted and irregular as to be useless for tapping purposes. The formation of burrs and nodules, however, is not necessarily associated with brown bast, as has been shown by Bateson, Bryce, and others.

Brown bast was widely reported as an epidemic in the plantations during 1916–18, and a satisfactory method of treatment became a matter of prime importance. Pending exact knowledge as to the cause of the disease, the methods recommended were based on the observations that affected latex-vessels do not again function, that the diseased portion of the bark is useless for further tapping, and that the disease "spreads" in the bark. Planters were therefore advised to remove the diseased tissue, either by "scraping" the brown bast tissue from the bark, or by carefully "stripping" off the bark down to the cambium. In the latter case, especially, measures should be taken to protect the delicate exposed surface so that a satisfactory regeneration of the bark by the cambium may take place. The removal of the superficial layers of the affected bark, followed by the application of warm tar to the exposed surface, has also been practised.

It was early recognised, however, that the best chance of devising adequate measures of control would result from a correct understanding of the nature of the disease, and considerable research on this subject has been carried out by British and Dutch botanists in the East. So far, attempts to associate the disease definitely with bacterial or fungal attack have failed, and at the present time brown bast cannot be ascribed to any causal organism, though it has been claimed by Keuchenius that bacteria are present in the diseased tissue. With the bulk of evidence against a parasitic origin of the disease, most investigators have fallen back on the theory that brown bast is a physiological disease, the result of metabolic disturbances as to the nature of which, however, little or no information is available.

Recently a series of important publications on the etiology of brown bast have appeared almost simultaneously. The results obtained are of exceptional interest, inasmuch as the work has been carried out by investigators widely separated and working independently on material derived from several different planting countries. Rands (1) and (2) has dealt with the disease in Java and Sumatra; Sanderson and Sutcliffe (3) in British Malaya; Gandrup (4) in Java; while Farmer and Horne (5) and (6), in London, have examined diseased material from British North Borneo and Malaya. These in-

[1] (1) "Brown Bast Disease of Plantation Rubber, its Cause and Prevention." By R. D. Rands. Mededeelingen van het Instituut voor Plantenziekten, Departement van Landbouw, Nijverheid en Handel, No. 47 (1921); overgedrukt uit her Archief voor de Rubbercultuur, Jaargang V., No. 5 (Mei 1921).

(2) "Histological Studies on the Brown Bast Disease of Plantation Rubber." By R. D. Rands. Mededeelingen van het Instituut voor Plantenziekten, Departement van Landbouw, Nijverheid en Handel, No. 49 (1921).

(3) "Brown Bast: An Investigation into its Causes and Methods of Treatment." By A. R. Sanderson and H. Sutcliffe. Pp. 71+26 plates. (London: The Rubber Growers' Association, Inc., n.d.) 7*s.* 6*d.* net.

(4) "Over den Steencellenring in de Schors van Hevea." Door Johannes Gandrup. Mededeelingen van het Besoekisch Proefstation, Rubberserie, No. 19 (1921); overgedrukt uit het Archief voor de Rubbercultuur, Jaargang V., No. 9 (September, 1921).

(5) "On Brown Bast and its Immediate Cause." By J. B. Farmer and A. S. Horne. *India-Rubber Journal*, vol. 61, No. 25, June 18, 1921.

(6) "Phloem Necrosis (Brown Bast Disease) in *Hevea brasiliensis*." By Arthur S. Horne. *Annals of Botany*, vol. 35, No. 139, July 1921.

[2] The term "bark" is here used in the planter's sense of the tissue actually involved in the tapping operation.

vestigations throw much light on the anatomy of the diseased tissue and the probable immediate cause of brown bast, while in the case last mentioned it seems probable that a valuable advance has been made towards a correct understanding of the nature of the disease.

The two papers of Rands (1) and (2), who published preliminary reports in 1919 and 1920, are complementary. The first-mentioned paper contains a full statement to date of the results of the author's investigations commenced in 1918 at the instance of the Director of the Government Rubber Estates in the Dutch East Indies, and still in progress. Rands's results support the view of the non-parasitic origin of the disease, and indicate that the repeated withdrawal of the latex from the same tissues is the chief causal factor concerned. The drained tissues respond by secreting a gum, which in its effects prevents a further loss of latex. The time-interval between successive tappings and the system of tapping adopted appear to be the most important predisposing factors; in the author's experience a heavy occurrence of the disease is invariably associated with a drastic system of tapping. The second paper records the botanical (anatomical) evidence on which the results are based. According to Rands, brown bast appears to be a special type of wound-gum secretion favoured by conditions which promote the vital activity of the tree. The characteristic brown discoloration of the diseased bark is stated to be due to the deposition of a yellow plastic "gum" in the cavities of the latex-vessels and in many of the intercellular spaces of the bark (phloem) parenchyma, thus recalling similar observations made by Bobilioff.

The gum is formed, not by the breaking down of cell-walls, but as a secretion of the protoplasts of the parenchymatous cells adjacent to the latex-vessels. It passes into the latter through the common cell-wall (which is thereby stained yellow), and also into the existing intercellular spaces or into such spaces formed and enlarged under the stimulus of the secretion. It is secreted in largest quantities during the wet season, and is most abundant in vigorous trees in full growth. Investigation showed that the gum is practically identical with the "wound-gum" formed locally as a result of artificial wounds made in the wood and bark of the tree, and is similar to the corresponding product in other plants. It differs from the true gums, however, in its chemical reactions. The clogging of the latex-vessels appears to be the chief factor in arresting the latex flow, but the coagulation of the latex within the vessels is also indicated as a contributory factor. Under the highest powers the gum is seen to possess a well-marked alveolar structure which is not an artefact. Rands was unable to determine whether the gum-formation results from enzyme action, as has been suggested in the case of the gummosis of Prunus. As regards the burrs, Rands's results in general confirm the previous work of Rutgers, Bateson, Bryce, and others, and especially the suggestion of Bateson that burr-formation is favoured by excessive tapping. The woody burrs arise from the activity of a secondary cambium formed about a group of gummed latex-vessels; the varied form of the mature structure (pea-shaped, knobby, or plate-like) depends upon the disposition and extent of the secondary cambium.

