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The Range of the Scientific Faculty.

"How can we harness opinion to knowledge and steady the emotions of the multitude with experience and science? This, it seems to me, is the master problem of our time."
J. A. SPENDER.

IN a recent address[1] on "Contacts of Science and Literature," which he delivered as president of the Science Masters' Association, Sir Richard Gregory has once more directed attention to the urgent need of a closer approach of letters and science. Sir Richard, as all know, is both broad and fair in his outlook; no one is less likely to present a prejudiced view of the situation; also he is ever an optimist. Any statement that he may make upon such a subject is not to be put lightly aside. In suggesting, as he does, that indifference to science among teachers of English is more general than neglect of literature by students of science, he is upon sure ground—almost that of platitude. What are we to say of his subsequent contention?

"We are not likely ourselves to forget that science and the humanities are the warp and woof of the fabric of modern life any more than we overlook the human factor in industry; but while these relationships are frequently presented to scientific assemblies, we miss the same friendly gestures to science from our literary colleagues. Men of letters tell us that men of science are the only people who have something to say and are unable to say it and we accept the rebuke, even though we know the difficulty of making the intricate processes of Nature intelligible in the vocabulary of ordinary life. Our retort, however, may very well be that men of letters should be expected in these days to know a little of Nature and science and to be able, therefore, to exercise their literary art in displaying the wonder and value of the rare treasures which the argosies of scientific explorers are continually bringing into our havens from uncharted seas. Science does not want a divorce from literature but closer union with it and a common understanding of the distinctive qualities by which each can contribute to the fullness of life. It would be easier to mention leaders of science who have enriched literature by their writings than to select men of letters who have exercised their imagination and art upon scientific knowledge and achievement; and we ask those who have the gift of radiant expression to remain no longer outside our temples but to enter and be moved to testify to the revelation which will then be given them."

Is the invitation thus given one that is likely to be accepted? Can men of letters ever enter into the Temple of Scientific Endeavour and do what is here asked of them? Have we not too long followed Adam and Eve?

"Thus they in mutual accusation spent
The fruitless hours but neither self-condemning
And of their vain content appeared no end."

[1] Published in the *School Science Review* for February.

Nothing can be gained by the one party always gibing at the other. Should we not rather consider the office of each, what is really within the power and province of each ?

Man is to be distinguished from the rest of animate creation by three, if not four, faculties—that of speech, the use of hands, commercial ability and the use of fire. The art of scientific inquiry is but a modern discovery—a modern superstition, may we not say, something foreign to man's ordinary nature—superadded to it and necessarily the prerogative of the few ? Carlyle has claimed that he is the tool-using animal, strangely forgetting that man, especially woman, is a literary creature almost from birth. The highest literary artist is but a biped in whom the chief art of his being is developed to the utmost—writing, after all, is nothing but the cultivated art of speech recording. It is no particular credit to us to write and speak well; rather are we to be blamed for the very partial and imperfect manner in which we are accustomed to develop and exercise our chief natural, inborn faculty.

Have we, then, not the right to rate the literary as an intellectually inferior class ? Have they not mere ordinary brains, however highly developed ? Hazlitt has painted them to the life, particularly in his essay " On the Ignorance of the Learned," in saying :

" All that men really understand is confined to a very small compass : to their daily affairs and experience ; to what they have an opportunity to know and motives to study or practise. The rest is affectation and imposture."

Can we expect the literary as a class, ever to be scientific ? It is absurd to suppose that, if the power were latent in them, men of the seeming intelligence of say Oxford dons should be proof against all persuasion to take an interest in the work of scientific discovery and be unable to do more than use more or less ordinary words in dealing with the ordinary events of common life and continually to depict only the obvious—glory in being masters of inextensible subjects. In truth, there is a factor of intelligence missing from their minds—let us call it factor X.

Sir Richard rightly had much to say in praise of poetry—he quoted examples to show that the poet is able to seize upon and portray the findings of scientific observers, Tennyson's felicitous lines, in particular. Yet the poet of old, we have to remember, was but the singer, the speaker of music : he is only to-day the writer and put into print ; he is but the highest form of speechmaker, no modern development or new discovery. Poetry, in fact, is more or less akin to our nature. Music also is a barbaric trait—it is in us all to some extent, especially in Germans ; there are few who do not hate noise, if they do not react to harmonious sounds.

Again, no special claim can be made on behalf of commercial ability—it is necessarily more or less born in us all. From his earliest days, man has been obliged to barter, buy and sell, in order to live : at least, up to the time of the discovery of the dole, the acceptance of which may but connote a superior form of commercial ability.

As to the use of fire, this is so ancient a custom that it is now an instinctive practice. Clearly it is not a sign of intelligence but rather the reverse—in its modern development, the sign of a desire for occupation and of its irrational satisfaction. The woman who knits, not only satisfies the desire of her being to be busy but also does something useful. The smoker but deadens the same desire in destruction and dirt ; it is true he occupies himself : the brute is tamed, usually *after* being fed—but wastefully and selfishly.

As to our use of hands, we could (we were allowed to) use these in the distant past to greater advantage than we do to-day : Egyptian tombs tell us this story. Only on Dec. 31 last, a picture was given in NATURE of a machine able to make a million bottles a week, which is to be worked by a single man ! Formerly, hundreds were needed to make any such number. None the less, *bottled* beer is dearer than it ever was. Who gains the advantage the hundreds formerly had from blowing bottles—what is behind the machine ? Is it not the execrable modern discovery we call scientific activity ? The effective activity of knowledge used systematically and by the very few, of set purpose, to a foreseen end ?

The systematic use of scientific method, the method of using knowledge not merely to do this or that but also to extend and verify knowledge—through reasoned observation and experiment : the existence of men gifted with the factor X, this is the paramount discovery of modern times, scarce centuries old. Let this not be confused with mere science—which is but exact knowledge. The faculty of using knowledge is a rare one, almost a modern discovery. The scientific, therefore, may claim to be a superior people, a people who can advisedly, of set purpose, find things out and do things, whilst the literary can at most talk about them. Natural science, the work of this new class, may claim to stand alone as the music of the future : either its priesthood will be the leaders of the people—the givers and guardians of their necessary

morality—or the people will perish, if not from want of knowledge, from lack of the power to use it.

The literary write themselves up everywhere—each goose as it comes to market is made into a swan in the reviews of to-day and the virtues in the classics are ever impressed upon us. Yet who shall say that the sciencers are behind: certainly not the physikers; the others at least write one another down. The scientific after all are much as other men, human in their foibles and vanities; yet they are gifted with a power—the mysterious factor X—which definitely divides them from the mass: however much they may be appreciated by society, they will never be really understood. In fact, they are very fine fellows and it is unfortunate that Mr. Bernard Shaw has not been induced to sketch their psychology for us—but they are a class of supermen which must ever be beyond such writers as he.

If our argument be sound, the literary will never do what Sir Richard Gregory suggests they should do. Factor X will never stir within them; they are mentally unresponsive. The work will only be within the power of those sciencers who are also competent as writers. As speaking is a common human attribute, there is no reason why such should not be forthcoming, provided the schools do their duty. These have yet to show that they can teach the use of words, let alone science. French men of science are able to write well, because training in rhetoric *is* given in their schools: in ours it is not.

To-day, the schools do not do their duty. They simply do not know what their duty is. They are controlled by people who only know the old knowledge and are without understanding of scientific method. Thring, the schoolmaster, told his colleagues long ago—to break down the knowledge idol. Sanderson, at Oundle, made an abortive attempt. Our universities are all engaged in its fervent worship. Education, like sport, is fallen a victim to professionalism: the system pursued is akin to that of the electric hare in coursing—its practical equivalent.

Being a nation of shopkeepers, willy nilly we are engaged in commercialising education in all its forms, including research. School is carried on mainly in the interests of the machine, not in the interest of scholars. Education is in the control of two of my inferior classes—the literary and the commercial. The writing upon the wall is very clear—needing no Daniel to interpret it. Who will read it out in the market places, so that it may be understood by all and my text be fulfilled? The first duty of scientific workers to-day is to the public. Having put such vast powers of exploitation in selfish hands, we at least must endeavour to inform the masses how best to use the opportunities before them—never to think of chalk as fuel.

To make university education of avail we must appoint teachers competent to teach, first the things of yesterday. Let the research workers be a class apart. The schools are not producing the men for whom the world is asking. We are moving to-day in a closed vicious circle—the schools say they are in the hands of the universities, whilst these retaliate that they are subject to the schools. Examinations pay everybody except the learner—the poor guinea-pig.

The teaching of science in our schools is a failure, because it is parrot work, not scientific; because it is confined to special subjects—chiefly chemistry and physics—geology, botany and biology being all but neglected; because it is so far beyond the common intelligence and the teacher's. No attempt is made in the schools to teach the simplest elements of scientific method, as applied to ordinary life and to ourselves. We must mend or end the system. The Science Masters' Association has neglected great opportunities in the past half-dozen years of discussing the problems, when at Oxford and Cambridge, with the authorities.

The public cannot allow the subject to be trifled with much longer; the two parties must meet and debate the situation, so that each may put its house in order without any further delay. H. E. A.

University College Centenary.

University of London: University College. Centenary Addresses. Bound together in one volume. With a Preface by Dr. R. W. Chambers. Pp. viii + 33 + 36 + 42 + 28 + 31 + 35 + 19 + 30 + 25 + 28 + 28 + 20. (London: University of London Press, Ltd., 1927.) 12*s.* 6*d.* net.

THE re-issue of these addresses in the form of a bound volume will be welcomed by an even wider public than the members and friends of University College, London. Anniversaries have been celebrated from the dawn of civilisation and correspond to something real and significant in human life. The 'majority'—the twenty-first anniversary—when a man comes to his estate and arrives at 'years of discretion,' was based presumably on some *pseudo*-physiological facts decocted by lawyers. It corresponds to nothing in the life of an institution, for an institution is born adult, at any rate in such matters as the privilege

of paying income-tax. Jubilee, the year following the Jewish seven Sabbaths of years, when liberty was proclaimed and every man returned to his family, had originally a religious and racial meaning. A centenary, representing an arbitrary period of time based on our decimal notation, offers some advantages from the viewpoint of institutional celebration. In the course of Nature, the founders of a college are not privileged to be present at its centenary; and for that reason their memory and achievements may more appropriately be revived and revered. Further, a college which has survived for a century has passed the audits of time and can look forward with equanimity to its future.

There may be risks attending the foundation of new universities, said Mr. H. A. L. Fisher in his Foundation Oration reprinted in this volume, expressing the accustomed Oxford view on this question—risks which we venture to suggest are usually over-estimated—but those risks, he added, do not apply to an institution which has weathered one hundred years. In an eloquent tribute to the ideals for which University College was founded, he said:

"Your college has given ample pledges. It has been served by a long line of distinguished teachers who have left their mark upon the intellectual life of the country. It has always stood for free and fearless inquiry. It has never receded from the large and undifferentiating hospitality which now, for one hundred years, it has extended to all who desire to learn."

Who was the founder of University College and of the University of London—for it is fair to acknowledge that the founder of University College was in one important sense the founder of the University? Thomas Campbell's letter to the *Times*, published in February 1825, urging the establishment of a great University of London, is well known. The letter was addressed to his dear friend Brougham, a somewhat sinister figure in the political life of his times, a man who was not a hero even to his biographer. Aspinall, in his book "Lord Brougham and the Whig Party," animadverts on his "faithlessness and egoism"—characteristics not to be looked for in a pious founder—but he pays tribute to the "influence, energy, and capacity" which "did most" to carry Campbell's scheme to execution. To Brougham, therefore, honour is rightly accorded in this centenary volume. But the authorities of the College have shown a wise discrimination in selecting Jeremy Bentham for special praise and thanksgiving as a founder of the College.

"I do not suppose," said the Bishop of Manchester, in the sermon preached at the special service in Westminster Abbey, "that it would be extravagant to say that no man in English history has accomplished so much definite good that can be plainly traced to his work and influence as Jeremy Bentham": and this high praise is endorsed by Prof. J. E. G. de Montmorency in his notable address on "A Century of Jurisprudence," who accords to Bentham the proud title of spiritual founder of University College "a utilitarian if you like, but a utilitarian who, being dead, has slowly brought the Platonic heaven to earth."

From the founders of University College we may pass to its teachers and students. Once a year the members of the College come together "to pay a tribute to the memory of our founders and to some of the distinguished men and women who have done so much to make the name of this College famous." Two of these commemorations are recorded in this volume, the first, on March 25, 1926, when the Provost (Sir Gregory Foster) delivered the Foundation Oration, and the second, a year later, when the delegates from 208 universities and colleges assembled to honour the centenary of the College, the orator on this occasion being Mr. H. A. L. Fisher, to whose address reference has already been made. Two lists of names selected for special honour are therefore published in the book. We do not claim to discern the principles on which the names are selected, for if the lists include some distinguished names, others not less distinguished are excluded—de Morgan, Lister, and Walter Bagehot, for example. Lister, one of the greatest benefactors of the human race, was a true son of the College, graduating both in arts and medicine, and receiving later in his life the rare distinction of an honorary degree from the University. Walter Bagehot, described by Morley as a "striking genius," had a deep and pervasive influence on political and economic thought, an influence not dissipated by the catastrophic events of recent years. He was elected a fellow of the College in 1849, and was induced to offer himself as a candidate for the original representation of the University of London in Parliament. Surely also, among former professors, Augustus de Morgan, the brilliant mathematician, should be considered worthy of inclusion among the teachers who built up the fame of the College; and might not the name of a representative of those students who fell in the War—William Howard Lister, for example—have been included in one of the lists, or even in both lists, to which are appended the memorable words:

"All these were honoured in their generations,

and were a glory in their days. Their glory shall not be blotted out."

The only name accorded the honour of inclusion in both lists is that of a benefactor, Sir William Bartlett, Bart.

Sir Gregory Foster selected an avowedly historical subject for his Foundation Oration—"These Hundred Years." This was, as to date of delivery, the first of the addresses included in this volume, and might well have been placed at the beginning of the book as furnishing an introduction to the other addresses. The address is full of interest to the student of educational history. If there is one subject for criticism, it is that the question of the relation of the College to the University of London might have been examined in more detail and with greater care. Reference is made to the 'evil' results to the London Colleges of "the severance in 1858 of the University from the affiliated Colleges." The word 'severance' is inappropriate to describe what took place at this time. Affiliation of colleges had become in course of time practically meaningless, and the affiliation of further colleges was therefore discontinued, the examinations (except in medicine) being thrown open to all comers. The relation of University College to the University remained, however, much as before. According to official evidence presented to one of the numerous Royal Commissions which have investigated the university question in London, both the University and University College received their original charters on the same day in 1836, and the College was always tacitly regarded as the teaching department of the University.

The union, it is true, was not organic; and the word 'severance' cannot therefore be used either as implying the pre-1858 relation or as defining the post-1858 relation of College to University. "Reform came in 1900," we are told, "but that reform was a tentative step." A tentative step, forsooth! The drab old gentleman of Burlington Gardens, busy exclusively with his written and practical examinations, was metamorphosed by this reform into an Apollo to whom the College at once proposed matrimony—'incorporation' is the technical word—a complete fusion of interests! "As you know," the Provost continued, "only the day before yesterday, a new plan of 'evolutionary' development was issued by the Departmental Committee appointed by Mr. Trevelyan." Is this a worthy reference to the culmination of twenty-six years of anxious thought and discussion, in which the Provost's views have always been listened to with strained and respectful attention? Great praise is accorded by the Provost to the "Education Acts of 1901 and 1902"—the reference must be to the Acts of 1902 and 1903—and to their inspirer, Sir Robert Morant. "Owing to those great Acts, the growth in this College and in other university institutions throughout the country has been remarkable." Has the College, the wayfaring man will ask, gained nothing from the closer association with the University and the other London Colleges secured by the "tentative" reform of 1900? By a slight extension of the title of his address, the Provost might well have attempted to limn the vision of the new University of London, with its libraries, research institutes, and special schools, growing in beauty and harmony alongside its greatest college—

> "Yet ever and anon a trumpet sounds
> From the hid battlements of Eternity;
> Those shaken mists a space unsettle, then
> Round the half-glimpsed turrets slowly wash again."

Interesting as the history of the College undoubtedly is *per se* and in relation to the development of our educational system, the addresses here reprinted on the progress of science during the century will appeal more directly to scientific readers—physiology by the late Prof. E. H. Starling, physics by Sir Oliver Lodge, a brilliant and characteristic *causerie*, medicine by Sir John Rose Bradford, electrical engineering by Prof. J. A. Fleming, and chemistry by Prof. J. Norman Collie. "At the date of the foundation of this College," said Prof. Starling, "science as an academic study was practically non-existent in this country." The College suffered abuse in its early days not only for its 'godless' character, but also on account of its enthusiasm for scientific teaching and research. 'Stinkomalee' was one of the epithets specially coined for the purpose of this abuse; and the noble motto *Patens omnibus Scientia* was converted into a nickname—Brougham's Patent Omnibus. An abridged list of names will suffice to establish the claims of the College in this respect. In physiology, the College can point to Sharpey and to his brilliant pupils Burdon-Sanderson, Michael Foster, and Schafer, of whom the first two bore the torch to Oxford and Cambridge; to Bayliss, Horsley, and Starling. In physics and chemistry, the list is not less distinguished, including the names of Graham, Williamson, and Ramsay. And may we not add that many of those who are still living and working in the College are worthily maintaining the high tradition of scientific research set by these honoured names?

"It is one of the glories of University College," said Mr. Fisher, "that it has contributed not to education only, but to the advancement of learning, and that its alumni and professors are taking their full share in that great movement of human curiosity, which is transforming our conceptions of the physical constitution of the universe, as well as in the many laboratory experiments which in the last one hundred years have lessened the physical sufferings of mankind." T. LL. H.

The Oldest of the Arts and the Youngest of the Sciences.

Animal Ecology: with especial reference to Insects. By Royal N. Chapman. Second edition. Pp. ix+187+183. (Minneapolis, Minn.: Burgess-Roseberry Co., 1927.) n.p.

PRESIDENT LOWELL was assuredly wrong when he gave to *business* the title of "the oldest of the arts and the youngest of the sciences." The art by which, for example, the naked Australian black extracts the means to live from country where a white man would starve—this art of food-getting—is surely older still. It depends on an extraordinarily detailed empirical knowledge of the habits, inter-relations, and distribution of animals and plants; in other words, on the subject matter of that newest of the sciences which clamours for the attention of every thinker under names as varied as the philosophic outlook of its numerous exponents.

Prof. W. M. Wheeler, so long ago as 1902 (*Science*, N.S., vol. 15, pp. 971-976), exposed the abundant synonymy to which its wide appeal has led. The first attempts to codify this knowedge took the form of such natural histories as that of Pliny. From this general, diffuse, and impractical subject split off specialised fragments like taxonomy and its ungrateful children, morphology and physiology. By these were organisms more or less satisfactorily named, their parts and the functions of those parts described. There remained that which was the *fons et origo* of man's primitive interest in animals and plants—their relations with other organisms including himself—in other words, what they do. This residual biological science was first distinguished by Saint-Hilaire in 1859 as *ethology*—a term which we may agree with Wheeler is etymologically more appropriate and all-embracing than any of its proposed successors. These latter were Haeckel's *Oekologie* (1866) (English *œcology* or *ecology*), Ray Lankester's (1889) *bionomics*, and Whitman's, Lloyd Morgan's, and Watson's *behaviour*, to which may be added the French *comportement* and the restricted German *Biologie*.

In man's dealings with organic Nature, the life and death practical necessities of this knowledge have been hitherto met almost solely by crudely empirical or traditional means. His conquest of the inorganic world by the application of the more exact physical sciences has now brought him to the position that he must either bring increasingly the biological sciences into his relations with other organisms, or lose that civilisation which physics and chemistry have built up but cannot unaided maintain. This is essentially a matter for applied ethology. Whatever else his specialised studies have made him—agriculturist, medical man, entomologist—the grower of man's crops and his and their protector against diseases and pests must be in increasing measure an ethologist.

So long ago as 1784, Bernardin de Saint-Pierre, whose ethological viewpoint is strikingly modern, envisaged that application of the qualitative data of entomological ethology now exciting considerable and well-deserved interest in the principle of biological control, or the suppression of insect pests by means of their natural enemies. He writes:

"It is important for us to be acquainted with at least such insects as destroy those offensive to man. We might take advantage of their hostility, and convert it into the means of our own repose. The spider catches flies by a net; the ant-lion surprises ants in a tunnel of sand; and the four-winged ichneumon seizes butterflies on the wing. There is another ichneumon so small and so cunning that it lays an egg in the anus of the vine-fretter. Man has it in his power to multiply, at pleasure, the families of insects which are useful to him, and he may find the means of diminishing such as commit depredations on his agricultural possessions."

In spite of the fact that the qualitative data on insect ethology are now extraordinarily voluminous—and commensurately difficult to codify and to synthesise—they are still fundamentally and appallingly incomplete. There is probably not a single injurious insect which could be at present economically controlled on the basis of data already accumulated and without the acquirement of further merely qualitative information. We therefore regret to see that Dr. Chapman, in the work under review, scorns *qualitative* data. He has, however, performed a service of inestimable value in bringing together references to or examples of almost all the *quantitative* work which has been accomplished on the ecology of insects. He has produced a book which Oliver Wendell Holmes' specialist in the Scarabæidæ might well have regarded with dismay, but it undoubtedly indicates the type of knowledge which must form part of the equipment of the applied entomologist of the future.

The entomologist of the old school was—and is—too prone to regard the place and time of capture and the movements of the insect in view, as more or less accidental; or if the latter looked purposeful or intelligent, to ascribe them to the workings of an inscrutable 'instinct' which stood like a wall against further inquiry. This reproach applies as much to the morphologist as to the taxonomist. The specificity of insect behaviour is so great that taxonomy must inevitably form the foundation of all entomological research and the basis of all intelligent ethological work; but the economic entomologist should above all remember that it is what the insect *does* which matters. Dr. Chapman has assembled a vast amount of useful data to show what it tends to *do* under the influence of all those extremely numerous stimuli which are exerted by the inorganic and the organic environment.

It is only fair to suppose that when this mimeographed book is finally printed such slips as "voluminious," "vestigal," "stimulæ," "calabrate," "resperation," and "canabilistic" will disappear. It may also be noticed that the leafhopper which threatened the Hawaiian cane-fields was not *Pyrilla aberrans* but *Perkinsiella saccharicida* Kirk., a very different insect. J. G. MYERS.

Early Man in East Anglia.

The Antiquity of Man in East Anglia. By J. Reid Moir. Pp. xiv + 172 + 25 plates. (Cambridge: At the University Press, 1927.) 12*s.* net.

MR. REID MOIR'S researches into the evidence for the antiquity of man in East Anglia have excited such widespread interest that he has done good service by summarising the results in a single convenient volume. He has provided for the specialist by giving copious references to the original papers by himself and others, in which the facts and observations were first published. He has also attempted to interest the general reader by enlivening his narrative with some popular interludes and elementary explanations. His numerous beautiful drawings and photographs add greatly to the attractiveness of the book.

Most of the work naturally deals with the Eolithic and Palæolithic divisions of the Stone Age, with which Mr. Reid Moir has been specially occupied. The evidence is chiefly that of flint implements, and as he admits that "it is very difficult, if not impossible, to tell in every case if any single flaked flint of a primitive, simple type is the result of human intention or natural fracturing, such as is caused by pressure or percussion," he begins by explaining the criteria on which he relies. He is satisfied that the 'eoliths' first found by the late Mr. Benjamin Harrison on the North Downs are "the earliest flint implements known to science, which were made by a race of ape-like people living in Kent, perhaps a million years ago." His explanation of the Eolithic plateau in Kent, however, is marred by a crude diagrammatic section across the Weald, which represents strange unconformities that do not exist. He considers that the occurrence of similar 'eoliths' in the detritus bed below the Red Crag in Suffolk fixes the geological age of this plateau, which he regards as early Pleistocene rather than late Pliocene. Both the Red and Norwich Crags are referred to the Pleistocene. All the 'eoliths,' however, are rolled and waterworn, and thus belong to an earlier period than the deposits in which they occur.

The large 'rostro-carinate' flint implements which Mr. Reid Moir was the first to recognise at the base of the Crag, are regarded as being of later date than the 'eoliths' and as forming "a connecting link between these primitive artifacts and the later palæoliths." He gives good figures of 'rostro-carinates' and various other chipped flints found associated with them, and thinks that some of the pieces of fossilised bone of the same age show traces of shaping by man.

Several early Palæolithic flint implements of the Chellean type, including one large specimen weighing 7 lb., are described as obtained from the Cromer Forest Bed. A fragment of wood, apparently yew, and a piece of fossilised bone, are supposed to have been shaped by man; and three bones discovered by Mr. A. C. Savin in the upper part of the Forest Bed at West Runton, are said to show "clearly defined cuts" which "can only have been produced by flint knives in removing the flesh."

Numerous Acheulean and later Palæolithic implements are known from several localities, of which interesting descriptions and illustrations are given. In some cases there are associated remains which afford scope for speculation. On one of the upper Palæolithic floors at Ipswich, fragments of human bones "exhibit cuts and marks of scraping and gnawing," from which it is "evident that the occupants indulged occasionally in cannibalism." On the same level were found some planks of wood and stakes, which are supposed to have been part of a wind-screen like that still constructed by the primitive Australians. Among surface finds which have also been regarded as probably of Palæolithic age, may be specially mentioned the natural cast

of a chamber of ammonite from the chalk, which Mr. Reid Moir still thinks has been touched up by man to give it the semblance of a mammoth.

To complete his account of the Old Stone Age, Mr. Reid Moir adds a short chapter on the known human remains from other localities, and concludes with some reference to East Anglian discoveries. It is difficult to believe that the very modern type of human lower jaw from Foxhall dates back to the period of the Red Crag in which it was found. The claims of the so-called Ipswich man to Palæolithic antiquity are also somewhat doubtful.

One chapter is devoted to the Neolithic period in East Anglia, with beautiful illustrations especially of the discoveries at Grime's Graves. Mr. Reid Moir suggests that these flint mines may have been begun in Palæolithic times, and includes a good photograph of the flint incised with the outline of an elk, which was discovered by Mr. Leslie Armstrong.

The men of the Bronze Age and later times in East Anglia are known chiefly from remains in burial mounds and cemeteries. There are still flint implements in some of the mounds of the Bronze Age, and a flint implement was found in each hand of a skeleton in one of the Roman cemeteries. In the latter case the implements were well patinated and clearly much older than the Roman period.

