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CONTENTS.

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Co-education.

SCIENCE does not give a clear lead on the question of co-education. The physiological and psychological differences between the sexes are not 'significant' enough to determine whether the sexes should preferably be educated together or apart. When in 1922 the Consultative Committee of the Board of Education was preparing its valuable report on "Differentiation of the Curriculum for Boys and Girls respectively in Secondary Schools," it wisely consulted a distinguished medical man, the late Dr. J. G. Adami, on the anatomical and physiological differences between the sexes. Dr. Adami classified those differences under four headings—(*a*) rate of growth ; (*b*) date of adolescence ; (*c*) anatomical age ; and (*d*) after puberty, the composition of the blood—and gave the Committee all the information available on the interrelationship of the internal secretions and the essential and secondary organs of sex ; for, as he said, "obviously it has a profound bearing upon the problem before the Committee."

The lower proportion of red blood corpuscles in women has been established by several workers. Dr. Adami discussed at some length recent work on the calcium metabolism of the body, referring especially to Blair Bell's conclusion that, with the onset of puberty, the calcium metabolism in the female becomes unstable, whereas in the male it remains comparatively constant. The committee observes that at that time Blair Bell's views had not been generally accepted by physiologists, but it appeared possible that the greater nervous excitability of the feminine sex might be ascribed to a deficiency in calcium. If the Committee showed a disposition to study its problem in the dry light of science, its recommendations stressed the need for further inquiries rather than the value of results already attained.

It must be remembered that the Consultative Committee was not concerned directly with the question of co-education. Evidence on this question was, however, received, and a digest is given in an appendix. The questions considered refer to the relations between boys and girls in mixed schools—whether, for example, boys tend to take a preponderating part in the social life of the school—the danger of overpressing girls and not pushing boys forward sufficiently, the relative failure to meet the individual needs of some girls, and, finally, staffing difficulties. These last appear to be the most serious, for the position under which mixed schools are, with some exceptions, under the control

of head masters, does not appear to offer a final solution. Women's education has already suffered too much from 'man-made' curricula, and a state of things in which all the responsible appointments in secondary education are held by men would not be acceptable to women under present social and political conditions.

Originally, in Great Britain, as in the United States, the establishment of mixed secondary schools took place without much premeditation. The geographical distribution of these schools in England is curious. Buckinghamshire, Derbyshire, Durham, Gloucestershire, Hampshire, Lancashire, Middlesex, Suffolk, Wiltshire, and the West Riding appear to like mixed schools; Kent, London, Northumberland, Staffordshire, Surrey, and Warwickshire appear not to like them. Lancashire has thirty-three mixed schools and thirty-eight boys' schools under the county authority; London has three mixed schools compared to forty boys' schools. Mr. R. F. Cholmeley, in his chapter on the boys' day school, contributed to "The Schools of England," edited by Prof. Dover Wilson, remarks that the origin of most of these mixed schools is due to convenience, including financial convenience; but he adds that "the interesting thing about them is the growth of a belief in them on educational grounds, and the remarkable success of their work." He regards the growth of the mixed school as one of the most striking developments in day school education. The proportion of mixed schools to boys' schools is almost exactly seven to eight, and the number of boys educated therein as two to five.

If the growth of the mixed school has been without premeditation, the same may be said of the growth of the girls' secondary school and college. The pioneers of women's education saw the nakedness of the land and established new schools and colleges for girls and women, making, at the same time, a reasonable claim to a small share of educational endowments. The University of London was an early convert to co-*examination*, admitting women to all examinations in 1878, with the significant reservation that "no female graduate of the said University shall be a member of Convocation of the said University, unless and until such Convocation shall have passed a resolution that female graduates be admitted to Convocation." Here we see obtruding the old and difficult question of control, a question of much controversy also at Oxford and Cambridge. In London this question has advanced a distinct stage under the new statutes which grant official membership of the Senate to the heads of several women's colleges, an 'ability' accorded to women which will be generally approved, as it seems desirable to ensure the inclusion of women on the governing bodies of universities.

In the British universities generally, co-education prevails and is unavoidable in the case of subjects studied by a small number of students. Oxford, Cambridge, and London, partly owing to their collegiate organisation, present some special problems.

The question of medical co-education in London has been widely discussed in consequence of the decision of several medical schools in future to exclude women students, a reversal of the policy adopted during the War. The usefulness of the Report of the Committee of the Senate of the University of London on this subject is, however, reduced, because it was not found possible to state specifically the reasons which led the medical schools in question to this decision; nor is there any report by the Faculty of Medicine, the advice of which we should have expected the Senate to seek on constitutional grounds. The committee states: "We are unable to see any valid argument on the merits against the provision of co-education in medicine. The pre-possession of the University is in favour of such co-education." Seeing that a large majority of the existing colleges of the University are uni-sexual, and that seven medical schools have recently expressed a preference for uni-sexual education, it is difficult to see on what evidence this 'pre-possession' is based. Statistics appended to the Report indicate that there is at present no difficulty in women undergraduates obtaining medical education; for whereas in 1920–21 the London School of Medicine for Women had 447 full-time students, that number had fallen in 1926–27 to 297. The throwing open of the other medical schools to a 'quota' of women would tend to reduce the success and efficiency of this well-organised school for women. Apart from this, is not the 'quota' system inherently objectionable? The University would do well to ensure that all special courses, especially those by research workers at the spear-head of knowledge, should be equally available for men and women. At the moment, no further action on the part of the University appears to be demanded.

Since the publication of the University of London Report, an important opinion on the question of medical co-education has been pronounced by Dr. Louisa Garrett Anderson, who, at a meeting held at the London School of Medicine for Women on Mar. 21, said that a medical school

for women alone had enormous advantages over a co-educational school. Where women held the professorial chairs, she added, women learned to trust women; but where there was co-education it had been found that the most important work was done by men. As the Senate Committee, though in its nature a lay committee, did not attempt to quote expert opinions for and against medical co-education, this professional opinion by a leading woman doctor comes at a convenient moment and should carry great weight.

The general tendency of co-education is towards creating large institutions. Co-educational secondary schools of 5000 pupils are not uncommon in the larger American cities. Co-education also facilitates a preponderance of one sex or the other in the teaching staff, whereas with separate schools there is a natural tendency towards an approximate equality. In some of our co-educational colleges, women do not appear to have obtained a fair proportion of the staff appointments. Nor can co-education offer much encouragement to specialisation on sex lines which may be desirable in certain subjects, *e.g.* medicine. In higher education, which demands consecration and dedication, the presence of the other sex may act as a distraction. Frank R. Arnold, in an article "The Mating Season of Co-education" (*Scribner's Magazine*, June 1926), refers to "co-educational calf-love," and argues that the finest type of woman is not likely to be produced by co-educational institutions. Such women "need years of meditative acquisition, mental brooding as well as physical, and the fault of co-education is that it awakens the mating mother instinct too early."

The Planetesimal Hypothesis.

The Two Solar Families: the Sun's Children. By Prof. Thomas Chrowder Chamberlin. (University of Chicago Science Series.) Pp. xxii + 311. (Chicago: University of Chicago Press; London: Cambridge University Press, 1928.) 12*s.* 6*d.* net.

THIS book, which appeared on the author's eighty-fifth birthday, and less than two months before his lamented death, is a summary of the well-known planetesimal hypothesis of the origin of the solar system which, with the collaboration of Prof. F. R. Moulton, he developed during the last thirty years. While the greater part of the book is a restatement of previously published results, some new material is included, and the whole forms a compact and useful account of a hypothesis which, whatever may be its ultimate fate, must take high rank among the generalisations which have stimulated and elucidated geophysical research during this century.

The "two solar families" are, in broad terms, the planets and the comets. The former class includes the major and minor planets and their satellites, and the latter the chondrulites, comets, and meteorites. In "the grey beginning of years," a star passed near the sun, and by tidal action, aided by propulsive forces in the sunspot zones, drew forth a succession of 'bolts' from the near and far sides of the sun. These bolts rapidly cooled and were largely disintegrated into a multitude of 'planetesimals' which, in the course of long ages, were gradually reabsorbed by the residual nuclei of the bolts, forming the planets. The cometary family owed little, if anything, to the passing star. It arose from material ejected from the sun in the manner of the eruptive prominences which are even now frequently observed. The hypothesis is extended in an ingenious way, without excess of purely *ad hoc* assumptions, to explain many details of the present solar system. Prof. Chamberlin's account is not distinguished by marked clearness of expression, but it is in the main free from ambiguity, and the meaning is rarely obscure to the careful reader. A bountiful provision of good diagrams and illustrations, and excellent productive work on the part of the publishers, make up a worthy conclusion to the author's long series of contributions to geology and allied sciences.

The publication of the book has seemed to Prof. Moulton a fitting occasion to direct attention to certain matters connected with the planetesimal hypothesis and its reception among astronomers. He has accordingly issued a pamphlet entitled "The Planetesimal Hypothesis," in which several important points are raised. It is made up of two distinct parts, which may be described succinctly as constructive and destructive. They are not entirely unrelated, for the instruments forged in the former are used as weapons in the latter, and in fact were clearly designed for that end, but the division is nevertheless a convenient one.

In the constructive part a sharp line is drawn between hypotheses of the Laplace type and those of the planetesimal type. "The gap between these different genera of intellectual constructions is as profound as that between different genera of living organisms, and as difficult to bridge." The characteristics of the genera are described by examples instead of specific statements, but it is clear that the typical feature of the former is the idea that the evolution of each cosmic mass is free from extraneous influences and consequently can be traced out rigorously

from a few fundamental principles in a statement of great simplicity. If intra-atomic sources of energy are ignored, these hypotheses require a cosmic time-scale of tens of millions of years. Hypotheses of the planetesimal type, on the other hand, regard the stars as mutually related objects, the evolution of each depending in part upon the others. The simplicity of the former type does not exist, so that some parts of the planetesimal hypothesis may be accepted and others rejected. The time-scale required here is of the order of thousands of millions of years.

Later in the pamphlet another classification is advanced which distinguishes hypotheses which are expressible in formulæ from those which are not. Prof. Moulton well explains the character of a 'formula' or 'law of Nature,' and although he does not actually state that this classification is a restatement of the former one, it may fairly be inferred that that is so. The Laplacian theory and the Genesis account of creation are cited as examples of hypotheses expressible by simple formulæ, and the planetesimal hypothesis as an example of the other kind.

So much for the constructive side of the pamphlet; now for the destructive side. This originates in the relations between the planetesimal hypothesis and the views of Sir James Jeans and Dr. Harold Jeffreys on the origin of the solar system, which are mainly contained in "Problems of Cosmogony and Stellar Dynamics" (1919) of the former and "The Earth" (1924) of the latter. The theories of Jeans and Jeffreys both invoke a passing star to produce the planets from the sun by tidal action, but the conditions of the process and the subsequent developments differ in the two theories, as does each of them from the planetesimal hypothesis.

Prof. Moulton first protests against the frequent ascription of the assumption of a passing star, and the proof of the invalidity of Laplace's hypothesis, to Jeans instead of to the prior work of Chamberlin and himself. Further, although the time-scale of cosmic processes has lately been greatly extended through the discovery that intra-atomic energy might be available for stellar radiation, no adequate acknowledgment has been made of the fact that this possibility was urged by Chamberlin nearly thirty years ago.

This, however, is not all. Prof. Moulton goes on to denounce the methods of Jeans and Jeffreys in claiming credit by implication for Chamberlin's work. He complains that these writers give the impression that the idea of a passing star and allied conceptions are mainly due to British workers, and that they do not fairly indicate the date of birth of the planetesimal hypothesis, so that priority is likely to be wrongly assigned. He gives a history of the development of that hypothesis and compares it with the later work of Jeans and Jeffreys, concluding that the 'tidal theory' of these writers is identical in every essential concept with the planetesimal hypothesis and that the former is an abortive attempt to put the latter into a formula.

From the point of view of scientific history and general principles, Prof. Moulton's pamphlet has much importance and some justification. There seems to be no doubt that due acknowledgment has not generally been given to the work of Prof. Chamberlin and himself with respect to the assumption of a passing star, the criticism of Laplace's hypothesis, and the realisation of the factors determining the cosmic time-scale. The planetesimal hypothesis is clearly entitled to very serious consideration, yet it has rarely been considered seriously outside the works of the authors themselves. It is easy to find reasons for this, but difficult to find excuses. We hope the pamphlet will make it unnecessary to look for them in the future.