The book by Sanderson and Sutcliffe (3) is primarily intended as a practical guide for estate managers in diagnosing the disease and in treating affected trees. The authors lay special emphasis upon the desirability of early treatment, and recommend "stripping" of the bark, not only as curative in effect, but also as the simplest and cheapest procedure. A considerable portion of the book, however, is devoted to the results of a microscopical study of the disease, and the authors claim their work to be the first attempt to describe the pathological anatomy of brown bast and to formulate a theory by which the observed facts may be explained. They regard brown bast as physiological in origin, and consider tapping to be its prime cause. As regards pathological anatomy, Sanderson and Sutcliffe find that the constant and characteristic feature is a meristematic activity of the parenchyma cells of the bark. Other characters described by them, viz. the deposition of "tannins" and crystals of calcium oxalate, the occurrence of abnormal numbers of stone-cells at unusual depths in the bark, the depletion of starch, and the presence of globules of "oil or fatty matter" (suggested possibly as a substitution product for starch, or as the result of a breaking down of that substance), are regarded as secondary symptoms arising from the meristematic activity.

Elsewhere, however, the authors state that the occurrence of "tannins" is not characteristic of the disease, while large numbers of oily globules are not constantly present. The meristematic tissue originates at a point roughly corresponding to the depth of tapping, and occurs almost invariably in the immediate vicinity of the latex-vessels. The result is a partial displacement of these vessels, which, in consequence, are often ruptured, the latex percolating into the intercellular spaces, where it coagulates. The latex within the vessels also appears to be coagulated *in situ* (*cf.* Rands), possibly through the agency of the by-products of the metabolism of the actively dividing cells. The coagulated latex is considered to be an additional source of irritation, stimulating the surrounding tissue to further meristematic activity.

The views put forward by these authors as to the immediate origin of the disease are interesting. They consider that the abnormal meristem may be due to the stimulus arising from the wound meristem formed just beneath the surface of the tapping cut, or it may be a secondary effect of the abnormal vigour of the cork cambium which early arises over the previously tapped surface to form the renewal bark. Sanderson and Sutcliffe regard it as "highly probable" that the growth of this cork cambium "provides the stimulus for starting meristematic activity at an equal, or almost equal, depth in the cortex below the tapping cut, *i.e.* in the untapped portion of the cortex below." Such induced cambial activity spreading from the renewal bark was first described by Lock, but it is not quite clear from the present paper whether Sanderson and Sutcliffe have independent evidence of a similar phenomenon in the case of brown bast.

As regards burr-formation, the case is put that, while the meristem of brown bast may remain as such, it may also give rise to woody tissue internally and unlignified elements externally. It is in this latter manner that burrs originate, and the degree and character of the burr-formation depend upon the amount and disposition of the meristem concerned. Sanderson and Sutcliffe ascribe considerable importance to the production of stone-cell tissue as a secondary character of brown bast. In this respect they are supported by other writers. The cells on the outer limits of the meristem may be largely converted into stone-cells, which sometimes form extensive scleritic masses resulting in the scaling of the outer bark. The observations of Gandrup (4) are interesting in this connection, since this worker shows that in the young Hevea plant the stone-cells arise among the thickened prosenchymatous pericycle fibres (bast fibres), which later are almost completely replaced by a ring of stone-cells.

The papers of Farmer and Horne (5) and (6) give the results of a research carried out in the botanical laboratories of the Imperial College of Science and

Technology on material received from British North Borneo and Malaya. The work formed the subject of an exhibit at the Rubber Exhibition of 1921, and was briefly noticed in NATURE of June 16 last, p. 499. It is understood that further work is in progress, and that a full illustrated account of the results will be published. These authors have concentrated attention upon the earliest stages of the disease, and obtained results which definitely advance the problem a step towards solution. In transverse sections of diseased bark, numerous minute golden-yellow spots of irregular outline were observed in the phloem from the cambium outwards. Under high magnification these coloured areas sometimes appeared to resemble intercellular spaces (*cf.* Rands's work), but on careful examination the golden areas were found to be sections of necrotic *sieve-tubes*, the waved outlines in many cases being clearly transverse sections of the large vertical sieve-plates characteristic of Hevea phloem. In the young phloem the disease is confined to the sieve-tubes, but in the older tissue phloem parenchyma, medullary-ray cells and latex-vessels have been involved in the local tissue degeneration. Commonly, a diseased area was found to be more or less completely surrounded by an active meristem (" wound-cambium "), which in some cases gave rise to lignified elements and constituted the initial stages of a burr.

It will be seen that this investigation emphasises the fact that, quite apart from the latex-vessels, elements (sieve-tubes) of vital importance in the nutritional processes of the plant are injured during tapping. The sieve-tubes cease to function and, in becoming disorganised, initiate the condition known as brown bast. The disease, therefore, is primarily due to phloem necrosis analogous to the cases of similar disease reported in the potato and in Liberian coffee. Observations were also made regarding the origin of burr development. It is stated that, as a result of the activities of the wound cambiums, diseased groups of cells become enclosed in " pockets " of stone-cells. Sanderson and Sutcliffe also refer to stone-cells derived from the pathological meristem in the bark tissue.