In a concluding chapter, Mr. Reid Moir discusses the place of origin and the progress of man. He thinks that England is just as likely as central Asia to have been his original home, and he pleads for a more intensive examination of the later geological deposits in Britain. He himself has long pursued the research with indefatigable zeal and with "well ordered imagination" (as he terms it), and his new book should stimulate others to follow his example. A. S. W.

Our Bookshelf.

A Graphic Table combining Logarithms and Anti-Logarithms: giving directly without Interpolation the Logarithms to Five Places of all Five-place Numbers and the Numbers to Five Places corresponding to all Five-place Logarithms; also a Graphic Table as above reading to Four Places. By Adrien Lacroix and Charles L. Ragot. Pp. xi+46. (New York: The Macmillan Co., 1926.) 6*s*.

THIS volume presents a 5-figure logarithmic and a 5-figure anti-logarithmic table in graphical form. A typical page is that providing the logarithms of the numbers 40,000 to 43,000. Twenty-five horizontal lines are divided on their upper side into 3000 parts, each about one mm. long. Every tenth division is numbered, thus forming a linear scale from 40,000 to 43,000. The lower side of each line is graduated logarithmically, these graduations extending from 0·60206 to 0·63347. Hence the logarithm of a number may be found to five decimals without interpolation by locating the point in the upper scale corresponding to the number, and then reading the lower scale at this point. The reverse process serves for the finding of a number from a given logarithm.

Although suggestive of the slide rule, the graphical table is merely one of logarithms and anti-logarithms. The advantages claimed are the elimination of interpolation, and compactness, for the table occupies only 40 pages as against 380 for a fully printed 5-figure table. The authors do not seem to be aware that such a table actually exists in Scott's "Tables of Logarithms and Anti-Logarithms to Five Places," which, incidentally, is sold at exactly the same price as their table. The choice between the two tables is entirely a matter of temperament. One computer will find the graphical table easy to use, while another will find the reading of scales irksome, as it calls into play faculties which he does not usually exercise in his profession, and so will prefer the extra labour of turning over more pages, with its compensation of the fully printed result opposite a fully printed argument.

At the end of the volume is a similar 6-page graphical table giving directly 4-figure logarithms and anti-logarithms, which would meet the needs of most workers in engineering, the field in which graphical methods are most in vogue. L. J. C.

Memoirs of the Geological Survey, Scotland. The Oil-Shales of the Lothians. Third edition. Part 1: *The Geology of the Oil Shales Fields.* By R. G. Carruthers, based on the work of H. M. Cadell and J. S. Grant Wilson. Part 2: *Methods of Working the Oil-Shales.* By H. Caldwell. Part 3: *Chemistry and Technology of the Oil-Shales.* By E. M. Bailey. Part 4: *History of the Scottish Oil-Shale Industry.* By H. R. J. Conacher. Pp. x+274+12 plates. (Edinburgh and London: His Majesty's Stationery Office; Southampton: Ordnance Survey Office.) 5*s*. 6*d*. net.

THIS memoir was first published in 1906, revised in 1912, and is now in its third edition. It deals fundamentally with the geology and technology of the Scottish oil-shales, and now, as hitherto, constitutes the standard authority on the subject, especially concerning Scottish retorting practice. Much of the section on the chemistry and technology of the shales has been rewritten by Mr. E. M. Bailey, while the methods of working the raw material have been revised by Mr. W. Caldwell. An interesting part has been added by Mr. H. R. J. Conacher on the history of the industry since its beginning in 1858 up to the present day. In other respects the volume is not greatly changed, except for the addition of several excellent illustrations and a decidedly improved version of the geological map. A sheet

of comparative vertical sections depicting stratal sequences in different areas is included and helps considerably in the visualisation of underground conditions. Considering the size and comprehensive nature of this volume, the price is remarkably modest, and a wide circulation should ensue.

Ethnographical Studies in Celebes. By Dr. Walter Kaudern. Results of the Author's Expedition to Celebes, 1917–1920. Vol. 3: *Musical Instruments in Celebes.* Pp. xiii+322. (The Hague: Martinus Nijhoff, 1927.) 20*s.* net.

THE third instalment of Dr. Kaudern's reports on his ethnographical expedition to Celebes in 1917–1920 deals with the musical instruments of the island as a whole, although the original intention was to deal with those of the Toradja. As so frequently happens, however, he found that the study of distribution of the instruments used by these tribes only lacked completeness without a study of all the groups. His own collection of instruments was large—the list given here runs to several pages—but it was in itself insufficient for his purpose. In drawing upon the material in several museums, the data of provenance, etc., were at times inadequate, and to this extent, as he himself confesses, from the absence of his own personal observation, there is necessarily sometimes a lack of precision in the information available.

The musical instruments are classified according to construction into idiophones, some of which are not truly instruments at all, being merely devices for producing a rattling sound devoid of rhythm, membranophones, cordophones, and ausphones. Several of the instruments have been introduced from outside; the bamboo flute of the schoolboy band mentioned by the author, for example, is of the common transverse form, which is not a native type. At one time there was a rule that certain instruments could be played only by certain people at certain times, but this has now died out. Dr. Kaudern's valuable study of a little known subject is very fully illustrated—a matter of the greatest importance in any work on musical instruments.

Mathematical Geography. By Prof. A. H. Jameson and Prof. M. T. M. Ormsby. Vol. 1: *Elementary Surveying and Map Projection.* Pp. ix+154. (London: Sir Isaac Pitman and Sons, Ltd., 1927.) 5*s.* net.

ALTHOUGH the subjects of field-work, surveying, and map projections are intimately associated, books have been devoted previously to one or two of these sections only. The study of map projections has aroused considerable interest recently, and now we are given a book which covers the whole of this work in broad outline.

The book is in two portions, which relate respectively to surveying and projections. In the former part, the three methods, chain, plane-table, and compass, together with relevant matters, are treated with clearness. One noteworthy feature which strikes the reader is the detailed description of the apparatus and of the method of its use. In the second part the small space is utilised fully. Although all the cases, equatorial, polar, and oblique, of the projections could not be treated separately, the commonly used projections are described, their uses are considered with examples, and the student is introduced to their constructions.

The authors have wisely, though perhaps a trifle harshly, warned students against imagining projections by means of a spot of light (p. 99). Thus errors due to facile conceptions will be avoided.

The work will be welcomed by geographers for its scope and clarity, and, moreover, with the exercises appended, will prove useful to all who are interested or concerned with this subject.

J. ELING COLECLOUGH.

Problems in Psychopathology. By Dr. T. W. Mitchell. (International Library of Psychology, Philosophy, and Scientific Method.) Pp. v+190. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1927.) 9*s.* net.

THE editor of the *British Journal of Medical Psychology* is a whole-hearted Freudian and does Freud justice. He shows how the study of hypnotism and hysteria in the late nineteenth century resulted in the development by Freud of his theory of psycho-analysis. He discusses very clearly the theory of the libido and Freud's conception of the Ego, the Super Ego, and the Id. Freud's views on the instincts are of course more or less unique, and the author, although critical, treats him fairly. In the chapter on the neuroses, he presents us with Freud's view that the repressed libido finds outlet through condensation and displacement, distortion, and disguise in neurotic symptoms. In his concluding chapter he points out in no uncertain manner that neither Jung nor Adler can be in any way considered as psycho-analysts. When Dr. Mitchell writes anything we expect a brilliant effort, and we are not disappointed in this series of lectures.

American Game Shooting. By Capt. Paul A. Curtis. Pp. xvi+279+15 plates. (New York: E. P. Dutton and Co., 1927.) n.p.

CAPTAIN CURTIS writes with twenty years' experience of game shooting in the United States and Canada. He admits that he is not a naturalist, but all the same he has studied closely the habits of various animals. Many naturalists might read his chapters with interest if every study of the ways of the animals were not an introduction to the best means of killing it. He deplores the decrease in wild life in America, and believes that big-game hunting in the United States is practically over; he estimates that, outside zoological gardens and the Yellowstone Park, there are only 250 grizzly bears in the United States. The author disparages indiscriminate slaughter, but the destruction of the game is surely in some measure due to the sport of hunting, of which he is so keen an advocate. He cannot expect every hunter to be so careful as he is not to overdo the sport. His own enthusiasm must contribute to the end which he deplores.

Letters to the Editor.

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

Liquid Stars.

IN NATURE of Feb. 4 (p. 173), Dr. Jeans has given an attractive exposition of his new theory of stellar evolution involving 'liquid' stars. With all goodwill towards innovations which might help to remove present difficulties of the evolutionary theory, I cannot follow Dr. Jeans's lead because I find myself in disagreement with him on two preliminary and essential points. These points, discussed separately below, have already been the subject of careful investigation, and even in Dr. Jeans's fuller papers on his theory I find no new considerations which would modify the conclusions formed.

(1) STATE OF HIGHLY IONISED MATERIAL.—The theory put forward in 1924 that stellar material is a nearly perfect gas up to densities exceeding those of terrestrial solids met with surprisingly little opposition at the time; but opposition has now come in the form of Jeans's liquid stars. Fortunately, he and I are agreed as to the extent of the ionisation. In the upper half of the main series the ions are chiefly nuclei attended by two K electrons—a structure having a radius of about 10^{-10} cm. The average distance between neighbouring ions is at least 100 times greater. Jeans assumes heavier ions than I do, but that only augments the disparity between size and separation. The hypothesis of liquid stars postulates that in this condition the ions are jammed; that is to say, their effective volumes are 100,000 times greater than the volume covered by the electron system, and the space apparently so empty is in reality packed full. The defence is (*Mon. Not. R.A.S.*, **88**, p. 736): "Even with neutral helium the effective diameter of the atoms in the liquid state is 7·4 times that of the electron orbits as calculated from Bohr's theory. No one can say what it would be if the temperature were raised from two or three degrees absolute to ten or a hundred million degrees absolute, and we might, in any case, expect atoms surrounded by a powerful electric field to have relatively larger effective diameters than neutral atoms such as that of helium." The last defence is certainly wrong. The effect of the electric fields has been investigated by Debye and Hückel, Kramers, and (with more specific reference to stellar conditions) by Rosseland, Fowler, and myself. It is not necessary to read far into these investigations to see that the electric fields make the gas superperfect and have the opposite effect to that which Jeans expects. His first defence is an *ad hoc* postulate that at high temperatures something unknown to present-day physics intervenes to give the ions what is apparently an impossibly large volume. All the evidence is that the volume diminishes with increasing temperature. Moreover, I understand that atomic volume is now generally regarded as conditioned by Pauli's exclusion principle, and I cannot think that physicists will easily be persuaded to admit the enormously extended sphere of exclusion demanded by Jeans.

Dr. Jeans's reference to atomic volume is so brief and perfunctory that I think I am not misrepresenting him in saying that he adopts liquid stars, not on grounds of physical plausibility, but for reasons somewhat as follows. He has persuaded himself that a gaseous star is necessarily unstable. Therefore a star in any one of the long-enduring stages *cannot* be gaseous; and if present-day atomic physics declares it to be gaseous, then so much the worse the present-day atomic physics. This is logical enough if we grant his premises—which I do not.

(2) THERMODYNAMIC INSTABILITY.—Any inclination I may have had to discuss Dr. Jeans's earlier theories of evolution was arrested at the start by disagreement as to stability; he made out to be stable the stars which I (following Russell) found unstable, and vice versa. He has now come into line with Russell and myself in agreeing that if the rate of liberation of subatomic energy E decreases as a consequence of compression the star is unstable. In the other direction agreement is still not complete. I have maintained that if E increases moderately with compression the star is stable, but too rapid a rate of increase will throw it into pulsation. Jeans does not disagree with this for the smaller stars, but he claims to have shown that for stars of mass greater than $2 \times$ sun the range of stability disappears. The cause of this divergence is pointed out by H. Vogt in the current issue of the *Astronomische Nachrichten* (No. 5545), who shows that Jeans has omitted a term in his equations, and when the term is included the range of stability does not disappear. The range of stability is, however, rather narrow, and I have long urged the consequent difficulties (NATURE, Mar. 21, 1925; May 1, 1926) which seemed to be passed over too lightly in Jeans's earlier theories of stellar evolution. I have pointed out that the range is widened indefinitely if the liberation of energy is a two-stage process with a time-lag between the formation of the active substances and their spontaneous disintegration. At present this seems the most plausible way out of the difficulty. In any case it scarcely calls for the desperate remedy of liquid stars.

With regard to the evolutionary part of his theory, I am puzzled to find these 'liquid' stars behaving very differently from the way we supposed them to do when last I (like others) believed in them five years ago. Then the effect of loss of energy and contraction was that the liquid core increased in size and diminished in temperature. This still seems to be the correct deduction. But it would rule out the increase of central temperature, with consequent jumps to states of higher ionisation, on which Jeans relies.

In refusing to follow Jeans into the fire, I do not wish to give the impression that the situation is entirely comfortable in the frying-pan. Besides numerous difficulties associated with sub-atomic energy, there is the discrepancy of a factor 10 or more which I found between the stellar absorption coefficient and the value derivable from Kramers' theory of electron capture. Although Jeans alludes to this as one of the difficulties of the gas theory, I am not sure from his discussion whether the liquidity of the stars is supposed to cure it or whether he adheres to his former view that the discrepancy is removed by assuming very heavy elements in the stellar interior. The latter possibility was examined when the discordance was discovered, and it appeared that there was little or no advantage in substituting heavy elements (*Monthly Notices*, **84**, p. 110; "The Internal Constitution of the Stars," § 168). If, on the other hand, he explains the discrepancy by liquidity, so that the perfect gas curves for giants run $2\frac{1}{2}$ magnitudes above those shown in his diagram, I can only feel the more amazed at the prodigous size of his ions which in M type stars must be supposed to jam at densities $\frac{1}{100}$ that of air.

A. S. EDDINGTON.

Observatory, Cambridge,
Feb. 12.

I AM very glad to have seen Prof. Eddington's critical comments on the theory of liquid stars.

The difficulty as to atomic diameters, which he places in the forefront, and also in the tail, of his letter, seems to me also to be the most serious difficulty in the way of the theory. But Prof. Eddington overestimates its amount, though arguing as though I maintained that the stars were liquid throughout, from centre to surface. If a star such as Betelgeuse breaks up by fission, it probably forms a binary system with the dimensions of V Puppis. If so, considerations of angular momentum show that before fission the greater part of its mass must have resided within about a twentieth part of its radius from the centre. For this reason I imagine Betelgeuse to consist of a liquid core having a radius perhaps only five per cent. of that of the star, while the other 95 per cent. of the radius is occupied by very tenuous gas. The small core determines the dynamical behaviour of the star, because it contains most of the mass; the rest is a mere obscuring veil. In more ordinary stars the liquid core may extend over perhaps a third or a fifth of the radius.

This consideration reduces the diameters which Eddington assigns to my ions by a factor of from 3 to 20, and the ionic volumes by a factor of from 27 to 8000; for example, the concluding words of his letter should not be "densities $\frac{1}{1000}$ that of air," but "densities 80 times that of air," which makes a difference.

All the same, the hypothesis admittedly requires effective diameters many times larger than the orbital diameters of the Bohr atom. What Eddington describes as my "defence" of this was only meant as a suggestion. It may be wrong, but I am surprised at Eddington describing it as "certainly wrong"; it had never occurred to me that modern quantum-dynamics was quite so sure of itself as this, especially in dealing with states of matter of which we have no experience. Meanwhile the atom, like the stars, is dissolving into radiation, and the wave-mechanics may throw new light on the matter before long. But I frankly admit the difficulty as a bit perplexing, although not in the least as fatal or insuperable.

I cannot follow either Eddington's arguments or his statements about instability, and I have not yet studied Vogt's paper in detail. I ought, however, to say that my own mathematical analysis did not confirm Eddington's conjecture as to the efficacy of a time-lag in promoting stability. With a long enough time-lag all matter is obviously reduced to the purely radioactive condition in which the liberation of energy is uninfluenced by changes of temperature and density, and I think Eddington agrees with me that gaseous stars of this type are unstable all along the line and in every conceivable configuration in which the gas laws are obeyed. I would also remark that, even if I were to concede all of Eddington's statements and arguments, the validity of the theory of liquid stars would remain absolutely untouched; his arguments are not directed against the tenability or accuracy of the theory, but only against its inevitability.

On this question, may I point out that there are only two possibilities open—in the central regions of stars, either the gas laws are obeyed or they are not. The former is the hypothesis of gaseous stars, and the latter of liquid stars. I still consider that stability considerations rule out the former, and so make the latter inevitable. But, apart from this, the theories admit of almost direct observational test, by comparing their predictions with the observed Russell diagram, which is observationally indisputable.

For the configurations possible for stars of given mass, the theory of gaseous stars predicts a system of parallel, slant, approximately straight lines. The theory of liquid stars predicts the wavy curves I showed in my article in NATURE. Seares (*Astrophys. Jour.*, **55**, p. 195; 1922) has drawn the lines indicated by observation and gives a set of curves which are very wavy indeed, and show the same general characteristics as the curves requisite for liquid stars; they show no resemblance at all to the straight lines of gaseous theory.

The two opposing theories can also be tested in terms of the areas of the Russell diagram which are tenanted by stars. The theory of liquid stars predicts a diagram shaped like a hand with white dwarfs lying along the thumb. Observation shows a diagram shaped like a hand, with white dwarfs lying along the thumb, the only complication being that observation cannot reach down to where the thumb joins the hand. The theory of gaseous stars predicts merely a flat, featureless diagram, into which features can only be introduced by extraneous *ad hoc* assumptions. Yet the observed features of the Russell diagram represent the outstanding facts of physical astronomy. Consider, for example, the almost sensational fact that no star of solar mass is known with a density intermediate between 1·4 (the sun) and 50,000 (Sirius B). The atomic nuclei are 15 times as widely spaced in one star as the other, and no intermediate spacing is known to astronomy. What does it mean? Apart from liquid stars, I know of only one suggested explanation, and this is purely *ad hoc*. All stability considerations being thrown to the winds, the stars are supposed to radiate by the same mechanism as an explosive at its flash-point. The flash-points of the sun and Sirius B are supposed to be so different that one is reached at a density of 1·4, and the other only at a density of 50,000; and it is assumed that no type of stellar matter exists with a flash-point intermediate between these two extremes. Does Prof. Eddington really prefer to accept this medley of *ad hoc* assumptions rather than concede the effective diameters demanded by the theory of liquid stars? Of course, he may say he prefers neither, thereby laying himself open to the charge he brings against me of waiting for something unknown to present-day physics to turn up.

I obviously cannot occupy more space, but I think all the other points raised by Prof. Eddington are dealt with in my papers in the *Monthly Notices*.

J. H. JEANS.

The Nature and Function of Golgi Bodies.

As he attributes to me the fallacy "that things which look alike are necessarily the same," it would appear that Dr. Ludford had forgotten parts of my letter to NATURE, Jan. 21, and corresponding parts of my paper (*Proc. Roy. Soc.*, B, vol. 101, 1927), before he wrote (NATURE, Feb. 4). These parts are very important, and show that, whether right or wrong, my arguments are not based upon the fallacy that Dr. Ludford sets up, and then proceeds to knock down.

All cells contain lipins. If acetic acid is used in fixing fresh material, the appearances known as 'Golgi bodies' are absent. If no acetic acid is used in the fixative, they appear after suitable treatment. My mixtures containing lipins behave in exactly the same way. The Golgi bodies appear or are absent, under the same conditions as they appear or are absent, in fixed cells.

If the Golgi bodies are really cell structures and not the products of the treatment to which the cells are subjected, then there should be two sets of Golgi bodies in each cell, for lipins are present in the cells

in the same order of proportions as in my mixtures. I consider as untenable the comparison between the structures described by me and the manufactured nuclei and other artefacts known to "Every elementary student of physiology." The nucleus can be seen in the living cell; it appears whatever fixative be used; and though possibly distorted, it is demonstrable and recognisable whatever the treatment to which the material be subjected, short of practical disintegration.

Dr. Ludford gives "the reasons why most cytologists have come to regard the Golgi apparatus as a definite cytoplasmic structure." Many workers have done little else than describe 'Golgi bodies and apparatus'; these doubtless believe, and their faith is founded, on such reasons as those given by Dr. Ludford. But there are others who have claim to be classed as cytologists who do not, and never have, agreed with them.

I will deal with Dr. Ludford's reasons under the numbers which he attaches to them.

(1) The 'Golgi apparatus' seen in the living spermatocytes of Helix (Platner, Murray, no reference given), apart from almost certain *ante-mortem* changes taking place in the detached cells, may well be the archoplasmic vesicles which appear in the various stages of the meiotic phase, and are destined to form the cap of the sperm. They have been described as occurring in every animal specially investigated. Their destiny was known long before the invention of the 'Golgi apparatus' in anything but nerve cells, and they can be demonstrated with or without acetic acid in the fixative, presenting much the same appearance in both cases. It is claimed by the supporters of the 'Golgi apparatus' that it is present at any rate in all animal cells. These vesicles, so far as I know, have been described only in cells involved in the meiotic phase. I see no valid reason for connecting them with what Dr. Ludford and others understand by the term 'Golgi apparatus.'

(2) We are not dealing with mitochondria, and whether or not I agree with Dr. Ludford's statements regarding them, I am not attracted by this particular red herring. The rest of the paragraph is too indefinite to deal with categorically. It is to be expected that some of the appearances claimed by Dr. Ludford and others as 'Golgi apparatus' may be structures that are really present in the cell (for example, the archoplasmic vesicles already referred to), and these would be demonstrable by both what he calls 'positive' and 'negative' methods. No doubt, also, anything that saturated the unsaturated fatty acid of the lipins would, under certain conditions, give a negative picture.

(3 and 4) These reasons were dealt with very fully in my paper (*loc. cit.*, *supra*). Suffice it to say here that it has been shown that the lipin content varies enormously in the cells of different tissues, and to a less extent in the cells of the same or similar tissues, according to their physiological condition. In cells where the lipin content is large, so is the 'Golgi apparatus.' Not only does the amount of lipin vary, but the relative proportion of saturated to unsaturated lipins varies with the physiological condition of the cell, and with the tissue. In my mixtures the 'Golgi apparatus' varies according to the lipin content. In some it forms a "net-work," in others a "compact cluster round the sphere," besides assuming many other forms and positions described and figured by workers on 'Golgi bodies and apparatus.' By saturating the fatty acids one should be able to produce entirely 'negative' pictures. The 'positive' depend upon the degree of unsaturation of the lipins.

(5) I do not see why anyone should accept Dr. Ludford's statement that the "secretion granules of gland cells arise in relationship with the Golgi apparatus." Some quite competent cytologists believe, and a great number have believed during the past thirty years, that many of these granules are simply the result of the methods of fixation. Nor can I accept a statement as to the position of the 'Golgi apparatus' in relation to these granules as a valid argument in favour of its reality, when its very existence is the point in dispute.

If my interpretation of these various observations be correct, then the nature, function, and destiny of the Golgi bodies are less obscure, and we may be a little nearer to the solutions of the problems of fat transference and metabolism. Otherwise, excepting the archoplasmic vesicles of the meiotic cells, which can have, as I have tried to show, no relation to what 'most cytologists' regard as 'Golgi bodies,' there is no evidence, scarcely even a suggestion, as to the function, nature, or destiny of these structures, which are supposed to be present in all animal and many vegetable cells.

CHARLES WALKER.

The University,
Liverpool, Feb. 7.

The Luminescence of the Dogfish *Spinax niger* Cloquet.

THE arrangement and the structure of the luminous organs of *Spinax niger* Cloquet have been thoroughly described by Johann.[1] Though these organs are present on the upper surface of the head and along the back (being distributed there mainly in association with the slime canals) they are enormously more abundant on the ventral surface of the body, and also on the flanks above the pelvic region, the black pigment, with which they are everywhere associated, forming a characteristic pattern on the skin of the fish.

I have very frequently handled Spinax at sea, and watched the luminescence of specimens taken from the trawl catch. When newly caught and vigorously alive, Spinax often shows no luminescence, nor are dead specimens luminescent. But while moribund, Spinax may show a greenish-blue light very distinctly visible to the dark-adapted eye.

Spots and streaks of light appear on the back of the fish, but their effect is very feeble compared with that of the belly, which appears as a steadily-glowing sheet of light, with brighter areas about the mouth, on the pectoral fin-bases, in the pelvic region, and on the tail fin. Th. Beer, who adds a note to Johann's paper, describing his observations on an injured specimen in the Naples Aquarium, says that the intensity of luminescence varied at short intervals, and was visible at a distance of 3-4 metres.

When a luminescent specimen is held so that one's line of vision is perpendicular to the ventral surface of the fish, the luminescence is plainly visible. When the fish is then rotated slightly to left or right about its long axis, the light disappears. This observation seems to offer some explanation of the function of the luminescence of Spinax.

Johann's description and figures of the luminous organs show that each organ has a complex structure, complete with reflector, lenses, and iris-diaphragm of melanophores. Moreover, he shows that, while the organs in the middle line of the belly have their axes perpendicular to the surface of the skin, those situated on the flanks are also arranged with their axes parallel to the median vertical axis of the fish, and therefore make a considerable angle with the

[1] L. Johann, "Über eigentümliche epitheliale Gebilde u.s.w. bei *Spinax niger*," *Zeitschrift f. wiss. Zool.*, **66**, pp. 136-260; 1899.

surface of the skin. This is carried to an extreme in the row of organs present on each side of the laterally compressed upturned tail. Here the organs lie with their axes almost parallel to the surface of the skin.

The complex lantern-like structure of each individual organ seems designed to throw out a parallel beam of light, and to prevent scattering of the rays; the arrangement of the axes of all the organs parallel to the median vertical axis of the fish, seems to aim at precisely the effect described above, namely, that the luminescence will only shine upon objects immediately beneath the ventral surface.

The mouth of Spinax is situated remarkably far behind the tip of the snout, so that Spinax can obviously only seize objects immediately beneath (in the relative sense) its mouth. But it is only when an object is immediately below the ventral surface of the fish that the light from the luminous organs flashes fully upon it. One may therefore suggest that the sudden flash of light, at the moment of attack, may cause the prey of Spinax to hesitate for just that fraction of a second in which the mouth can make a successful snatch.

C. F. HICKLING.

Fisheries Laboratory,
Lowestoft, Jan. 27.

An Optical Paradox.

A PARADOX propounded at a meeting of the Physical Society may be of interest to a wider scientific circle.