Very pertinent also are Prof. Moulton's remarks concerning the significance of formulæ. A mathematical statement undeniably carries with it an air of authenticity which does not usually accompany general descriptions, although the latter may involve greater imaginative insight and approach more nearly to the actual happenings of Nature. In the attempt to reconstruct cosmic history, the inquirer may be actuated by either of two motives: he may believe that something actually occurred in pre-human times, and seek to discover what it was, or he may be concerned to weld together observed phenomena into a consistent logical scheme, and introduce the past as a useful parameter without necessarily assigning to it the dignity (or indignity) of actuality. Usually, perhaps always, the two motives are mixed, but on the whole the former predominates in the descriptive, non-mathematical theorist, and the latter in the mathematical physicist. So long as our knowledge is partial, at least, the two motives will urge the inquirer along diverging paths. We are glad that Prof. Moulton has had the courage to insist that one is not inevitably more valid than the other.

Having made so clear a distinction, however, Prof. Moulton most surprisingly fails to preserve it, and as a result we have his vigorous criticism of Jeans and Jeffreys which his own general principles, if properly applied, would discredit. The starting-point and sole sanction of the attack is the assump-

tion that the 'tidal theory' of these writers is merely a vain attempt to formularise the planetesimal hypothesis and consequently is separated by a profound gap from hypotheses of the Laplace type. It is difficult to understand how such an assumption could be made, for there could scarcely be a more typical example of the Laplacian type of hypothesis than the tidal theory. It has, in common with the planetesimal hypothesis, the assumption of a passing star as the origin of the whole process, but the subsequent development is so profoundly different in the two lines of thought that the bodies which give the name to the hypothesis of Chamberlin and Moulton do not exist in that of Jeans and Jeffreys.

Extracts from prefaces will perhaps make this clear. Jeans writes: "The present essay is primarily an attempt to follow up a line of research initiated by Laplace and Maclaurin, and extended in various directions by Roche, Lord Kelvin, Jacobi, Poincaré, and Sir G. Darwin." Prof. Moulton's examples of the Laplacian type of hypothesis are the works of Laplace, Helmholtz, Sir G. Darwin, and Lord Kelvin. Jeans continues: "When a firm theoretical framework had been constructed, it seemed permissible and proper to try to fit the facts of observational astronomy into their places." Chamberlin, on the other hand, was led to theoretical discussion by a desire to explain geological facts. "We may make the vestiges of the genetic events serve as our guide. All the peculiarities of the planetary system . . . should serve as system-pointers to the true interpretation."

Again, Jeffreys writes: "Quantitative comparison of theory with fact has always been the main object of the book." Clearly it is the 'formula' type of theory that is attempted here.

Prof. Moulton's attack on Jeffreys's 'tactics' is regrettable and, it appears to us, without justification. It is unfortunate that Jeffreys does not give a specific date to Chamberlin and Moulton's work, but the character of his discussion of it is not fairly indicated in the pamphlet. After very favourable mention in Chap. ii. it is discussed in an appendix of seven pages beginning: "The Planetesimal Hypothesis was historically the parent of the Tidal Theory. . . . It was invented by T. C. Chamberlin and F. R. Moulton in the early years of the present century, and detailed accounts of it may be found in" (three sources). Since Prof. Chamberlin gives 19 references to original papers on the hypothesis, excluding its exposition in books, Jeffreys's date is perhaps as specific a one as could conveniently be given, and should certainly mislead no one in the matter of priority. The historical importance of the hypothesis is again emphasised at the end of the appendix.

We are convinced that Prof. Moulton's charge of national jealousy is unfounded, and the foregoing quotations appear to us to be strong evidence on this point. It will nevertheless be appropriate to examine the matter more generally. An analysis of the personal references in the indexes of the books here considered reveals the following percentage figures:

	References to		
	English Writers.	American Writers.	Others.
Chamberlin . .	13·1	65·6	21·3
Jeans . . .	22·8	37·9	39·3
Jeffreys . .	58·6	16·8	24·6

Prof. Chamberlin's book has been included, not in order to criticise his neglect of non-American work, but to show the inevitability of an apparently undue emphasis on the work of one's own countrymen in any original investigation. We do not complain of Prof. Chamberlin's 'tactics': we go to his book for an account of the planetesimal hypothesis, which was indisputably made in America. But we do think that Sir James Jeans and Dr. Jeffreys are entitled to a similar consideration. Their theories are as original as Prof. Chamberlin's, and we hope that Prof. Moulton's just objection to a general neglect of Prof. Chamberlin's work will no longer be weakened by an unjust attack on the work of others.

H. D.

The Study of Corals.

Catalogue of the Madreporarian Corals in the British Museum (Natural History). Vol. 7: *A Monograph of the recent Meandroid Astræidæ.* By Prof. George Matthai. Pp. v + 288 + 72 plates. (London: British Museum (Natural History), 1928.) n.p.

THE existing corals are the most unsatisfactory group of the animal kingdom from a systematic point of view. They are accursed in that they have supposed ancestors and relations so far back as the early Cambrian, the play of stratigraphers, who care not for life. Their most prominent feature is an exo-skeleton of carbonate of lime, which is neither for protection nor for muscular attachments, both of which are reflected in those of vertebrates and arthropods. There are radiating plates (septa) from centres, over which lie the mouths (stomodœa) of the anemones (polyps) that are seated upon them. Other structures are central columns (columella) and surrounding walls, all free edges toothed perhaps, and the skeleton (corallum) goes on perpetually thickening so long as the

anemones live. There is immense variation in the size and height of septal teeth, and the septa vary in length, height, and thickness, as do all other structures, in correlation with rapidity of growth, with incidence of light, with water movements, and so on. Systematy becomes worse in ' colonial ' or many mouthed or polyped forms, for these show in addition, more clearly correlated with environment, variation in the position and rate of production of new polyps such as to give wide differences in the coralla. All modern reef builders have algæ living and reproducing within their polyps, and these we judge to be the most important factor in their nutrition. They, like the chlorophyll in the tree, may produce vast modifications in the growth form of their host.

Yet modern corals must be classified for the sake of the palæontologists, who have to make their deductions as to the fossil species from the analogous living forms, if for no other people. About half a century ago their skeletons were all we really knew. They were supposed to be internal before von Koch found them to be formations or precipitations outside the animals. Then the anatomy of the polyps was partially cleared up by von Koch and by von Heider, Fowler, Bourne, and Duerden, amongst others, while Wayland Vaughan, by his studies on both living and fossil corals, greatly enriched our knowledge. The barrenness and inadequacy of any systematic study based on corallum alone was made clear. Yet, to bring conviction, the attempt had to be made to bring order out of confusion on the old lines, and the Natural History Museum issued six catalogues dealing with eight genera. Brooks and Bernard ' made confusion worse confounded.' The latter never examined scientifically even a single coral polyp, and yet stated that their skeletons " follow the growth of the polyps closely." He was unable to determine his species, and adopted a geographical arrangement, for example, enumerating twenty-four forms, which he termed " Porites Fiji Island, 1–24 " ; growth forms are correlated with localities rather than with environments. These catalogues were misfortunes, sheer waste of money, which could have been avoided if any member of the Museum staff had been sent to any coral reef for six months' study of the living forms.

It was at this stage that Prof. Matthai commenced his researches eighteen years ago. He made a profound study of polyps and coralla together, specialising on the massive, many polyped Astræidæ, some of which have separate seats for each polyp, separate corallites, while others have meandering valleys with many stomodœa. Of the former he had more than eight hundred specimens in the collections at Cambridge, and he examined the polyps of seventy-five of these by sections. He also worked over the collections of Glasgow and of most of the European capitals, in which he found 590 colonies. His results (*Trans. Linn. Soc.*, **17**; 1914) reduced the described species by three-quarters, and he showed that, once the polyp form of a species was determined, the species could be recognised by coralla alone. Hermaphroditism was seen to be a common phenomenon, and fission of the polyps by division through their stomodœa was proved not to exist, thus upsetting a main character in all former classification.

Prof. Matthai then extended his researches to the reefs of the West Indies and, *en route*, examined many of the Dana and other types in the United States. His "Colony Formation in Astræid Corals" (*Phil. Trans. R.S.*, 1926) sets out two modes of polyp budding, inside and outside their tentacular rings. The extratentacular budding corals have only a single stomodœum within each circle of tentacles, whereas the intratentacular are di-, tri-, or poly-stomodœal, the stomodœa joined to each other by either one or two couples of mesenteries. The foundation of the long meandering valleys of the brain corals was made clear. *Hydnophora* is the extreme case ; its monticules are isolated bits of corallite walls, while the polyp surface between has vast numbers of stomodœa, the ' colony ' being really a single poly-stomodœal anemone, seated on a coral base of complicated plates and walls.

The systematic examination of the vallied Astræidæ was the test required for these results. The Cambridge collections, both of these and of the genera previously examined by Matthai, were given to the Natural History Museum, together with all sections, etc., for permanent reference. The Museum at once offered to print a catalogue, and this has now appeared, with such a wealth of illustration that, be the system correct or not, we have a mass of information from which any subsequent researcher may conveniently start. Matthai's services were given under considerable personal sacrifice, but he should be satisfied with the results, which reflect the highest possible credit on himself and on the Indian Educational Service to which he belongs. This is a strong statement, but I confess that I was sceptical as to the application of his theoretical paper to systematy. As a result, I have been testing his methods and conclusions as to the species of his corals off and on, since I first learnt them, more than a year ago. I

find they work with comparative ease, and I have no advantage over any other systematist save a very limited acquaintance with corals as living organisms.

The secret expounded by Matthai is first to study the polyps, none of which have directive mesenteries, to determine how they form fresh mouths, and this gives the clue to valley formation, etc. He finds the same methods in quite diverse colonies; these form a genus to be further divided into species on other anatomical characters. The mesenteries joining stomodœa, the varied forms of nematocysts, and the number of principal mesenteries are some of the accessory characters of his polyp-key. Those chosen for the skeleton-key are septal margins toothed or not, septa thick or thin, columella present or absent, and lamellar, dense or trabecular, etc.; these, unfortunately, bear a minimal relationship to the growth methods of the polyps, with which the mesenteries of the first key are concerned. Each key will help the systematist to name, but the corallum key gives no clue to the phylogeny of the group, as to which the author rightly speculates. The interesting fact appears that of the 28 genera described, 16 are confined to the Indo-Pacific and 12 to the Atlantic, their centres respectively in the East and West Indies. Ten of the genera are monotypic, while 10 others have 2 species each. Of the more abundant brain corals, the Indo-Pacific *Cœloria* has 4 species (2 new) in place of 16, and the Atlantic *Mœandrina* 3 in place of 28. *Mussa* of the West Indies—it is a pity that Matthai could not obtain polyps—is stated to be monotypic, whereas its supposed Indo-Pacific forms are placed in three species of *Lobophyllia*, which would be easier to follow were their numerous figures less scattered in the plates.

In conclusion, we congratulate the Directors and the Keepers of the Natural History Museum that have been concerned on their bravery and scientific acumen in recommending the publication of this catalogue, after six previous quite disastrous volumes. The refiguring by photographic methods of a large number of 'type specimens' in many museums is of immense value, and only made possible by the recognition that science is international. This shows a healthy spirit in zoological science, as does the co-operation of directors and collectors with a real worker. On the whole, I am disposed to consider that the method here sketched is almost the last word so far as the anatomy of 'wild' species is concerned, and for the next advance I look to experiment and to a study of the whole physiology of coral polyps, particularly to that of corallum formation. That many species are adapted to wide changes in salinity, in temperature, in currents, in mud content of the water, in light, in phosphate content (especially in connexion with the commensal algæ), etc., is certain. All these are felt by the living polyps and are reflected in the growth of large colonies. We must know here more about our living beasts before we study further their systematy.

J. STANLEY GARDINER.

The Origins of European Culture.

The Most Ancient East: the Oriental Prelude to European Prehistory. By Prof. V. Gordon Childe. Pp. xiv + 258 + 24 plates. (London: Kegan Paul and Co., Ltd., 1928.) 15*s.* net.