In reading this series of papers for the first time it is difficult to believe that the authors are dealing with the same problem. No evidence for a parasitic origin of the disease is brought forward in any case, but their respective investigations lead the authors to differ in their views as to the immediate origin of the disease. Sanderson and Sutcliffe point to an induced meristematic activity in the bark as the characteristic feature of the pathological anatomy. To Rands the disease is a special case of gummosis which is the outcome of a wound response resulting from tapping; while Farmer and Horne regard phloem necrosis as, " beyond doubt," the immediate cause of the disease. The present writer carefully examined Horne's remarkable preparations and camera-lucida drawings shown at the Rubber Exhibition last year, and recently he has been allowed to compare further the drawings with the illustrations accompanying the papers of Rands and of Sanderson and Sutcliffe. He considers that the true relations of the seemingly conflicting results are apparent on the view that a difficult piece of anatomy has been carried out to varying degrees of finality by the respective workers. In the case of Horne's work there is little doubt that his investigation has shown that the immediate cause of brown bast is a degeneration of the sieve-tubes and neighbouring elements, accompanied by the more or less complete localisation of the necrotic area by an active meristem. Rands's research appears to have fallen just short of complete success. In spite of his histological methods to prove his " intercellulars " to be such, comparison of his drawings with those of Horne strongly suggests that they are the necrotic sieve-tube areas illustrated by the latter worker. It is remarkable that throughout Rands's anatomical paper he uses the word " sieve-tube " twice only, though in the only diagram in which sieve-tubes appear each of the two sieve-tubes figured is blocked with " gum." Rands's view that the disease is a type of " gummosis " is by no means beside the mark; it may well be so regarded in its ultimate symptoms, but he failed to detect the primary cause. The abundant meristematic activity emphasised by Sanderson and Sutcliffe would appear to be a secondary character, and is possibly a development of the pathological meristem referred to by Farmer and Horne. It may be significant in this connection that the bark examined by Sanderson and Sutcliffe was from trees which " had been taken out of tapping for some little time owing to brown bast," and in which, therefore, there may have been time for the meristem to reach considerable development. The suggestion that the pathological meristem is formed as a result of the stimulus afforded by the activity of the cork-cambium of the tapped bark above the diseased area is interesting, and the authors might usefully have given further evidence in support of the contention.

There would appear to be some difference of opinion as to the condition of the starch reserves in the diseased bark. Sanderson and Sutcliffe report that starch is usually absent, or present in small quantities only, and regard this depletion as accounted for by the demands for food materials made upon the neighbouring tissue by the meristematic cells. Rands, however, states that evidence based on observations of the starch reserves indicates that the response of the tissues, resulting in the " disease," is more the effect of a stimulus connected with a loss of latex than of an actual depletion of (starch) reserve food, though he suggests the possibility of effects caused by the temporary depletion of other food substances, *e.g.* the proteid constituents of the latex which are known to suffer a reduction as the consequence of hard tapping.

If the initial occurrence of phloem necrosis is confirmed, there will remain the problem of the cause of this condition. The solution of the problem is inseparably connected with the general question of phloem necrosis in plants. Thus light may be thrown on brown bast by the recent work of Quanjer, who claims that phloem necrosis in the potato can be transmitted from one plant to another.

As pointed out by Farmer and Horne, the current investigation of brown bast disease points clearly to the urgent need for a wider understanding of the general physiology of Hevea, in which, of course, the laticiferous system would call for special attention. The present writer ventures to suggest that before this question (of which little is as yet known) can be dealt with successfully, it is essential that fuller knowledge of the anatomy and histology of laticiferous tissue in general should be available. Useful pioneer work has been done by Meunier, but the papers under review show how far from complete such knowledge is at present in the case of Hevea alone. There is little doubt that, as in zoology, *comparative* anatomy would be highly suggestive and helpful. The study should extend at least to carefully selected arboreal laticiferous plants, of which the various " rubber-trees " which have been cultivated or exploited commercially would probably be sufficient, since the character of their laticiferous systems varies greatly in important features. The essential

difference between the laticiferous systems of Hevea and Funtumia, and the presence in Castilloa, Funtumia, and Landolphia of a striking development of laticiferous tissue in the xylem (medullary rays), connecting the latex-tubes in the phloem radially with those in the pith, are but instances of a significant state of affairs. A thorough study of this question could not fail to lead to important scientific knowledge which, in competent hands, might well result in practical applications. Again, such striking facts as the occurrence in *Funtumia elastica* of an excellent latex rich in caoutchouc, while in the closely related *F. latifolia* (often found growing with the former species) there is a commercially useless latex containing abundant "resins" in place of caoutchouc, present problems, difficult indeed, that might well receive more attention at the hands of biological chemists. The preliminary anatomical work would be best carried out in the tropics, but with a little organisation much might be accomplished in this country, as is evident from the fact that observations which may prove to be the key to the correct understanding of a baffling disease of Hevea have recently been made in London.

Dairy Cattle and Milk Production.

THE urgency of the problem of milk supply has of late years caused much attention to be devoted to the improvement of dairy cattle, and to the increase of milk supply on an economic basis. During the last twenty-five years the Danish Milk Recording Societies (*Journ. Min. Agric.*, October and November 1921) have been working towards the improvement of herds by the gradual elimination of unproductive cows, and Government grants have been made to aid them in the formation of strains of dairy cattle producing a higher yield of butter. The keeping of private and official handbooks is encouraged, and a special feature is made of two-year competitions between entire herds, the best herds being awarded prizes and officially recognised as breeding centres. The earlier work dealt entirely with the yield of cows, but later it was realised that the character of the bull was of equal importance with regard to milk production, as high milk-yielding capacity is a character that can be inherited through the sire as well as the dam. By close observation of records and careful breeding, attempts have been made to obtain bulls with a good influence on the milk yield, with considerable success. As Denmark is chiefly a butter-producing country, the main object of the milk-recording societies has been to raise the percentage of butter fat, thus aiming at improvement of quality more than at increase of quantity.

The milk problem is by no means confined to European countries, but various aspects of dairying are being investigated elsewhere, as in the Madras Agricultural College, India (Bull. No. 79). Special consideration is given to business aspects as well as to the technical methods of dairying. Approved methods of selection are applied to the dairy herd, unprofitable cows being weeded out, and pedigree registers are maintained. A creamery is also run for the preparation of butter on a commercial scale, milk being purchased from outside to supplement the home supply. The prospects of success are good, and a future seems to be before the dairy industry of India if it is managed with scientific and business knowledge.