Suppose that we have two lamp sockets, connected to perfectly steady electric supplies, clamped in fixed positions on an optical bench; exactly midway between these sockets is a photometer, also clamped. The photometer field, we will say, is divided by a fine vertical line into two parts, that on the left of the line receiving light only from a lamp placed in the socket on the left side of the observer, the part on the right of the dividing line receiving light only from a lamp placed in the socket on his right. Assume also that we have a series of lamps A, B, C, D . . . Z proceeding in finite steps from a lamp A, which emits at a definite rate light of a certain quality, to a lamp Z, which gives at some other rate light of some other quality.

We shall not be concerned with the ways in which the output of these lamps is to be measured quantitatively or qualitatively. Fechner's law applies to visual sensations, and we can therefore construct our finite sequence of lamps connecting any two given lamps A and Z in such a way that any two consecutive lamps of the series, if placed in the two sockets on our bench, will so illuminate their respective halves of the photometer field that the most critical observer can detect no difference between them. In other words, the visual sensations corresponding to the two halves of the field are identical. To say that the sensations differ by an amount so small that the observer is unconscious of the difference is to quibble.

Let us now suppose the lamps compared by an observer who is not subject to fatigue or other disturbing factor. We start with lamp A in the left socket and lamp B on the right. Each gives rise to the same sensation, which we will call S. Without in any way disturbing the system to the right of the photometer, we replace lamp A by lamp C. The sensations derived from the two lamps B and C are again identical, and since the system on the right is not in any way altered the new sensations are again exactly represented by S. We now leave the left-hand system alone and replace B by D; the previous argument applies without change, and the sensations are still S. The procedure indicated can evidently be carried as far as we like, and leads to the conclusion that any two lamps, A and Z, placed at the same distance from the photometer give rise to exactly the same sensation S. In other words, their candle power and their colour are the same, a conclusion which is absurd.

The significance of the paradox lies in the fact that the error in the argument arises from the neglect of a consideration widely ignored in scientific work. It should be observed that the experimental principles adopted, the use of a null indication and of simple substitution, are those most approved for precise measurements.

T. SMITH.

The National Physical Laboratory,
Teddington, Middlesex,
Jan. 28.

A Simple Form of Photo-electric Photometer.

DR. N. R. CAMPBELL (*Phil. Mag.*, **111**, pp. 945, 1041; 1927) has described a new method of using a gas-filled photo-electric cell by which small illuminations can be measured by the use of a telephone only. This method is, however, only applicable to gas-filled, and not to vacuum, cells; and for accurate measurements of strong illumination the latter are much more trustworthy. It is possible by using the well-known phenomenon of the intermittent discharge through a neon lamp to employ a somewhat similar method in the case of a vacuum cell. The circuit necessary is very simple. The photo-electric cell and the neon lamp are connected in series with a high tension battery of suitable voltage, and the neon lamp is shunted with a condenser. Under these conditions intermittent flashing will occur in the lamp when the photo-electric cell is illuminated, and the frequency of the flashes will increase with the illumination. It is accordingly only necessary to time this frequency to obtain a measure of the illumination. To do this it has been found more convenient to insert a telephone in series with the shunting condenser, and to count the clicks heard in it.

Some preliminary tests of the arrangement have been carried out, and they have shown that while the method is decidedly hopeful, it will need careful investigation before it can be considered reliable. The leakage current through the neon lamp before flashing occurs evidently limits the lowest illumination that can be detected. In the commercial Osglim lamp I have employed, this current appears to be unduly large, possibly due to insufficient insulation in the cap of the lamp. To obtain the best results it will probably be necessary to use special neon tubes. Leakage in the shunting condenser may also be troublesome. The sensitivity of the apparatus can easily be altered by using a variable condenser, and hence lights of very different intensities measured. It has been found, however, that the condenser should not be made too small, as then the flash discharge tends to become irregular.

If the method proves itself capable of yielding consistent and trustworthy results, it will undoubtedly be very useful for what we might call field measurements of daylight illumination with photo-electric cells. In these cases it is always inconvenient, and sometimes impossible, to use either a sensitive galvanometer or electrometer, and the only alternative is to employ some telephonic method such as has been developed by my brother, Dr. H. H. Poole (*Scientific Proc. Royal Dublin Society*, vol. 18, No. 9; 1925), in connexion with the measurements of

submarine illumination. The new neon lamp method would be simpler, more portable, and much cheaper than this arrangement, and probably less liable to go out of order as it contains no moving parts. It remains to be seen, however, whether it can be made to give as good results.

J. H. J. POOLE.

Physical Laboratory,
Trinity College, Dublin.

The Excitation of Spectra by High Frequency Oscillations.

WITH reference to M. Ponte's letter in NATURE of Feb. 18, p. 243, may I say that my letter in the issue of Nov. 19, 1927, p. 727, did not pretend to be a full account of the development of the spectrum of mercury by the method of the electrodeless discharge, nor was it my intention to give the impression that I thought the phenomena observed were necessarily dependent on the short wave-length of the exciting oscillations. It was stated in that letter that the spectrum of mercury was examined as a preliminary to work on other substances; one of the advantages of this procedure was that mercury had already been studied by MM. E. and L. Bloch, using a similar method.

My results, however, differ from those obtained by these investigators in what I regard as an important particular. Apparently all the spectra which they photographed consisted of a large number of lines; the 'arc' lines appeared first, then the 'first spark' lines, and so on. On the other hand, I was able to develop the 'arc' spectrum in stages, first the triplet series, then the singlet series. This may have been due to the better control over the exciting conditions which is given by the valve method of generating the oscillations in the exciting coil. MM. Bloch themselves point out, in the paper to which M. Ponte (*J. de Physique*, **4**, 333; 1923) refers, that they could not keep the potential constant during an exposure. The method I used permits of this being done over a long period. This has the additional advantage that a steady temperature and pressure can be realised, with the coil activated, before an exposure is made.

The account which M. Balasse gives of his work with undamped oscillations is very brief; he says that he obtained the glow spectra of mercury, cæsium, and potassium, "which only showed arc lines." He does not mention any stages in the development of these arc spectra, and I look forward to a fuller account of this work.

M. Ponte attributes the absence of the p series "to the kind of discharge employed"; I suggested that it might be due to insufficiently high potentials applied to the exciting coil. Perhaps we may mean the same thing, for I observe that many of the lines recorded by MM. Bloch as 'spark lines' are members of this series. These spark lines were excited by increasing the length of the spark used in the production of the condensed discharge passed through the coil, and this lengthening of the spark involves a higher initial discharge voltage.

I would assure Prof. Bloch and his colleagues that I know and value their work. Nevertheless, the possibility of developing spectra series by series, not merely by stages of arc, spark, and so on, was new to me. It is the use of undamped oscillations at constant voltage which renders this possible because it facilitates control of the discharge, and it is this series by series development which I regard as full of promise.

J. R. CLARKE.

Physics Department,
University of Sheffield.

The Exit of *Leishmania tropica* through the Proboscis of *Phlebotomus papatasii*.

IT has been shown (*Ann. Trop. Med. and Parasitol.*, vol. 19, No. 3, and vol. 20, No. 2) that human beings can be infected with *Leishmania tropica* by inoculation with Herpetomonas from naturally infected sandflies. It has also been shown that sandflies (*P. papatasii*) both wild and laboratory bred can be infected with *L. tropica* by feeding on oriental sores, and further, that after a certain period of development the artificially infected sandflies contain flagellates which on inoculation into man produce cutaneous leishmaniasis. The development of *L. tropica* in *P. papatasii* suggests very strongly that infection in Nature is through the bite of a sandfly, but actual experimental proof of the exit of the flagellates via the proboscis of sandflies has been hitherto lacking.

The following experiment proves beyond all shadow of doubt that *L. tropica* can be expelled from the sandfly via the proboscis.

19/1/28.—Seven specimens of *P. papatasii* ♀♀ (hatched in laboratory 17-19/1/28) fed through a membrane of rabbit skin on an emulsion of culture of *L. tropica* in inactivated rabbit blood (3000 per c.mm.).

23/1/28.—All the sandflies re-fed on a human being.

27/1/28.—One sandfly died, and on dissection was found to be heavily infected with *L. tropica*.

27/1/28.—Three sandflies re-fed through a membrane on inactivated rabbit blood. The experiment was performed at 37° C.

After the sandflies had fed, some of the inactivated rabbit blood was sown on a tube of Shortt's N.N.N. The remainder was examined microscopically. In nine coverslip preparations not a single flagellate was found.

2/2/28.—The inoculated tube was examined and found positive, that is, *L. tropica* had passed via the proboscis into the fluid above the membrane. The number of flagellates which had passed through must have been very small, because no flagellates were found in the coverslip preparations.

Further, under the conditions of the experiment, all possibility of fæcal contamination from the rectum of the sandflies was completely excluded.

The method of infecting sandflies by feeding through membranes has been described (*Ann. Trop. Med. and Parasitol.*, vol. 21, No. 2).

Further details will be given elsewhere.

S. ADLER.
O. THEODOR.

Microbiological Institute,
Hebrew University,
Jerusalem, Feb. 3.

Segmental Interchange and Crossing-over.

IN October last I published a working hypothesis for segmental interchange between homologous chromosomes (*Proc. Nat. Acad. of Sciences*, U.S.A., vol. 13, pp. 717, 718). Since that date, further work with liliaceous plants has led to an addition to this hypothesis.

It is presumed that the two strands of each homologue have breaks in the chain of genes at the leptotene stage (leptophase). These breaks are presumed to be at random in each of the two strands making up each homologue. The breaks are supposed to be only in the chain of genes, and not in the visible thread itself. They are to be regarded as places where the genes have separated far enough to be out of the sphere of mutual attraction.

In this case, if $1/x$ represents the probability of

two breaks in any particular two of the four strands present at the zygotene stage (zygophase) coinciding, then the chance for such coincidence in any two of all four strands is $6/x$. One-third of these cases of coincidence will be between sister strands of the same chromosome. Hence the chance for coincidence between two breaks at a particular point in the twin halves of opposed homologous chromosomes is $4/x$. (The chance for coincidence between four such breaks, one in each of the four strands at pachyphase, is only $1/x^2$ at any particular point.)

In any coincidence of two breaks in strands of different homologues, for which the chance at any particular point is $4/x$, we may suppose that in half the cases the ends of the same threads are reunited, and in the other half of the cases ends of different threads unite, thus forming a chiasma. Hence the chance of a chiasma, or point of segmental interchange, between homologues at any one point in the bivalent is $2/x$. Since there is no chiasma between the other two strands, $1/x$ represents the chance of segmental interchange at any one point in the chromosomes resulting from the maturation division. (The occurrence of a second, or even a third, chiasma is to be allowed for.)

Hence $1/x = c/100$, where c is the observed percentage number of cross-overs between two adjacent genes.

JOHN BELLING.

Dept. of Genetics,
Carnegie Institution of Washington,
Cold Spring Harbor,
Long Island, N.Y., Jan. 21.

Optically Excited Iodine Bands with Alternate Missing Lines.

WE have recently been studying, under improved conditions, the fluorescent bands which develop around the 'fundamental' doublets when iodine is excited, in the presence of helium, by the green mercury line. The use of a battery of four mercury arc lamps surrounding the iodine tube excites such a brilliant fluorescence that it is possible to photograph it in 24 hours in the second order of a 9-foot grating. On the plates so obtained it is apparent that only alternate lines of the corresponding absorption bands occur, namely, those for which m' is even. Now the fluorescent bands are known to be developed by collisions of the second kind between excited iodine molecules and helium atoms, wherein m' is changed from 34, the value originally excited, to various neighbouring values. The new data, then, show that the rotational quantum number of the excited iodine molecules can change only by even numbers during these collisions of the second kind.

This result, while incomprehensible on the classical Bohr-Lenz theory, is entirely in accord with the conclusions of the wave mechanics. According to the theory of Hund, successive rotational states of a symmetrical molecule, such as I_2, have, alternately, eigen-functions symmetric and antisymmetric in the two nuclei. Moreover, since the symmetric and antisymmetric eigen-functions correspond to different orientations of the spins of the two nuclei, and since these spins are presumably very loosely coupled, it is to be expected that transitions between symmetric and antisymmetric states will be very infrequent. In fact, Dennison has recently solved the long-outstanding problem of the specific heat of hydrogen by assuming that transitions between symmetric and antisymmetric states do not occur in appreciable numbers, even during the time it takes to make a measurement of specific heats.

The absence of the alternate lines in the optically excited iodine bands affords direct evidence in support of the theories of Hund and Dennison.

R. W. WOOD.
Johns Hopkins University, F. W. LOOMIS.
New York University.

Absorption of X-Rays in Various Elements.

PROF. RICHTMYER, in a letter published in NATURE of Dec. 24, 1927, p. 915, states that he has formerly tried the formula

$$\delta_K = \frac{E_K}{E_{L_1}} \quad . \quad . \quad . \quad . \quad (1)$$

for the ratio δ_K of the absorption coefficients at the K-discontinuity. In the paper cited by Prof. Richtmyer (*Phys. Rev.*, **23**, p. 292, Feb. 1924) he says: "This ratio is of the same order of magnitude as, but somewhat smaller than, the ratio of the energies required to remove a single K and a single L electron from an atom of the absorber." But the formula which contains the empirical facts, and given in my letter to NATURE of Nov. 12, 1927, p. 695, is not this one but

$$\delta_K = \frac{E_K}{E_{L_I}} \quad . \quad . \quad . \quad . \quad (2)$$

Numerically, this formula (2) differs considerably from (1).

As the notations may easily cause confusion, I wish to point out the different meanings of the two equations.

There exists three energy-levels in the L-group which have been designed by L_1, L_2, and L_3, where L_1 is much more marked than the two others. In the system of notation introduced by Bohr these levels were designated by L_{III}, L_{II}, and L_I respectively; that is, L_1 corresponds to L_{III} and L_3 to L_I. The fact that L_1 (or L_{III}) is the most prominent level in the L-group might explain why the true formula (2) containing the less prominent level L_3 or L_I has up to this time escaped observation.

As will be seen from my doctorate dissertation, the experimental results found by Prof. Richtmyer also fit very well with the two laws described in my former letter.

EDVIN JÖNSSON.

Physical Laboratory,
University, Upsala, Sweden,
Jan. 9.

Inflammable Gas from Plants.

IN Prof. Findlay's letter in NATURE of Jan. 14, he refers to Black's statement that "the *Dictamnus Fraxinella* emits" marsh gas "from its flowers," and asks for information on the topic.

Black undoubtedly alluded to *Dictamnus albus*, the fraxinella or dittany of southern Europe and central Asia, an old inhabitant of country gardens, which has showy, varicoloured, fragrant flowers. The plant is covered with glands that secrete a volatile oil, and in hot weather the air about the plant sometimes becomes inflammable therefrom.

According to Schimmel and Company (*Geschäftsber*, Oct. 1906) oil of white dittany contains 85 per cent. of pulegone, of which it smells strongly. Pulegone, or pulegenone, has been described by Semmler (*Ber.*, **35**, 1022; 1902), and by Wallach (*Ann.*, **329**, 125; 1903).

W. A. HAMOR.
(Assistant Director.)
Mellon Institute of Industrial Research,
Pittsburgh, Pa.,
Jan. 30.

Engines.[1]

By Prof. E. N. DA C. ANDRADE.

THERE is a certain appropriateness in 'Engines' as a subject for Christmas lectures at the Royal Institution. Most engines are machines for converting heat into work, and the first man to show experimentally the connexion between heat and work was Count Rumford, who founded the Institution in 1799. The original purpose of the Institution was "for diffusing the knowledge, and facilitating the general introduction of useful mechanical inventions and improvements; and for teaching by courses of philosophical lectures and experiments the applications of science to the common purposes of life." A course of lectures on engines certainly complies closely with this plan. While if it be urged that a physicist trained to occupy himself with vibrations and atoms should not meddle with things outside the usual scope of his studies, the physicist may, perhaps, without exposing himself to the absurd charge of arrogantly claiming kinship with so great a philosopher, point out that Thomas Young lectured at the Royal Institution on architecture and carpentry, on machinery, on hydraulics, and on what he called pneumatic machines, which included Newcomen's and Watt's engines, and the locomotive. In more recent times the present distinguished Fullerian professor of chemistry has lectured on trades. Precedent, then, is not lacking for the choice of so mechanic (using the word in the Shakespearian sense) a subject by a physicist.

Anything about engines has a claim on the attention of a juvenile auditory, but naturally with so vast a subject it is particularly necessary to have a very definite plan if the lectures are to be coherent. It was decided to make the course an illustrative commentary on the first two laws of thermodynamics, pointing out with a variety of examples how these laws operated, but carefully refraining from mentioning them by name, for fear of creating alarm and despondency in the juvenile ranks. The second law of thermodynamics may be held to be tough meat for the young, but it is perfectly easy to make boys and girls understand that you must have two different temperatures if heat is to be turned into work; to point out the two different temperatures in the case of each particular engine; and to show how there is always a striving on the part of the engineer to make the difference between these two temperatures as large as possible, because that enables us to turn the greatest fraction of our heat into work. The two laws were condensed in the phrases "Heat is work and work is heat" and "Lost temperature is lost opportunity," forms open, maybe, to criticism, but which proved convenient reminders of the substance of the rules. The last lecture was devoted to refrigerating engines, with the particular object of bringing home the essential character of the heat engine by showing what happens when it is driven backwards.

The chief difficulty in a course of Royal Institution lectures on engines is clearly the question of experiments and demonstrations. Some two hundred and fifty slides were prepared or borrowed, which helped to provide the necessary something-to-look-at. There is a certain number of simple experiments on mechanics and heat—on vapour pressure and steam, on explosions and on refrigeration—which can be conveniently shown to a large audience. Something more is needed, however, to give the lectures an engineering character, and that something was supplied by a large assortment of actual component parts of engines, and of models of engines and mechanisms, which the lecturer was fortunate enough to obtain on loan. Foremost among the lenders were the Science Museum, the director of which, Sir Henry Lyons, gave the most generous aid, and Mr. George Cussons, of Manchester, whose firm makes excellent working section models of all the chief types of engines and mechanisms, which proved admirably adapted for exhibition to a large audience. Loans from these sources were in evidence at nearly every lecture. Many other gentlemen[2] lent models of the products of their particular firms, models which proved a source of great interest.

In the first lecture, "The Rules which all Engines must obey," it was pointed out that, if there were no friction, the work done by any mechanism of pulleys, screws, or levers would be equal to the work done on the mechanism, but that, owing to friction, it was actually always less. A model hydraulic accumulator was used to emphasise the conservation of energy, and the meaning of power: a little pump slowly forced in the water which raised the accumulator piston, and then the energy so stored was quickly released to crush a cylinder of plasticine in a press. Talk of friction led to ball and roller bearing, and the Michell thrust block. A heavy wheel mounted on Skefko ball bearings (which, although it weighed some hundreds of pounds, turned to a silk handkerchief thrown on the spokes), and an air-lubricated model on the Michell principle provided practical illustrations. From the fact that diminished friction means diminished heat at bearings, passage was made to examples of great friction producing great heat, illustrated by the stock experiment of boiling ether in a rotating copper tube by friction against a wooden holder, the vapour blowing out a cork. Foucault's disc was used to show that, no matter how the resistance to motion arises, work done is turned into heat if no other effect is produced. Simple analogies of money changing were invoked to make clear the first law of thermodynamics. The fact that to convert heat into work special

[1] Summary of the one hundred and second course of Juvenile Christmas Lectures delivered at the Royal Institution on Dec. 29, 31, 1927, and Jan. 3, 5, 7, 10, 1928.

[2] Whose services will be acknowledged in the book which the writer is now preparing, to be published by Messrs. G. Bell and Sons.

conditions are necessary was then simply discussed, and the second law presented from the point of view already mentioned.

In the second lecture, "Learning about Steam," the meaning of vapour pressure and the simple properties of steam—such as the variation of boiling point with pressure, and the difference between saturated and superheated steam—were explained. The experiments on this point included lighting a cigarette at a jet of superheated steam. It was pointed out that steam is only an intermediary in the conversion of heat into work, and has no magical virtues of its own, and, to emphasise this, model engines were made to work with alcohol vapour, hot air, and liquid air. The creation of a partial vacuum by condensation of steam was discussed, with special reference to condensers.

The elementary properties of steam having been exposed, it was possible to run rapidly through the early history of the steam engine. A model working on Savery's principle, and the Science Museum model of Newcomen's atmospheric engine, were shown. Attention was directed to the experiments and inventions of Watt, in particular the separate condenser, the closed-in cylinder, the double-acting engine and the governor. It was mentioned incidentally that Watt did not invent the steam engine. This has caused abundant comment, and has made it clear that the belief that Watt did invent the steam engine is much more widely spread than the lecturer supposed.

The third lecture dealt with the reciprocating engine. First of all, methods of changing reciprocating into rotary and rotary into reciprocating motion were discussed—crank, eccentric, cam, and swash-plate, or slant. This last, an invention of Watt's, is now applied in the so-called crankless engine. A few words were said on valves and valve gear, in connexion with which models built of Meccano strips were demonstrated. The consequences of the modern use of high-pressure steam, the main advance since Watt's time, were mentioned, and the meaning and advantages of compounding briefly explained. The marine reciprocating engine was illustrated by a very fine model lent by Mr. Scott, of Michell Bearings, Ltd., a model which roused enthusiasm and envy among the juveniles. The merits and demerits of the steam locomotive were then discussed, the flexibility on one hand, and the waste consequent on the lack of a condenser on the other hand, being among the points mentioned. The locomotives built for different purposes nowadays differ widely in design, a great contrast being, for example, provided by the enormous American articulated goods locomotives and the elegant high-speed 'crack' English passenger locomotives. The lecturer ventured to put in a word on the beauty of the modern locomotive, in which the English practical genius finds artistic expression, and encouraged boys to continue to admire such engines as the *King George V.*, the *Royal Scot*, and the *Lord Nelson*.

The fourth lecture dealt with turbines. The simplest principle of converting the energy of a moving fluid into energy of rotary motion was illustrated by the windmill, in connexion with which the question of best speed of running was raised. The de Laval turbine led from this to the principle of velocity compounding and pressure compounding. The difference between an impulse and a reaction turbine was illustrated by a model consisting of two bicycle wheels, to the rim of one of which small rockets could be fastened obliquely. When the rockets were lit, the wheel to which they were attached rotated rapidly by the reaction principle if it was free. If, however, this wheel was held, and the other wheel, provided with oblique cup-like projections, brought near to it, then the rockets blew the second wheel round by the impulse principle.

The services of Sir Charles Parsons, who was called the Watt of the turbine, were then outlined, and a large number of slides of different turbines and components were shown, in particular of the Chicago 50,000 kilowatt installation. The special problems of the marine turbine—reversing and gearing—were then indicated. Finally, the turbine locomotive was mentioned, with a special word on the condenser which is fundamental for such a machine.

The subject of the fifth lecture was the internal combustion engine, where the heat is generated in the cylinder itself. Some explosions of gaseous mixtures in long tubes served to illustrate certain fundamental points of the gaseous explosion, such as finite velocity of travel and the effect of confinement. The fundamental importance of the compression stroke was emphasised, and the question of 'knock' consequent upon excessive compression and of anti-knock substances briefly handled. After gas engine and petrol engine followed the Diesel engine, simple physical experiments being shown to demonstrate the heating of air by compression. Two beautiful working sectioned models, some seven feet high, lent by Messrs. Burmeister and Wain, helped to make the action of the Diesel clear. The lecture closed with a word about the Still engine and the new Kitson-Still locomotive.

In the last lecture the principles of refrigeration were discussed, both the absorption and the vapour-compression plan. Water was very rapidly frozen on the Carré principle, by the use of a modern fast-sucking pump. The important part played by mechanical refrigeration in modern life was stressed, examples ranging from mining to food preserving and from ice-making to oxygen-making being cited. After the principles of the vapour compression machine had been demonstrated, the two laws of thermodynamics were restated and now mentioned by name. A simple illustration was provided by the help of a step ladder and a pile of flat wooden blocks, painted 'heat' on one side and 'work' on the other. Starting with the pile at the top of the ladder, it was explained that one unit could be turned from heat to work for every step of temperature through which the pile descended, and the conversion was effected by lifting a block and turning it round. When the heat was at atmospheric level, refrigeration was produced, the heat being made to go up a step by turning a unit of work into heat, and adding it to the pile.

In conclusion, the lecturer put in a plea for the recognition of the importance of a sound foundation of physics for engineering students, and ventured to ask if, perhaps, a little too much stress was not sometimes laid on workshop experience and the 'start at the bottom and sweep up the shavings' precepts. He suggested that workshop experience could always be acquired, but that unless physics was learnt early in life, it was never learnt properly. He therefore told his young listeners that if they wanted to be engineers—good engineers—they must study the working of the few simple rules of mechanics and physics of the operation of which they had seen so many examples in the course of the lectures.

Voices Across the Sea.

A JOINT meeting of the Institute of Electrical Engineers in New York and the Institution of Electrical Engineers in London was held on Feb. 16, between 10.30 and 11 A.M. New York time, and 3.30 and 4 P.M. London time. The occasion was the discussion of a paper on trans-Atlantic telephony at New York. For this purpose the telephone system connecting Great Britain with the United States was employed. Loud speakers were used, so that everyone in the Council Room and Lecture Room of the London Institution heard with perfect distinctness everything that was said by the speakers. Similarly, everyone in New York, at both the principal meeting and the overflow meeting, heard the speeches with perfect clearness, the disturbance from atmospherics being quite negligible.

Mr. Gherardi, the president of the American Institute, moved that Mr. Page, the president of the English Institution, take the chair at the joint meeting. This was agreed to unanimously. Mr. Page then invited Mr. Gherardi to address the meeting. Mr. Gherardi said that in the auditorium from which he was speaking there were present about a thousand electrical engineers, who came from all parts of the New World. He said that, as the result of the accumulated work of the scientific worker, the inventor, and the electrical engineer, this joint meeting had been made possible. In particular he mentioned Faraday, Maxwell, and Kelvin as having laid the foundations on which their art was built. Starting in 1876 with instruments and lines which with difficulty permitted communication over a few miles, telephone conversation now spanned the Atlantic. It had added yet another tie to the many uniting the two electrical institutions.

Mr. Page in his reply said that he represented the thirteen thousand members of the English Institution. He spoke feelingly of the boon that Graham Bell gave to the world by the invention of the telephone. His memory, along with that of Franklin and Henry, will ever be cherished as benefactors of mankind. He paid tribute to the great American Institution which has contributed so largely to the progress of electrical science, and has proved over and over again that the benefits conferred by engineering are truly international.