A NEW book by Prof. V. Gordon Childe is always welcomed by students, and the volume under notice has special value as it carries the history of European cultures, as described in his "Dawn of European Civilization" (1925), to their origins in the ancient East, for the whole chronology of prehistoric Europe ultimately rests on synchronisms with the historical cultures of Babylonia and Egypt. The book begins with a reconstruction of the culture of the then thickly populated pleasant grass-lands of northern Africa and southern Asia of late palæolithic times. Firm ground is reached in the description of the culture recently found at Badaria, south of the Fayum. Culturally, the immigrant Badarians were a whole stage removed from the savagery of the Capsian hunters; they had mastered all the arts that are usually termed neolithic, and in addition they were acquainted with copper. The Badarians may have been autochthonous in the Nile valley or somewhat farther east; the modern Hadendoa appear to have relations with this ancient stock. They were the founders of Egyptian agriculture. Later, the first pre-dynastic culture arose in Upper Egypt from this basis and an infiltration of Getulian elements from the west.

The First Dynasty of Babylon can be fixed at 2196 B.C., but long before this there are written records of kings of various cities that date back to an event termed the Flood, and even earlier. The First Dynasty of Ur dates from before 3000 B.C., and belonging to a period some 500 years earlier are the royal tombs excavated by Mr. C. L. Woolley. Those who have seen his exhibitions in the British Museum will recognise that this very rich and mature civilisation must have had a long history behind it. Gordon Childe discusses the character and affinities of the first and second prediluvial

cultures; the former is mainly revealed from excavations at Susa (S. I.) and at al'Ubaid, the latter is that of Susa II. and of other sites.

As we have the first account in book form of the Badarian culture, so also we have that of the Indus civilisation. We find, thanks to work of Sir John Marshall, on the now impoverished banks of the Indus a brilliant civilisation in touch at once with the prediluvial villages of the Iranian plateau and the nascent city-states of Babylonia, and the Arabian Sea was ploughed by dhows freighted with the stuffs of Sindh consigned to Babylonian river towns. Thus the civilisation of Sindh was ahead of that of Sumer. About 3000 B.C. a catastrophe overtook the cities of the Indus basin. Gordon Childe thinks it is a legitimate deduction that the rôle of the maritime peoples of Arabia was to act as intermediaries between Egypt, Mesopotamia, and India.

This book should be of definite interest to the non-specialist reader, as it is pleasantly written, copiously illustrated, and will enable him to place in their historical setting the discoveries that are continually being noticed in the daily Press.

A. C. H.

Our Bookshelf.

Morpheus: or the Future of Sleep. By Prof. D. F. Fraser-Harris. (To-day and To-morrow Series.) Pp. 94. (London: Kegan Paul and Co., Ltd.; New York: E. P. Dutton and Co., 1928.) 2*s.* 6*d.* net.

A NUMBER of eminent men of science have contributed to the admirable series to which this little book belongs, and success has attended their efforts varying with their ability to cast aside professional restraints and speak their adventurous and unguarded minds. If the unsophisticated reader is willing to add Dr. Fraser-Harris's name to the list, it will be for reasons which are unfortunately concealed from the specialist. No subject could offer a greater opportunity for daring and ingenious speculation founded in scientific fact; but Dr. Fraser-Harris prefers to follow (rather lamely) the story of the journals. On p. 11 expectation is aroused by the statement that "comparatively few people could tell us exactly what it is that makes us sleepy and finally permits us to go to sleep." Gall, Mosso, Pupin, Claparède, Ramon y Cajal, Duval, Howell, Coriat, and Pavlov did not claim to do more than suggest tentatively, and while the author gives some account of their work, it is for the most part shorn of those honest doubts and reservations which somehow constitute a real contribution to the subject. Finally, he takes refuge in that disastrous propensity of physiologists confronted with conflicting streams of evidence, the 'omnibus' theory. Thus we have the absurdity: 'types' of sleep (p. 26). Particularly it is confusing to see Pavlov taken into the omnibus. First among physiologists he seems to have broken with the earlier inactivity theories completely. There is still the problem of sleep.

Some serious errors are made. The granules of Nissl are scarcely "rod-like" and they certainly are not to be found in the nuclei of nerve-cells in any circumstances, as Dr. Fraser-Harris implies (p. 25). The dream does not appear to have a very respectable biological ancestry if all we can say is that "we are entitled to assume that certain animals, for instance the dog, can dream." For many animals the dream is a most important protective mechanism. "The speech centres in the frontal lobes" does some injustice to several workers, and it is to be doubted whether insistence upon the hallucinatory character of dream images is to be commended even in a popular work. Several passages suggest that Dr. Fraser-Harris has not observed the manias associated with low blood-pressure. Whether there "seems no reason to doubt that . . . information is conveyed telepathically or directly to the brain without having been communicated through any of the sleeper's organs of sense" (p. 77) is a matter of opinion, as is also the statement "that some dreams are the expression of ancestral memories is an attractive theory" (p. 78).

The future of sleep is discussed in sixteen pages. Evidently its security will depend largely upon social and political agitation for the suppression of its prolific modern enemies.

Elements of Alternating Currents and Alternating Current Apparatus. By Prof. J. L. Beaver. Second edition. Pp. xiii + 393. (New York, London and Toronto: Longmans, Green and Co., Ltd., 1928.) 18*s.* net.

THIS book is written mainly for the benefit of those commencing the study of alternating currents. The numerical examples are numerous, and a very fair attempt has been made to explain away the difficulties which every one experiences in studying the subject. For those who have not the benefit of a teacher, numerous references are given to papers and other text-books where fuller explanations will be found. Some of these papers, as, for example, the *Bulletins* of the General Electric Company of America, cannot easily be obtained on the eastern side of the Atlantic. The nomenclature used is mainly that standardised in America. Capacity is called capacitance and a condenser is sometimes called a 'capacitor.' Possibly this is to prevent confusion with a steam condenser, which is quite a different device. It has long been thought desirable by electricians to standardise the termination 'or' to designate a piece of apparatus. But the difficulties in the way seem insuperable. Arrestor, startor, and divertor are coming into use, but exciter, damper, and feeder still have the 'er' termination.

Naturally, in an elementary book it is difficult, if not impossible, to state the theorems rigorously and to give their limitations. We think, however, that a word of warning might have been added on

p. 166 to the formula given for eddy current losses. On p. 44 it is misleading to state that the 'convex surface' of a conductor carries the high-frequency current. In a concentric main with high-frequency currents the current nearly all flows near the concave surface of the outer conductor, the current near its convex surface being almost negligible. On p. 107 the method of representing a vector by a complex number is attributed to Dr. Kennelly. Mathematicians usually attribute it to J. R. Argand (1806), but it seems to have been previously used by Gauss and Wessel (1797).

L'Industria chimico-metallurgica del solfato di rame e le miscele cupriche funghicide ed anticrittogamiche. Per E. Crivelli. Pp. viii + 321. (Milano: Ulrico Hoepli, 1928.) 35 lire.

THIS is an interesting book, which can be heartily recommended to makers or users of copper sulphate, to all chemists, and, as regards some sections of it, to the general reader.

Part 1 deals with the development of the blue vitriol industry and with its marketing, methods of analysis and properties, and contains also a detailed description of its manufacture, including treatment of by-products. In Part 2, the metallurgy of copper, in so far as it concerns the manufacture of the sulphate, is considered, and in Part 3, such subjects as its physiological effects, its mode of action in lime–copper sulphate pastes, its uses as an anti-cryptogam, and various minor applications, are discussed.

The book has been carefully written and, although the information given must be almost exhaustive, is far from being a mere compilation, the material being dealt with in a logical and readable manner. To the majority of readers, probably the most interesting portions of the book are those of Part 3, in which the available experimental data concerning the effects of copper salts on animals and plants are subjected to critical examination.

No index is provided, but this lack is largely compensated for by the table of contents. A few minor misprints occur, and the first logarithm given on page 52 for $CuSO_4$ is actually that of the pentahydrated salt. The printing is of the usual high Hoepli standard.

An Atlas of Economic Geography (Text and Maps). By John Bartholomew and Prof. L. W. Lyde. Third edition, revised and enlarged in co-operation with M. R. Shackleton. Pp. xciii + 74. (London: Oxford University Press, 1928.) 8*s.* 6*d.* net.

THIS is more than an atlas of economic geography, for the text runs to nearly a hundred pages, and besides explaining the maps, adds a great deal of useful geographical matter. It is full of ideas, and points out many striking geographical correlations. Prof. Lyde is responsible for the whole of the text. The number of coloured maps is slightly reduced from the original edition, but two dozen black and white distributional maps have been added. In these, as in the coloured maps, the technique is excellent and the standard of accuracy is high. Minor changes might be made in the map of religions and of commercial development, and it is to be hoped that in the next edition the colour division of the races of man may be abandoned. Another improvement in a most useful work would be the re-introduction of the maps of seasonal distribution of rainfall and of languages of commerce.

Stage A Geometry. By R. W. M. Gibbs. (Black's Mathematical Series.) Pp. viii + 109. (London: A. and C. Black, Ltd., 1927.) 2*s.*

ALL teachers will recognise the importance of the Mathematical Association's Report on "The Teaching of Geometry in Schools," and the value of Mr. Gibbs's work lies in his successful attempt to provide a suitable text-book to cover Stage A as recommended in the Report. The arrangement of subject matter and the selection of examples show that the author is used to the practical difficulties of approaching the subject of geometry for the first time.

Emphasis is naturally laid on the experimental aspect; and field work, and what is sometimes known as 'boy-scout geometry,' are well treated. In addition to general ideas on mensuration, including Pythagoras's theorem, the book concludes with introductions to symmetry, loci, and similar figures. This volume should form an excellent stepping-stone to the other stages, deductive and systematising, mentioned in the Report.

H. D. A.

Volumetric Glassware. By Verney Stott. (Books on Glass and Glass Technology.) Pp. 232. (London: H. F. and G. Witherby, 1928.) 20*s.* net.

THIS work comes as a wholesome corrective to those trustful chemists and physicists who are tempted to accept their volumetric instruments even with a modicum of faith. The author emphasises the importance of quality and accuracy in volumetric glassware, and his book is intended for manufacturers and users of such apparatus. Various common types, including measuring flasks, graduated cylinders, pipettes and burettes, are treated in detail, and a description is given of the processes of marking and graduating. Other essential subjects, such as units of volume, calibration tables, and the effect of apparatus errors on results, are also adequately treated. The book, which contains numerous illustrations and tables, can be recommended to all who are concerned with volumetric analysis and similar work.

School Researches in Heat. By C. W. Knight. Pupil's Book. Pp. ii + 96. 1*s.* 3*d.* Teacher's Handbook. Pp. 80. 1*s.* 6*d.* net. (London: George Philip and Son, Ltd.; Liverpool: Philip, Son and Nephew, Ltd., n.d.)

LITTLE books which follow the author's method of teaching heat to an elementary standard by means of questions and answers. They are good in their way, though somehow the spontaneity which the method demands seems dulled by the formality of print.

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.*]

Nervous Impulse in *Mimosa pudica*.

Is the conduction of the excitatory impulse in the plant essentially similar to that of the nervous impulse in the animal ? This problem is of great theoretical interest. In his "Nervous Mechanism of Plants" (1926), Bose states that the intercommunication and interaction between more or less distant organs in the plant are brought about, as in the animal, "in two different ways—by translocation of matter and by transmission of motion. The first is effected by the *slow* movement of fluid carrying chemical substances in solution, such as occurs in the circulation of sap ; the second by the *rapid* propagation of protoplasmic excitation such as the nervous impulse in the animal." In his presidential address at the Indian Science Congress, Lahore (1927), Bose makes his position perfectly clear by the statement that in physiological investigations the inquirer is primarily concerned *with the function of the organ and not with its outward form.* In support of this he adduces the case of insectivorous plants (*Drosera*, *Dionœa*, and *Nepenthes*) which are universally acknowledged to possess digestive organs, in spite of the fact that the organs are very different in appearance from those of the more complex animal. The employment of the same term for these plant and animal reactions is justified by the fact that the function of digestion is performed by similar processes in both : the solution of organic food-material by a glandular secretion, and the subsequent absorption of the dissolved product.