One point which has a close bearing on dairy-farming is the varying cost of milk production, which has ranged from 3¼*d.* to 4*s.* 7½*d.* per gallon since 1908 on Yorkshire farms for which records are available (*Scottish Journ. Agric.*, vol. 4, No. 4). Some of the factors concerned are not under the control of the producer, and are due to increase in the labour and food bills, and to the increased depreciation of the cows. In pre-war time the cost of attention per cow per week varied from 1*s.* 6*d.* to 2*s.*, but owing to the rise in agricultural wages it is now 4*s.* 6*d.* to 6*s.*, an increase which is estimated to have added 4*d.* per gallon to the pre-war cost of milk production. The cost of food has risen on every hand. Grazing is far more expensive owing to increased cost of manure and upkeep, home-grown food costs at least twice as much to produce, and, above all, purchased food has risen so much in price that it is probably the one factor more than any other which has been responsible for the high prices of milk during recent years. During the war, too, the difference in value between in-milk and dry cows greatly increased, and this depreciation in value has had its effect upon the cost of milk production. The tables drawn up indicate that in some cases the total costs have exceeded pre-war costs by 300 per cent., but happily there are indications that the inflated prices are easing off, and they show signs of being still lower in the near future.

W. E. B.

University and Educational Intelligence.

CAMBRIDGE.—The Smith's prizes have been awarded to E. A. Milne, Trinity College, for an essay on "Studies in the Theory of Radiative Equilibrium," and to G. C. Steward, Gonville and Caius College, for an essay on "The Aberration-Diffraction Problem." A Rayleigh Prize has been awarded to T. A. Brown, Trinity College, for an essay "On a Class of Factorial Series."

J. A. Carroll, Sidney Sussex College, has been elected to an Isaac Newton Studentship, and the Studentship of W. M. H. Greaves, St. John's College, has been renewed for a year.

Regulations have been proposed for the degrees of M.Litt. and M.Sc. The chief difference from the Ph.D. regulations are that a student must for these degrees do research for two years as against three for the Ph.D. The Board of Research Studies publishes its second annual report. There have now been 143 research students admitted, of whom 5 have already taken the degree of Ph.D. Of these 95 are working in scientific subjects—physics with 22, chemistry with 16, and botany with 12, head the list.

LONDON.—The under-mentioned French professors in the Faculty of Medicine of the University of Paris will lecture (in French) at the Rooms of the Royal Society of Medicine, 1 Wimpole Street, W.1, at 5 P.M., on the dates stated :—

March 20, Prof. H. Roger (Dean of the Faculty), "Les fonctions du Poumon"; March 23, Prof. A. Chauffard, "Syndrome Humoral de la Goutte"; March 27, Prof. P. Duval, "Données actuelles de la Chirurgie Intra-Thoracique."

PROF. H. R. DEAN has been appointed as from June 1 next to the University Chair of Bacteriology tenable at University College Hospital Medical School. Since 1915 Prof. Dean has been Professor of Pathology and Pathological Anatomy in the University of Manchester. He has been Horace Dobell Lecturer for the Royal College of Physicians, and is the author of numerous papers on pathological and bacteriological subjects.

Calendar of Industrial Pioneers.

March 16, 1864. Richard Roberts died.—A man of invention, whose genius did not save him from ultimate poverty, Roberts was the son of a Welsh shoemaker. He worked at various trades in different parts of England, and in 1816 settled in Manchester, where he made improvements in engineers' machine tools, such as planing machines, and in textile machinery. His self-acting mule was patented in 1825.

March 16, 1908. William Petrie died.—Sent at the age of nineteen to study at Frankfort-on-Main, Petrie devoted himself to electricity and magnetism, and in 1847 invented one of the first self-regulating arc lamps, which in the following year was displayed from the portico of the National Gallery. His efforts proving financially unsuccessful Petrie turned his attention to the management and equipment of chemical works.

March 17, 1806. David Dale died.—A notable Scotch industrialist, Dale began life as a Paisley weaver. He gained a fortune, however, as an importer of yarn, and in 1783, by the establishment of spinning mills at New Lanark, founded the cotton industry of Lanarkshire.

March 17, 1887. William Denny died.—The son of Peter Denny, one of the founders of the Dumbarton firm of shipbuilders and marine engineers, William Denny was one of the most scientific naval architects of his day, and at his Leven shipyard constructed the first privately-owned experimental tank, over which he placed an inscription to Froude, "The greatest of experimenters and investigators of hydrodynamics."

March 18, 1899. Sir Douglas Strutt Galton died.—A captain in the Royal Engineers, Galton did valuable work in connection with the application of iron to railways, structures, and the laying of the Atlantic cable, and was well known for his writings on sanitary science. He held various public offices, was made an honorary member of the Institution of Civil Engineers, and in 1895 served as president of the British Association.

March 19, 1888. Thomas Russell Crampton died.—An assistant to Gooch in the Great Western Railway, Crampton in 1848 set up in business for himself, and in that year constructed the locomotive "Liverpool," one of the most powerful engines of the time. It embodied many special features and was adopted as the type of locomotive for some of the French railways. Crampton also laid the first practical submarine cable from Dover to Calais, and with Fox carried out the Berlin water-works.

March 21, 1888. Ludwig August Colding died.—From the Polytechnic School at Copenhagen Colding passed into the public service and became an inspector of roads. While thus engaged, in 1843 he wrote his "Theses concerning Moving Forces," a paper which entitles him to a place among the founders of thermodynamics. He published other scientific memoirs and rose to be chief engineer of Copenhagen.

March 21, 1914. August Wöhler died.—One of the earliest and most distinguished of Prussian railway engineers and a pioneer in the testing of materials, Wöhler began his investigations on railway axles in 1852, and in 1859 established at Berlin an experimental station for the testing of iron and steel under repeated stresses.

March 22, 1831. William Symington died.—The maker of the first practical marine steam engines, Symington by his work for Patrick Miller in 1788 and for the Earl of Dundas in 1801 solved the problem of driving boats by steam, but failing to obtain support for his projects he sank into poverty and died in London a disappointed man. He is buried in St. Botolph's, Aldgate. E. C. S.

Societies and Academies.

LONDON.