Colonel Purves, the engineer-in-chief to the Post Office, said it was a privilege to participate in a pioneer demonstration of a wider use of telephony which would tend to bring nations into closer relationship. It was a great thing that two large assemblies, separated by a wide expanse of ocean, could join together in interchanging their thoughts and ideas by the simple and natural medium of direct speech. It will conduce to a better mutual understanding. As we sit and talk to each other our speech is launched into the air by the radio transmitting stations at Rugby and at Rocky Point with an electromagnetic wave energy of more than 80 horse-power. By various refinements and special devices the speech-carrying efficiency of each unit is many thousands of times greater than that of an equivalent amount of power radiated by an ordinary broadcasting station. General Carty, of the American Telephone and Telegraph Company, brought forward a motion to the joint meeting that it express feelings of deep satisfaction that recent advances in radio communication have made it possible to have international assemblies, which should prove to be powerful agencies in the increase of goodwill and understanding among the nations.

In seconding the motion, Sir Oliver Lodge pointed out the various causes that have contributed to the success of radio communication. In the first place, there was the invention of the telephone. Next, in order to transmit speech by ether waves it was necessary to harness electrons by a thermionic valve. That ether waves are constrained by the atmosphere to follow the curvature of the earth's surface is an unexpected bonus on the part of Providence, such as is sometimes vouchsafed on behalf of human effort. The actual achievement of to-day is due to the scientific and engineering skill of many workers, both those in the background and those whose names are familiar to the public. The motion was then put by the chairman and carried unanimously. The meeting was then adjourned, the chairman adding 'good-bye.'

Before the joint meeting a film entitled 'Voices across the Sea' was shown, illustrating the processes that have to be gone through before a person in San Francisco can get into oral communication with a person in Plymouth. The path of the waves by the wires and over the ocean was indicated by luminous lines in motion. The delays at the various stations were also indicated, the whole operation before the lines were complete for speech taking only two or three minutes. From San Francisco to New York is by land line. The next link is to the transmitting station at Rocky Point, Long Island, then by radio to Cupar, and thence to Plymouth by land lines. The first link of the return journey is to Rugby, then by radio to Houlton, Maine, and so to San Francisco. The length of the radio link is about 3000 miles.

Obituary.

PROF. H. A. LORENTZ, FOR. MEM. R.S.

HENDRIK ANTOON LORENTZ, whose death on Feb. 4 has already been recorded in our columns, was the subject of an article by Sir Joseph Larmor in NATURE of Jan. 6, 1923, when we had the privilege of reproducing his portrait in our Scientific Worthies series. Reference must be made to this article for a complete account of his scientific work and its significance in the progress of physics. It will suffice to state here that Lorentz was born at Arnheim, Holland, on July 18, 1853, and received his early training at the University of Leyden, where he became professor of theoretical physics in 1878. In 1902 he received the Nobel Prize for Physics; in 1905 he was elected a foreign member of the Royal Society; three years later he received its Rumford Medal, and in 1918 the Copley Medal. Such was his record; his personal qualities are described in the following brief messages with which we have been favoured.

EVERY student of the physical sciences knows the magnificent work of Lorentz: and his contributions have already been warmly and ably explained to the world. It may be justifiable to write a few words concerning the part that he played as a leader in international science, for that is less well known.

For many years Lorentz naturally and by general consent took the leading place in every European conference of physicists. He had won the affection and respect of men from all countries. He could use several languages fluently and accurately. He could grasp quickly the meaning of a speaker, and immediately on the termination of an address he could repeat its arguments and conclusions in such other languages as might be desirable, so that all present were kept in touch with one another. He never allowed a discussion to stray.

Nevertheless, even his great abilities and his sound judgment would not alone have made Lorentz the perfect president that he was. His success was due also to a wonderful and most attractive courtliness, to a humour that could express itself in not one language alone, and not least to the charm of a kindly and affectionate disposition. He was really beloved by all who sat under him. In his own field, and that no insignificant one, he was one of the forces that drew together men of different nations and brought them to a mutual understanding. W. H. BRAGG.

IN thinking of Prof. Lorentz one calls to mind, before all scientific achievements, his charming personality. A familiar figure at international and other conferences, speaking fluently several languages, he delighted everyone with his happy speeches and engaging simplicity of manner. There was no eccentricity of genius about him; he was just one of the simplest and most likeable of men. He must have wielded an immense influence, for he had come to occupy a unique place in the esteem of scientific men of all nations. Meeting him last autumn at the Conference at Como, I could see no sign of any failure of activity; and his mind was always young and able to enter with zest into the latest and most difficult advances of physics. In his long career he produced much work of the highest rank. The older work is now part of the commonplace matter of physics which we learn without thinking very much as to who originated it, and it is not easy to recollect at short notice the numerous developments that we owe to him. But his name recalls especially the Lorentz transformation, the culminating point of one phase of electrodynamic theory and the foundation stone of the next—relativity. I think it would be from about 1895 to 1902 that Lorentz and Larmor between them created a new chapter in electrodynamics. This development had two sides, one concerned with the effect of motion on all kinds of phenomena, and the other with the transition from Maxwell's continuous theory to the theory of electrons. I can well remember (as a student about 1905) how exciting was the escape from the old elastic solid ethers with their specific inductive capacities and other conventionalised conceptions to this new world of electrons. Lorentz's "Versuch einer Theorie" (the abbreviation is so familiar that one forgets there must have been some more of the title) alongside Larmor's "Æther and Matter" was the opening to the new physics; and what an opening it has proved! A. S. EDDINGTON.

MY own connexion with Lorentz, or rather with his works, goes back into a somewhat distant past. I took my degree at Cambridge in 1876, a few months after he had graduated at Leyden. A conversation with Stokes directed me to optics, Fresnel's wave surface, and the laws of double refraction as a first subject of investigation, and made me acquainted with Lorentz's dissertation on the reflection and refraction of light. From that time on I learnt to admire his work, and as the years passed on to recognise in him a master of physical science. Only some few weeks since I became possessed of the first volume of his lectures just published, and read again with increased feelings of regard and admiration some of that earlier work.

But to pass on. Lodge's paper on aberration problems aroused afresh the interest in the Michelson and Morley experiment of 1887; I think it was in June of 1893, when Fitzgerald was examining in the Natural Sciences Tripos along with J. J. Thomson, that he told us one evening in Thomson's rooms of his explanation of the difficulty—the brilliant baseless guess of an Irish genius we thought it at the time—he had given it in his lectures, he said, and then rather later we learnt of Lorentz's work and his paper in the *Transactions of the Amsterdam Academy of Sciences*. Little did we realise at that time all that was involved in the Lorentz transformation and his brilliant investigations into the laws of electromagnetism applied to moving media.

For me, however, much personal contact with Lorentz did not come until later; administrative work at the National Physical Laboratory severed in great measure my connexion with theoretical physics, but in 1922 I met him again at a meeting of the International Research Council at Brussels. The Council had been formed in 1919 to consist of allies and neutral nations replacing the former Association of Academies. Holland became a member at an early date, and Lorentz realised that, in many directions for the advancement of natural knowledge, the co-operation of the Central Powers was a matter of necessity. To this end he worked, feeling, as he wrote in 1925, that "the time had come to give as soon as possible to scientific effort that character of universality which, as a consequence of the nature of science, it ought to possess, believing that the action which he desired the Assembly to take would show a confidence in the future which could not fail to call forth a reciprocal feeling and assist in scattering the shadows darkening the life of nations."

Those of us who, in 1926, after the president, M. Emile Picard, had declared the proposal to invite Germany, Austria, Hungary, and Bulgaria to join the Council, to be carried by the unanimous votes of the 25 countries present, listened to his speech of thanks realised, if we had not known it before, that Lorentz was a great man, not only an eminent man of science, but also one who for his efforts in the cause of peace in science had fitly earned the gratitude of all who hold that on the growth of scientific knowledge depends the future welfare of mankind.

The International Research Council meets again in Brussels this summer. Is it a vain hope that at that meeting all nations may unite in doing honour to the memory of a man whose devotion to the cause of science has been so great, and whose work has proved a starting-point of one of the most marked advances of our time?

RICHARD GLAZEBROOK.

IN 1879, Maxwell was taken away in the prime of life, leaving behind him a mass of unfinished problems which seemed to call for the special genius of a Maxwell for their solution. It soon became clear that his mantle had fallen in a very special degree on the young Dutch mathematician who had just been appointed, at the early age of twenty-five, to the chair of theoretical physics at Leyden.

Lorentz took up in turn almost all the unfinished threads of Maxwell's work and carried them at least to the stage which Maxwell might have hoped to reach in a normal span of life, and often far beyond. He examined the effects of fine-grainedness of structure of media which Maxwell had treated as continuous; he took account of the mass of electrical charges which Maxwell had been content to neglect. These last investigations assumed great importance after the electron had been unearthed experimentally and established in its proper place in physics. Indeed, Lorentz's name is very specially associated with the mathematical theory of electrons, and his immediate explanation of the newly discovered Zeeman effect was one of his most sensational, although perhaps not one of his greatest, achievements. Whereas Maxwell had generally disregarded the effects of motion through the ether, Lorentz set to work to correlate the phenomena observable in systems at rest with those of systems in motion. He got so far as to show that the two sets of phenomena would be the same except for slight differences, imperceptible in practice, such as might be attributed to small (second-order) differences in clocks and measuring-rods. But this edifice needed for its consolidation a theory which ultimately came from other hands.

The aims of the two men were the same, but not their methods. Maxwell's science was an enchanted fairyland in which no one knew what magic would happen next. Lorentz's science was a workshop, in which tools of exquisite precision were fashioned with infinite care in view of all the world, and turned to their prearranged purposes; one almost seemed to see science growing according to plan.

Lorentz was beloved by all who had the honour of knowing him; the present writer can pay special tribute to his unfailing kindness and patience in discussing problems with men of a younger generation who had no conceivable claims on his time. Our admiration for his achievements is unbounded, but we will remember him mainly as our genial, kindly, and very human friend.

J. H. JEANS.

THERE is a remarkable unity, for the most part, in the work of Lorentz, converging as it does on the great purpose, to frame if possible a consistent theory of electricity and light and their mutual relations, and to clear up the obscurities inherent in these subjects, which are scarcely yet entirely dissipated. His studies on thermodynamics and radiation and gas theory may be recognised as all ancillary to the main purpose. To survey the titles alone of his published papers, in anything like a chronological sequence, is to recall the successive stages in a long endeavour which culminated in the theory of electrons and (in a restricted sense) of relativity. It is unfortunate from this point of view that the issue of his collected papers, begun in 1907, has not been continued. It was characteristic of the writer, though perhaps to be regretted on historical grounds, that he could not resist the very natural temptation, in a progressive subject, to revise and even to rewrite many of these by the light of further knowledge and reflection. It is to be hoped, in the interests of scientific history, that the publication will before long be continued and completed, as a fitting memorial of a great and effective genius.

The contents of the volume already published show that his interests were not wholly restricted to the speculations referred to, absorbing as these were. We find, for example, a paper on the turbulent flow of water in pipes. The theoretical work of Reynolds is here presented in a simplified form, and a novel attempt is made to find, on theoretical grounds, a limiting value of the 'critical

velocity.' The paper was probably the first introduction of the matter to continental readers. We find, again, an elegant mathematical paper on viscous motion of fluids, in which a certain 'reciprocal theorem' is used to extend somewhat the range of soluble problems. There is also an interesting discussion of the Hertzian dynamics, which was attractive, no doubt, for the 'geodesic' principle on which it is based. Finally, we may mention an elegant article on the classification of crystal forms.

To British investigators, Lorentz was ever a most sympathetic figure. This was due partly to his mastery of our language, which made personal relations easy, partly to his keen admiration of the work of the great English leaders of his time (notably Maxwell), and above all to the transparent kindliness and charm of his character, with its strict integrity, and the engaging candour with which he always admitted and even emphasised such difficulties as he had not been able to surmount.

H. LAMB.

THE unexpected death of Prof. Lorentz, premature not in years but in intellect, removes from the world a gracious figure, that will stand in the range of succession of other past leaders—Volta, Davy, Ampère, Faraday, Hamilton, Stokes, Helmholtz, Kelvin, Kirchhoff, Maxwell, Rayleigh, Boltzmann, Willard Gibbs, Hertz, Poincaré—in the development of physical ideas, especially on the side of the consolidation of theory. The main characteristic which he exhibited, most prominently in recent years, has been great rapidity of assimilation, resulting in conciseness and clarity of exposition, over all the field of mathematical physics. This has always been a welcome feature to his colleagues in Great Britain, brought up, from the mode of their education, towards width of outlook. He was the ideal leader for an international congress, for he was the most learned and rapid of contemporary physicists. Of necessity, therefore, he took his knowledge from where he could most readily find it; and perhaps the work of the great originating minds of the British school was not so fully before him historically as it has been to their own countrymen—as indeed on occasion he has been the first to admit. When one considers his fifty years of scientific activity, absolutely in the front rank, the zest and power with which in recent years he has thrown himself into new phases of physical development, such as relativity and *quanta*, often problematical and perplexing to older modes of thought, have been most remarkable. He has been an outstanding ornament of the Dutch school, and of their historic university of Leyden: and when one looks around for his peers the name of Huygens is apt to rise to mind.

JOSEPH LARMOR.

THE concentrated power of the human mind is illustrated by the achievements of mathematical physicists more decisively than by any other pursuit. The miracle does not lie in the working out of equations, but in the dissection and recognition of the essential operations of natural law with such completeness and clarity that the construction of equations to represent the intrinsic forces at work becomes possible. The deduction of consequences then naturally follows, or can be left to time.

In addition to analytical power, H. A. Lorentz had an exceptionally clear perception of the essentials of a physical process, and was able to state them with novel precision. He had thus the rare and enviable power of dealing with elementary and familiar facts in such a way as to interest advanced experts; for he could display unexpected connexions, and disentangle unforeseen contradictions, even in subjects which have long been taught superficially to first-year students. In this illuminating and clarifying power he has been likened to the late Lord Rayleigh, and the comparison is just. The difference was that Lorentz was a professor with worshipful students who took down and published some of his lectures, whereas Rayleigh had for the most part to range over the field of physical science by himself. Both clarified everything they touched. The way in which Lorentz's work dovetailed into, and often heralded, some of the modern developments—a search for invariants and the like,—his thorough grasp of the knowledge of his time, and his many steps over the border into new territory, have been dealt with in NATURE of Jan. 6, 1923, by a master mind: the only defect being that Larmor's own precursory or simultaneous contributions, which enabled him to appreciate so quickly the work of Lorentz, have been slurred over or ignored in that appreciative article.

In the past, too much of Lorentz's work has been partially buried in the *Archives Néerlandaises*, or has been made known only through lecture notes. A collection of his papers for English-speaking countries would be a great help; they might serve to recall attention to the physical bearing of some of the recondite speculations and revolutionary methods of treatment now in vogue, and help to re-establish connexion with much that has gone before.

Where so much has been done, it may seem trivial to pick out a single instance of Lorentz's scientific insight, but I was personally concerned in verifying the Zeeman dissection of spectrum lines by a magnetic field, at an early stage ("Year-book of the Royal Society for 1897," 98, p. 119), and could appreciate the almost contemporaneous electron-orbit precessional theory of Lorentz. It is well known that he anticipated or predicted a number of subsidiary details, about polarisation and the like, which were forthwith abundantly verified by observation.

I had the pleasure of entertaining Prof. and Mme. Lorentz at Edgbaston on the occasion of the conferment of an honorary degree, and they became our valued friends. With his scientific or philosophic outlook I found myself in close sympathy.

OLIVER LODGE.

I CANNOT pretend to write any appreciation of Lorentz's scientific work. I have only known him as chairman of a small international body of which I am a member, the committee set up by the League of Nations to provide the machinery

of international co-operation, when required, in questions of science, arts, and letters. It is generally known as the C.I.C. or Committee of Intellectual Co-operation.

The first chairman was the philosopher Bergson, a swift and subtle thinker, a man of infinite accomplishments, accustomed to the great world, and a speaker of distinguished eloquence, equally at home in French and English. When Bergson retired, it seemed almost impossible to fill his place, until someone—I have been told it was his pupil Einstein—suggested the name of Lorentz. He was not at the time a member of the committee, but as soon as he came among us he impressed all his colleagues as the right man. He had not the brilliance or the diplomatic power of Bergson; but his patience and courtesy, his imperturbable fair-mindedness, his transparent simplicity and goodwill, together with his great scientific eminence and his easy command of English, French, and German, gave him at once the entire confidence and affection of the committee. He had the advantage, of course, of coming from a neutral country; he had no old enmities to forget, and his own devotion to the cause of international appeasement and common sense was so obvious that one never spoke of it. It could be taken for granted.

All the multifarious undertakings of the committee come before the chairman, and Lorentz had to arrange for the consideration of problems of bibliography, of art, and even of law, as well as of science proper. He never failed in lucidity and never lost patience. But above all he enabled his literary colleagues to understand and appreciate the noble simplicity of a great mind genuinely devoted to science. GILBERT MURRAY.

ALL physicists, young and old, realise and appreciate the importance of Lorentz's work. Those who are old enough to be his contemporaries, who read his papers as they appeared, or rather as they were translated, who know the views prevalent before they came out and the changes they produced, can perhaps realise more easily than the younger men the effect of his work and the magnitude of the influence it has had on the progress of science. This feeling will be especially acute in those who more than fifty years ago were convinced of the truth of Maxwell's theory of light and interested in its development, for Lorentz was the first pioneer of Maxwell's theory.

Lorentz's first work, a dissertation for the doctor's degree in 1875, was an application of Maxwell's theory to the problem of the reflection and refraction of light by dielectrics and also by metals. This, so far as my knowledge goes, was the first application of Maxwell's theory other than those made by Maxwell himself. This was followed by a still more important paper on the relation between the refractive index and the density of bodies; this was the first application of Maxwell's theory to a medium consisting of discrete molecules which could be polarised by electric forces. We have in the same connexion his great memoirs, "La Théorie électromagnétique de Maxwell et son application aux corps mouvants" (1892) and "Versuch einer Theorie der elektrischen und optischen Erscheinungen in bewegten Körpern" (1895), the second of these being the beginning of the great subject of relativity.

There is no space here to discuss Lorentz's work in any detail; it covered so much ground and his papers throw so much light on the state of scientific opinion when they were written that an edition of collected papers, which it is to be hoped will be one of the ways in which his memory will be commemorated, would supply invaluable material for the history of physics during the past half-century.

Lorentz's services to science were not confined to his own researches; he was an admirable expositor in many languages. Those who heard him give in 1923 the Rede Lecture in Cambridge on Maxwell's electromagnetic theory will remember that without any notes he spoke for an hour in perfect English, never hesitating for a word. In addition to expressing his own ideas clearly, he was remarkably quick at understanding the ideas of other people, and often, though he might not agree with them, put them more clearly than their author. These qualities, combined with unfailing courtesy and kindliness, made him unrivalled as the chairman at a scientific conference. He was, I should think, the most cosmopolitan man of science that ever lived. He travelled widely in many countries, and there can be but few universities either in the Old World or the New in which he had not lectured and inspired and encouraged both teachers and students, and stimulated them to undertake further investigations. Besides his own researches, great as these are, science owes to him many others of which he was directly or indirectly the begetter. J. J. THOMSON.

THE news of Prof. Lorentz's death will be heard with deep regret by many friends in England and Scotland who had come under the influence of his remarkable personal charm, and admired him for his grace, sincerity, and kindliness, no less than for his great scientific achievements.

Lorentz's fame will, I think, ultimately rest chiefly on his electron-theory and all that followed from it. The essential characteristics of this theory were that all electric, magnetic, and optical phenomena were supposed to be due to the presence or motion of individual electric charges, constituting the link between ponderable matter on one hand, and the ether on the other. Matter and ether were supposed not to interact directly, and to be capable of influencing each other only through the mediation of electrons: moreover, the electrons were assumed not to interact directly (as they had been supposed to do in the older electron-theories), and to be capable of influencing each other only through the mediation of the ether. The ether itself was conceived to be at rest everywhere and at all times, whereas in the earlier theories it had been regarded as entangled with the particles of bodies, and carried along with these when they

move: Lorentz's ether was, in fact, merely space endowed with certain properties. The general plan of the investigation was to reduce all the complicated cases of electric and magnetic action, *e.g.* the properties of dielectrics, metallic conduction, metallic reflection, the Hall effect, etc., to one simple and fundamental case, in which the field contained only free ether with electrons at rest or moving in it.

The theory was remarkably successful, unifying and simplifying everything, and, in particular, reconciling the electromagnetic equations with Fresnel's law of the propagation of light in moving bodies. But it was, in its original form, incompetent to explain the negative result of the Michelson-Morley experiment: to meet this difficulty, the additional hypothesis of the Fitzgerald contraction was adopted in 1892: and in 1895 Lorentz made another advance on the road to relativity by introducing the idea of 'local time.' Larmor in 1900 extended the analysis so as to include small quantities of the second order, and thereby discovered the connexion of Lorentz's theory of local time with FitzGerald's contraction: and in 1903 Lorentz went further still and obtained the exact transformation which is known by his name and is the basis of the theory of special relativity. The principle of relativity itself was first clearly enunciated in the following year by Lorentz and Poincaré, especially in the latter's address delivered in September 1904 before the International Congress of Arts and Science at St. Louis. To the subsequent development of the subject Lorentz made important contributions, though perhaps none so epoch-making as his great discoveries of the period 1892–1904.

E. T. WHITTAKER.

News and Views.

THE Bill for the Stabilisation of Easter was advanced a stage in the House of Commons on Feb. 17, when, on the motion of Captain Bourne, seconded by Mr. Withers, it was read a second time. Following the suggestion of the League of Nations special committee of inquiry, the proposed date for Easter is the Sunday after the second Saturday in April, the purpose of this provision being (1) to make the festival coincide as nearly as possible with what appears to be the actual date of the event commemorated, and (2) to avoid the clashing of Passion Sunday with the Feast of the Annunciation (as actually happens this year when Easter falls on the second Sunday). Some of the speakers opposing the Bill urged that meteorological conditions are apt to be unfavourable at the period named, but such objections must be completely outweighed by a consideration of the historical grounds on which the proposed date has been chosen and the fact that Easter is a festival for all countries. A point which emerged clearly in the course of the debate is that the promoters of the Bill have no desire to override the ecclesiastical authorities. The Bill itself provides that it shall not come into operation without an order in Council, so as to give an opportunity for arrangement with the Churches, and the Home Secretary, in supporting the Bill, remarked that its promoters were willing to strengthen this safeguard by inserting a further clause under which such an order shall not be made without a resolution by Parliament in its favour. The Bill was actually a response to the desire of the ecclesiastical authorities for assurance that the stabilisation of the festival is demanded, and the Home Secretary said that its acceptance would be regarded as an instruction to set to work on the requisite negotiations. Sir H. Slesser, who had moved the rejection of the Bill, then withdrew his motion.

As regards the meteorological side to the problem of choosing the best period for a fixed Easter in April, statistics show that there is a slight general tendency over Great Britain as a whole for more rain to fall as the month grows older. This is due, no doubt, to the fact that the heating effect of the sun, and consequently the average temperature of the lower layers of the atmosphere during the middle of the day, is increasing rather rapidly, in consequence of which convectional rain of the type of the thunder shower becomes more common. This tendency is, however, too small to be of much practical importance. Some meteorologists believe that a sudden set-back of temperature is particularly liable to take place at certain fixed times in the spring and early summer, but even if this belief can be justified statistically—a matter of some doubt—the regularity of recurrence of these set-backs is not sufficient for the effect to be worth taking into account. That abrupt changes from summer warmth to winter cold do take place in most years at least once between the beginning of April and the end of May, is a matter of common knowledge, but it seems probable that this effect is associated with a marked annual variation in the frequency of occurrence of anticyclones over Greenland. The northerly or north-easterly winds that bring the cold weather normally descend to temperate latitudes along the eastern margins of such anticyclones; the maximum frequency is reached in May, and although a gradual increase takes place in the course of April, which gives the early part of the month some slight advantage, this is more than outweighed later by the greatly increased length of the day, and by the fact that not only does the earth then receive more heat and light from the sun, but also a higher proportion of the ultra-violet radiation, without which no holiday can be regarded as ideal from the point of view of health.

THE Galton Lecture delivered on the anniversary of Sir Francis Galton's birthday is an annual feature of the Eugenics Society, The lecturer this year was Dr. C. J. Bond, of Leicester, who chose as his subject "The Distribution of Natural Capacity in the Population and the Need for a National Stocktaking." Though it cannot be said that Dr. Bond introduced his audience to any new ideas, yet he gave forceful expression to several well-established ones at present

too much neglected. He pointed out that in all societies aristocracies tend to die out, and that the great reservoir of vigour from which the life of the nation is recruited is to be found in the middle class. Since this class consists of those who by their energy and perseverance have raised themselves to a position of financial independence, and since in the last resort the life of the nation rests on the daring and enterprise of its citizens, this is what might be deduced from *a priori* consideration. The younger sons of middle-class families who go abroad on errands of commercial enterprise or colonial government are the legitimate successors of the merchant adventurers of Queen Elizabeth's time, who, although they used more questionable methods for the promotion of British trade, were the real founders of the British Empire. Dr. Bond pointed out, however, that the middle class is losing its reproductive capacity, and he attributed this chiefly to the practice of voluntary birth-control. The motive inducing this practice is largely the desire to avoid being crushed by the taxation levied on them to supply the needs of what Dr. Bond called the degenerate class—the cancer-cells of the social organism who reproduce recklessly without any thought of the morrow, and propagate stupidity and laziness from generation to generation. Dr. Bond's remedy is to give free knowledge of the means of birth-control to all who desire it, and if this is ineffective he boldly advocates the ultimate sterilisation of the thriftless. Though Dr. Bond's views may be unpopular in a sentimental age, the nation which neglects them is doomed to decline and degeneracy.

Dr. Bond's plea for a 'stock-taking' or mental and physical measurement of the population, introduced more questionable considerations. The ultimate test of the fitness to survive which Nature applies to the citizen is his ability to maintain himself under existing conditions—in ultimate analysis, fitness is economic fitness. Leaving aside the pathological cases of the victims of hereditary disease or mental weakness, who only constitute at the worst a small percentage of the community, it seems to us impossible to devise an arbitrary test which shall separate the fit from the unfit. The Simon and Binet mental tests have proved disappointing in practice: often those whose response to these tests indicates a low mental age, prove better able to maintain themselves in the struggle for life than their supposedly better intellectually equipped brethren. Differences of physical development may be partly due to 'inborn characters,' but we are constantly receiving shocks in discovering that what were considered to be hereditary defects are really due to the handing on from generation to generation of bad diet and bad air. Dr. Bond rightly compared the aberrancies of human population to the 'sports' in domestic animals. He did not reflect, however, that 'sports,' although hereditary, must owe their origin to definite causes, and that the evidence before us justifies the belief that when these causes cease to operate the 'sport' ultimately reverts to the wild type. The ultimate cause of many of the physical defects in the population of England is overcrowding, due to over-population. When this is remedied such defects will disappear, if not entirely in one generation, at any rate in two or three.