The plant-world offers a unique opportunity for the study of the gradual evolution of a simple and primitive organ into one of greater complexity. In regard to the nervous function, it is to be remembered that the conducting tissue in the animal kingdom itself exhibits wide variation : from the simpler type as in the Medusæ to the more complex in the higher animals. The conducting tissue of the plant would naturally be expected to be much simpler in structure, and as a matter of fact it is very different in appearance from the nerve of the higher animals. The question to be decided is whether or not the process of conduction of excitation is similar in the two cases (being usually detectable by the contractile movement of the terminal motor organ).

There are several physiological tests of a crucial character by which the nature of the transmission of the impulse in *Mimosa* can be ascertained ; whether it is dependent upon a movement of sap, or is a conduction of protoplasmic excitation. Sir J. C. Bose has been kind enough to offer me every facility for working in his Research Institute at Calcutta, and an account of the following experiments on transmission of excitation in *Mimosa* will doubtless be of interest to readers of NATURE. It may be stated that the series of experiments which I repeated were accomplished without a single failure. Limitation of space allows me to describe only one typical example of each series.

The experiments were carried out in winter (January 1929). Though the physiological condition of *Mimosa* was not so favourable as in summer, yet I encountered no difficulty in obtaining the following results in a green-house (temp. 30° C.) in which the sunlight was uniformly diffused by glass thinly coated with white paint.

EXPERIMENTAL SERIES 1. *Discriminative Polar Action of Electric Current in Excitation.*—In an animal nerve, a feeble electric current initiates excitation at the cathodic point at 'make' (there being no excitation at the anode) ; the transmitted excitation is detected by the twitch of the terminal muscle.

In the parallel experiment with *Mimosa*, I made suitable electric connexions with two opposite petioles at a distance of 20 mm. from the motile pulvinus. When the point on the right petiole was made the cathode, an excitatory impulse was generated which, travelling against the direction of the normal transpiration current, reached the pulvinus and caused the fall of the leaf after an interval of 1·5 sec. Making allowance for the latent period of the pulvinus, the velocity of transmission of excitation in this winter specimen was found to be 14·3 mm. per second. Reversal of the direction of the current by a Pohl commutator caused cathodic stimulation of the left petiole, resulting in the fall of that leaf.

Similar results were obtained with the secondary petiole of a leaf, in which the propagation of the excitatory impulse is exhibited by the upward closure of the sensitive leaflets (Fig. 1). Bose found that the

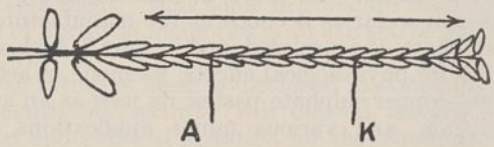

FIG. 1.—Effect of feeble current. *K*, cathode : excitation transmitted across feeble anode *A*. Arrows indicate directions of propagation of impulse which ultimately causes closure of all leaflets to right and left.

velocity of transmission in *thin* petioles is very much higher, being 100-350 mm. per second. My results fully confirm this.

It will be noted (1) that the impulse was transmitted in the complete absence of any hydromechanical disturbance ; (2) that excitation was originated and conducted without any wound which might have induced the secretion of some hypothetical stimulant which could be translocated by the movement of sap ; (3) that the direction of transmission of impulse was inwards, against the direction of the normal transpiration current ; (4) that the speed of transmission was incomparably higher than that of the slow movement of sap ; and (5) that the characteristic polar action of the current which initiates nervous impulse in the animal also caused an excitatory impulse in the plant.

EXPERIMENTAL SERIES 2. *Arrest of Conduction by Anodic Block.*—With feeble current, the impulse in the animal nerve is transmitted across the anode ; but with a stronger current, the depression of conductivity at or near the anode is so great that the impulse is arrested by an anodic block.

In *Mimosa*, parallel effects can easily be demonstrated in the secondary petiole, conduction taking place in both directions as in the nerve. On starting a feeble current (1·4 microamperes), the cathodic excitation at *K* was transmitted (Fig. 1) to the right and to the left (across the feeble anode). The experiment was repeated with a stronger current (3·5 microamperes) ; the impulse initiated at the cathode *K'* was now transmitted to the extreme right end of the secondary petiole ; whilst the impulse to the left was

completely arrested at A' by the depression of conductivity caused by the stronger anode (Fig. 2).

EXPERIMENTAL SERIES 3. *The Reflex Arc.*—The phenomenon of the reflex arc is well known in the animal, where the afferent or ingoing impulse due to peripheral stimulation is reflected at a centre and is transmitted along a new path as an efferent or outgoing impulse.

It is very surprising that exactly parallel effects are observable in *Mimosa*. Peripheral stimulation of the

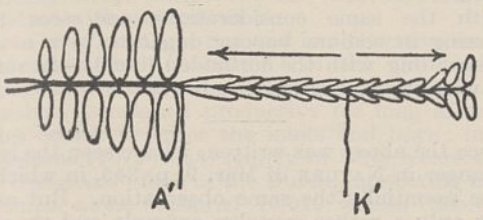

FIG. 2.—Effect of stronger current. Block at stronger anode A'.

secondary petiole (1) at S, by tetanising electric shock of moderate intensity (Fig. 3), gives rise to an ingoing or afferent impulse, which reaches the pulvinus and causes the fall of the leaf. After a short while, the existence of an efferent or outgoing impulse is detected by the serial fall, from base towards apex, of the leaflets on the secondary petiole (2). There is a marked difference between the velocities of the ingoing afferent and of the outgoing efferent impulses. Bose found it to be about seven times greater. In the experiments which I carried out I found it to be six to eight times quicker.

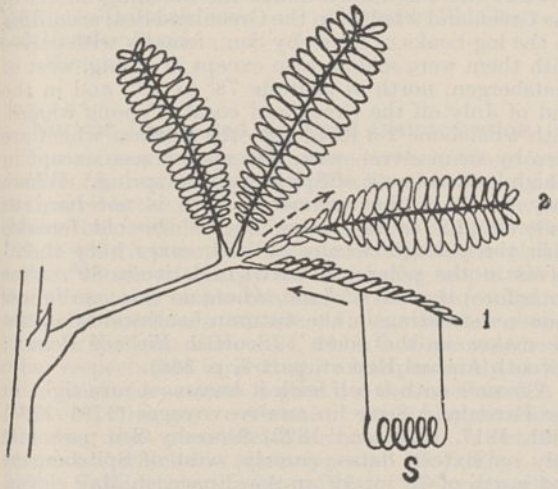

FIG. 3.—The reflex arc. Peripheral stimulation of secondary petiole 1 at S causes afferent impulse (continuous arrow), which after reflection at pulvinus gives rise to efferent impulse (dotted arrow) in secondary petiole 2.

As all the characteristic effects of the transmitted impulse in *Mimosa* are in every way similar to those of the nervous impulse in the animal, the most natural inference is that the process of transmission is of the same nature in both. Physiologists will therefore be inclined to agree with Bose's conclusion, that if the impulse be called 'nervous' in the animal, there is equal reason for applying the same term in the case of the plant.

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Jan. 29.

Growth-gradients and the Development of Animal Form.

D'ARCY THOMPSON in his "Growth and Form," Chapter xi., deals lucidly with the properties of logarithmic spirals, and the reasons for their frequent occurrence in organisms. He points out that for them to arise, (1) parts of the growing edge must be growing at different rates, the growth-rates of any two points on the edge preserving a constant ratio of growth-rates for so long as a regular logarithmic spiral is produced; (2) the growth-rate must fall off more or less steadily from one end of the growing surface to the other; (3) the products of growth must be laid on as so much dead matter, or at least matter incapable of further growth. In his own words (p. 500) the logarithmic-spiral form of an organic structure can be explained "if we presuppose that the increments of growth take place at a constant angle to the growing surface, but more rapidly at the 'outer edge' than at [the 'inner edge'], and that this difference of velocity maintains a constant ratio. Let us also assume that the whole structure is rigid, the new accretions solidifying as soon as they are laid on."

It is, I think, worth pointing out that this and the type of growth which Champy (C. Champy, "Sexualité et Hormones," Doin, Paris; 1924) and I (J. S. Huxley, *Biol. Zentralblatt*, Bd. 47, p. 151; 1927) have called heterogonic (in which the size-relations of organs x and y can be represented by the equation $y = bx^k$) are both special cases of the same phenomenon, namely, of constant differential growth-ratios in different regions of the organism. The sole difference is that in logarithmic-spiral growth the increments produced take no further part in growth, but are locked up as so much rigid structure, while in heterogonic growth the increments are added to the mass of living tissue capable of continued growth. The difference is similar to that between two sets of sums of money growing at different rates of simple interest and at different rates of compound interest respectively.

There is a further interesting similarity between the two types of differential growth. In logarithmic-spiral growth, the growth-rates fall off more or less evenly from one margin of the growing surface to the other. I have succeeded in showing (*l.c.* and unpublished work) that in markedly heterogonic organs such as crustacean chelæ (*Uca*, *Maia*, *Homarus*, *Eupagurus*, various prawns, etc.) the most rapid growth-rate is that of the penultimate joint, the growth-rates of the other joints falling off regularly as the body is approached. Similar facts appear to be true for the limbs of ungulates, according to my friend Mr. J. C. Hammond, and the abdomen of female spider-crabs (M. E. Shaw, *Brit. J. Exp. Biol.*, **6**, 145; 1928). When, on the other hand, growth is isogonic, all the parts (joints of female chela, *Uca*, *Maia*; joints of male abdomen, *Inachus*) grow at the same rate.

As I previously pointed out, and as has been stressed by Pearsall (W. H. Pearsall, "Growth Studies." 6. "On the Relative Sizes of Growing Plant Organs," *Ann. Botany*, vol. 41, No. 163, pp. 549-556; 1927) in his analysis of similar heterogonic relations between the parts of plants, heterogony is really the simplest type of differential growth, occurring, namely, when the ratio of two growth-rates remains constant over long periods. It is interesting to find that one of the other most generally distributed modes of growth, that in the form of a logarithmic spiral, is deducible from the same principle. Various shells depart slightly from the strict logarithmic spiral; and various disharmonically-growing organs depart slightly from the accurate heterogonic formula. But this does not obscure the basic nature of the differential growth-ratio.

It would further seem to be a general principle that when two regions of markedly different growth-rate exist in an organ or region, there is a graded change of growth-rate in the intermediate space. The biochemical basis of such graded differences in growth-rate should be interesting to investigate.

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April 3.

Difference between the Absorption and the Raman Spectrum.

SEVERAL investigators have recently stated that in many cases Raman lines are found which do not correspond with infra-red absorption frequencies (Carelli, Pringsheim, and Rosen, *Zs. f. Phys.*, **51**, p. 511; 1928: Czerny, *ibid.*, **53**, p. 317; 1929: McLennan and McLeod, NATURE, **123**, p. 160; 1929: Ellis, *ibid.*, p. 205: Rasetti, *ibid.*, 205: R. W. Wood, *ibid.*, p. 279, and others). Several authors state this as contrary to the theoretical expectations. The purpose of this note is to direct attention to the fact that the above-mentioned phenomena, far from being a contradiction to the theory, really furnish a very good proof for the validity of the Kramers' theory of dispersion, which includes the theory of the Raman effect.

If we consider two levels A_1 and A_2 we have absorption if the transition coefficient a_{12} is different from zero. But this coefficient does not enter at all into the expression which determines, according to Kramers and Heisenberg, the intensity of the Raman line. From the fact that this coefficient is zero, one cannot therefore conclude that the corresponding Raman line must be absent and vice versa. The intensity of the Raman lines is determined by the transition coefficients to levels B_1, B_2, B_3, etc., which can combine with both A_1 and A_2. The Raman frequency can therefore always be regarded as the difference between the frequencies of two lines, one of which must be an absorption line, and this in agreement with the results of Rasetti and especially with those of McLennan and McLeod. A very good example is also furnished by the beautiful results of Wood in hydrochloric acid. Wood finds that the so-called missing line occurs with great intensity in the modified radiation, whereas the real lines of the absorption band are faint and doubtful.