Geological Society, February 17.—Mr. R. D. Oldham, president, in the chair.—R. D. **Oldham**: The cause and character of earthquakes (Anniversary Address). The term "earthquake" is here applied only to a disturbance which can be felt, and as such, it is a form of elastic wave-motion of extreme complexity; this may be distinguished as the orchesis of the earthquake. In addition there is, in some cases, a molar, permanent displacement of the solid rock, which forms the mochleusis, which is probably the secondary result of a more deep-seated disturbance, which has been distinguished as the bathyseism. The origin of the elastic wave-motion must be a sudden disturbance not more than ten miles down, and in this outer portion of the earth's crust the only sudden disturbance conceivable is fracture. In certain cases such fracture, accompanied or not by displacement, has been recognised at the surface, and measurements of the displacements show that a state of strain must have existed before actual rupture took place, but give no indication of the rate of growth of the strain. This problem can only be attacked through the variation in the frequency of earthquakes, and only one existing record, the Italian one, is available. From this the rate of growth of strain is, at slowest, such that the breaking-point will, on the average, be reached in a year at most, and, at the quickest, may be of such rapidity as to be analogous to a separate explosion for each earthquake. Changes producing such strains are probably to be referred to the material below the crust. Researches on the change of bulk resulting from a change in the mineral aggregation of the same material indicates one means by which the effect may be brought about. The cause of the great majority of earthquakes is a rapid growth of strain, due to changes in the material underlying the outer crust of solid rock.

February 22.—Prof. A. C. Seward, president, in the chair.—C. W. **Andrews**: Description of a new Plesiosaur from the Weald Clay of Berwick (Sussex). The parts preserved are the posterior region of the skull, numerous cervical and dorsal vertebræ, the shoulder girdle, and the humeri. The bones lay mixed up, in an intensely hard matrix. The skull is very imperfect: it resembles the skull of *Plesiosaurus capensis*, Andrews, from the Uitenhage Series of South Africa. The cervical vertebræ are also very similar to those of the African species, having the central portion of the articular surfaces deeply cupped; they have also inter-vertebral discs, possibly of calcified cartilage, between successive centra. The clavicular arch in the shoulder girdle is large and well developed, being very similar to that of some Lower Liassic forms. The retention of this primitive condition in this and other Wealden Plesiosaurs may be the consequence of their comparatively sheltered life in a fluviatile or estuarine habitat. The name *Leptocleidus superstes* is suggested for the specimen.—T. **Landell-Mills**, A. Smith **Woodward**, and A. **Gilligan**: The Carboniferous rocks of the Deer-Lake district of Newfoundland. The Carboniferous rocks form a synclinal flexure with its longer axis trending north-east and south-west. Underlying these is a limestone series of undetermined age resting on highly-folded gneisses and schists of Archæan age. A thick mantle of Pleistocene deposits covers the whole region, but deeply-trenched valleys give good exposures of the Carboniferous rocks. Fishes and plant-remains occur abundantly at several horizons in the Lower Carboniferous shales, but no fossils have been found in the Upper

Carboniferous. The mineralogical constituents of the deposits are remarkably like those making up rocks of similar age in the north of England, hence it is inferred that the deposits on both sides of the Atlantic were derived from the same land-mass. The fish-remains are fragmentary; they represent three species closely related to those found in the Lower Carboniferous of Scotland. A group of ribs with the caudal fin and scattered scales belongs to a Dipnoan fish; a new species of Uronemus and some specimens of a Palæoniscid fish are also found.

Zoological Society, February 21.—Prof. E. W. MacBride, vice-president, in the chair.—Miss L. E. **Cheesman**: (1) The position and function of the siphon of the amphibious mollusc, *Ampullaria vermiformis*. (2) The habits, in captivity, of the fresh-water crab, *Cardisoma armatum*.—H. **Blegvad**: Animal communities in the southern North Sea.—C. Tate **Regan**: The Cichlid fishes of Lake Victoria.—C. F. **Sonntag**: (1) On the vagus and sympathetic nerves of the Edentata. (2) On the vagus and sympathetic nerves of *Hyrax capensis*.

Physical Society, February 24.—Dr. A. Russell, president, in the chair.—H. **Levy**: The number of radio-active transformations as determined by analysis of the observations. The expression for the nth product of a series of radio-active transformations is represented as the sum of n terms of the type $a_n e^{-\lambda n t}$. When n is known, the coefficients a_n and λ_n can be determined. A criterion for determining n, the number of transformations, by successive evaluation of a system of determinants constructed from the observations is given. The value of n is found from the order of the particular member of the system that vanishes.—C. H. **Lees**: A graphical method of treating Fresnel's formulæ for reflection in transparent media. The directions of the reflected and refracted rays having been determined by known graphical methods, a construction, based on Fresnel's formulæ, is given for finding the amplitudes of the electric vectors of these rays, in and normal to the plane of incidence.

Aristotelian Society, March 6.—Prof. J. S. Mackenzie in the chair.—S. N. **Dasgupta**: The Logic of the Vedanta. The earliest Upanisads, forming the concluding part of the Vedic literature, were completed certainly before 500 B.C. The main doctrine found in them is that self is the ultimate reality. This self is not the Ego but pure consciousness, which was regarded as supremely unchangeable. The early Buddhist philosophy sought to prove that everything was changing and that there was nothing which could be regarded as permanent. The nihilistic school of Buddhism as interpreted by Nagarjuna and Aryadeva (A.D. 100) demonstrated, by critical and dialectical reasoning of the type which Mr. Bradley has used, that our ordinary conceptions of experience were absolutely relative and were therefore indefinite and indefinable. The idealistic Buddhists accepted this position and held that all worldly experience is due to mental construction. The Vedanta, as explained by Sankara, and as interpreted by Sriharsa and Madhusudana Sarasvati and others, held that pure consciousness, as revealed in immediate experience and as distinct from its particular form and content, was self-contained and absolutely real. Particular forms are relative and mutually interdependent. They are definable either as being or as non-being for they participate in the nature of both. They are the modifications of a separate logical category called the indefinite and have the same sort of logical status as illusions. They appear as existent by virtue of their relation with pure consciousness which is absolutely unchangeable and self-contained and immediate. Everything which has any form or content is thus a joint manifestation of the absolutely real, *i.e.* the consciousness, and the category of the indefinite. The nature of all that is relative is that it has being in some sense and it has no being in another, and it cannot therefore be regarded either as positive or negative. This necessitates the acceptance of the indefinite as a separate logical category which explains the logical status of all that is relative.