Prof. Hugh S. Taylor, of Princeton University, has been awarded the Nichols medal for 1928 by the New York Section of the American Chemical Society. The medal, awarded for "the research published during the current year which in the opinion of the jury is most original and stimulative to further research," will be made to Prof. Taylor at a gathering of American chemists in Rumford Hall, 50 East 41st Street, on Mar. 9, when he will deliver an address on "Catalysis as an Inspiration of Fundamental Research." Prof. Taylor, who is widely known for his studies in catalysis, holds the David B. Jones research professorship of chemistry in Princeton, a chair founded last year by Miss Gwenathlyn Jones, of Chicago, in memory of her father, David B. Jones, and as part of the newly organised endowment for scientific research in Princeton. Prof. Taylor is English by birth and was educated at the University of Liverpool, and at the Nobel Institute, Stockholm, under Arrhenius, where he made his first investigations on catalysis, and at the Technische Hochschule at Hanover, where he carried out investigations with Prof. Max Bodenstein on photo-chemistry and reactions produced by the α-particles from radium. Prof. Taylor went to Princeton early in 1914 as instructor in physical chemistry and was made assistant professor in 1915. During the War he was employed on munition work by the Government of Great Britain on problems relating to the fixation of atmospheric nitrogen for use in explosives.

On his return to Princeton in 1919, Prof. Taylor initiated a wide programme of research on the physical and chemical properties of the catalytic materials used in such important catalytic industries as ammonia synthesis, the hardening of oils to produce edible fats, and the more recent industrial synthesis of wood alcohol or methanol. This work led to the formulation, in the *Journal of Physical Chemistry*, in 1925, of a theory of the catalytic surface which is now accepted generally by students of catalysis. In attempting to explain the acceleration of chemical processes occurring at such surfaces, it was postulated that the reacting elements might exist on the surface of catalysts in the atomic condition. This was demonstrated experimentally and led to a study of the properties of free atomic hydrogen. In this work new methods of producing hydrogen peroxide and formaldehyde were worked out, the industrial applications of which are being studied in the United States and in Germany. During the last two years Prof. Taylor has been chairman of the Central Petroleum Committee of the U.S. National Research Council, in which capacity he has charge of the allocation of grants from the 500,000 dollar fund created by gifts from John D. Rockefeller, sen., and the Universal Oil Products Company for the promotion of fundamental research in the physics, chemistry, and geology of petroleum. In this connexion he has recently devoted considerable attention to the scientific problems involved in the conservation of gas and oil in the recovery of oil.

Prof. Taylor is the author, with Dr. E. K. Rideal, of "Catalysis in Theory and Practice," the editor and part author of a "Treatise on Physical Chemistry," and has written monographs on "Industrial Hydrogen" and on "Fuel Production and Utilisation."

WICKEN FEN, half-way between Ely and Newmarket, promises to become one of the most interesting of the reserves held under the National Trust for Places of Historic Interest or Natural Beauty. The history of old England lies in its sedge beds and is embedded in its peat, and the old story since the days when the walrus sported in the sea which covered the Fen area, lies, complete and untampered with by the hand of man, awaiting the unfolding of the naturalist. In a pamphlet which accompanies a new part of the "Natural History of Wicken Fen," Prof. Stanley Gardiner shows how circumstances have conspired to retain this aboriginal inlier in the midst of an area which man has interfered with, at latest since the Romans began to drain the marsh. A very large area of the marsh has been recovered, but, because of its position as an area for drainage concentration, Wicken Fen has not only never been cultivated, but also has never been deliberately drained. So that, if its peat layers retain the relics of successive faunas of prehistoric times, the Fen itself retains, so far as may be, the original fen fauna of earliest historic England. It may be said that similar native areas are to be found in the wilds of the Scottish Highlands. But there is a vital difference: Scottish and other moorland marshes are saturated with acid waters which breed their own special flora and fauna; Wicken, peculiar in possessing alkaline water, stands at the opposite pole as regards the composition of its plant and animal life. For this reason alone, it is worthy of preservation and investigation; but when it is added that it contains the relics of an old flora and fauna now rapidly disappearing, and that it offers almost the only opportunity of interpreting the changes which the centuries have wrought in the fen assemblages which predominated over a large part of ancient England, the need for preserving it intact for present and future generations becomes insistent.

UNFORTUNATELY, this keeping intact is not so easy of accomplishment at Wicken as in many another reserve. The sedge, under the deliberate cropping of centuries for the thatch of houses, grows so strongly that if left uncut it forms a tangle impenetrable to the delicate bills of wading birds, which nest in summer and resort in multitudes to the marsh in winter. Brushwood, which has conquered much of the surrounding land and has there reduced the fauna from about 6000 to less than 2000 species, gradually intrudes and has to be uprooted. Gunmen hire adjoining areas, and, like the professional collectors of rare insects and rare birds and their eggs, regard the abundance of preserved creatures as a godsend, and make the most of opportunities they have done nothing to create. Watchers must be hired to keep them at bay, an expensive item, which would be reduced if the outlying areas abutting on or penetrating into the reserve—and some are already derelict—could be purchased as they come into the market. The recurring annual upkeep and the need for non-recurring expenditure in purchasing such desirable extensions, cannot be met by the funds at the disposal of the local committee. We understand that the National Trust is at the present moment issuing an appeal for such sums as would make Wicken Fen a permanent and worthy acquisition for the nation and an inestimable boon to the naturalist and the scientific student of ecology and of the history of England's fauna and flora. Most heartily we commend to the attention and generosity of our readers this appeal, copies of which may be obtained from the secretary of the Trust, 7 Buckingham Palace Gardens, London, S.W.1.

A SECOND annual report upon "Bird Sanctuaries in Royal Parks in Scotland," by the Committee appointed by Viscount Peel, has just been issued by H.M. Stationery Office (Price 6*d*. net). It shows how effective, even in the course of a couple of years, may be the planting of suitable cover and food plants and the protection of an area in inducing the presence of additional species of birds. At Duddingston Loch, within the precincts of Edinburgh, twelve additional species nested during the summer of 1927, and five birds, not before recorded, visited the sanctuary, including a goldfinch, attracted by teazle which had been planted during the spring. It is now considered that sufficient additional cover has been provided. The population of this interesting area, which is particularly favoured by hosts of immigrant ducks during the autumn and winter, now numbers 39 nesting species, 33 regular visitors, and 23 casual visitors. The Committee has wisely enlisted the co-operation of local naturalists by appointing several recognised ornithologists as official observers. Further, in order that a scientific study of the inter-relationships of plant and animal life, and of the changes in fauna and flora brought about through the reversion of the sanctuary to a state of Nature, may be made, the Committee has in addition instituted a botanical and entomological survey of the area. In this it is fortunate to have enlisted the help of the officers of the Royal Botanic Garden, Edinburgh, and a summary of a detailed report on "The Plant Life of Duddingston Loch," by Mr. J. R. Matthews and Mr. G. Taylor, is appended to the Report.

IN a further lecture "From Faraday's Note Books" at the Royal Institution on Feb. 16, Sir William Bragg stated that Faraday's work on gold films and gold suspensions is one of the fundamental researches of the subject. He chose the subject for his Bakerian Lecture before the Royal Society in 1857; and few Royal Society papers have been more widely read and quoted. Curiously enough, his first inquiries were made without any consideration of the rich system of gold colours; and of course with no idea of the ultimate importance of his work to colloid chemistry. He wished to enter the field of research opened up by the then recent discoveries belonging to the undulatory theory of light. He thought that

if he could investigate the action upon light of particles or films which were so small or so thin that several of them could be contained in the length of a wave of light, then some special phenomenon might be found which would help him to extend the new theory. His thoughts turned towards the use of gold leaf; and he arranged for a visit to his friend Mr. Warren de la Rue, the well-known printer, who was the fortunate possessor of a fine microscope; and on Jan. 27, 1856, they "had a good evening together." This was the beginning of several months of hard work. His laboratory notes fill hundreds of pages; and hundreds of the specimens which he made still remain at the Royal Institution, carefully arranged and indexed. The problem opened out in unexpected directions. He was never able to co-ordinate completely all the extraordinary observations which he made; nor indeed has modern theory been able to complete the task with all satisfaction. It did not throw much light on the undulatory theory, but it has been invaluable to the colloid chemist engaged in an attempt to unravel the mysteries of one of the most complex, fascinating, and important of all the sciences.

THE publication of the first number of *Africa*, the journal of the International Institute of African Languages and Cultures, will afford a wider public an opportunity of appreciating the importance of this movement for placing African studies on a broader basis. In present conditions, political and other, international co-operation and co-ordination are essential in the solution of the many-sided problems presented by Africa. This is as true in the field of purely scientific research as it is in the domain of the practical problem of administration. Mr. Driberg, for example, in this number, in discussing primitive law in eastern Africa, emphasises the danger of generalisation from data which extended observation may show to be sporadic only, and perhaps even restricted to a certain area. The success of the Institute and the measure of support it may expect will depend upon the extent to which it is able to promote investigation on these lines, otherwise it merely enters into competition with existing organisations which deal with African studies. Its aims, as formulated here by Sir Frederick (now Lord) Lugard, are admirable, especially in so far as attention is to be given to the practical bearing of research on economic and administrative questions. Excellent as is the first number of *Africa*, however, it cannot be said that all the papers are of the type which might most usefully be published by the Institute; but Mr. Driberg's paper already mentioned, and Capt. Rattray's article on "Anthropology and Christian Missions," are very much to the point.

INVITATIONS are to be sent out shortly for the next meeting of the International Astronomical Union, to be held at Leyden on July 5-13 of this year, together with the provisional programme of the meeting. The president of the Union is making use of his statutory prerogative to invite persons belonging to nations that have not yet joined the Union, and it is expected with certainty that many of these will accept the invitation. The Leyden meeting of the Union will thus be the first of the congresses of the unions founded under the auspices of the International Research Council, that will be completely international in character and in which representatives of science belonging to countries that stood on opposite sides during the War will meet in a spirit of international brotherhood.

IN all fields of biology the importance of accurate measurements and quantitative data is being increasingly realised. Much work is not infrequently rendered useless, or at least much less useful than it might be, through neglect of simple precautions in the making, recording, analysis or presentation of such data. A committee of Section D (Zoology) of the British Association has concerned itself with these matters, and has issued a valuable report in which important recommendations are made. The committee found that the satisfactory presentation of statistical data is often impaired by the reluctance of editors to print extensive numerical data in full, and negotiated for the establishment of centrally placed archives for the reception of original data too extensive for complete publication. The Natural History Museum at South Kensington and the Royal Society of Edinburgh have both agreed to undertake this function. The data thus deposited in these archives will be available to students, and in this sense will have secured effective publication.

THE leaflet which has been issued by this Committee consists of a foreword illustrating the needs of biological work, followed by sections on (*a*) the planning and execution of research by metrical methods, (*b*) the methods of compact presentation of data and the recognised methods by which it can be adequately summarised, (*c*) the interpretation of statistical results and tests of significance, and (*d*) detailed references to text-books on the several types of tests generally required. The leaflet will be of the greatest possible service to biological workers, and should go far towards securing uniformity in the compilation and presentation of statistical data. It deserves to be widely known among workers in this field of biology.

SOME new picture postcards have been placed on sale at the Royal Botanic Gardens, Kew. The most interesting is probably a view of the Iris Garden, in natural colours, showing the beds of Iris in full bloom. Other pictures include *Angræcum sesquipedale*, an orchid which has a nectary up to 1½ feet in length: *Dendrobium thyrsiflorum*: *Prunus Lannesiana*. There is a set of six pictures in colour, representing several kinds of brilliantly coloured water-fowl which inhabit the neighbourhood of the pond; also a set of seven black-and-white cards showing some of the ornamental geese which are to be found near the lake. This set includes a picture of "Joey," the handsome Stanley crane which must be familiar to most visitors during the summer months. The prices are 6*d*. for a set of seven black-and-white cards, and 1*s*. for a set of six coloured cards with descriptive leaflet.

A VERY interesting feature of Section K at the Leeds meeting of the British Association in September last was Dr. Lotsy's demonstration of wild hybrids from various parts of the world, which attracted so much attention that it had to be twice repeated. The importance of such investigations, especially in relation to Dr. Lotsy's well-known views on the rôle of hybridisation in evolution, is so obvious as to require no special emphasis, and Dr. Lotsy is to be congratulated on the accumulation of a wealth of highly interesting material. Starting with coloured drawings illustrating the wide diversity in the second generation of crosses made in his own experimental garden between two varieties of pumpkins and between *Tragopogon pratensis* and *T. porrifolius* respectively, Dr. Lotsy proceeded to demonstrate the occurrence of similar hybrid swarms in Nature. In the first place, he showed a series of coloured drawings of segregates from the spontaneous cross *Primula auricula* × *P. viscosa*, found on the Weisshorn near Arosa, and prepared by their discoverer, Dr. Knoll. As an American example he demonstrated the wide range within certain species of Opuntia observed by him around Tucson in Arizona in connexion with Dr. MacDougal's investigations on artificial Opuntia-hybrids.

MANY of the examples used in Dr. Lotsy's demonstration were obtained in New Zealand, partly by Dr. Lotsy himself during three months' exploration of both islands under the invaluable guidance of Dr. L. Cockayne, the pioneer in this field in New Zealand, and partly by Dr. H. H. Allan, of Fielding, and Messrs. A. W. Thomson, J. Scott Thomson, and G. Simpson, of Dunedin. Even a three weeks' stay in Australia afforded some interesting cases, thanks to the help of Profs. Lawson and Osborn, as well as of Messrs. S. L. Kessel and C. A. Gardner, of the Forestry Department, and of Mr. W. H. Carne, of the Department of Agriculture, Perth. Finally, Dr. Lotsy showed a fine collection of coloured drawings by Dr. Goddyn, both of plant hybrids and of hybrids between different human races, from South Africa. In obtaining these he was materially assisted by Prof. Schönland, Dr. Marloth, and Mr. Dyer, of the Botanical Survey. In concluding, Dr. Lotsy expressed his great indebtedness to the many who assisted him in the search for wild hybrids, either directly or by extending hospitality to himself and his party, and also to the governments of the three Dominions who materially aided his investigations by providing free railway passes and other facilities.

MANY of us who scan the posters of the Empire Marketing Board may be inclined to ask whether, and to what extent, the Board is assisting the British agriculturist to extend his markets. These and other questions are answered in a pamphlet, "The Empire Marketing Board and the Home Producer," which will be sent free to any inquirer by the Board on application to its offices, 2 Queen Anne's Gate Buildings, Dartmouth Street, London, S.W.1. In this pamphlet the Board outlines briefly the methods by which, directly or indirectly, it has given real help to the British farmer, as distinct from the Colonial agriculturist. Its posters have advocated "home buying first"; grants have been made to the Ministry of Agriculture to enable the Ministry to conduct investigations into improved methods of packing, grading, and marketing produce (some of these, no doubt, based on the best experience of the Colonial producer); while the Ministry of Agriculture has, in turn, made substantial grants to various fruit growers' associations and agricultural research departments. Grants have also been made direct by the Empire Marketing Board to the Scottish National Milk and Health Association to enable the latter to carry out large-scale experiments on the feeding of school children in various Scottish centres upon milk, and to increase the consumption of milk in Scotland, while in Northern Ireland it is co-operating in investigations into the marketing of Northern Ireland butter and eggs. The Board is also now issuing a series of *Weekly Fruit Intelligence News*, to keep the British consumer up-to-date in the matter of supplies from the Colonies. Any one further interested in the work of the Board is recommended to obtain a free copy of the first report, "A Year's Progress," which gives fuller details of grants made and the research and other work to be covered by such grants.

THE annual Congress of The South-Eastern Union of Scientific Societies will be held at Rochester on June 6-9 inclusive, under the presidency of Sir Martin Conway.

MR. W. H. WRIGHT, of the Lick Observatory, has been appointed George Darwin lecturer for 1928 of the Royal Astronomical Society. The lecture will be delivered in June, and will probably deal with the photography of the planets with different colour filters.

SIR JOSEPH THOMSON will deliver the thirteenth Guthrie Lecture of the Physical Society, taking as his subject "Electrodeless Discharge through Gases." The lecture will be given on Friday, Mar. 9, at the Imperial College of Science and Technology, South Kensington, commencing at 5 o'clock. No tickets are required.

A PROVISIONAL programme has been issued of the summer meeting of the Institution of Electrical Engineers, to be held in Norway on June 9-24. The meeting will take the form of a tour, including Bergen, Dale, Eide and Ulvik, Odda, Voss, Oslo, and Gothenburg, where power stations, nitrate and other works will be visited.

AT the annual general meeting of the Quekett Microscopical Club on Feb. 4 the following were elected officers for the ensuing year: *President*, Dr. W. T. Calman; *Vice-Presidents*, Mr. C. D. Soar, Mr. D. J. Scourfield, Sir David Prain, Dr. C. Tierney; *Hon Treasurer*, Mr. F. J. Perks; *Hon. Secretary*, Mr. W. S. Warton; *Hon. Reporter*, Mr. A. Morley Jones; *Hon. Librarian*, Mr. C. S. Todd; *Hon. Curator*, Mr. C. J. Sidwell; *Hon. Editor*, Mr. W. S. Warton.

THE Society of Chemical Industry was first established at Merseyside, and an interesting account by Dr. A. Holt of the development of chemical industries

in Liverpool and the neighbouring districts is contained in its *Transactions* dated Dec. 2. Rather more than one hundred years ago, this part of Great Britain was chiefly given over to agriculture, but with the provision of cheap transport facilities its character has changed, until now almost every industry in which chemistry plays a part, from metallurgy to the manufacture of artificial silk, is carried on there. A summary is given of the progress of each separate industry.

A NEW catalogue (No. 301) has just reached us from Messrs. W. Heffer and Sons, Ltd., Cambridge. It deals with nearly 2400 second-hand works on mathematics, physics, astronomy, chemistry, chemical technology, metallurgy, dictionaries, and books of reference. It can be obtained free upon application to the publishers.

MESSRS. Dulau and Co., Ltd., announce the forthcoming publication by them of "Index Londinensis," containing illustrations of flowering plants, ferns, and fern allies, being an emended and enlarged edition, continued up to the end of the year 1920, of Pritzel's Alphabetical Register of representations of flowering plants and ferns. The work has been compiled by Dr. O. Stapf, and will comprise six volumes and be completed by 1930.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A lecturer in mathematics at University College, Dundee—The Secretary and Registrar, The University, St. Andrews (Mar. 2). An assistant pathologist and research fellow in the pathological department of the Hospital for Sick Children, Great Ormond Street—The Secretary, Hospital for Sick Children, Great Ormond Street, W.C.1 (Mar. 5). Teachers of mathematics and of science at the new boys' secondary school, Heaton, Newcastle-upon-Tyne—The Director of Education, Education Office, Northumberland Road, Newcastle-upon-Tyne (Mar. 10). A biologist at the Dove Marine Laboratory, Cullercoats—The Registrar, Armstrong College, Newcastle-upon-Tyne (Mar. 17). A senior lecturer in physiology in the University of the Witwatersrand, Johannesburg—The Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (April 16). A lecturer in mathematics at the University College of Hull—The Secretary, University College, Hull. A whole-time worker in the research department of St. George's Hospital Medical School—The Dean, St. George's Hospital Medical School, Hyde Park Corner, S.W.1. A lecture assistant in physical chemistry in the University of Bristol—The Registrar, The University, Bristol.

Our Astronomical Column.

HAS SIRIUS CHANGED COLOUR ?—Much has been written on this question in recent years. Prof. T. J. J. See, in a *Sondernummer* of vol. 229 of *Astr. Nach.*, collected a large amount of evidence from classical sources which certainly appeared on the face of it to establish that Sirius was ranked with orbs of undoubted redness like Antares. The *a priori* improbability of such a change in 2000 years is so great that most astronomers seek some way of escape from this conclusion. Sirius can be seen closer to the horizon than most stars, and in that position it is truly said that it "alters hue, and bickers into red and yellow." In Egypt especially, where the heliacal rising of Sirius was watched for as a sign of the rising of the Nile, it must often have been observed near the horizon.

E. Dittrich, in *Astr. Nach.*, No. 5542, examines an Assyrian tablet of the epoch 885 to 860 B.C., in which Sirius (Kaksidi) is described as "red as copper," and gives reasons for concluding that this refers to the time when Sirius rose at the beginning of the night, and that its rising at that time would be the occasion of special observations. He alludes to the fact that Sirius is now classed as a dwarf, though one of the brightest of the dwarfs ; this increases the number of stages through which it must have passed since it was a red giant.

ANALYSIS OF CEPHEID VARIABLES.—W. Zessewitsch contributes a paper on this subject to *Astr. Nach.*, No. 5534. He notes that many of these variables show periodic changes both in their periods and in the form of the light-curves. These can be represented analytically by series of sine terms. He considers that a physical explanation is afforded by Jeans's suggestion that these stars have split into two orbs at a date that is recent (in the standards of cosmogony) and that the period of rotation is not equal to that of pulsation. The period of rotation would tend to lengthen owing to tidal friction ; on the other hand, increasing density would shorten the period of pulsation. The two stars RW Draconis and XZ Cygni are mentioned as those that have been most carefully studied ; the results, so far as they go at present, are considered to support Jeans's theory.

PERIODIC VARIATIONS IN TERRESTRIAL MAGNETISM.—In *Geofysiske Publikasjoner*, vol. 5, No. 3, K. F. Wasserfall discusses the presence of periodic variations in magnetic data obtained from the polar station at Gjøahavn, which was occupied by Amundsen from Nov. 1903 until June 1905. The geographical co-ordinates of this station, situated near the magnetic pole, are Lat. 68° 37′ N., and Long. 95° 55′ W. The data used in the discussion are daily means of horizontal force derived from photographic registers ; temperature records for Gjøahavn and Oslo, and Wolfer's sunspot numbers for the same interval, are also used for comparative study. On analysis of the data, the author finds indications of various periods ranging from 3·3 days to 70 days. The distribution of sunspots in longitude is examined in some detail, and suggestions are offered to account for a relationship between the indicated periods in the magnetic and temperature records and the state of solar activity at the time. The results obtained from so very limited a series of observations are naturally open to much criticism in spite of the value of records from high latitude stations. The only consistent periods found in magnetic data which are of general acceptance as being related to the sun's activity are (1) the 11-year cycle of the sunspots and allied solar phenomena, and (2) a period of about 27⅓ days, which corresponds to the sun's synodic rotation as given by the sunspot latitudes.

Research Items.

THE MALTESE CART-RUTS.—In *Man* for February, Miss M. A. Murray discusses, with a number of illustrations, the possible origin and purpose of the so-called cart-ruts of Malta. These cart-ruts are disappearing, but a series of air photographs, to be the basis of a complete map, is now being prepared by Prof. Zammit and Commodore Clark Hall. As regards their origin, it is clear that they are not the well-known natural parallel fissures which occur in limestone, for they curve, and are equidistant throughout their length, the gauge being a little greater than that of a Maltese cart. The depth is not great, being about a foot. The Greeks appear to have cut similar ruts to facilitate the passage of carts over rough ground, but the curves for passing do not occur in Malta. There is a network of the ruts all over the island, and short lengths are frequent in connexion with megalithic monuments. This is an indication of age, which is also supported by the fact that they were made when the configuration of the island was different. One at St. George's Bay was evidently made across a gulley now covered by the sea, as it appears on both sides of the bay. Tracks also lead to the edge of cliffs, where they end abruptly. A tradition says that the tracks were made for a boat which went on wheels. It is possible that they are part of a road system which was superseded by the Roman roads.

NEW DEEP SEA FISHES.—Among the collections of the third oceanographic expedition of the *Pawnee* were 32 specimens of the deep sea fishes of the sub-order Ceratioidea, which are described by Mr. A. E. Parr in the *Bulletin of the Bingham Oceanographic Collection*, vol. 3, Art. 1, August 1927. The collection was composed of eighteen species, eleven of which are regarded as new to science. So little is known of the developmental stages of these deep sea anglers that the author makes a point of recording a number of different body measurements for each specimen. The commonest species was *Melanocetus Murrayii* Günther, of which there were ten specimens, covering a wide range of size, the smallest being 17 mm. in total length, and the largest 115 mm. without the caudal fin. In the same series of publications, vol. 1, Art. 1, October 1927, Mr. C. M. Breder, Jr., records the results for fishes collected on the first expedition of the *Pawnee* in the West Indies by Mr. Harry Payne Bingham. The area from which the fish were taken includes the coastal regions of South Florida, Bahamas, Cuba, Grand Cayman, and British Honduras. Records for large numbers of different species are given, mostly shallow water and shore forms, and twenty new species are described. The most remarkable was a small eel-like fish named *Anguillicthys bahamensis* nov. gen., n. sp., by Mr. L. L. Mowbray, from whom the collections were taken over. This fish, about 4½ in. in length, differed from other eels in having a well-developed lunate caudal fin, the insertion of the anal and dorsal fins behind the vent, and their separation from the caudal fin by a long peduncle. The specimens were taken at the surface at night and were very rapid swimmers. They were considered to be eels that have taken to a mid-water life, and to lie between Anguilla and the type of true fishes. Both publications are well illustrated by Mr. W. S. Bronson, who is also executing a number of coloured paintings for the collection.

RESEARCH WORK AT PORT ERIN.—The forty-first Annual Report of the Marine Biological Station of Port Erin, Isle of Man, drawn up by the Director, Dr. Jas. Johnstone, professor of oceanography in the University of Liverpool, states that the work has been carried on along the usual lines during the year 1927, the equipment for general biological and chemical investigations having been improved and being now quite satisfactory. The pupils of Dr. Margery Knight have added much to the knowledge of the algæ of the district, and a series of memoirs have been written. Among these the researches by Miss E. M. Higgins on *Colpomenia sinuosa* are of peculiar interest, as this alga, formerly known from warmer seas, has since 1905 been found on the British coasts, and in 1916 was freely floating in the Irish Sea. As it affects oysters by clinging to their shells and then forms vesicles having sufficient buoyancy to lift away the whole mollusc, it is of considerable economic importance. The plaice in the hatching ponds continue to spawn, upwards of 4,000,000 larvæ having been set free from February to April, and also more than 4000 larval lobsters, besides 387 lobsterlings reared in the laboratory and liberated at suitable places along the coast. Research in the bio-chemical laboratory has been chiefly on the physical and chemical side, the Naturalist of the Marine Station, Mr. J. R. Bruce, having completed papers on "The Physical Factors on a Sandy Beach" which are about to be published.