This is exactly what we must expect. For let us consider a hydrochloric acid molecule in a definite rotational state j, and confine ourselves to the different vibrational and rotational states of the normal molecule. Then there is, on account of the selection rule for j, not a single state which can combine at the same time with the j and the $j \pm 1$ rotational state, or differently expressed, an absorption line of the HCl band cannot be written as the difference of two other lines and therefore ought not to occur in the Raman spectrum. On the other hand, every transition in which the rotational quantum number j does not change or varies two units (the *vibrational* quantum number varies from zero to one for all lines under consideration) can be written in more than one way as a difference of two line frequencies. We must, therefore, expect these frequencies in the Raman spectrum rather than the frequencies of the absorption band. The transitions in which j does not change give the 'missing line' and are forbidden as absorption lines. Raman lines corresponding to transitions $j \rightarrow j \pm 2$ must be expected very much weaker, as they are distinct lines for different values of j with twice the distance of the absorption lines, whereas all the $j \rightarrow j$ transitions correspond to lines which coincide on the place of the zero line and give rise, therefore, to one intensive line. This seems to be in agreement with Wood's observations. Rotational transitions $j \rightarrow j+2$ of the expected type seem to have been observed by McLennan and McLeod in H_2. If also the ultra-violet absorption bands, of which nothing is known, are taken into account, these considerations have to be modified a little. But from the general structure of the molecular terms it can be deduced that, for diatomic molecules at least, an absorption line never can be expected as a Raman line. Apparent exceptions to this rule find their explanation in an unresolved fine structure.

With the same considerations one sees that scattering in sodium vapour ought to give a shift corresponding with the forbidden line $1s - 2s$ rather than with the absorption line $1s - 2p$.

Since the above was written, I have seen the letter by Langer in NATURE of Mar. 9, p. 345, in which he makes essentially the same observation. But as he treats only a rather complex example and proceeds according to somewhat different lines of reasoning, the present note is perhaps not superfluous. It ought to be mentioned also that Schrödinger's theory of dispersion in its original form is, contrary to Langer's statement, not in agreement with the facts, whereas the present form of quantum mechanics (Dirac) leads exactly to Kramers and Heisenberg's results.

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Holland, Mar. 8.

Breeding Habits of the Greenland Whale.

VERY little is known about the breeding habits of the Greenland whale. In the Greenland Sea, according to the log-books of Scoresby Sen., females with calves with them were seldom seen except in spring, west of Spitsbergen, north of latitude 78° or 79°, and in the end of July off the Greenland coast. Young whales, with whalebone 2-3 feet long—the smallest which are seen by themselves—were also seldom seen except in a high latitude west of Spitsbergen in spring. Where they go to in the summer months is not hard to understand: as my father says, "the old females with the younger whales of both sexes bury themselves in the polar ice, north of latitude 80°, after (or before) the end of June, where no ship can follow them; retreating in the autumn southwards as the ice makes in the north" (Scottish Fishery Board; Seventh Annual Report, part 3, p. 366).

A female with a calf with it became a rare sight in the Greenland Sea; in twelve voyages (1791–1798, 1801, 1817, 1820, and 1822) Scoresby Sen. saw one only on sixteen dates, namely, west of Spitsbergen, and north of 78° or 79° in April once, in May eleven times, and in June once; and off Greenland twice, both times at the end of July, in latitude 70°; in the forty-four voyages he was master (1849–1891 and 1893) my father only saw about a dozen (*l.c.*, p. 365), and in his last twenty voyages only one (in the end of July in latitude 73° off the Greenland Coast), and in the log-books of twenty-nine other voyages made in the period 1872–1908 not a single instance is recorded.

There are few facts to go on, but it seems safe to infer from what the Scoresbys and from what Eschricht and Reinhardt say, that at least some of the young are produced in the spring. Even less is known about where they produce; at one time they entered the inlets of western Spitsbergen in the summer months, and Sir Sidney Harmer (*Proc. Linn. Soc.*, May 1928, p. 89) connects their visits with the function of

parturition and looks on the unmolested use of the Spitsbergen bays as of importance to them; this, however, seems unlikely for the following reasons:

1. In the spring, when some, possibly all the whales of the species, as Scoresby suggests, produce their young, the sheltered parts of the west Spitsbergen inlets are usually still covered with the ice that forms in the winter months.

2. In Davis Strait, according to Eschricht and Reinhardt, the corresponding visits of the species to the inlets of west Greenland synchronised with the proximity of the pack-ice to the coast and were not connected with parturition.

3. In the Greenland Sea and in the waters west of Spitsbergen (the 'Greenland' of the old whalers), contrary to what Sir Sidney Harmer states (*l.c.*, p. 59), the fishery continued productive for long after the whales ceased to enter the inlets and bays; in the ten seasons (1679–1688) (thirty or forty years after) the 'Greenland' fleet of the Dutch, numbering about 190 ships, alone captured 10,019 whales (Scoresby, vol. 2, p. 156), and so late as 1814 in the same waters 76 English and Scotch 'Greenland' ships alone captured 1413 in a single season (*ibidem*, p. 121).

Sir Sidney Harmer seems to imply that the females with calves with them not only entered the Spitsbergen bays, but also were destroyed in these situations in large numbers by the early whalers; this, again, seems unlikely, for in the seventeenth century the whalers do not appear to have arrived at Spitsbergen until the end of May, and after the time at which the females with calves with them usually disappear amongst the impenetrable polar ice; a separation of the sexes seems to take place in the summer months, and it seems more likely that the whales that entered the Spitsbergen bays and were killed by the early whalers (if they all belonged to this species) belonged mostly to the male sex.

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Nuclear Levels and Artificial Disintegration.

THE existence of quasi-discrete levels in the atomic nucleus has been suggested by Dr. Condon and myself in a paper in the *Physical Review*, in which the nuclear theory first outlined in NATURE, Sept. 22, 1928 (vol. 122, p. 439), is pursued. These quasi-discrete levels are narrow ranges of energy for which the amplitude of the ψ-functions inside the nucleus is large compared with the amplitude outside. In a very interesting letter in NATURE of Nov. 24, 1928, G. Gamow, who in other respects had arrived quite independently at the same basic ideas with regard to the nucleus (*Z. f. Phys.*, **51**, 204), gave a résumé of various applications, including that of artificial disintegration, a detailed account of which has since appeared (*Z. f. Phys.*, **52**, 510). Considering the intensities of the transmitted and reflected waves, he inquires how the probability of penetration into the nucleus will fall off with decreasing velocity of the incident α-particle; treating the nucleus as a simple potential barrier, he naturally finds that the probability shows a steady decrease.

The object of the present note is to direct attention to the possibility of resonance phenomena if we take into account the solutions of the Schrödinger equation which for certain ranges of energy give ψ-functions the amplitude of which inside the nucleus is large compared with that outside. For this seems to indicate that variation of the velocity of the incident α-particle may be accompanied by an enormous fluctuation in the probability of penetration when the energy approaches and enters the range of energy corresponding to one of the possible quasi-discrete levels. A systematic examination of thin films of various elements might disclose such a fluctuation, if the experimental difficulties can be overcome. No resonance effect would be possible if we had discrete levels, indefinitely narrow; the absence of any genuine quantisation in the nucleus is due to the fact that the potential energy of the α- or β-particle must be taken as tending to zero when distant from the nucleus, in contrast to the method of Laue; it would seem, then, that the *Eigenwerte* of which he speaks (*Zeit. f. Phys.*, **52**, pp. 731-2) do not exist, but that all energies are possible (a continuous spectrum).

The transmission of particles through a simple potential barrier resembles transmission of light at a single reflecting surface, in that the coefficient falls off steadily with varying wave-length. But it is of course well known that the addition of a second reflecting surface (as in Fabry and Perot parallel plates) causes large fluctuations in the transmission, those wave-lengths being favoured for which standing waves are possible, that is, when the thickness of the film is equal to one or more half-wave-lengths. This provides a crude analogy to the case of the nuclear ψ-functions, one half-wave-length for a free swift α-particle being about $2{\cdot}5 \times 10^{-13}$ cm. Possibly the discovery by Rutherford and Chadwick of an energy giving minimum intensity of reflection of α-rays at 135° (*Phil. Mag.*, **50**, p. 900; 1925) was a resonance phenomenon.

The application of the quantum mechanics may modify the interpretation, but seems to throw no light on the origin of the discrepancies between the results obtained at Cambridge and Vienna. Although, for example, the argument in favour of a theoretical minimum range for the ejected H-particles has lost its validity, since they may now escape through the potential barrier instead of having to fall through the entire repulsive field as had been previously argued by Chadwick (*Phil. Mag.*, **2**, pp. 1073-4; 1926), the experimental observation remains unaffected.

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Tokyo, Japan, Feb. 20.

The Average 'Forward' Momentum of Photoelectrons.

IT is well known that the emission of photoelectrons by X-rays is not symmetrically distributed about the plane normal to the rays, the photoelectrons possessing an average momentum in the 'forward' direction. I showed about a year ago (NATURE, Jan. 28, 1928, p. 134) that, contrary to general supposition, the average forward momentum, μ, of a photoelectron is, according to experiment, not equal to the momentum $h\nu/c$ of an incident quantum, but is appreciably greater. Sommerfeld in his recently published book, "Atombau und Spektrallinien, Wellenmechanischer Ergänzungsband" (1929), has treated the problem theoretically by the wave mechanics, and the purpose of the present note is to show the remarkable agreement of Sommerfeld's result with experiment.

Sommerfeld (p. 218) finds that the probability $P(\phi).d\phi$ of emission of a photoelectron at an angle between ϕ and $\phi + d\phi$ with the incident radiation is proportional to

$$\{1 + \tfrac{1}{5}\sqrt[8]{(h\nu/mc^2)}\cos\phi\}\sin^3\phi.d\phi \quad . \quad (1)$$

It follows from this that the average momentum of a photoelectron is

$$\mu_{\text{theor.}} = 1{\cdot}44(h\nu/c). \quad . \quad . \quad (2)$$

The value found experimentally by Nuttall Barlow

and myself (*ibid.*; also *Proc. Roy. Soc.*, December, 1928) is

$$\mu_{\text{expt.}} = 1{\cdot}40(h\nu/c) \quad . \quad . \quad . \quad (3)$$

If $\overline{\cos\phi}$ denotes the mean cosine of ϕ, θ the 'bipartition' angle (defined by $\int_0^\theta P(\phi)d\phi = \int_\theta^\pi P(\phi)d\phi$), and ρ the ratio of the forward to the backward emission, then according to (1)

$$2\,\overline{\cos\phi}/\beta = 1{\cdot}44,\ 2\cos\theta/\beta = 1{\cdot}80,$$
$$2(\rho-1)/(\rho+1)\beta = 2{\cdot}70 \quad . \quad . \quad (4)$$

β being the velocity of the photoelectron relative to that of light. The observed values of these quantities are 1·4, 1·8, and 2·6 respectively. Thus there is very good agreement with experiment whatever quantity is chosen as a measure of the asymmetry.

Formula (1) expresses the asymmetry to a first approximation, and is applicable only if $(h\nu/mc^2)$ and $(J/h\nu)$, where J is the binding energy of the electron, are small. These conditions are adequately satisfied in the cases investigated in the above experiments, namely, photoelectrons produced in nitrogen and oxygen by X-rays of wave-length 0·6 A.

Mention should be made of P. Auger's recent experiments in which he finds $\mu = 1{\cdot}30(h\nu/c)$ for argon and $\lambda = 0{\cdot}21$ A., and $\mu = 1{\cdot}30(h\nu/c)$ for argon and $\lambda = 0{\cdot}71$ A. (*Comptes rendus*, Dec. 10, 1928). These results and (3) show that $\mu/(h\nu/c)$, equals σ say, is approximately independent of λ and J as is required by (2). As mentioned in the previous paragraph, formula (1) represents the asymmetry only to a first approximation, and theoretically there should be a small variation of σ with λ and J which may account for the slightly smaller values of σ found by Auger. Auger's earlier observations (*Jour. d. Phys.*, February 1927) quoted by Sommerfeld correspond to $\sigma \doteq 0{\cdot}9$, but this is refuted by his recent experiments.

Sommerfeld states that his calculated asymmetry is 9/5 times that expected on simple light quantum theory, but if we consider the mean momentum of the photoelectrons instead of the bipartition angle as Sommerfeld does, the ratio is $\frac{4}{3} \times \frac{9}{5} = 1{\cdot}44$, as expressed by (2). The difference arises from different ways of regarding the simple light-quantum theory and is unimportant.