PARIS.

Academy of Sciences, February 20.—M. Emile Bertin in the chair.—E. **Borel**: Functions of a real variable capable of differentiation without limit.—H. **Douvillé**: The Nummulitic to the south of the Pyrenees.—G. **Gouy**: The tensions and pressures of Maxwell in magnets and dielectrics. Maxwell has given two expressions involving the field (H) and the induction (B), one for magnets and a second for dielectrics. Only the first of these, a tension of $\left(\frac{1}{4\pi}\right)$BH along the lines of force and a pressure p in all directions of $\left(\frac{1}{8\pi}H^2\right)$, appears to give exact results in all cases.—G. **Julia**: Functional equations and conformable representation.—J. **Rémoundos**: The coincidence of lines and the plane elastic curve.—R. **Lagrange**: Some applications of the absolute differential calculus.—B. **Gambier**: Point correspondence between two surfaces with exchange of conjugated into orthogonal systems and *vice versa*.—M. **Frontard**: Cycloids of sliding of soils.—J. **Petitpas**: The work expended in the mechanical working of wood.—P. **Bourgoin**: The velocity of combustion of colloidal powders.—A. de La Baume **Pluvinel**: A *coudée* telescope designed for the application of the method of equal heights.—M. **Baudouin**: The prehistoric material representation of the Pleiades with ten stars in a rock basin in Epesses (Vendée). This prehistoric engraving on a stone basin is unique in that ten instead of the usual seven stars are represented.—G. **Perrier**: The differences of altitude of the stations of the meridian arc of the Equator. Fifty-four of the stations on this arc, now being measured, are at heights between 3500 and 4500 metres, whilst towards the south the triangles fall suddenly to the sea-level. The reduction of the observations is discussed and it is shown that a term commonly neglected in geodesic operations must in these reductions be taken into account.—MM. **Courtines** and **Villey**: Barovariometers with capillary flow. The apparatus consists of a glass bulb, thermally isolated by a vacuum, communicating with the outside air by a capillary tube and furnished with a sensitive manometer indicating variations in the external pressure. The conditions under which the instrument can be made to furnish accurate figures are worked out.—Mlle. P. **Collet**: Thin layers formed by mixtures of glycerides.—H. **Chaumat**: The measurement of power in alternating currents in some abnormal cases.—M. **Galibourg**: The utilisation of the thermo-electric force of contact for the identification of certain steels. Diagrams of the apparatus used are given and some figures obtained for carbon, silicon, nickel, and chrome tungsten steels. Taken in conjunction with the Brinell test, the determination of the thermo-electromotive force at 120° C., under the conditions indicated, suffices to determine the nature of the steel without an analysis.—M. **Curie**: The action of the red and infra-red rays on phosphorescent sulphides. The author puts forward the hypothesis that the action of the extinguishing rays consists in making the medium

conduct by detachment of electrons from the atoms of sulphur.—G. **Mouret**: The prolongation of the fracture of Argentat (Corrèze) in the region of Dorat (Upper Vienne and Vienne).—L. **Dussault**: The Tam Dao and the region of the lower river Claire (Tonkin).—C. **Gorceix**: The formation of the "Gouf de Cap-Breton." A close study of the profile of this cavity shows that it cannot be regarded as an estuary or valley. The best explanation of the observed facts appears to be the assumption of a band of gypsum-salt formation; the gypsum and the salt have been dissolved by water and the associated clay washed out.—J. **Fromaget**: The geology of the environs of A Mi Tchéoü (Eastern Yunnan).—M. **Gignoux**: The presence of the Tortonian at Valence (Spain).—E. **Wertheimer**: The entero-hepatic circulation of the bile acids. A description of an experiment confirming the views of Stadelmann on the passage of glycocholic acid in bile of the dog. The elimination of the bile acids takes place exclusively through the intermediary of the portal vein.—F. **Maignon**: Researches on the physiological and therapeutic properties of the diastases of the tissues. The existence of synthesising diastases. An account of experiments on the injection and ingestion of diastases extracted from various organs (thyroid, suprarenal capsules, ovary, pancreas, etc.). The action of these diastases is specific, in the sense that those extracted from the liver exert hepatic functions only, those from the thyroid affect the thyroid secretion, etc. These diastases have no action when administered to healthy subjects whose organs are working normally.—R. **Jeannel**: The geographical dispersion of *Silphidae Catopinae* during the Tertiary period.—R. **Noël**: The phenomena of condensation of fatty bodies on the surface of mitachondria.—R. **Argaud**: Some functions of the tumoral megacaryocyte and especially its vasoformative function.—A. **Goris** and A. **Liot**: New observations on the culture of the pyocyanic bacillus on definite artificial media. The amides could not be used for the culture of this bacillus; amino acids could be used, but growth did not take place so readily as with ammoniacal salts of dibasic acids.—L. **Cavel**: The method of purification by means of activated sludge and its application to the separative system.—J. **Glover**: Electrical auscultation of respiration at the commencement of tuberculosis. A new method of auscultation based on the use of amplifying microtelephonic stethoscopes.—E. **Sergent** and A. **Donatien**: The stomox as a propagator of trypanosomiasis in dromedaries.

Official Publications Received.

Bulletin of the National Research Council, vol. 3, Part I., No. 16, December: Research Laboratories in Industrial Establishments of the United States. By Alfred D. Flinn. Revised and enlarged by Ruth Cobb. Pp. 135. (Washington: National Academy of Sciences.) 2 dollars.

Smithsonian Institution: United States National Museum. Bulletin 113: Life Histories of North American Gulls and Terns: Order Longipennes. By Arthur C. Bent. Pp. x+345+93 plates. Bulletin 114: A Revision of the King Snakes: Genus Lampropeltis. By Frank N. Blanchard. Pp. vi+260. (Washington: Government Printing Office.)