ICE-DRIFTS AND SEAL-FISHING.—In a note on Dr. Iversen's paper "Drivis og Selfangst" in our issue of Jan. 14, p. 71, it was stated that "The Bladder-nosed seals . . . defend their young, keeping with them for a longer time" than the Greenland seal does. Dr. Iversen writes to correct this, as it is the period during which births are known to occur which is longer for the Bladder-nosed seal than for the Greenland seal, not the length of time the young is cared for. He says: "The drift ice at Jan Mayen is the breeding-place both for Greenland seal and Hooded seal at the end of March and in April. The Hooded seal is believed to give birth to its young at about the same time as the Greenland seal, the period being, however, somewhat more extended and the breeding area generally situated a little more to the south." Further, referring to the statement that whole families of Bladder-nosed seals are often shot down, he says, "It is, of course, not possible to say whether the small flocks met with really represent an actual family, wherefore I have placed the word in question (*familien*) between inverted commas. Very little, as a matter of fact, is known about the habits of this species."

THE STORING OF EARTHWORMS BY MOLES.—In view of the fact that the most authoritative work on British mammals, by the late Major Barrett-Hamilton, throws grave doubt upon the reliability of the accounts of the deliberate storing of earthworms by moles, the experiments of M. Degerbøl deserve attention (*Vidensk. Medd. f. Dansk Naturh. Foren.*, Bd. 84). He recounts the plain evidence previously furnished by Fr. Dahl and Ritzema Bos, and shows how, during his own experiments, the supply of superabundant food led to underground storing by a captive mole. As many as 49 large earthworms were stored in underground runs in 40 minutes, and the storing ceased only because the earthworm store was exhausted. Careful excavation of the runs showed that the worms had been pushed into holes formed in compressed earth in the walls of the burrows. In each hole a series of worms was placed, from a depth of about 4 inches to the surface of the run, but each worm was separated from its neighbours by a thin layer of packed earth. The worms were all alive, and except when the mole was flustered by too great *embarras de*

richesse, the escape of the victims was provided against by the destruction of the first few head segments. The evidence of the experiments, as well as the evidence of other well-authenticated cases in natural conditions, suggests that the storing is not a provision against the appearance of dearth in hard weather, but is a direct reaction to over-abundant food supplies.

THE BREWING VALUES AND ANTISEPTIC POWERS OF HOPS.—In Great Britain the three principal methods for the analysis of hops in use at the present time are: a gravimetric method, Chapman's biological method (NATURE, **115**, 244; 1925), and a method in which the amounts of lactic acid produced in a standard volume of malt wort by *Bacterium Delbruckii*, in the presence of varying quantities of a decoction of the hop, are determined by titration. The advantages of biological methods, the Chapman method in particular, include the speed with which they may be carried out, and the production of a result which depends on the actual antiseptic power of the hop. Gravimetric methods, on the other hand, though more readily standardised, depend on the extraction of the α- and β-resins by means of solvents and the grading of the hops in terms of an arbitrary factor connecting the two values obtained. The need for strict standardisation in the latter case is thus apparent, and papers by J. J. H. Hastings and T. K. Walker, and by A. H. Burgess and H. Martin (*Jour. Inst. Brew.*, **34**, 9, 13; 1928) may be welcomed as a step in this direction. Both pairs of authors have come to the same main conclusion, namely, that to secure a more complete extraction of the β-resin, which is of brewing value, the methyl alcohol used must be diluted. An improved method is thence described in which the ether extract of the hop is re-extracted with the necessary amount of methyl alcohol, the α-resin precipitated by lead acetate, and the β-resins determined by difference from the total soft resin content. Unfortunately, in the past a close correlation between resin content, preservative value, and the results of small-scale experimental brews has not always been obtained, and it is hoped that the improved method may to some extent remedy this.

EUCALYPTS IN SCOTLAND.—A paper by Mr. J. A. B. Macdonald in the *Scottish Forestry Journal* for October last affords some interesting details of the growth of certain species of Eucalyptus which were planted out from thirty to thirty-three years ago at Kinlochourn, Inverness-shire, by the late Mr. R. Birbeck. The site is a steep sheltered slope, with a southern aspect; the rainfall varies from 90 to 140 inches per annum; and although the climate is generally mild, the sea loch is frozen over on very rare occasions. It was observed by Mr. Birbeck that the trees, when planted in a well-drained soil, enjoyed the high rainfall; the young trees, however, were tried severely by the Atlantic gales. *E. amygdalina*, *E. coriacea*, *E. regnans*, *E. rudis*, and *E. resinifera* suffered from the climate, and *E. globulus* was killed by fifteen or twenty degrees of frost. Specimens of *E. vernicosa*, *E. alpina*, *E. angustifolia*, *E. cordata*, and *E. viminalis* were flourishing in 1899 at the time of Mr. Birbeck's report; but of some fifty species originally planted out, the hardiest were *E. coccifera*, *E. Gunnii*, and *E. urnigera*. Three species have recently been identified and examined. A specimen of *E. cordata* measures 35 feet in height, with a girth of 81 inches; a specimen of *E. Muelleri* is 40 feet in height and 57 inches in girth. The commonest species is *E. coccifera*, which has attained a maximum height of 65 feet, with a girth of 45 inches. There are also other species in the area; all of them appear to fruit profusely, but no seedlings have been found. The members of a neighbouring group of birch trees of the same age vary from 20 to 35 feet in height, with an average girth of 25 inches, and the tallest trees in a group of Scots pines growing alongside are about 35 feet in height, with a girth of 32 inches. *E. coccifera* is one of the few endemic eucalypts of Tasmania, where it grows on or near the snow-line; it belongs to the 'peppermint' group, and yields an essential oil containing α-phellandrene and piperitone; like *E. Gunnii*—the 'cider gum' of Tasmania and the highlands of Victoria and New South Wales—it has no economic value as an oil-producing tree. *E. cordata*, *E. Muelleri*, and *E. urnigera* are Tasmanian species which yield a good type of oil containing cineole and pinene.

THE EFFECT OF HEAT ON COMMON HORNBLENDE.—The *Science Reports of the Tôhoku Imperial University*, Ser. 3, vol. 3, No. 2, Nov. 1927, contain a preliminary paper on the dissociation temperature of brown hornblende by S. Kôzu and B. Yoshiki, which is followed by a more detailed account (with the additional collaboration of K. Kani) of the transformation of common hornblende into the basaltic variety at 750° C. At this temperature the refractive indices and birefringences rapidly increase, and the extinction angles decrease to nearly zero on the prism face. The pleochroism also changes from various tints of green to brownish green into the characteristic reddish-brown shades of the basaltic type. The expansion on heating gradually increases to 750° C., and then changes suddenly to a contraction; at 790° expansion begins again. Natural basaltic hornblende shows none of these changes on being heated, but has from the start almost the same properties as those reached by ordinary hornblende beyond 750° C. The expansion curve shows no break until 1080° C. is reached, at which point there is great expansion accompanying the dissociation of the mineral. These results clearly have petrological implications of considerable importance.

BASALTS OF THE GALAPAGOS ISLANDS.—A paper by H. S. Washington and Mary G. Keyes in the *Jour. Wash. Acad. Sci.*, Dec. 19, 1927, contains an account, with chemical analyses, of some specimens collected on the islet of Eden. These are mainly palagonite tuffs and an olivine-andesine-basalt closely resembling a common Hawaiian type. The authors make no mention of the recent *St. George* Scientific Expedition (*Geol. Mag.*, 1925, p. 371) or of the collections of lavas then made by L. J. Chubb. Some of these, from Albemarle and James, have already been analysed by Raoult and described by Lacroix (*Mém. de l'Acad. des Sciences*, p. 69; 1927). Chubb's basalts are more basic than the one from Eden; they are respectively rich in bytownite and olivine. All the authors cited are agreed that there is close similarity between the Galapagos basalts and those of the Central Pacific. Lacroix points out the striking difference of the lavas from those of the andesitic types of the Circum-Pacific belt. Washington and Miss Keyes direct attention to the earlier observations of Gooch, which indicate the presence of trachyte and trachybasalt on some of the islands. It is clear, therefore, that the Galapagos Islands afford another example of the frequent oceanic association of common basalt with trachytic and melanocratic differentiates.

THE ABSORPTION SPECTRUM OF NITROGEN PEROXIDE.—The results of a careful investigation of the absorption spectrum of nitrogen peroxide are embodied in a dissertation by L. C. K. Carvile, presented

to the Academic Faculty of the University of Virginia. The spectrum was photographed with a 21-ft. Rowland grating, but in consequence of the difficulty of maintaining constant temperature during the long exposures required, the average deviation from the mean for the same line on different plates amounted to 0·03A. This, however, is a great advance on any previous measurements, and the new determinations will provide a substantial basis for an investigation of the structure of this spectrum. About 6600 lines, covering the range λ3978 to λ6323, are included in the catalogue. No change in the positions of the lines could be detected when the temperature of the absorbing gas was raised from 4° to 26° C. Anyone interested may obtain a copy of the dissertation gratis on application to the Director of the Rouss Physical Laboratory, the University, Virginia, U.S.A.

GASEOUS BEARINGS.—The issue of the *Journal de Physique* for November contains a communication from MM. E. Henriot and E. Huguenard on the use of gaseous bearings for small rotors and on the extremely high speeds of rotation which can be obtained in this way. The fixed part of the bearing is a vertical cone of semivertical angle about 60° and 1 cm. side. Half-way down the side there are 8 or 10 holes up which air or carbonic acid gas at 2 to 6 atmospheres pressure is forced. The rotary part is coned underneath, the semivertical angle being about 65°, and the conical surface is provided with fine grooves along its generating lines. With a rotor of 1 cm. diameter a speed of 11,000 revolutions per second was obtained, and with it the Foucault measurement of the speed of light could be made with the reflecting mirror only 1 m. away. Rotors of 2·5 kilograms have been driven at 1100 revolutions per second. In all cases it is found desirable to mount the fixed part of the bearing so that a little side play is possible.

MICROSCOPE TECHNIQUE.—In the January issue of *Watson's Microscope Record*, T. Thorne Baker discusses the use of light filters for increasing contrast in photomicrography. Contrast filters should be complementary in colour either to the primary object or to the background. To get the best results a plate suitable to the composition of the contrast filter must be used. Ordinary plates are suitable for use with violet or blue filters; orthochromatic plates with green or yellowish-green filters; and panchromatic plates with orange, red, or deep red filters. A list is given of some common microscopic stains and the colours of the most suitable contrast filters for use with them. Various methods of preparing metal specimens for microscopical examination are described by W. Cartwright. The structure of the metal may be developed by polish attack instead of by etching. In this method the polishing process is carried on in the presence of a slightly corrosive liquid. The method of heat tinting is useful for the detection of small differences in concentration of solid solutions, whilst electrolytic etching is of value in special cases. The journal also contains articles on measurements with the microscope, and on the use of the microscope in the textile industries and in the paper industry.

A NOVEL DISTILLATION FLASK.—A novel type of distillation flask is described in the *Chemiker-Zeitung* of Dec. 21, which, it is claimed, possesses many advantages over the ordinary Claisen-flasks used in distilling liquids under reduced pressure. By means of a simple device, any liquid which may be carried forward mechanically with the vapour is separated from the latter and returned automatically to the main bulk of liquid. The apparatus is supplied by the firm of Emil Gundelach, Gehlberg, Thüringer Wald.

THE CHLORINATION OF MUSTARD GAS.—Although mustard gas (β, β-dichloroethyl sulphide) may be destroyed in small quantities by treatment with nitric acid or steam, the only practical methods for its removal involve the use of chlorine. Almost all the compounds theoretically possible on treating mustard gas with chlorine have been isolated by T. P. Dawson and W. E. Lawson, and an account of their properties is contained in two papers in the December number of the *Journal of the American Chemical Society*. All the chloro-derivatives below the hexa-compound are, with one exception, unstable, and on distillation form unsaturated compounds with evolution of hydrogen chloride. All the chlorination products of mustard gas are non-vesicant, that is, they do not cause blistering of the skin.

STUDIES ON INFLAMMABILITY OF HYDROGEN.—The influence of dimethyl selenide and telluride on the limits of inflammability of hydrogen–air mixtures has been investigated by Yoshio Tanaka and Yuzaburo Nagai, and their results are described in the *Journal of the Society of Chemical Industry of Japan* (vol. 30, No. 10). The addition of two molecular per cent. of dimethyl selenide caused the molecular per cent. of hydrogen to fall from 71 to 37·5 in the case of upper limit mixtures, while with the same amount of telluride the molecular per cent. of hydrogen was 40. Hydrogen selenide and dimethyl and diethyl selenides have the same theoretical flame propagation temperature, namely, 1750° C., but different amounts of each are required to raise the flame propagation temperature of hydrogen from its initial value of 1090° C. to 1750° C. This appears to be due to differences in the mean cross-sectional areas of the molecules of the selenides giving rise to different collision probabilities for the selenide molecules with the activated hydrogen molecules.

THE COPPER-OXIDE RECTIFIER.—At the National Radio Exhibition considerable interest was shown in a new and very efficient form of rectifier called the copper-oxide rectifier. The phenomenon on which the working of the device depends was described by Grondahl and Geiger in April 1926 to the American Physical Society. A full account of the construction and properties of actual rectifiers appeared in the *Jour. Amer. Inst. Elect. Eng.* for March last, and a brief account is given in *Experimental Wireless* for January 1928. Grondahl found that when a layer of oxide is formed on a sheet of copper and contact is made through a piece of lead pressed against the oxide, the resistance to an electric current passing from the lead to the copper is in certain cases very much less than when the current flows in the opposite direction. The action is analogous to a slightly leaky hydraulic valve, in which the water flows easily in one direction and scarcely at all in the other. For an applied pressure of four volts, the resistance in one direction is 12,000 times that in the other. In practice the rectifier consists of an oxidised copper disc against which a leaden ring is clamped. If properly designed for the output required, an efficiency of 80 per cent. can be obtained. The film of oxide is only about one-thousandth part of an inch thick, and no satisfactory theory has yet been given of the action of the valve. This type of rectifier has many advantages, from the engineering point of view, over the liquid types at present in use for rectification, as there is no liquid to spill or evaporate. There are also no moving parts. It is being made for many purposes. One form can be used for charging a six-volt battery at a two ampere rate. Another form can be used for charging the high tension batteries used in broadcasting.

Royal Society Election.

SELECTED CANDIDATES.

THE president and council of the Royal Society have recommended the following candidates for election as fellows of the Society:

G. ANREP, M.D., D.Sc. Distinguished as a physiologist, especially for his work on conditioned reflexes, nature of the secretory process, physiology of digestion, and significance of adrenaline. Has during the last few years conducted a series of masterly researches on the central and reflex regulation of the heart and circulation, and of the blood supply to the heart muscle, based on the use of the innervated heart lung preparation, which was invented for this purpose.

H. BATEMAN, M.A., Ph.D. Professor of Mathematical Physics in the California Institute of Technology, Pasadena. Formerly Fellow of Trinity College, Cambridge. Introduced (*Proc. Lond. Math. Soc.*, 1909) into the relativity theory of the electromagnetic equations a general quadratic form whose coefficients are characteristic of the medium supporting the field—partial anticipation of general relativity. Discovered the integral equation by which seismic rays in the earth's interior were afterwards calculated by Knott (*Phil. Mag.*, 1910). Has greatly extended the theory of solutions of partial differential equations, especially those occurring in physics. Has published solutions, both analytical and numerical, of various types of integral equations; also papers on radiation and geometry.

C. H. BROWNING, M.D., D.P.H. Professor of Bacteriology, University of Glasgow. Distinguished for his researches in bacteriology, immunity, and chemotherapy. Author of "Recent Methods in the Diagnosis and Treatment of Syphilis" (with J. Mackenzie, 1911); "Applied Bacteriology" (1918); "Chemotherapy in Trypanosome Infections" (*Jour. Path.*, 1908); a number of papers on an analysis of the Wassermann reaction, especially on the action of cholesterin and lecithin; "Isolation of Typhoid Bacilli by means of Brilliant Green" (*Jour. Hyg.*, 1913); "On Flavine and Brilliant Green" (*Brit. Med. Jour.*, 1917); "Bactericidal Action of Ultra-violet Radiation" (*Proc. Roy. Soc.*, 1917, with S. Russ); "Bactericidal Properties conferred on the Blood by Diamino-Acridine Sulphate" (*ibid.*, 1918); papers on antiseptic action and chemical constitution (*ibid.*, 1922, 1924, jointly); and others.

STANLEY S. COOK. Engineer. Since 1906, controlling calculation steam turbines for Parsons' Marine Steam Turbine Co., and licences all principal countries. On Sub-Committee of B.I.R., calculated pressures attained by collapsing water cavities, results independently confirmed by Lord Rayleigh. Calculated temperatures reached by compression of flame. Joint author of "Compressibility" (*Proc. Roy. Soc.*); "Erosion of Propellers" (*Inst. Naval Arch.*, 1919); "Mechanical Double Reduction Gears, investigating Torsional Vibration" (*ibid.*, 1921); "Mechanical Gearing, investigating Oil-quenched Nickel Steel Pinions" (*ibid.*, 1923). Roy. Soc. Arts, Howard Lectures, 1923.

W. D. DYE, D.Sc. (Lond.), A.C.G.I. Head of Electrical Standards and Measurements Section of the National Physical Laboratory. Has established accurate and permanent standards of capacity and inductance suitable for radio frequencies, and has developed a self-contained standard of radio frequencies of high accuracy embodying a tuning fork control. Member of the National Committee for Wireless Telegraphy and of the International Committee for Radio Standards and Measurements. An authority on electrical standard measurements and precision measurements and on the magnetic properties of materials. Publications: "Calculation of a Primary Standard of Mutual Inductance" (*Proc. Roy. Soc.*, A, **101**); "The Valve maintained Tuning Fork as a Precision Time Standard" (*ibid.*, A, **103**); "A Self-contained Standard Harmonic Wavemeter" (*Phil. Trans.*, A, **224**). Author of articles on magnetic measurements and on radio measurements in Glazebrook's "Dictionary of Physics."

C. C. FARR, D.Sc. Professor of Physics, Canterbury College, N.Z. Fellow and Hector Medallist, New Zealand Institute. Distinguished for his contributions to general physics. As Director of Christchurch Magnetic Observatory, he made a complete magnetic survey of New Zealand and outlying islands. The results were published by the New Zealand Government. Author of many papers including "Interpretation of Milne Seismograms" (*Phil. Mag.*, 1903); "Continuous Observations of Dissipation of Electric Charges in Open Air" (*Proc. Roy. Soc.*, 1905); "Radium Contents of Igneous Rocks from Subantarctic Islands of New Zealand," with D. C. Florance (*Phil. Mag.*, 1909); "The Viscosity of Sulphur," with D. B. Macleod (*Proc. Roy. Soc.*, 1920).

MAJOR GREENWOOD, F.R.C.P. Has applied the statistical method to the elucidation of many problems of physiology, pathology, hygiene, and epidemiology. Is the author, or joint author, of more than sixty papers dealing with these applications, including important contributions to the experimental study of epidemiology (*Jour. Hyg.*, **24**, 1925, Greenwood and Topley; *ibid.*, **25**, 1926, Greenwood, Newbold, Topley, and Wilson). Has done much to encourage and develop the use of modern statistical methods by medical laboratory investigators, and, as chairman of the Medical Research Council's Statistical Committee, to secure the adequate planning and execution of field investigations.

J. W. H. HARRISON, D.Sc. Lecturer in Zoology at University College (Armstrong College), Newcastle-on-Tyne. Distinguished for his original work in experimental zoology, demonstrating the non-Mendelian inheritance of specific characters and the breaking down of a Mendelian unit-character (melanism) in interspecific crosses in Lepidoptera; the induction of melanism in Lepidoptera by feeding larvæ on plants charged with metallic salts and its subsequent inheritance on a Mendelian basis; the inheritance of acquired egg-laying instincts in Hymenoptera and the importance of extraneous influence in the determination of sex. He has also studied the cytology of the varieties and hybrids of British roses and willows.

W. N. HAWORTH, D.Sc. (Manc.), Ph. D. (Göttingen). Professor of Chemistry in the University of Birmingham. Author or joint author of many memoirs, published chiefly in the *Journal of the Chemical Society*, on organic synthesis and on the constitution of some terpenes and carbohydrates. He had determined the structure of many of the di- and trisaccharides, including sucrose, maltose, lactose, melibiose, cellobiose, gentiobiose, raffinose, and gentiacrose, and has synthesised amygdalin.

D. KEILIN, M.A. (Cantab.), D.Sc. (Paris). University Lecturer in Parasitology, Cambridge. Distinguished for his researches on (*a*) Insecta, their anatomy, biology, and physiology; (*b*) Protista, having made important contributions dealing with the life history of new parasitic forms; (*c*) Cellular respiration, having made a fundamental discovery in the intra-

cellular pigment 'cytochrome' which is present in all organisms.

F. L. KITCHIN, Sc.D. (Camb.), Ph.D. (Munich). Palæontologist to the Geological Survey of Great Britain. Distinguished for his researches in invertebrate palæontology, especially in its application to stratigraphical geology. Has elucidated the lower Cretaceous fauna of South Africa (*Annals S. African Museum*, 1908) and the Jurassic Brachiopoda and Lamellibranchia of India (*Palæontologia Indica*, 1900, 1903). Has thoroughly investigated the faunas and correlation of zones in the concealed Mesozoic rocks of the Weald (*Mem. Geol. Survey*, 1911, 1923); has investigated the zonal representation and relations of the Gault of England (*Geol. Mag.*, 1920, 1922). Author of many palæontological contributions to Geological Survey memoirs.

F. S. MACAULAY. Distinguished for his contributions to the theory of modular systems. Author of "On the Resolution of a Firm Modular System into Primary Systems" (*Math. Ann.*, **74**, 1913); "The Algebraic Theory of Modular Systems" (Camb. Math. Tracts, No. 19, 1916); "The Resultant of a Number of Polynomial of the same Degree" (*Proc. Lond. Math. Soc.*, **21**, 1922); "Some Properties of Enumeration in the Theory of Modular Systems" (*ibid.*, **26**, 1927). Also of various papers on algebraic geometry.

S. B. SCHRYVER, Ph.D., D.Sc. Professor of Biochemistry, Imperial College of Science and Technology. Distinguished for original investigation in chemistry, especially biochemistry. He has made valuable contribution to our knowledge of morphia alkaloids (*Trans. Chem. Soc.*, 1900); autolysis (*Jour. of Physiol.*, 1904); Aggregation in colloids, especially clotting (*Proc. Roy. Soc.*, 1910–16); "The Chemical Aspects of Proteins, especially Gelatine" (*Biochem. Jour.*, 1920, onwards). He has done valuable work in chemistry in relation to plant physiology, including studies of the nitrogenous metabolism of plants (*ibid.*, 1920), of pectic substances and hæmicelluloses (*ibid.*, 1918, onwards). In addition he has been the instigator of much other research work issuing from his laboratory. A series of papers has been published on the hydrolysis of proteins and on the discovery of hitherto unknown hydrolysis products of these substances.

W. STILES, Sc.D. Professor of Botany, University of Reading. Distinguished for contributions to plant physiology. In his work on permeability he developed new methods, and his investigation of the equilibria concentrations of salts within and without the cell are of particular importance. He has made valuable contributions to knowledge of the action of cold on tissues, "The Preservation of Food by Freezing" (1922), and on "Diffusion through Gels." His books on the assimilation of plants (Jørgenson and Stiles), "Carbon Assimilation" (1917), and on "Cell Permeability" (1923), exhibit critical powers of a very high order and are of great value in the further development of research work in these fields.

R. WHYTLAW-GRAY. Professor of Chemistry, University of Leeds. Distinguished for his researches in physical and inorganic chemistry, especially in the application of the determinations of the densities and combining volumes of gases to the atomic weights of the constituent elements. Was the first to correct Stas' atomic weight of nitrogen. With Sir William Ramsay determined the density of radium emanation and the atomic weight of radium. With collaborators carried out various researches on the compressibilities and limiting densities of various gases. Determined the critical constants and orthobaric densities of xenon. Has carried out extensive researches for the Chemical Warfare Department on the behaviour of clouds and smokes.

The Gold Coast Forests.

AN important monograph has been drawn up recently by Dr. T. F. Chipp, entitled the "Gold Coast Forests: a study in Synecology" (Oxford Forest Memoirs, No. 7, 1927). In the introduction it is pointed out that no purely ecological study of the Gold Coast forests has been recorded, and that such a study has been impossible so long as the component units forming the structure of this mass of tropical vegetation have remained undetermined and uninvestigated. Considerable progress has been made in the floristic study of this forest area, as evidenced in the gradual expansion of the enumeration of the flora in the successive volumes of the "Flora of Tropical Africa," a work commenced in 1868 and only now approaching completion. A similar advance has also been made in the study of the plant distribution, and Engler's comprehensive survey in "Die Vegetation der Erde" (1908–10) is passing out of date.

The study of economic botany has made rapid progress with the establishment and expansion of the Agricultural and Forestry Departments. This progress is also depicted by such publications as "The Useful Plants of Nigeria" (*Kew Bull.*, Ad. Ser. 9) which includes the economic plants of the Gold Coast. Climatology has also recently received considerable attention. Apart from ecology, the area covered by the forest mass has been definitely determined, the chief physiognomic types of the forest have been recognised, and variations corresponding to the chief changes in climatic and edaphic factors have been recorded. Thompson's "Report on Forests: Gold Coast" (1910) recognises certain serial stages, plants, and communities of indicator value, and discusses the reaction of the population to the forest; he also adds lists of species occurring in different parts of the forest. Dr. August Chevalier in "Les végétaux utiles de l'Afrique tropicale française" has enabled the Gold Coast Forest, as a whole, to be viewed in its right perspective in relation to the rest of the vegetation in West Africa. During the War, A. Bertin, Conservateur des Eaux et Forêts, travelled extensively in some of the forest areas in the French possessions in this region, and published descriptions of the trees and their economic uses in five volumes, "Mission forestière coloniale," of high interest. As an outcome, soon after the termination of the War, Bertin was entrusted with the formation of a forest department to have charge of these areas. At the International Forestry Congress held at Rome in May 1926, Bertin read a paper on these forests, having for its object the placing of some of their timbers on the Italian market, Italy importing a considerable proportion of her annual timber requirements.