E. J. WILLIAMS.

Cavendish Laboratory,
Cambridge, Mar. 6.

Anomalous Terms in the Spectrum of Doubly Ionised Lead.

IN the course of an analysis of the spectrum of doubly ionised lead (Pb III), the results of which will shortly be published, some combinations of more than usual interest to spectroscopists were found to occur. These combinations involve the anomalous terms arising from the state of the doubly ionised atom of lead when both the two remaining valence electrons occupy $6p$ orbits. The terms to be expected for this state of the atom are 6^3P_{012}, 6^1D_2, and 6^1S_0.

As is well known, the rules for the transitions between states of an atom with two valence electrons are that $\Delta l_1 = 0$, $\Delta l_2 = \pm 1$, or $\Delta l_1 = \pm 1$, $\Delta l_2 = \pm 2$ where l_1 and l_2 are the azimuthal quantum numbers of the two electrons. Accordingly transitions from the $6p6p$ state to the following low-lying states may be expected to occur: $6p6d$, $6p6s$, $6d6f$, $6s6f$. The second and fourth of these states lead to the important low-lying terms 6^3P_{012}, 6^1P_1, 6^3F_{234}, and 6^1F_3. Applying the inner quantum number selection rules, we obtain between these terms and the anomalous $6^1\bar{D}_2$ term the following possible combinations: $6^3P_{12} - 6^1\bar{D}_2$, $6^1P_1 - 6^1\bar{D}_2$, $6^1\bar{D}_2 - 6^3F_{23}$, and $6^1\bar{D}_2 - 6^1F_3$.

All these combinations have been found. λλ995·75, 1165·05 form the doublet $6^3P_{12} - 6^1\bar{D}_2$, and λλ4004·16, 3925·23 the doublet $6^1\bar{D}_2 - 6^3F_{32}$, λλ1439·42, 3832·83 are $6^1P_1 - 6^1\bar{D}_2$ and $6^1\bar{D}_2 - 6^1F_3$ respectively. The measures below 2000 A. are by Dr. R. J. Lang and are expressed in λI.A. vac., and those above 2000 A. are by myself and are expressed in λI.A. air. The source in each case was the vacuum spark.

It may be recalled that Sawyer (*Jour. Opt. Soc. America*, **13**, p. 431; 1926) in the case of the arc spectrum of zinc, classified a doublet as arising from combinations between the 4^3P_{12} terms and an anomalous $4^1\bar{D}_2$ term. But so far as I am aware there have as yet been no cases recorded of the appearance of $F\bar{D}$ combinations for two valence electron systems. For this reason the $F\bar{D}$ lines mentioned above are of peculiar interest.

Of the three terms $6^3\bar{P}_{012}$, only $6^3\bar{P}_1$ has been found. This apparent absence of the $6^3\bar{P}_{02}$ terms is in agreement with the known facts regarding the corresponding terms of Zn I, Ca I, and Hg I. The line λ2868·16 is also worthy of notice, as it appears to be $6^3\bar{P}_1 - 6^3F_2$, a combination which is also to be expected. It is of course the only combination between the F terms and the $^3\bar{P}_1$ term permitted by the inner quantum number transition rules. The $6^1\bar{S}_0$ term has not yet been determined. Unfortunately, only the combinations $6^3P_1 - 6^1\bar{S}_0$ and $6^1P_1 - 6^1\bar{S}_0$ are to be expected. There is at least one likely pair having the $6^3\bar{P}_1 - 6^1P_1$ separation, but the absence of confirmatory evidence in the form of further combinations makes it difficult to come to a definite decision.

The first spark spectrum of thallium (Tl II), which is analogous to that of Pb III, has also been investigated and the $6^3P_{12} - 6^1\bar{D}_2$ and $6^1P_1 - 6^1\bar{D}_2$ lines have been found. The $F\bar{D}$ combinations would give rise to lines lying far in the infra-red, and consequently have not yet been identified.

STANLEY SMITH.

University of Alberta,
Edmonton, Canada, Mar. 4.

Agricultural Education.

THE leading article in NATURE of Mar. 9 on "Land and Industry" indicates an interesting possibility of dealing with the unquestionably important problem of establishing a 'land interest' among non-agricultural citizens. It might be worth while to consider the relation of agricultural education to this problem.

No one who has seriously considered the problem of national agricultural prosperity is likely to deny that the interest of the city and urban public is a primarily important factor. Nor is he likely to deny that those of us who are responsible for developing interest in agriculture have practically ignored the non-agriculturist. The activities of agricultural education have increased enormously during the last quarter of a century, but it seems to have been tacitly assumed throughout its developments that agricultural education is essentially and almost exclusively a provision for agriculturists, and that for the most part the proper people to exercise primary control over it are agriculturists and not educationists.

I have an ever-increasing conviction (confirmed to no small extent by Mr. C. G. T. Morison's presidential address to the Agriculture Section of the British Association in 1927) that agricultural education can render a far greater service to the country if it will remove its delimitations and endeavour to attract

others than intended agriculturists. If our university departments of agriculture would open their doors wider and offer courses for laymen as well as for agriculturists, and regard such courses as equally important, the ultimate development of a 'land interest' would surely be considerable. If men and women who are destined to teach in our schools or to take a part in public affairs had the opportunity to read agriculture during a university course, the ultimate indirect effect on our national agriculture might be as great as the present direct effect of agricultural education.

So far as its direct influence on farming practice is concerned, agricultural education is normally associated with some such phrase as "the application of science to farming." When, however, one considers the two great groups of factors which alone can create or alter an economic condition—scientific facts and philosophical outlook—one is left with more than a suspicion that the greater defect in our agriculture is not in science but in philosophy. Great as is the scope for bringing more scientific knowledge to the farm, the limiting factor to-day is interest in farming and in the phenomena of the farm. Without slackening its efforts to find scientific solutions of specific farm problems, agricultural education can greatly increase its service to the community by giving more attention to what after all is the essence of education, namely, the development and propagation of an interest in its subject matter.

This suggestion in no way implies a criticism of the work of those agriculturists who, for the most part, control the administration of agricultural education in Great Britain. The suggestion is rather that their work needs to be balanced by purely educational aspects of the teaching of agriculture in order that agricultural education may be developed with properly distributed emphasis and with greater usefulness to the community.

N. M. COMBER.

The University, Leeds.

The Occurrence of Ergosterol in Phytosterols.

THE interest which has been aroused by the discovery that ergosterol is converted into vitamin-D on irradiation has led us to consider its possible mode of formation in the vegetable kingdom.

In this connexion some interesting facts arise from the recent work of Bonstedt (*Zeitschr. für physiol. Chem.*, **176**, 269; 1928) on γ-sitosterol, first detected by Anderson and Shriner in corn oil (*Jour. Am. Chem. Soc.*, **48**, 2976; 1926). This investigator has prepared a number of derivatives of this sterol, and a comparison of their physical properties with those of the isomeric derivatives in the ergosterol series reveals, as shown in the following table, a remarkable similarity:

Formula.	Substance.	m.p.	$(\alpha)D$.	Authority.
$C_{27}H_{48}O$	γ-sitostanol	143-4°	+21°	Bonstedt (*loc. cit.*)
	,,	144-5°	+18°	Anderson, Shriner (*loc. cit.*)
	allo-α-ergostanol	144-5°	+16°	Reindel and Walter, *Annalen*, **460**, 212; 1928.
$C_{29}H_{50}O_2$	γ-sitostanol acetate	144-5°	+12°	Bonstedt.
	γ-sitostanol acetate	143°	+9°	Anderson, Shriner.
	allo-α-ergostanol acetate	145°	+6°	Reindel, Walter.
$C_{27}H_{46}O$	γ-sitostanone	163°	+38°	Bonstedt.
	allo-α-ergostanone	164°	..	Reindel, Walter.
$C_{27}H_{48}$	γ-sitostane	87°	+20°	Bonstedt.
	allo-α-ergostane	84-5°	+17°	Reindel, Walter.

Reindel and Walter (*loc. cit.*) have shown that there is no depression of melting-point on mixing γ-sitostanol acetate with allo-α-ergostanol acetate, but infer from the difference in specific rotation that the two substances are not identical. This contention we feel is open to question, for, as we have already pointed out (Heilbron, Morton, and Sexton, *Jour. Chem. Soc.*, p. 47; 1928), owing to the complex nature of the sterol molecule, the possibilities of racemisation at one or more of the asymmetric centres during the operations involved in their preparation cannot be excluded.

The common and probably general association of dihydrositosterol with sitosterol in vegetable oils (*see* Bonstedt, *loc. cit.*; Anderson *et alia*, *Jour. Amer. Chem. Soc.*, **48**, 2972 *et seq.*; 1926) suggests its genesis by a reduction process. Similarly, as there is every reason to believe that ergosterol is also present in all phytosterols (Heilbron, Kamm, and Morton, *Biochem. Jour.*, **21**, 1279; 1927), we venture to suggest with all reserve that concurrent with its reduction to dihydrositosterol (sitostanol), oxidation of sitosterol (possibly γ-sitosterol) to ergosterol occurs.

The fact that neither of the two known tetrahydroergosterols (ergostenols) is identical with the isomeric γ-sitosterol is in no way remarkable. It has been established that ergosterol contains an ethenoid linkage which resists hydrogenation under conditions which suffice to convert γ-sitosterol into the fully saturated derivative; consequently, in the conversion of ergosterol to its tetrahydro derivative, the ethenoid linkage remaining must be in a different position from that present in γ-sitosterol. The suggested identity therefore only reveals itself in the fully saturated products.

It is hoped that work which is now in progress in these laboratories may throw additional light on this important problem.

I. M. HEILBRON.
W. A. SEXTON.

The University, Liverpool.

Transmutation of the Lighter Elements in Stars.

THE formula given by Gamow (*Zeits. f. Phys.*, **52**, p. 512; 1928), for the probability that an α-particle will penetrate the nucleus of an atom with which it collides, can be readily adapted to the case of proton-impacts. These have only half the charge of an α-particle, and for the same energy twice the velocity, so that under conditions approaching thermodynamical equilibrium they have an enormously greater penetrating-power. We have investigated the possibility that in the interior of stars the process should actually occur with appreciable frequency, and we find that for the heaviest elements the probability is extremely small. For the lightest, however, we obtain an average life varying roughly from 10 seconds for helium to 100 years for carbon in a fairly typical case. The protons that are most effective, when their number is taken into account, are those with from three to four times the most probable velocity of the Maxwell distribution.

We cannot well estimate the probability that a proton which has entered a nucleus will anchor itself there by radiating, but there are some indications that it may be high. In that case there is an obvious possibility of gradually building somewhat heavier elements out of the lightest ones; this possibility is much improved if *electrons* can also penetrate the nucleus, but the calculation of this case has not yet proved practicable. It seems, however, a plausible assumption. We may then expect that the isotope Be^8 will be one of the products; this is probably unstable (it does not occur on the earth), and will then almost certainly break up into two helium-nuclei, so that the supply of helium does not become exhausted, and the process

is limited only by the amount of hydrogen. The theory obviously contains several uncertain hypotheses, but a calculation of the amount of energy that would be set free by the process gives quite the right order of magnitude. In addition, the process fulfils the requirement of Eddington that its probability should increase very rapidly with the temperature at about 40 million degrees, and can also fulfil his requirement that it should contain a 'delay-period' which is not dependent on temperature or pressure. It thus seems possible that the stellar energy has a source in this method of element-building which the wave-mechanics has opened up to us. But there are so many astrophysical difficulties that we hesitate to express a definite opinion, more especially as it is difficult to see how the heaviest elements can be formed by this means at all.

A full account of the investigation will appear shortly in the *Zeitschrift für Physik*. It would seem worth while to investigate the effect of fast protons on light elements in the laboratory, and experiments along these lines are contemplated.

R. D'E. ATKINSON.
F. G. HOUTERMANS.
Physikal. Institut der Techn. Hochschule,
Berlin-Charlottenburg,
Mar. 22.

Internal Absorption of γ-rays.

FOUR years ago (NATURE, **115**, 13, 86; 1925), one of us estimated the internal absorption of the γ-rays of radium-D and the fraction of the atoms emitting γ-rays. Due to an oversight and, in the latter case, an arithmetical error, both estimations are incorrect. They have recently been re-calculated in the following manner.