The Carnegie United Kingdom Trust. Eighth Annual Report (for the Year ending 31st December 1921) submitted by the Executive Committee to the Trustees on Friday, 3rd March 1922. Pp. ii+66. (Edinburgh.)

Department of Commerce. Technologic Papers of the Bureau of Standards. No. 204: Cutting Fluids. By Eugene C. Bingham. Pp. 35-76. (Washington: Bureau of Standards.) 15 cents.

Department of Commerce. Scientific Papers of the Bureau of Standards. No. 422: Studies in Color Sensitive Photographic Plates and Methods of Sensitizing by Bathing. By Francis M. Walters, Jr., and Raymond Davis. Pp. 353-375. 15 cents. No. 424: Mathematical Theory of Induced Voltage in the High-Tension Magnets. By Francis B. Silsbee. Pp. 407-470. 15 cents. No. 425: Characteristic Soft X-rays from Arcs in Gases and Vapours. By F. L. Mohler and Paul D. Foote. Pp. 471-496. 10 cents. No. 426: Thermal Expansion of Nickel, Monel Metal, Stellite, Stainless Steel, and Aluminium. By Wilmer H. Souder and Peter Hidmert. Pp. 497-519. 10 cents. No. 427: Some Effects of the Distributed Capacity between Inductance Coils and the Ground. By Gregory Breit. Pp. 521-527. 5 cents. (Washington: Bureau of Standards.)

Ministry of Public Works, Egypt. Report on the Work of the Physical Department for the Year ending March 31, 1921. By Dr. H. E. Hurst. Pp. ii+22. (Cairo: Government Publications Office.) P.T. 5.

Ministry of Finance, Egypt. Survey of Egypt: Geological Survey. Palæontological Series, No. 5: Catalogue des Invertébrés fossiles de l'Égypte représentés dans les Collections du Musée de Géolpgie au Caire. Par R. Fourtau. Terrains Crétacés—3me Partie: Échinodermes (Supplément). Pp. viii+101+v+11 plates. (Cairo: Government Publications Office.) P.T. 50.

Synoptic Series of Objects in the United States National Museum Illustrating the History of Inventions. By Walter Hough. (No. 2404, From the Proceedings of the U.S. National Museum, Vol. 60, Art. 9.) Pp. 47+56 plates. (Washington: Government Printing Office.)

Fifty-ninth Annual Report of the Secretary of the State Board of Agriculture of the State of Michigan and Thirty-third Annual Report of the Experiment Station from July 1, 1919, to June 30, 1920. Pp. 700. (Lansing, Mich.)

Department of the Interior: United States Geological Survey. Bulletin 679: The Microscopic Determination of the Nonopaque Minerals. By Esper S. Larsen. Pp. 294. (Washington: Government Printing Office.)

Report of the Secretary of the Smithsonian Institution for the Year ending June 30, 1921. (Publication 2659.) Pp. 119. (Washington: Government Printing Office.)

University of Wisconsin Studies in Science. No. 1: The Fishes of Lake Valencia, Venezuela. By Prof. A. S. Pearse. Pp. 51. 50 cents. No. 2: Papers on Bacteriology and Allied Subjects. By Former Students of Harry L. Russell. Pp. 199. 1 dollar. No. 3: The Distribution and Food of the Fishes of Three Wisconsin Lakes in Summer. By Prof. A. S. Pearse. Pp. 61. 50 cents. (Madison: University of Wisconsin.)

Proceedings of the First Pan-Pacific Scientific Conference under the Auspices of the Pan-Pacific Union, Honolulu, Hawaii, August 2 to 20, 1920. Part 1. Pp. ix+308. Part 2. Pp. iii+309-636. Part 3. Pp. iii+637-950. (Bernice P. Bishop Museum Special Publication, No. 7, parts 1, 2, and 3.) (Honolulu: Honolulu Star-Bulletin, Ltd.)

Ministère de l'Agriculture. Direction générale des Eaux et Forêts. (2me Partie.) Service des Grandes Forces Hydrauliques (Région du Sud-Ouest). Résultats obtenus pour le bassin de l'Adour, pendant les années 1917 et 1918. Tome VII, Fascicule B. Pp. 48+charts 2-65. Résultats obtenus pour le bassin de l'Adour. Tome Ibis, Fascicule A. Pp. iv+charts 2-67. (Paris: Ministère de l'Agriculture.)

Diary of Societies.

FRIDAY, MARCH 17.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.

INSTITUTE OF TRANSPORT (at Royal Society of Arts), at 5.—F. Pick: The Operation of an Omnibus Company, with reference to Capacity and Cost under Given Conditions.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—P. C. Dewhurst: British and American Locomotive Design and Practice.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 7.—C. C. H. Wade: The Electron Theory.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—G. H. Ayres: Power Factor Improvement.

ROYAL SOCIETY OF MEDICINE (Electro-therapeutics Section), at 8.30.—Dr. M. Legge and others: Discussion on the Pathological Changes produced in Subjects rendered Unconscious by Electric Shock, and the Treatment.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. A. P. Laurie: The Pigments and Mediums of the Old Masters.

SATURDAY, MARCH 18.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Radioactivity (3).

PHYSIOLOGICAL SOCIETY (at University College).

MONDAY, MARCH 20.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section), at 7.—Capt. H. Whittaker: Hydro-electric Course at the University of Grenoble.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—H. D. Searles-Wood: The Building Timbers of the Empire.

ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street, W.C.1), at 8.—Prof. R. F. A. Hoernlé: Some Byways of the Theory of Knowledge.

ROYAL SOCIETY OF ARTS, at 8.—L. G. Radcliffe: The Constituents of Essential Oils (Cantor Lectures) (1).

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—H. Temperley: The Geography of the Treaty of Rapallo.

TUESDAY, MARCH 21.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Arthur Keith: Anthropological Problems of the British Empire. Series I. Racial Problems in Asia and Australasia (5).

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. A. Feiling: The Interpretation of Symptoms in Disease of the Central Nervous System (Goulstonian Lectures) (1).