As Dr. Chipp points out, and the remark applies equally to several of our other Colonies and Protectorates. In a new country like the Gold Coast, where agriculture and forest exploitation have only assumed importance during the present generation, the tendency has been to concentrate all study and investigation on these, for they alone have an immediate economic bearing. In the meantime, the natural covering, a knowledge of the stages in development of which may prove of great economic importance to the inhabitants, is rapidly disappearing. The value of a study, in time, of the indicator communities and individuals may prove of equal importance from the protective point of view; such a study will indicate the parts of a country which it is

vital to keep afforested. For example, in the case here considered, to check the oncoming effects from the desert to the north, to ascertain over what areas forest will naturally replace destructive forest exploitation, the protection required in the catchment areas of the rivers and springs of the country, and whether hill systems or isolated peaks may be deforested with impunity. Dr. Chipp well sums up the case as to the importance of such investigations in the following:

"The value of the economic interpretations resulting from such a study cannot be over-estimated in the case of a country almost entirely dependent on the character and maintenance of its vegetation, not only for its material wealth, but ultimately for the very existence of its inhabitants. A narrow strip of country abounding in natural and easily exploitable wealth and actually 'sandwiched' between an ever-encroaching desert and the sea, is literally dependent on scientific management to retain its existence. Such management must of necessity be based on studies such as the present, carried out in the field and worked out in the light of a knowledge of similar problems that have been encountered elsewhere."

Dr. Chipp therefore set himself the task of studying the forest-mass from the point of view of the basic units of which it was composed, their characteristics, the factors controlling them, and the scheme by which they joined together to constitute the whole. This, as he says, is where the present work breaks ground. It is impossible, within a limited space, to consider at any length the results achieved, but it may be stated that Dr. Chipp has carried out his object in a most painstaking manner, and it may be hoped that the valuable monograph, of value alike to the forester and the ecologist, is but the forerunner of others undertaken for other parts of the Empire. The work is illustrated with a number of interesting photographs, charts, and plans which serve to interpret the text in the clearest fashion.

University and Educational Intelligence.

CAMBRIDGE.—A very important development is indicated in a report of the Council recommending the institution of a library building fund. The need to move the University Library to a fresh site, where it would have room to grow up to its present needs, while keeping an eye on the future, has been urgently before the University for some years, but the sum of £500,000 required for the complete scheme has seemed prohibitive. The Council has, however, found ways and means to finance a scheme of half that amount, and that would enable a substantial part of the new library to be erected. A recent bequest of £65,000 and other available monies are all to be devoted to this one purpose, and a recent increase in the University income under the new statute is in large part also to be assigned to the Library.

The Gordon Wigan prize in chemistry has been divided between A. Caress, Trinity Hall, for an investigation on "The Chemical Reactions of Atoms and Molecules Activated by Electron Collisions," and F. F. P. Smith, Peterhouse, for an investigation on "Studies in Chemical Reactivity."

Mr. J. E. Littlewood, F.R.S., fellow and lecturer in mathematics, Trinity College, has been appointed to the newly established Rouse Ball chair of mathematics.

LONDON.—A course of three free public lectures on "Heredity" will be delivered at Birkbeck College on Feb. 29, Mar. 7 and 9, at 5.30, by Dr. F. A. E. Crew, of the Animal Breeding Research Station, Edinburgh.

ST. ANDREWS.—At a meeting of the University Court on Feb. 17, a resolution was adopted recording the "deep sense of sorrow and loss" occasioned by the death on Jan. 29 of Field-Marshal the Earl Haig of Bemersyde, Chancellor of the University for the past six years.

AN election to Beit fellowships for scientific research will take place in July next. Forms of application and all information concerning the fellowships may be obtained by letter addressed to the Rector, Imperial College of Science and Technology, South Kensington, S.W.7. The latest date for the return of application forms is April 20.

PROF. J. H. DIBLE, professor of pathology in the University of London and honorary pathologist to the Royal Free Hospital, has been appointed to the chair of pathology in the Welsh National School of Medicine (University College, Cardiff), in succession to Prof. E. H. Kettle. Prof. Dible previously held pathological appointments in the Universities of Sheffield and Manchester.

DR. LARS G. ROMELL, of the Swedish Forest Experiment Station at Stockholm, has been appointed to the Charles Lathrop Pack research professorship in forest soils at Cornell University. The establishment of this professorship, the first of its kind in an American university, has been made possible by the endowment of 130,000 dollars for the chair, together with important additional gifts for its operating funds, from the Charles Lathrop Pack Forestry Trust, founded by Charles Lathrop Pack, of Lakewood, N.J., president and founder of the American Tree Association. The new investigation will co-ordinate studies in several fields of science, and apply all the obtainable and applicable knowledge to the special problems of forest soils. Dr. Romell studied at the University of Stockholm, and has done special work in botany at the University of Strasbourg under Prof. Jost, and in botany and cytology at the University of Lund under Prof. Lundegardh; he has also worked on the bacteriology of soils with Dr. Winogradsky near Paris. Since 1918 he has held an appointment at the Swedish Forest Experiment Station, in association with Dr. H. Hesselman, dealing with forest soils. The results of this pioneer work in America will be watched with interest by those concerned in the conservation of wood supply.

THE International Federation of University Women has published a report of its eleventh council meeting held at Vienna last July. At the opening, semi-public, session, Madame Puech, of the French Association, pleaded for a united effort against the exaggerated spirit of nationalism. In former times men of science and letters were to some extent supernational, but the modern, general, and democratic educational systems tend to foster a spirit which, far from "making the world safe for democracy," creates a feeling in the nationals of each country that it is entitled to a proprietary right in those intellects whose work should be regarded as the common property of humanity, and intellectual workers are thus tempted to adopt an antagonistic attitude towards other nations. To this the Federation can and does oppose its ideal of the open and friendly forum for university women of all countries. Reports from national associations of the United States, Austria, Belgium, Bulgaria, Canada, Czecho-Slovakia, Denmark, Estonia, Finland, France, Germany, Great Britain, Holland, Hungary, Ireland, Italy, Norway, Poland, Rumania, South Africa, Spain, Sweden, and Switzerland, show that all are actively engaged in promoting this ideal. The Federation is financed, however, mainly from America, whence came, last year, nine-tenths of the gifts and subscriptions. The headquarters of the Federation have been transferred from Victoria Street to Crosby Hall, Cheyne Walk, London, S.W.3.

Calendar of Customs and Festivals.

February 26.

FIRST SUNDAY IN LENT.—Known in Ireland as Chalk Sunday. It was customary for a great number of marriages to be celebrated in Ireland on Shrove Tuesday as the last opportunity before Lent. On the following Sunday, the girls surreptitiously chalked the coats of eligible young men who had not availed themselves of the occasion, thus exposing them to ridicule.

February 27.

SCAMBLING DAYS.—The Mondays and Saturdays in Lent were known as Scambling Days. On these days no regular meals were provided and the members of the great households 'scambled,' *i.e.* made their meals off food obtained as best they could.

Feb. 27 is assigned as the day of several saints, of whom not unnoteworthy is St. Thalilæus of Syria, who "wept almost without intermission for sixty years and for ten years lived in a cage."

March 1.

ST. DAVID'S DAY.—St. David, Archbishop of Menevia, afterwards called St. David's. This saint flourished in the fifth and sixth centuries and is reputed to have died at the age of 146 years. He is said to have been of royal extraction but illegitimate, his father being one of the Welsh princes, his mother Non, daughter of Ynyr of Caer Gawch. In another account he is stated to have been an uncle of King Arthur—a matter of interest in view of the association of St. David with Glastonbury, where he founded a monastery, and to which place, it was said, his relics were translated in the tenth century.

St. David took a prominent part in the synod for the suppression of the Pelagian heresy held at Brevy in Cardiganshire. On this occasion he restored a child to life, and the ground whereon he stood to preach rose under him until it became a hill. When, after this synod, he designed to repair to his Glastonbury Monastery, he was forbidden by Our Lord in a vision, who with his finger pierced a hole in the saint's hand which remained open until the next day. St. David is also said to have been responsible for the heat of the waters of Bath, which he "cured of an infection." Many centuries after his death, in the reign of King Stephen, he caused the brook in the churchyard of St. David's to flow with wine, and the well near by to send forth milk instead of water.

St. David's Day, as that of the national saint of Wales, was at one time observed in the Principality with much festivity in rural areas. The wearing of the leek was general. It was the occasion for the exercise of a number of primitive beliefs. For example, the churchyards were visited at night to watch for corpse candles. The families on whose graves these appeared would, it was believed, lose a member within the next twelve months. A shoe thrown over the head indicated by the direction in which its toe pointed whether the thrower would move from that house or die within the year. If anyone walked round the bed of leeks three times in silence on St. David's Eve, he or she would see future wife or husband as the case might be.

The great feature in the observance of a saint's day in Wales, especially a local patron saint, was the Mabsant-revels which were celebrated up to so late as 1840 or 1850, and corresponded to the Irish Pattern and Breton Pardon. Their celebration on St. David's Day was, of course, general and not restricted to one locality. Religious services and processions were followed by feasting and dancing in the village inn.

It is clear that popular tradition has associated with St. David something over and above the miraculous element found in the lives of most early saints. This is shown, for example, by the Mabsant and in his reputed relationship to King Arthur. The wearing of the leek is linked with St. David, yet it is probable that the custom is much older. The traditional account is that it commemorates a battle in which the Saxons were defeated by the Welsh, who, at the instigation of St. David, wore the leek as a distinguishing badge. Another explanation is that the leek was worn to perpetuate the memory of David's abstinence in subsisting on this and other roots of the ground for many years.

It has been suggested that the veneration for the leek arose from its use by the Druids as a symbol. Possibly, however, it is connected with the custom of *cymhortha*, when farmers joined together to plough their lands in co-operation. It is said that each farmer had to provide a portion of leeks to make up the common meal. The closely interrelated interests of a small community with lands partly in common made it desirable that agricultural operations should be carried out more or less simultaneously, while for the heavier work, co-operation was essential. This can still be seen in remoter parts where one great plough, which can be drawn only by a large number of horses, has to serve the needs of all the farms of a district. The leek thus becomes a symbol of the vegetation to spring from this communal activity at the beginning of March, of which the termination was marked by a feast—the Mabsant. The saying, "On St. David's Day put oats and barley in the clay," may be an indication of some such communal activity as well as a mnemonic. The custom in London of burning a Welshman in effigy, to which Pepys refers in 1667, and of hanging up 'Taffies' or Welshmen of ginger-bread for sale on St. David's Day, may be a topical adaptation of the traditional lay figure of the spring observances to which reference has been made previously.

March 2.

ST. CHAD. A.D. 673.—Founder and bishop of the See of Lichfield. One of the numerous holy wells of London was dedicated to St. Chad. This was situated near Battle Bridge, and was still frequented for its medicinal virtues in the late eighteenth and early nineteenth centuries.

Friday in Lide, from *Lide*, A.S. March. In Cornwall on the first Friday in March, so called, a young lad was sent to the top of a mound or hillock and allowed to sleep there as long as he could, the length of his sleep fixing the duration of the tinners' midday rest for the next twelve months.

March 3.

ST. WINNOLD.—ST. WINWALOE, son of Fragan, who was nearly related to a prince of Wales, and took part in the Welsh migration to Armorica on account of the Saxon invasions. He gave his name to Plou-Fragan. Winwaloe founded a monastery at Landevinech near Brest, and, with other members of his family, is prominent in the hagiology of Brittany.

A priory in the Parish of Wereham, Norfolk, was dedicated to St. Winnold by the family of Clare at some date before 1206. Associated with it was Winnold's Fair for horses and cattle, at one time the largest and the oldest of the fairs in England. The name was retained though the fair was moved twice, first to Wimsbolsham and then to Downham, after the Dissolution.

Societies and Academies.

LONDON.

Royal Society, Feb. 16.—**A. Fowler** and **E. W. H. Selwyn**: The arc spectrum of carbon. Further observations of the arc spectrum of carbon (C I) have been made, and the classification of the lines has been considerably extended. The deepest term is a triplet P_0, the value of which is estimated as 90107, corresponding to an ionisation potential of 11·2 volts.

R. H. Fowler: The chemical constant of hydrogen vapour and the failure of Nernst's heat theorem. Dennison's theory of the specific heat of hydrogen requires that at ordinary and low temperatures it should behave as a non-combining mixture of two different sorts of molecules, the symmetrical and the antisymmetrical, in the proportion 1 to 3. It follows that the observed constant in the vapour pressure equation will be given only if liquid and solid hydrogen are equally mixtures of the two non-combining molecules in the same proportion. It then follows that the weight of the lowest state of solid hydrogen cannot have the value 1, so that the entropy of the solid remains positive at the absolute zero.

A. H. Wilson: The ionised hydrogen molecule. Schrödinger's method is applied to the quantisation of a molecular system consisting of one electron and two protons. If wave functions which are bounded in the whole of three dimensional space are used, the system admits of no stationary states. By employing a wave function which becomes infinite at the two nuclei and along the line joining them, stationary states exist for all distances apart of the nuclei. Formulæ are given for the calculation of the energy of the lowest state, and the minimum value of this for different nuclear separations gives the energy of the ion H_2^+.

A. H. Wilson: A generalised spheroidal wave equation. The equation is a second-order differential equation with three real singular points, two regular and the third irregular. It contains three independent parameters, and there are many types of solutions, but only two are of importance. The first class consists of those functions which are bounded in the real interval joining the two regular singularities. To obtain these functions it is necessary to impose one relation on the parameters. The second class of functions consists of those bounded in the real interval joining a regular singularity to the irregular point, and two algebraic relations must be imposed on the three parameters.

O. H. Walters and **S. Barratt**: The alkaline earth halide spectra and their origin. A method has been found by which the alkaline earth halide spectra can all be observed in absorption. The conditions of experiment prove that the spectra originate from subhalide molecules, probably of the type MX, and not from the normal salts. These subhalides exist in stable equilibrium with the metal and the normal salt as vapours at 1000° C. The spectra have been examined by the absorption method, and new band groups have been observed in the ultra-violet. The calcium fluoride band 5292 has been examined under high dispersion. Its structures, in absorption and emission, have proved to be very different.

T. R. Merton: On a new effect in the electric discharge. A new type of electric discharge has been observed in vacuum tubes containing helium and carbon. The principal feature consists in the formation of bright discs which, unlike the striæ usually observed in vacuum tubes, are unaffected by weak magnetic fields. A violent disturbance, such as the passage of a condensed discharge, is necessary to start the formation of the discs, which can only be maintained with alternating currents. When a direct current is superposed on the alternating current the disc moves towards the anode. When the tubes are excited by direct current there is a migration of carbon compounds to the cathode. The phenomena have been investigated by stroboscopic methods. Carbon monoxide is decomposed in the discs with the formation of a particulate cloud of carbon. The effects are discussed in relation to the phenomenon known as ball lightning.

P. A. M. Dirac: The quantum theory of the electron (Part 2). Proof is given of the conservation theorem, and further developments are made in the application to spectra of atoms with single electrons. The various series of terms are described by a single quantum number j, taking both positive and negative integral values. The selection rule for j is equivalent to the two selection rules of the previous theory. Relative intensities of lines of a multiplet, and the anomalous Zeeman effect for weak and strong fields, also give results in agreement with previous theories.

S. W. Watson and **M. C. Henderson**: The heating effects of thorium and radium products. A resistance thermometer method was employed, the calorimeter wall having an absorbing thickness equivalent to 0·7 mm. of aluminium. Using the known rate of emission of particles by thorium C relative to radium C, the ratio of observed to calculated heating is constant within experimental error for all five products, and agrees well with Hess and Lawson's value of Z, namely, $3{\cdot}72 \times 10^{10}$ α-particles per gm. per sec. The discrepancy in the worst case, namely, thorium (B + C), is 2 per cent. If Geiger and Werner's value of Z, namely, $3{\cdot}40 \times 10^{10}$, be correct, the excess heat over and above that provided by the known radiations must be a nearly constant fraction of the whole (9 to 12 per cent.) for all the substances investigated. It must also be in a form easily absorbed by 0·7 mm. of aluminium, and if electromagnetic would require about 40 quanta at least per atom disintegrating.

H. F. Baker: Note on the paper "Commutative Ordinary Differential Operators" by J. L. Burchnell and T. W. Chaundy. In the classical theory of Abelian functions, the passage from the algebraic functions to the theta functions is made by a function which is the exponential of a sum of integrals of the third kind; the upper limits of these depend on arguments determined by an inversion theorem. Messrs. Burchnell and Chaundy's paper deals with the particular case of this when all these arguments except one are zero. They use an extended inversion theorem which disguises the essential character of the coefficients in the differential equations obtained. Simplification is possible in the modular expression of algebraic integrals when the fundamental algebraic equation has the canonical Weierstrass form.

L. S. Ornstein, **W. Kapuscinski**, and **J. G. Eyners**: Intensity measurements in the secondary spectrum of hydrogen. The intensities of the lines in the secondary spectrum of hydrogen have been measured in the region 4500-4900 A. by the Utrecht method.

Optical Society, Jan. 19.—**T. Smith**: (1) On toric lenses. A system of toric lenses having a common normal to all their surfaces possesses in general ten independent primordial coefficients. A single surface has only three degrees of freedom, and this number also holds for any system of negligible axial depth. Formulæ are given for the calculation of the ten coefficients, which are only all independent when the system includes at least three separated toric refract-

ing surfaces with their planes of principal curvature finitely inclined to one another. An eye with both its cornea and its crystalline lens astigmatic and the meridians of principal curvature different has more independent coefficients than a spectacle lens has effective degrees of freedom. (2) Canonical forms in the theory of asymmetrical optical systems. Canonical forms for the quadratic terms of the eikonal and of the characteristic function for any optical instrument involve only six arbitrary constants. The seven constant canonical form of the characteristic function obtained by Larmor is not general. Larmor's theorem on the equivalence of any optical system to a symmetrical instrument together with two thin astigmatic lenses also fails. Three separated astigmatic lenses are needed to represent the general system.—**M. Herzberger**: Some remarks on an extension of the optical cosine law. In this note reference is made to an extension of the optical cosine law, a full description of which will appear in the *Zeitschrift für Physik*.

Physical Society, Jan. 27.—**W. E. Pretty**: The Swan band spectrum of carbon. The Swan spectrum has been obtained in carbon monoxide and in the carbon spark in the absence of hydrogen. A discussion of the results of experiment and theory leads to the conclusion that the emitter of the Swan band system is the molecule of carbon (C_2).—**T. Smith**: On some misapplications of the law of errors and on the intrinsic error in focometry. In some physical measurements the uncertainty due to a single cause is not infinitesimal, and the precision of the mean of a large number of observations given by the law of errors is not then physically significant. An example is afforded in attempts to identify the position of an optical image. According to geometrical optics, this lies in a definite surface; but, owing to the physical properties of light, this surface cannot be identified experimentally. The use of a double cylindrical lens as a means of limiting more narrowly the space in which this surface lies is discussed.—**A. H. Davis**: Some acoustical phenomena illustrated by ripples—transmission through Quincke filters, curved conduits and vibrating partitions. The paper employs ripple photographs to illustrate the action of the Quincke acoustical filter, and directs attention to the filtering action which is likely to occur at bends in curved sound conduits or in curved horns owing to resonant transverse vibration of the contained air. It also illustrates by the ripple analogy the transmission of sound through partitions.

EDINBURGH.

Royal Society, Jan. 9.—**Penelope M. Jenkin**: Note on the sympathetic nervous system of *Lepidosiren paradoxa*. A slender sympathetic trunk without obvious ganglionic swellings runs along each side of the dorsal aorta, receiving a *ramus communicans* from each spinal nerve throughout the length of the splanchnocœle. The trunk could be traced for a short distance into the tail region; anteriorly it could not be traced farther forwards than the first spinal nerve. Ganglion cells were found diffusely scattered through the trunk. No communication with the vagus ganglion, no collateral trunk, no medullated fibres, could be detected. On the whole, the sympathetic of Lepidosiren shows most close affinity to that of *Salamandrine urodeles*.—**D. Noël Paton**: Reflex postural adjustments of balance in the duck. A series of reflexes in the intact and in the decerebrated duck induced by disturbing the balance round antero-posterior and a transverse axes are described and analysed and explained as developed for the readjustment of equilibrium.—**E. A. Baker**: The law of blackening of the photographic plate at low densities (3). The dependence of the density of a photographic deposit on the conditions of exposure and development, in particular when the density is low, is interpreted as indicating that several distinct latent images are formed, the most important being a slowly developing image involving two consecutive quantum absorptions; a rapidly developing image involving three absorptions, together with an intervening 'emission' and a very slowly developing 'reversed' image involving three consecutive absorptions. Various phenomena, including those involving two separated exposures, are successfully predicted.—**Edith Philip Smith**: A comparative study of the stem structure of the genus Clematis, with special reference to anatomical changes induced by vegetative propagation. The genus includes 160 species, of cosmopolitan distribution, ranging in habit from lianes to woody herbs. Of these, 137 were examined. The general vascular anatomy of the genus is remarkably consistent, centring round the simple Vitalba-type with 12 foliar bundles. The origin of callus is from the interfascicular cambium: adventitious roots come from the fascicular cambium. Propagation by stem cuttings is made easier by previous partial etiolation: the anatomical effects of this treatment are discussed.

PARIS.

Academy of Sciences, Jan. 16.—**Pierre Termier**: The *pays de nappes* of the French Alps.—**E. Leclainche** and **H. Vallée**: Vaccination against anthrax. A description of improved methods of preparing immunising sera from *Clostridium Chauvœi*. Filtration has been abandoned for supercentrifugation with subsequent addition of formaldehyde, and a mixed culture of various strains and different ages is used. Details are given of the results of the practical application of the sera, which is shown to be safe and effective.—**Nemours-Auguste** and **A. R. Barrieu**: The treatment of angina pectoris by radiotherapy.—**G. Nicoladzé**: An arithmometer with purely electrical direct multiplication.—**d'Ocagne**: Remarks on the preceding communication.—**Charles Colombi**: The number of specific turns of steam turbines.—**Emile Merlin**: Fluids with cylindrical stratification in rotation round an axis.—**Jean Fieux**: A new gyroscopic apparatus for preventing rolling of vessels. A description and drawing of the proposed apparatus is given, together with a curve showing the result of applying the apparatus to a vessel of 880 tons displacement.—**A. Lévèque**: The difference of the variation of temperature along the surface of exchange on the transmission of heat between this surface and a fluid in motion.—**A. Lafay**: The electromotive force of friction of metals. Subject to certain precautions described, it has been proved experimentally that the E.M.F. produced by the friction of metals is proportional to the relative velocities of the rubbing substances, and is independent of the pressure maintaining them in contact.—**H. Jedrzejowski**: The phenomenon of inversion in biotite submitted to the action of the α-rays. Joly, in discussing the explanation of the ring structure of the haloes in biotite, has suggested an inversion analogous with that shown by over-exposed photographic plates as the cause. This view is confirmed experimentally, and it is proved that in consequence the determination of the age of minerals by the haloes may lead to erroneous conclusions.—**Frilley**: Spectrography of the γ-rays by crystalline diffraction. The apparatus, described in detail, furnishes a parallel bundle of γ-rays, freed from β-rays, and the spectrum is obtained by the rotating crystal method (rock salt).

The lines attributable to radium *B* and radium *C* are comprised between 35 and 284 U.X.—**Georges Simon**: The development of a Daguerre plate by cathode pulverisation.—**Henri Chrétien**: Photographic method with high luminosity.—**H. Colin** and **Mlle. A. Chaudun**: Velocity of hydrolysis and hydrogen ion concentration. The results of experiments on the hydrolysis of sugar are given, in which the effect of various acids and addition of salts were studied: it was found that the variations of the hydrolysis constant are never parallel with the variations in hydrogen ion concentration.—**Pierre Chevenard** and **Albert Portevin**: Causes of the variation of volume accompanying the hardening of the light aluminium-copper alloys.—**P. Laffitte** and **P. Dumanois**: The velocity of the explosive wave. The velocities of the explosive wave in mixtures of hydrogen and oxygen and methane with oxygen, at varying initial pressures, have been measured by the photographic method both with and without added lead tetraethyl. The velocity of propagation of the explosive wave proved to be independent of the presence of the antidetonant in the gaseous mixture.—**Max** and **Michel Polonovski**: ψ-scopine and scopoline.—**E. Tassilly, A. Belot**, and **M. Descombes**: The saponification of ethyl phenylethylmalonate by alkalis. In this saponification, some phenylethylacetic acid is always formed, this forming the main product of the saponification in hot alcoholic solution.—**J. Bougault** and **L. Daniel**: The sulphoxytriazines.—**A. Apard**: The metallic complexes of the cellulose nitrates.—**Jacques Bourcart** and **M. E. Denaeyer**: The lithological characters of the intrusive rocks of the Central Sahara Massif (Jacques Bourcart expedition, 1922-1923).—**Paul Fallot**: The central part of the Sierras of Segura (Andalusia).—**F. Bordas** and **A. Desfemmes**: Rains containing dust and salt.—**A. Guilliermond**: Some new facts relative to the development of *Spermophthora gossypii*.—**P. Gavaudan**: The relations between the vacuome and the oil-bearing system of the Jungermanniaceæ.—**J. Amar**: The respiratory quotient.—**A. Fessard, H. Laugier**, and **S. Nouel**: The recovery index of a neuro-muscular system in the course of work.—**Philippe Fabre**: The form of the muscular contractions in indirect stimulation by linear currents.—**J. M. Le Goff**: The vasodilative action of the salts of cobalt.—**C. Dawydoff**: Some observations on the development of the Enteropneusts.—**L. Léger** and **C. Motas**: The lacustral fauna of the Grand Laûtien.—**C. Mathis**: The experimental transmission of the spirochæte of the shrew mouse by the louse.—**Cordier, Lesbouyries**, and **Verge**: Hypoglycæmic syndrome and vitular fever.—**Marcel Labbé, H. Roubeau**, and **F. Nepveux**: The action of nickel and cobalt salts on the hypoglycæmic power of insulin in diabetes.—**Léon Blum** and **P. Grabar**: The alterations in the renal function by hypochlorination. An account of changes in the renal secretions, simulating nephritis of toxic origin, due to a deficiency of sodium chloride.—**Jean Saidman**: The therapeutic properties of X-rays of wave-length 8 A.