The relative ionisations produced by the β-rays of radium-E (in equilibrium with the radium-D), and the soft and hard γ-rays were measured in an electroscope, the walls of which consisted of paper coated with graphite and, after correction, were found to be 24,000, 40, and 2·6 respectively. Assuming that the energy in a beam of X- or γ-rays is proportional to the total ionisation produced in air, the respective energies in the three types of rays were found to be proportional to 1500, 13, and 23. As the respective average energies of single rays are 350,000, 12,000, and 46,700 electron volts, we find that for the disintegration of 43 atoms of radium-E or radium-D, 11 atoms emit a soft γ-ray (*L*-radiation) and 5 atoms a hard γ-ray. No allowance, however, has as yet been made for the fact that β-rays are ejected by the hard γ-rays from *M* and *N* levels (the consequent *M* and *N* radiations would not be observed in our experiments). Curtiss estimates that the intensity of the β-rays ejected by the hard γ-rays from the *M* and *N* levels is 70 per cent that from the *L* levels, so that, assuming the number of hard γ-rays absorbed to be proportional to these intensities, 8 atoms emit *M* and *N* radiations.

We arrive, therefore, at the following figures. Out of 43 atoms disintegrating, 24 atoms emit γ-rays. Of these 24 γ-rays, 19 suffer internal absorption. It seems probable that, in the case of all substances, only a fraction of the atoms emit γ-rays after a β-ray disintegration. This should be taken into account in estimating times of emission of γ-rays.

A further set of experiments was carried out to determine if there were any β-rays emitted from radium-E with energy of the order 2,000,000 electron volts. The method used may be of interest and is given below. An electroscope was placed on top of the poles of an electromagnet, which produced an average field of 1250 gauss. The active material was 10 cm. below the bottom of the electroscope. Sufficient material was placed beneath the electroscope to cut off secondary β-rays produced by γ-rays, and, directly over the active material, absorption sheets which cut down β-rays of energy 2,000,000 volts until the issuing rays had a value of $HR < 6000$. Such rays would be deflected from the electroscope by the magnetic field. No difference was found between the electroscope readings with and without magnetic fields. Allowing for the difficulty of measuring small differences, we estimate that less than one atom in 25,000 emits a β-ray of energy 2,000,000 volts, and possibly none at all.

J. A. GRAY.
A. J. O'LEARY.
Queen's University, Kingston,
Feb. 7.

Dicœcism in *Ranunculus acris*.

MR. R. O. WHYTE'S letter in NATURE of Mar. 16, p. 413, on the cytological aspect of the hitherto little noticed peculiar form of the common acrid buttercup, stimulates me to make some general remarks respecting it.

I first made its acquaintance in the spring of 1923 near my home in Cumberland, and sent specimens to the Linnean Society of London. They were exhibited at the meeting held on June 21 (*Proc. Linn. Soc.*, p. 50, 1923). Through lack of time, I believe, they were not discussed. I then approached a leading authority on the British flora, Dr. Claridge Druce, who kindly replied to the effect that this form was strange to him. He incorporated it in his "Plant Notes" for 1923 (*Report*, Bot. Exchange Club, p. 24, 1923), with an extract from my letter, naming it *Ranunculus acris* L. var.; sub. var., or forma *minutiflorus*, Druce.

Finding that Mr. Marsden-Jones was working on the genetics of the genus *Ranunculus*, I sent specimens to him, and he was not long in reporting to me the occurrence of the same in his own neighbourhood, Potterne, Wilts. I am glad to see that he has not only taken up the genetics of it, but also has prevailed upon Mr. Whyte to work out the cytological side—a piece of research which promises to shed light on the origin of unisexual from hermaphrodite flowers.

It is curious that this 'female' form of *Ranunculus acris* has not excited attention previously. None of the British floras consulted refer to it. Since it came under my notice for the first time in 1923, I have seen it every subsequent season in fair abundance in my own neighbourhood. Apparently it is a general associate of the ordinary form of this buttercup. What exactly is its significance in the bionomics of the species it is difficult to say. One might hazard the view, tempting but not altogether probable, that *Ranunculus acris* is in the incipient stage from hermaphroditism to gynodiœcism.

Though no exact calculation as to the frequency of this 'female' form among the ordinary type in my neighbourhood has been made, one per cent might be a possible estimate; though of the extreme cases with stamens as mere rudiments this might be a considerable overstatement. The extreme form is very noticeable on account of the much smaller size of the petals. Moving such 'female' plants to the garden has not changed the size or character of the flowers in subsequent seasons, so that the reduced nature of the corolla and the abortion of the stamens are apparently not due to poverty of soil or other adverse conditions. No difference in vegetative characters can be detected between the ordinary and the 'female' plants. The latter appear just as vigorous in growth.

JOHN PARKIN.
Blaithwaite, Wigton,
Cumberland, Mar. 20.

Excitation of Mercury Vapour by the Resonance Line.

IN supplement to my letter in NATURE of Mar. 30, p. 488, under the above title, I have now made a series of experiments, starting with mercury resonance radiation under typical conditions at room temperature. As the temperature of the mercury is progressively raised, and a rapid stream of vapour is generated, the secondary source, originally symmetrical on either side of the primary beam, begins gradually to elongate on the down stream side, until finally it is wholly on this side, being traceable for a distance of about 3 cm. down stream.

Although this result is unexpected, and contrary to prevailing views, the photographic evidence is very clear. I hope to publish the photographs in due course. RAYLEIGH.

Terling Place, Chelmsford,
Essex, Mar. 30.

Invisible Oxide Films on Metals.

THE well-known work of Evans on the passivity of metals has led to the conclusion that oxidation can occur at room temperature on copper and iron, giving a film which is too thin to show interference colours. In his lecture to the American Institute of Mining and Metallurgical Engineers (1929) he has remarked that it is logical to suppose that the oxide film has a real existence before any interference tints are shown. Evans quotes the work of Freundlick, Patscheke, and Zocher (*Z. physikal. Chem.*, **128**, 321; 1927), who have made pure metallic iron mirrors from iron carbonyl. They find distinct changes in the reflecting power when air is admitted, showing the formation of oxide films of the order of 10^{-7} cm. in thickness.

Müller and Koenigsberger (*Phys. Zeit.*, vol. 5, p. 413; 1904) have found that there is little difference in the reflecting powers of iron in the active and passive states. In my experiments at temperatures at which the iron interference colours are formed very slowly, there is distinct evidence from the reflecting power of surfaces that there is an oxide film present before there is any evidence of interference colours visible to the eye (cf. *Proc. Roy. Soc.*, A, vol. 117, p. 376; 1928).

In the early stages of oxidation the reflecting power of iron, nickel, and copper becomes somewhat smaller over the whole range of the spectrum, but slightly more so at the violet end of the spectrum than in the red, showing the existence of an absorption maximum far away in the ultra-violet region.

During the study of the spectrophotometry of the growth of sulphide films on metallic copper, evidence was obtained strongly supporting Evans's conclusions of the formation of an oxide film at room temperatures. If reduced copper be attacked with a mixture of one volume of hydrogen sulphide and five volumes of air, two complete colour sequences are produced in a few minutes; if, however, the copper surface be left exposed to air for some hours, and then hydrogen sulphide and air admitted, the interference colours are developed very slowly indeed. Only one colour sequence could be observed during a whole day's exposure. In addition there was a general dulling of the colours so formed.

Heating the metal to 300° C. in a nitrogen vacuum of 10^{-3} mm. did not remove the film. Hence there is clear evidence in support of the conclusion that a thin film of oxide is formed on copper merely on exposure to air at ordinary temperatures.

F. HURN CONSTABLE.

St. John's College,
Cambridge.

Solutions and Heat Engines.

THE nature of osmotic pressure is a matter of such great importance both to chemists and to physiologists that I must again crave space to reply to the remarks of the reviewer in NATURE of Mar. 23, p. 445.

In justification of his, or van't Hoff's, account of osmotic pressure, he points to the description in my book of what would happen if a mixture of two gases at atmospheric pressure in a rigid chamber was separated by a rigid septum, permeable by only one of the two gases, from pure gas of the same kind as could permeate, and at the initial pressure of the mixture. The pure gas would pass into the mixture, the pressure of which would rise until the pressure of the penetrating gas was the same in the mixture as outside of it. The gas which penetrates corresponds to the solvent in a solution, and the non-penetrating gas to the solute, while the extra pressure developed in the mixture might be held to correspond to osmotic pressure. May I point out, however, that this extra pressure is due to solvent and not to solute molecules. There is thus in the phenomena no way of escape from the dilemma for van't Hoff's theory which I indicated in my letter. Van't Hoff's assumption that osmotic pressure is due to extra bombardment pressure of solute molecules is both unintelligible physically and inconsistent with the facts as revealed by the experiments of Morse and Lord Berkeley.

The algebraical statement on page 25 of my book, to which the reviewer objects, is, I maintain, perfectly correct, and I am well content to leave the judgment as to its correctness with readers of the book.

J. S. HALDANE.

Cherwell, Oxford, Mar. 23.

I WILL add only one short note to what I have said. Consider two cases. (1) One atmosphere of hydrogen on each side of the septum and no nitrogen. The osmotic pressure is zero. (2) Two atmospheres of nitrogen inside the chamber and again one atmosphere of hydrogen on each side. This also is an equilibrium case and the osmotic pressure is TWO atmospheres. By what wild theory is this attributed to the ONE atmosphere of hydrogen! THE REVIEWER.

Science and Mathematics.

THE sentence italicised in the following from a work published in 1877, seems to have anticipated the views of relativists by half a century: "Any kabalist well acquainted with the Pythagorean system of numerals and geometry can demonstrate that the metaphysical views of Plato were based upon the strictest mathematical principles. 'True mathematics,' says the *Magicon*, 'is something with which all higher sciences are connected; common mathematics is but a deceitful phantasmagoria whose much-praised infallibility only arises from this—that materials, conditions, and references are made its foundation.' . . . As long as exact science confines its observations to physical conditions and proceeds by the Aristotelian method it certainly cannot fail. But, *notwithstanding that the world of matter is boundless for us, it still is finite*; and thus materialism will turn forever in this vitiated circle, unable to soar higher than the circumference will permit. The cosmological theory of numerals which Pythagoras learned from the Egyptian hierophants is alone able to reconcile the two units, 'matter' and 'spirit,' and cause each to demonstrate the other mathematically." —"Isis Unveiled," i. 7. W. W. L.

Evolution in its Course.

ONE of the most persistent plaints of the anti-evolutionist is that the biologist has failed to demonstrate to the satisfaction of the unbeliever the actual occurrence of evolution in the present-day world. The criticism is difficult to meet, for, apart from the blind eye which the critic is apt to turn to the well-meaning efforts of the biologist, evolution is a slow process not readily to be caught in its stride. Even amongst biologists themselves there has been a tendency in recent years to look askance at the work of the systematist, and to lean upon the experiments of the laboratory as the only sure test of biological processes.

It is well to be reminded, therefore, that the last decade has seen a great advance in the technique of the systematist, and that the advance has afforded new ground for the examination of the problem of evolution in natural conditions. In the old days an account of the bird-life of a limited area in California would have meant little more than the bare records of a local list of the bird inhabitants, but, under the new analysis, Mr. Joseph Grinnell's "Distributional Summation of the Ornithology of Lower California" (*Univ. California Pub. Zool.*, vol. 32, No. 1, 1928, pp. 1-300) becomes a plea for the recognition of evolution in its course.

Two factors have made for this progress in method. The first is the attention given to the discernment of minute differences in form, and it is sufficient answer to those who cavil at the difficulties of the determination of sub-species, that in these barely recognisable differences lie the critical, formative stages, which may lead to the development of easily distinguished species. The second factor lies in the attempt to associate these minute differences of sub-species with the peculiar conditions of environment in which each is situated, in an endeavour to discover something of the causes and essential conditions of the differentiation.

The general results of the analysis of the bird-life of California show, then, the progress of evolution in Nature, as closely as the examination of static conditions can be expected to interpret a continuous process. They do not reveal anything that is particularly novel or unexpected, but the fact that they are based upon an intensity of examination and detail of comparison such as was unavailable to Darwin or Wallace, lends them new weight and authority.