ROYAL STATISTICAL SOCIETY, at 5.15.—J. Y. Hart: Sickness Data of Public Elementary School Teachers in London 1904–1919.
MINERALOGICAL SOCIETY (at Geological Society), at 5.30.—Sir William Bragg: Recent X-ray work on the Crystal Structure of Organic Substances.
ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—G. Blaine: Notes on the Zebras and some Antelopes of Angola.—R. I. Pocock: The External Characters of some Histricomorph Rodents.—H. R. Hogg: Some Spiders from South Annam.
INSTITUTION OF CIVIL ENGINEERS, at 6.—W. Willox: All-Electric Automatic Power Signalling on the Metropolitan Railway.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—S. Bridgen: Landscape from the Practical Side.
RÖNTGEN SOCIETY (at Institution of Electrical Engineers), at 8.15.—Sir Oliver Lodge: Magnetism—and the Ether (Fifth Silvanus Thompson Memorial Lecture).

WEDNESDAY, MARCH 22.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Sir Charles J. Holmes Lionardo da Vinci as a Geologist.
ROYAL SOCIETY OF ARTS, at 8.—Prof. A. P. Laurie: The late Mr. Holman Hunt's Experiments on the Permanency of Artists' Oil Colours.

THURSDAY, MARCH 23.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. P. Chalmers Mitchell: The Cinema as a Zoological Method (2).
ROYAL SOCIETY, at 4.30.—*Probable Papers.*—Sir Richard Glazebrook: The Specific Heats of Air, Steam, and Carbon Dioxide.—Lord Rayleigh: A Photographic Spectrum of the Aurora of May 13-15, 1921, and Laboratory Studies in connection with it.—F. A. Freeth: The System: $Na_2-CO_2-NaCl-H_2O$.—M. A. Catalán: Series and other Regularities in the Spectrum of Manganese.—D. W. Dye: Calculation of a Primary Standard of Mutual Inductance of the Campbell Type and Comparison of it with the similar N.P.L. Standard.—P. E. Shaw and N. Davy: The Effect of Temperature on Gravitative Attraction.
ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. A. Feiling: The Interpretation of Symptoms in Disease of the Central Nervous System (2).
CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—F. Whelen: The League at Work (League of Nations Union).
CONCRETE INSTITUTE, at 7.30.—S. F. Staples: Floating Docks.

FRIDAY, MARCH 24.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Prof. H. E. Armstrong: The Indigo Situation in India.
PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.
INSTITUTION OF PRODUCTION ENGINEERS (at Institution of Mechanical Engineers), at 7.30.—E. Fairbrother: Inspection Methods.
JUNIOR INSTITUTION OF ENGINEERS, at 8.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. F. G. Donnan: Auxiliary International Languages.

SATURDAY, MARCH 25.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Radioactivity (4).

PUBLIC LECTURES.

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

FRIDAY, MARCH 17.

METEOROLOGICAL OFFICE (South Kensington), at 3.—Sir Napier Shaw: The Structure of the Atmosphere and the Meteorology of the Globe (9).
KING'S COLLEGE, at 5.—Prof. R. Robinson: Orientation and Conjugation in Organic Chemistry from the Standpoint of the Theories of Partial Valency and of Latent Polarity of Atoms (3).
TAVISTOCK CLINIC FOR FUNCTIONAL NERVE CASES (at Mary Ward Settlement, Tavistock Place, W.C.1), at 5.30.—Dr. H. C. Miller: The New Psychology and its Bearing on Education (8).
BIRKBECK COLLEGE, at 8.—F. Hodges: Trade Unionism. (Meeting arranged by the London Branch of the National Union of Scientific Workers.)

SATURDAY, MARCH 18.

THE POLYTECHNIC (Regent Street, W.1), at 10.30 A.M.—P. A. Best: The Romance of Commerce.
HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. N. Milligan: The Natural History of Elephants.

MONDAY, MARCH 20.

ROYAL SOCIETY OF MEDICINE, at 5.—Prof. H. Roger: Les fonctions du Poumon.

TUESDAY, MARCH 21.

KING'S COLLEGE, at 5.30.—F. H. Rolt: Accurate Measurements in Mechanical Engineering: The Use and Testing of Gauges (5).
UNIVERSITY COLLEGE, at 5.30.—Col. W. M. St. G. Kirke: Imperial Defence as affected by the War (2).

WEDNESDAY, MARCH 22.

SCHOOL OF ORIENTAL STUDIES, at 12.—Miss Alice Werner: Bantu Mythology and Folklore (5).
EAST LONDON COLLEGE, at 4.—Prof. F. E. Fritsch: Certain Aspects of Freshwater Algal Biology (6).
SCHOOL OF ORIENTAL STUDIES, at 5.—M. de Z. Wickremasinghe: Tea and Rubber Industries in Ceylon.
KING'S COLLEGE, at 5.15.—Prof. N. Bohr: The Quantum Theory of Radiation and the Constitution of the Atom (3).
HORNIMAN MUSEUM (Forest Hill), at 6.—W. W. Skeat: The Living Past in Britain (9).
UNIVERSITY COLLEGE, at 8.—The Current Work of the Biometric and Eugenics Laboratories (6). Dr. M. Greenwood: Occupational Mortality.

THURSDAY, MARCH 23.

ROYAL SOCIETY OF MEDICINE, at 5.—Prof. A. Chauffard: Syndrome Humoral de la Goutte.
SCHOOL OF ORIENTAL STUDIES, at 5.—Dr. L. D. Barnett: The Hindu Culture of India (4).
KING'S COLLEGE, at 5.30.—Dr. O. Faber: Reinforced Concrete (10).
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—H. E. Stilgoe: Water (1): Its Storage and Filtration (Chadwick Lecture).

FRIDAY, MARCH 24.

METEOROLOGICAL OFFICE, (South Kensington), at 3.—Sir Napier Shaw: The Structure of the Atmosphere and the Meteorology of the Globe (10).
KING'S COLLEGE, at 5.30.—Dr. G. Cook: Some Recent Advances in our Knowledge of the Strength of Materials.

SATURDAY, MARCH 25.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. E. Marion Delf: Science and the Food we eat.

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