ROME.

Royal National Academy of the Lincei. Communications received during the vacation, 1927.—**U. Cisotti**: Spiral vortices.—**E. Bompiani**: Darboux quadratics and projective normal in a point of a surface.—**C. Rosati**: Riemann matrices.—**S. Cherubino**: Notions of parity and the real character of real Abelian varieties (1). Subnormal Riemannian matrices.—**G. Vitali**: A covariant derivation in generalised absolute calculus.—**Francesco Sbrana**: Theorems of the mean for the solutions of certain equations with partial derivatives.—**B. Finzi**: Biharmonic functions on a surface.—**A. Terracini**: Differential projective geometry of hyper surfaces.—**A. Masotti**: Observations on the motions of a fluid in which the distribution of the vortex is stationary.—**F. Ruda**: Explanation of the green ray. The variations in the colour of the last rays of the setting sun from green to blue may be attributed to the variable dimensions of the corpuscles held in suspension in the atmosphere, especially in the lower layers near to the earth's surface. When the absorption is very intense, the green or blue ray is naturally not seen, this being the case when the sun is red. Various factors may intervene to cause the divergence, at times considerable, between the theoretical and the actual durations of the phenomenon.—**C. G. Fontana**: Gold purple (2). Substances analogous to purple of Cassius may be obtained without the use of a stannous salt, the hydroxide of aluminium, zirconium, or thorium being utilised as a supporting material. In such cases the preparation is effected by means of a red, alkaline gold sol. The structure of aluminium gold purple and zirconium gold purple are completely analogous to that of purple of Cassius, the gold being present in the elementary condition and with the same high degree of dispersion. No such conclusion is found possible with the thorium gold purple.—**A. Desio**: The presence of the Miocene in the neighbourhood of El-Abiàr (Cyrenaica).—**S. Ranzi**: Differential inhibition in the development of cephalopods and considerations on the so-called axial gradient. The phenomena which, in embryos, seem to indicate the presence of an axial gradient, have their *raison d'être* in the special manner of development of the forms in question. The so-called axial gradient is not a regulator of the development, but a resultant, more apparent than real, of the occurrent phenomena, which in all cases diverge widely from Child's scheme of one or two dominant points (at the cephalic and caudal extremities).—**D. Cattaneo**: Ultramicroscopic investigations on the crystalline lens (3). Modifications of the ultramicroscopic structure by the action of disimbibition in dry air, of hydration in water, and of low and high temperatures. When the crystalline lens of the eye of the ox is kept in a desiccator containing calcium chloride for a period exceeding 24 hours, the surface fibres become slender and assume a diffuse and marked refractivity, the chondriosomes being then no longer visible; this condition of the fibres persists even if the lens is afterwards placed in water, in which the lenticular substance swells. When the fresh lens is immersed in water, the imbibition occurring reveals itself in gradual and rapid diminution up to complete disappearance of the chondriome, that is, of the differentiated part of the lenticular protoplasm. The changes produced in the lens by the action of cold are those which are manifested after the death of the cells and are thus not directly dependent on the lowering of the temperature. The effects of a high temperature on the crystalline fibres are a gradual disappearance of the differentiated part and a precipitation of the colloids constituting the fundamental protoplasm, which loses its homogeneity and becomes granular; this is essentially the phenomenon determined by the action of acids.—**A. Galamini**: The daily thermal curve of the albino rat. In accordance with the life habits of the albino rat, its temperature-time curve exhibits two maxima, at 7 A.M. and 10 P.M.-midnight, and two minima, at 1 P.M.-5 P.M. and 4 A.M. respectively.—**C. Artom**: The circulating elements of the hæmolymph of euphyllopod crustaceans. As is the case with other entomostracans, the functions of these elements seem to consist of elaboration of the fats absorbed by the epithelium of the intestine and of transport of the elaborated fats to the various tissues.

Official Publications Received.

BRITISH.

Trinidad and Tobago: Council Paper No. 90 of 1927. Department of Agriculture: Administration Report of the Director of Agriculture for the Year 1926. Pp. 42. (Trinidad: Government Printing Office, Port-of-Spain.) 1s. 6d.

The Victoria Bush Nursing Association. Report and Statement of Accounts to 30th June 1927. Pp. 205. (Melbourne.)

Department of Agriculture, Ceylon. Bulletin No. 82: Field Experimentation with Rubber (Hevea brasiliensis). By L. Lord and L. Abeyesundera. Pp. 21. (Peradeniya.) 40 cents.

The Chemist in the Photographic Industry. By O. F. Bloch. (Streatfeild Memorial Lecture, 1927.) Pp. 18. (London: Institute of Chemistry of Great Britain and Ireland.)

The Institute of Chemistry of Great Britain and Ireland. Jubilee Celebration, 14th-15th December 1927. Pp. 53. (London.)

Journal of the Chemical Society: containing Papers communicated to the Society. January. Pp. viii+iv+255. (London: Gurney and Jackson.)

Aeronautical Research Committee: Reports and Memoranda. No. 1104 (Ae. 281): On the Flow of Air behind an Inclined Flat Plate of Infinite Span. By A. Fage and F. C. Johansen. (A.1.b. Photographic Work-Flow, etc. 13.—T. 2401.) Pp. 26+3 plates. 1s. 3d. net. No. 1105 (Ae. 282): The Aerodynamics of a Simple Servo-Rudder System. By H. M. Garner and F./Lt. C. E. W. Lockyer. (A.3.b. Fins and Rudders, 10.—T. 2488.) Pp. 8+2 plates. 6d. net. (London: H.M. Stationery Office.)

Navy (Health). Statistical Report of the Health of the Navy for the Year 1925. Pp. v+139. (London: H.M. Stationery Office.) 4s. 6d. net.

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, St. Lucia, 1926. Pp. iv+29. (Trinidad, B.W.I.) 6d.

Royal Botanic Gardens, Kew. Bulletin of Miscellaneous Information, 1927. Pp. iv+432+98+8 plates. (London: H.M. Stationery Office.) 12s. 6d. net.

Transactions and Proceedings of the Perthshire Society of Natural Science. Vol. 8, Part 4, 1926-27. Pp. 159-233+xxxix-xlix+10 plates. (Perth.) 3s. 6d.; to Members, 2s. 6d.

Journal of the Indian Institute of Science. Vol. 10A, Part 7: Esterification in mixed Solvents. By B. V. Bhide and H. E. Watson. Pp. 71-77. 8 annas. Vol. 10A, Part 8: Nitrogen Fixation by 'Azotobacter Chroococcum.' By S. Ranganathan and Roland V. Norris. Pp. 79-96. 1.4 rupees. (Bangalore.)

Records of the Botanical Survey of India. Vol. 11, No. 2: The Flora of the Chakaria Sundarbans. By Dr. J. M. Cowan. Pp. 197-225. (Calcutta: Government of India Central Publication Branch.) 10 annas; 1s.

Committee of the Privy Council for Medical Research. Report of the Medical Research Council for the Year 1926–1927. (Cmd. 3013.) Pp. 152. (London: H.M. Stationery Office.) 3s. net.

Colony and Protectorate of Kenya. Bulletin 18: The Common Coffee Mealy-Bug (*Pseudococcus Lilacinus*, Ckll.) in Kenya Colony. By T. W. Kirkpatrick. Pp. viii+110+6 plates. (Nairobi: Government Printer.)

Proceedings of the Royal Society of Victoria. Vol. 39 (New Series), Part 2. Pp. 53-203. (Melbourne.)

Proceedings of the Fourteenth Indian Science Congress, Lahore 1927 (Second Circuit). Pp. xxiv+384. (Calcutta: Asiatic Society of Bengal.)

Department of Public Instruction, Technical Education Branch: New South Wales. Technological Museum: Extracts from the Curator's Annual Report for Year ended 31st December 1926. Pp. 4. (Sydney, N.S.W.: Alfred James Kent.)

Aeronautical Research Committee: Reports and Memoranda. No. 1108: The Rotating Wing in Aircraft. By H. E. Wimperis. Pp. 7+1 plate. 6d. net. No. 1109: The High-duty Compression-Ignition Engine. By D. R. Pye. Pp. 15. 9d. net. (London: H.M. Stationery Office.)

Proceedings of the Royal Irish Academy. Vol. 38, Section A, No. 1: Observations on Atmospheric Electrical Conductivity in connection with the Solar Eclipse of 29th June 1927. By Dr. P. J. Nolan and Cilian O Brolchain. Pp. 17. 6d. Vol. 38, Section A, No. 2: Undulating Theory of Two Electron Orbits. By A. W. Conway. Pp. 18-28. 6d. (Dublin: Hodges, Figgis and Co.)

The Journal of the Royal Horticultural Society. Edited by F. J. Chittenden. Vol. 53, Part 1. Pp. 199+lxxx+xviii+25 plates. (London.) 7s. 6d.

Report of the Committee of the Privy Council for Scientific and Industrial Research for the Year 1926–27. (Cmd. 3002.) Pp. iv+157. (London: H.M. Stationery Office.) 3s. net.

Margarine and the Vitamin Problem. Pp. 18. (Brombro Port, Cheshire: Planters Foods, Ltd.)

FOREIGN.

Department of the Interior: U.S. Geological Survey. Water-Supply Paper 596-E: Quality of the Surface Waters of New Jersey. By W. D. Collins and C. S. Howard. (Contributions to the Hydrology of the United States, 1927.) Pp. iv+89-119+plate 10. (Washington, D.C.: Government Printing Office.)

Department of the Interior: U.S. Geological Survey. Bulletin 795-D: The Brown Iron Ores of West-Middle Tennessee. By Ernest F. Burchard. (Contributions to Economic Geology, 1927, Part 1.) Pp. iv+53-112+plates 4-8. 15 cents. Bulletin 795-E: Quicksilver Deposits of the Pilot Mountains, Mineral County, Nevada. By William F. Foshag. (Contributions to Economic Geology, 1927, Part 1.) Pp. ii+113-123+plate 9. 5 cents. Bulletin 796-A: The Gillette Coal Field, Northeastern Wyoming. By C. E. Dobbin and V. H. Barnett; with a Chapter on the Minturn District and the Northwestern Part of the Gillette Field, by W. T. Thom, Jr. (Contributions to Economic Geology, 1927, Part 2.) Pp. v+64+13 plates. 35 cents. (Washington, D.C.: Government Printing Office.)

Department of the Interior: U.S. Geological Survey. Professional Paper 150-A: Cephalopods from the Lower Part of the Cody Shale of Oregon Basin, Wyoming. By John B. Reeside, Jr. (Shorter Contributions to General Geology, 1927.) Pp. ii+19+8 plates. 15 cents. Professional Paper 150-B: The Scaphites, an Upper Cretaceous Ammonite Group. By John B. Reeside, Jr. (Shorter Contributions to General Geology, 1927.) Pp. ii+21-36+plates 9-11. 10 cents. Professional Paper 151: The Cephalopods of the Eagle Sandstone and related Formations in the Western Interior of the United States. By John B. Reeside, Jr. Pp. iii+87+45 plates. 60 cents. (Washington, D.C.: Government Printing Office.)

Carnegie Institution of Washington. Publication No. 378: Steam Wells and other Thermal Activity at "The Geysers," California. By E. T. Allen and Arthur L. Day. Pp. 106. (Washington, D.C.: Carnegie Institution.)

Carnegie Institute of Washington. Publication No. 322B: The Pleistocene of the Western Region of North America and its Vertebrated Animals. By Oliver P. Hay. Pp. v+346+12 plates. (Washington, D.C.: Carnegie Institution.)

Carnegie Instution of Washington. Publication No. 380: Contributions to Embryology, Vol. 19, Nos. 98-108. No. 98: The Menstrual Cycle of the Monkey, *Macacus rhesus*; Observations on Normal Animals, the Effects of Removal of the Ovaries and the Effects of Injections of Ovaries and Placental Extracts into the Spayed Animals, by Edgar Allen; No. 99: Embryology of the Neuromuscular Spindle, by Fidel Cuajunco; No. 100: Development of the Mesoblast and Notochord in Pig Embryos, by George L. Streeter; No. 101: Growth of the Human Foot and its Evolutionary Significance, by William L. Strauss, Jr.; No. 102: Lymphatics of the Fallopian Tube of the Sow, by Dorothy H. Anderson; No. 103: Correlated Physiological and Morphological Studies on the Development of Electrically Responsive Areas in the Cerebral Cortex of the Opossum, by Orthello R. Langworthy; No. 104: Histological Development of Cerebral Motor Areas in young Kittens correlated with their Physiological Reaction to Electrical Stimulation, by Orthello R. Langworthy; No. 105: On the Placentation of the Tridactyl Sloth, *Bradypus griseus*, with a Description of some Characters of the Fetus, by George B. Wislocki; No. 106: A Study of the Implantation of the Ovum of the Pig from the Stage of the Bilaminar Blastocyst to the completion of the Fetal Membranes, by Chester H. Heuser; No. 107: Development of the Human Heart from its First Appearance to the Stage found in Embryos of 20 Paired Somites, by Carl L. Davis; No. 108: Observations on the Ovary of the Opossum, *Didelphis virginiana*, by Carl G. Hartman. Pp. iv+300+60 plates. (Washington, D.C.: Carnegie Institution.)

Agricultural Experiment Station, Michigan State College of Agriculture and Applied Science. Technical Bulletin No. 84: The Clarifier and the Filter in Processing Milk. By P. S. Lucas, L. H. Cooledge, O. T. Goodwin and R. J. Werdon. Pp. 27. (East Lansing, Mich.)

Technical Books of 1926: a Selection. Compiled by Donald Hendry. Pp. 28. (Brooklyn, N.Y.: Pratt Institute Free Library.)

Institut de France: Académie des Sciences. Annuaire pour 1928. Pp. 384. (Paris: Gauthier-Villars et Cie.)

Proceedings of the United States National Museum. Vol. 72, Art. 7: Insects of the Subclass Apterygota from Central America and the West Indies. By J. W. Folsom. (No. 2702.) Pp. 16+8 plates. Vol. 72, Art. 19: The Green Pit Viper, *Trimeresurus gramineus*, in China. By Leonard Stejneger. (No. 2715.) Pp. 10. (Washington, D.C.: Government Printing Office.)

Société des Nations (League of Nations). Bulletins de l'Institut International de Coopération intellectuelle: Bulletin des Relations scientifiques. 2me année, No. 4, Décembre. Pp. ii+403-458. (Paris: Les Presses universitaires de France.) 8 francs.

El Observatorio del Ebro: idea general sobre el mismo. Por Rev. P. Ignacio Puig. Pp. viii+188. (Tortosa.)

Rendiconti del Seminario Matematico e Fisico di Milano. Vol. 1, (1927-V). Pp. viii+128. (Milano.)

United States Department of Agriculture. Technical Bulletin No. 53: Scouting, Quarantine and Control for the European Corn Borer, 1917–1926. By L. H. Worthley and D. J. Caffrey. Pp. 143. (Washington, D.C.: Government Printing Office.) 30 cents.

New York Academy of Sciences. Scientific Survey of Porto Rico and the Virgin Islands. Vol. 9, Part 4: The Birds of Porto Rico and the Virgin Islands. Psittaciformes to Passeriformes. By Alexander Wetmore. Pp. 409-589+xiii+plates 62-65. (New York City.)

Marine Borers and their Relation to Marine Construction on the Pacific Coast: being the Final Report of the San Francisco Bay Marine Piling Committee. C. L. Hill and C. A. Kofoid, Editors-in-Chief. Prepared under the direction of the San Francisco Bay Marine Piling Committee cooperating with the National Research Council and the American Wood-Preservers' Association. Pp. ix+357. (Berkeley, Cal.: University of California Press.) 4 dollars.

Annual Report of the Naval Observatory for the Fiscal Year 1927. (Appendix No. 2 to Annual Report of the Chief of the Bureau of Navigation, 1927.) Pp. 16. (Washington, D.C.: Government Printing Office.)

Proceedings of the United States National Museum. Vol. 72, Art. 20: Foraminifera of the Genus Siphonina and related Genera. By Joseph Cushman. (No. 2716.) Pp. 15+4 plates. Vol. 72, Art. 23: The Flora of the Esmeralda Formation in Western Nevada. By Edward W. Berry. (No. 2719.) Pp. 15+2 plates. (Washington, D.C.: Government Printing Office.)

Veröffentlichungen des Geophysikalischen Instituts der Universität Leipzig. Zweite Serie: Spezialarbeiten aus dem Geophysikalischen Institut. Band 3, Heft 4: Über warme Hochdruckgebiete und ihre Rolle im atmosphärischen Wärmehaushalt. Von R. Mugge. Pp. 239-266. Band 3, Heft 5: Beziehungen zwischen Luftdruck- und Temperaturänderungen; ein Beitrag zur Frage des "Sitzes" der Luftdruckschwankungen. Von Bernard Haurwitz. Pp. 267-336+4 Tafeln. (Leipzig.)

The University of Colorado Studies. Vol. 16, No. 1, June. Pp. ii+74+9 plates. (Boulder, Colo.)

U.S. Department of Agriculture. Technical Bulletin No. 26: Our Migrant Shorebirds in Southern South America. By Alexander Wetmore. Pp. 24. (Washington, D.C.: Government Printing Office.) 5 cents.

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards. No. 564: Absolute Measurement of Capacitance by Maxwell's Method. By Harvey L. Curtis and Charles Moon. Pp. 487-531. 15 cents. No. 565: Thermal Expansion of Beryllium and Aluminium-Beryllium Alloys. By Peter Hidnert and W. T. Sweeney. Pp. 533-545. 10 cents. No. 566: Indeterminateness of Electrical Charge. By Chester Snow. Pp. 547-556. 5 cents. (Washington, D.C.: Government Printing Office.)

Journal of the Faculty of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 21, Part 3: Beiträge zu einer Monographie der Gattung *Pucciniastrum* Otth. Von Naohide Hiratsuka. Pp. 63-119+1 Tafel. (Tokyo: Maruzen Co., Ltd.)

Calendario del Santuario e delle Opere di Beneficenza Cristiana di Valle di Pompei, 1928. Pp. 256. (Valle di Pompei.)

Abisko Naturvetenskapliga Station. Observations météorologiques à Abisko en 1914. Rédigées par F. Lindholm et Bruno Rolf. Pp. ii+76. Observations météorologiques à Abisko en 1925. Rédigées par Bruno Rolf. Pp. iv+66. (Stockholm.)

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 7, 1925. iii: Vattenstånden vid Rikets kuster. Pp. ii+21. (Stockholm.) 2.00 kr.

Diary of Societies.

SATURDAY, FEBRUARY 25.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates and Students' Section) (at Neville Hall, Newcastle-upon-Tyne), at 3.—Dr. R. J. Perring: Miners' Nystagmus.—*Paper open for further discussion*:—A Contribution to the Solution of the Problem of Underground Haulage Accidents, with special reference to the Northern Mines Inspection Division, by A. M. Bryan.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—C. Dodgson: The Life and Work of Albrecht Dürer (I).

MONDAY, FEBRUARY 27.

INSTITUTE OF ACTUARIES, at 5.—C. F. Warren: Further Notes on an Investigation into the Mortality Experienced by Pensioners of the Staffs of Banks and Insurance Companies.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—L. Emanueli and others: Discussion on 130,000-volt Cables.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—D. S. Munro: Modern Electrical Wiring, particularly as applied to Small Houses.

ROYAL SOCIETY OF ARTS, at 8.—Dr. H. Gough: Fatigue Phenomena, with special reference to Single Crystals (Cantor Lectures) (III.).

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—Mrs. Lilian Lindsay: Dentistry as one of the Fine Arts.—A. T. Marston: A Case of Necrosis of the Mandible.

TUESDAY, FEBRUARY 28.

ROYAL SOCIETY OF ARTS (Dominions and Colonies Meeting), at 4.30.—Sir Stephen Montagu Burrows: The Ancient Civilisation of Ceylon.

ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.—Dr. H. L. Tidy: Hemorrhagic Diathesis.

ILLUMINATING ENGINEERING SOCIETY (at E.L.M.A. Lighting Service Bureau), at 6.30.—W. E. Bush: The Activities of the E.L.M.A. Lighting Service Bureau.

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at Loughborough College), at 6.45.—H. B. Poynder: Some Practical Considerations in the Design of Automatic Equipments for Heavy Traction Substations.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—C. H. Oakden: The Photographic Work of the Rev. J. B. Reade.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—E. K. Tratman: Aveline's Hole, a late Upper Palæolithic Station in Somerset.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 8.30.—Prof. R. V. Wheeler and Dr. G. B. Maxwell: Flame Characteristics of Pinking and Non-Pinking Fuels.

WEDNESDAY, FEBRUARY 29.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. S. Huxley: The Behaviour of Animals (II.).

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (at Wellcome Historical Medical Museum, 54A Wigmore Street), at 5.30.

ROYAL SOCIETY OF ARTS, at 8.—A. Crawford: Industry Fifty Years Hence.

BRITISH ASTRONOMICAL ASSOCIATION (at Sion College, Victoria Embankment).

THURSDAY, MARCH 1.

ROYAL SOCIETY, at 4.30.—Dr. A. E. H. Tutton: The Hexahydrated Double Sulphates containing Thallium.—The Hexahydrated Double Selenates containing Thallium.—W. H. J. Childs: The Distribution of Intensity in the Band Spectrum of Helium: the band a λ4650.—M. C. Johnson: Studies in the Behaviour of Hydrogen and Mercury at the Electrode Surfaces of Spectrum Tubes.—*Papers to be read in title only*:—Prof. W. E. Curtis: The Structure of the Band Spectrum of Helium.—Prof. H. A. Wilson: The Saha Theory and the Conductivity of Flames containing Alkali Metal Vapours.—R. G. Lunnon: Fluid Resistance to Moving Spheres.—Prof. S. Chapman: On the Brownian Displacements and Thermal Diffusion of Grains Suspended in a Non-Uniform Fluid.—N. F. Mott: The Solution of the Wave Equation for the Scattering of Particles by a Coulombian Centre of Force.—G. H. Biggs: A Redetermination of the Velocities of α-Particles from Radium C, Thorium C and C'.

LINNEAN SOCIETY OF LONDON, at 5.—A. M. Smith: The Algæ of a Bog. Five Years' Observations.—Dr. C. Crossland: Coral Reefs of Tahiti, Moorea, and Rarotonga.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. F. A. E. Crew: Individual, Familial, and Racial Differences in Respect of Immunities and Disease Resistance (Milroy Lectures) (I.).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. F. Ll. Griffith: Nubia in Antiquity and in the Middle Ages (II.).

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Dr. S. Z. de Ferranti: Electricity in the Service of Man (Faraday Lecture).

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—Wing Comdr. R. M. Hill: Experiences with the Baghdad Air Mail.

INSTITUTE OF METALS (Birmingham Local Section) (at Engineers' Club, Birmingham), at 7.—Prof. C. A. Edwards: Gases in Metals.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (jointly with Bristol Section of Society) (at Bristol), at 7.30.—T. Penny: The Art of Soap Manufacture.

CHEMICAL SOCIETY, at 8.—F. G. Mann: The Complex Salts of Divalent Platinum with $\alpha\beta\gamma$-triaminopropane.

INSTITUTION OF MECHANICAL ENGINEERS (Glasgow Branch).—W. Watson: The Spinning of a Cotton Thread and the Machinery Used.

FRIDAY, MARCH 2.

ROYAL ASTRONOMICAL SOCIETY, at 4.30.—Geophysical Discussion: Periodicities. Chairman: Dr. G. C. Simpson. Speakers: Sir Gilbert Walker, Prof. Turner, Mr. Yule, Mr. Brunt.

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (at Engineers' Club, Manchester), at 7.—Dr. T. Callan and S. Horobin: Some Industrial Applications of the Potentiometric and Conductometric Method of Analysis.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—Annual General Meeting.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—A. Abbey: Some Notes on a Recent Visit to the United States of America.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—Prof. E. J. Garwood: River Meanders (Lecture).

PHILOLOGICAL SOCIETY (at University College), at 8.—L. C. Wharton: Universal Language of late Dr. Mason.—Report of the Copenhagen Conference on Transcription and Transliteration.

OXFORD UNIVERSITY JUNIOR SCIENTIFIC CLUB (in Department of Biochemistry and Physiology, Oxford), at 8.15.—H. T. Tizard: Careers for Scientific Men.

ROYAL SOCIETY OF MEDICINE (Anæsthetics and Obstetrics Sections), at 8.30.—Discussion on Anæsthesia in Obstetrics. Speakers: Dr. J. Blomfield and H. A. Richards (Anæsthetics); E. Holland and W. Gilliatt (Obstetrics); also H. E. G. Boyle and Dr. H. R. Spencer.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Farquhar Buzzard: The Psychology of the Sick.

SATURDAY, MARCH 3.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—C. Dodgson: The Life and Work of Albrecht Dürer (II.).

PUBLIC LECTURES.

SATURDAY, FEBRUARY 25.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. Edith Durham: Primitive Life in South-East Europe.

MONDAY, FEBRUARY 27.

GRESHAM COLLEGE, at 6.—G. P. Bailey: Modern Science and Daily Life: Chemistry in Industry.

LEEDS UNIVERSITY, at 8.—Dr. Ll. Wynn Jones: Recent Advances in Experimental Psychology: Applications to Education and Industry.

WEDNESDAY, FEBRUARY 29.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.30.—Sir Robert Armstrong-Jones: The Present Legal Aspect of the Treatment of the Insane and the Mentally Defective.

BIRKBECK COLLEGE, at 5.30.—Dr. F. A. E. Crew: Heredity. (Succeeding Lectures on Mar. 7 and 9.)

THURSDAY, MARCH 1.

LEEDS UNIVERSITY, at 8.—Air Vice-Marshal Sir Sefton Brancker: Some Recent Developments in Aviation.—A. N. Shimmin: Economics in Everyday Life: The Getting of Money.

FRIDAY, MARCH 2.

KING'S COLLEGE, at 5.30.—S. Gasalee: Greek Culture in Egypt at the Time of the Arab Invasion.

SATURDAY, MARCH 3.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—J. E. S. Dallas: A Naturalist at Land's End.

CONFERENCE.

FEBRUARY 24 AND 25.

ASSOCIATION OF TECHNICAL INSTITUTIONS (Annual Meeting) (at Stationers Hall).

Principal G. H. Austin: Commercial Education.

Principal S. Carter: Suitable Courses in Commerce for Small Institutions.

T. P. Bennett: The Technical Training of the Architect.

Principal F. E. Drury: Technical Education for the Building Trades.

F. W. Roberts: Technical Education for the Boot and Shoe Industry.