In the first place, there is evidence of gradual differentiation. Among the numerous races of Californian birds, examples can be selected showing practically every appreciable stage in differentiation, from neighbouring stocks showing departures from a type so slight that they can be appreciated only when a long series of individuals is averaged, to full-blooded species, sharply distinct, no longer crossing with related species, judging from the absence of wild hybrids.

In the second place, the differentiation, that is, the variational move towards species, is not everywhere a uniform process. The inequality may be associated with several definite characters of the environment. Thus, in many of the groups of wide distribution, the amount of difference shown by the geographical races varies directly with the degree of spatial separation. Take the clear case of the group including the California linnet (*Carpodacus*). The group extends over the mainland, a distance north and south of some eight hundred miles, and in that space has three recognisable subspecies. But on Los Coronados Islands, only seven miles off shore, there is another race, appreciably but not constantly or conspicuously different. Forty miles from the nearest mainland, on the San Benito Islands, there are greater and fairly constant differences from the birds of the mainland, and on Guadalupe Island, 135 miles away, the differences are so great and constant that the form there is designated a full species.

The differences themselves are significant. The Guadalupe birds are distinguished by their larger size, longer legs, relatively shorter wings, and shorter keel of sternum — indications of a loss of wing power, which suggest a step towards the flightlessness of some other birds on remote Pacific islands.

Even a slight water barrier may be influential as an effective form of isolation, preventing free interbreeding of birds from neighbouring places. Although there are no apparent barriers in the whole extent of the mainland of lower California, long distance has had the same isolating effect, allowing differentiation in remote stocks despite commingling over adjacent territory.

Other cases of the influence of isolation, such as that shown by the spotted towhee (*Pipilo maculatus*), could be cited; they illustrate the fact that closely similar races in a series are not situated "within the same differentiation area, nor yet in remote differentiation areas, but in separate and adjacent differentiation areas."

In the third place, it becomes clear that environment may have an effect which, no matter that the subjects of its influence are different, results in a remarkably similar set of results. A very peculiar climatic condition exists between the crest of the Sierra San Pedro Mártir and the Pacific, where a region of meagre rainfall has a high atmospheric humidity—a humid desert. Various birds in this region, as different as flycatchers, finches, and woodpeckers, show similar modifications, especially marked in deeper coloration, certain proportions of wing and tail, lesser size of bill, and so on. Subjection of very different stocks to the same peculiar set of critically important conditions has brought parallel modifications in certain functions and structures.

This suggests that the inherited variations have not been random, but have been directed. So far so good, but the author goes on to say that sub-specific characters are therefore to be regarded, either intrinsically in themselves or in their linkages, as of *worthy* sorts in the racial struggle for existence —not, ordinarily, indifferent or useless ones. Here he seems to travel in advance of his facts, for it has

yet to be shown that the common characters which have been induced by a peculiar environment in so many different kinds of birds can have an equal survival value to each of these birds of habits so different. On the facts put thus, the safer assumption would seem to be that similar conditions induce a similar organic reaction irrespective of 'worthiness' or 'unworthiness.'

After all, unworthiness in the evolutionary sense is not likely to survive in hard competition with worthiness, and Mr. Grinnell finally reaches a Darwinian conclusion. "The accumulating evidence of the field naturalist is bringing conviction that the incipient species in nature, the subspecies, owes its origin to a process, on a vast scale, of trial, discard, and preservation, of individuals, and of groups of individuals comprising populations, which populations from generation to generation are thereby rendered more nearly adjusted to such environments as they can endure at all. But environments themselves never stabilize; they are changing, proliferating, evolving continually. A balanced state of perfect adaptation of the organism can never be attained, but only continually approached, such approach being forced, under penalty of extinction." J. R.

Physical Foundations of Chemical Theory.

NO task is more difficult for the chemist of the present day than that of trying to keep abreast with those advances in atomic physics which affect him so closely that he cannot ignore (even if he cannot hope fully to understand) them. Sidgwick's book on "The Electronic Theory of Valency," which was reviewed at length in these columns last year (April 7, 1928, vol. 121, p. 527), provided a partial solution of the problem from the chemist's point of view; but the brief monograph of Lessheim and Samuel referred to below [1] may be regarded as a complementary contribution of unrivalled value from the physical side. The professional spectroscopist does not often realise how difficult his subject can be made for the lay reader, and it is a common experience, even when reading books or lectures of a semi-popular character, to be pulled up short by technical or controversial details of which no explanation is given or attempted.

In the more leisurely days of the past, there was usually ample time for one fundamental idea to be grasped before attention was distracted by the next new development. Progress was then made by the orderly passing of the ball from one three-quarter back to another, until it was safely placed behind the goal, and in due course 'converted' from speculation or hypothesis to theory. Now, however, the ball progresses amid the confusion of a wild 'forward' rush, in which the casual onlooker can only occasionally get a glimpse of the ball, and has but little chance to observe the effects of individual play, whilst even the professional reporter is in danger of overlooking essential points in the game. Thus, whereas Bohr's 'principal quantum number' n had a sufficient start to secure universal acceptance, and has retained its strictly integral character, it has been followed in the works of subsequent authors by a trail of subsidiary numbers, which are in open competition with one another, and (to add to the confusion) appear at some stage to have undergone a process of 'disintegration' whereby integral quanta have been resolved into proper fractions.

The difficulties arising from such causes as these are in large measure removed by the careful and concise exposition of Messrs. Lessheim and Samuel, and it is a high compliment to their skill that we can claim to have been able to understand and to make use of the major portion of their monograph. It was, indeed, only on reaching the tenth section of the book that it became necessary to add a marginal comment, "I cannot follow this," and to call in the help of a professional physicist to explain in fuller detail the complex behaviour of systems with several outer electrons. The elaborate spectroscopic analysis of sections 12 and 13 was also too complicated to be understood at one reading, but it would be difficult to praise too highly the way in which the spectroscopic evidence is used in order to provide a sure foundation for definite chemical deductions; and it is one of the conspicuous merits of the book that this evidence is set out in such a convincing way, that its validity is no longer open to question even by the most extreme type of 'sceptical Chymist.'

Much of the charm of the quantum theory of the present day arises from the introduction, by Goudsmit and Uhlenbeck in 1925, of the conception of the spinning electron. This conception has, indeed, done more than anything else to bring order out of the chaos of subsidiary quantum numbers, and thus to restore to Bohr's theory some semblance of the simple and logical character which it possessed in 1913. From the chemical point of view, the principal merits of this early quantum theory was the provision of a logical basis for the valency theories of Kossel and Lewis, since it indicated the existence of groups of electrons with identical 'principal quantum numbers' $n = 1, 2, 3, 4, 5$, etc., corresponding with the K, L, M, N, O, etc., levels of the X-ray spectra of the elements. In this way it explained the inertness of the noble gases, and the ionisation of adjacent elements such as the halogens and the alkali metals, as depending on the exceptional stability of certain completed groups of electrons. Since, however, the theory gave no clue to the number of electrons in each quantum group, these numbers must logically have followed the Rydberg series, with 2, 8, 8, 18, 18, and 32 electrons in successive levels, corresponding with the number of 'cells' which Langmuir postulated in successive layers or 'shells' of his static atomic model.

[1] Die Valenzzahl und ihre Beziehungen zum Bau der Atome. Von Hans Lessheim und Rudolf Samuel. (Fortschritte der Chemie, Physik und physikalische Chemie, herausgegeben von A. Eucken, Band 19, Heft 3.) Pp. 98. (Berlin: Gebrüder Borntraeger, 1927.) 6·40 gold marks.

Two years later, in 1915, Sommerfeld found it necessary to introduce a second ('subsidiary' or 'azimuthal') quantum number k, in order to explain the fine structure of the hydrogen and helium spectra. This 'subsidiary' quantum number immediately assumed a dominant position in spectroscopy, where series of spectroscopic terms for which $k=1, 2, 3, 4$, were distinguished by the capital letters S, P, D, F, corresponding with the initial letters of the 'sharp,' 'principal,' 'diffuse,' and 'fundamental' series of spectral lines with which the terms are associated. It is unfortunate for the lay reader of spectroscopic literature that the fascinating explanation which Sommerfeld gave of the fine structure of hydrogen, as depending on the varying mass of electrons moving with varying velocity in elliptical orbits of different eccentricities, has now been abandoned in favour of a fine structure depending on a third (instead of on the second) quantum number; but the classification of Bohr's 'groups' of electrons into 'sub-groups,' under the headings $n_k = 1_1 2_1 2_2 3_1 3_2 3_3$, etc., was nevertheless an advance of permanent value. In particular, it was these sub-groups which enabled Bohr in 1921 to develop his well-known classification of the elements, in which the inertness of the noble gases is no longer attributed to the completion of the main groups with principal quantum number $n=1, 2, 3, 4$, etc., but to the completion only of successive n_1 and n_2 sub-groups, as in the table below:

X-ray level.	K.	L.	M.	N.	O.	P.
Quantum No.	1_1	$2_1 2_2$	$3_1 3_2 3_3$	$4_1 4_2 4_3 4_4$	$5_1 5_2 5_3$	$6_1 6_2$
He = 2	= 2					
Ne = 10	= 2 + 8					
A = 18	= 2 + 8 + 8					
Kr = 36	= 2 + 8 + 18 + 8					
X = 54	= 2 + 8 + 18 + 18 + 8					
Rn = 86	= 2 + 8 + 18 + 32 + 18 + 8					

This well-known system of classification assigns an outer shell of 8 electrons to each of the noble gases, and explains the old 'law of octaves' by the repetition which results from building up this outer octet in one level after another. It then proceeds to account for the properties of the transition elements of the first and second long periods as depending on a subsequent expansion of the M and N octets into shells of 18 electrons. The final expansion of the N octet to a shell of 32 electrons (at a stage when the O and P levels are already partially filled) then provides a natural explanation of the still slower gradation of properties in the elements of the rare earth group.

Since the number of similarly placed electrons was still undetermined, Bohr adopted the simple plan of distributing them equally amongst the sub-groups of a given level. The N-level was therefore supposed to contain $4+4$ electrons in krypton, $6+6+6$ in xenon, and $8+8+8+8$ in radon. It is, however, rather illogical to postulate that a condition of maximum stability exists in a sub-group when occupied by 4 *or* 6 *or* 8 electrons. Stoner therefore suggested in 1924 that the various sub-groups should be filled up completely one after another, and then remain full to the end of the chapter. It then follows logically that the sub-groups for which $k=1, 2, 3, 4$, etc., must contain 2, 6, 10, 14, etc., or in general $2(2k-1)$ electrons, whatever may be the value of the principal quantum number n. The close similarity between the members of the various natural families of elements was then explained by the identical development of successive sub-groups differing only in their 'principal' quantum numbers. Thus the alkalis all contain *one* electron in an n_1 sub-group, whilst the alkaline earths contain a complete sub-group of *two* electrons. In the same way carbon and its homologues contain *two* electrons in an n_2 sub-group, in addition to the two electrons in the n_1 sub-group, whilst the inert gases contain a complete sub-group of *six* n_2 electrons.

In the periodic classifications of Bohr and of Stoner, the maximum number of sub-groups in a group is fixed by the fact that k may have any integral value between 1 and n. The number of sub-groups is therefore equal to the principal quantum number n, and has the value 1, 2, 3, 4, 5, in the K, L, M, N, O levels. Coster found, however, in 1921, that the X-ray absorption spectra of the elements have a fine structure like that of hydrogen or helium, the number of components in the K, L, M, N, O, P levels being expressed by the series 1, 3, 5, 7, (5), (3), instead of the series 1, 2, 3, 4, 5, 6. In order to explain this result, he introduced a third quantum number in the form $n_{k_1 k_2}$, where k is now written as k_1 and may be any integer between 1 and n as before, whilst k_2 may be either equal to k_1 or 1 unit less. The sub-groups of the preceding classification are thus divided up into 'grouplets' corresponding with a series of triple quantum numbers as follows: 1_{11}; 2_{11}, 2_{21}, 2_{22}; 3_{11}, 3_{21}, 3_{22}, 3_{32}, 3_{33}, etc. This system gives the required series of 1, 3, 5, 7 components in the K, L, M, N levels, as required by the X-ray spectra, and we may then suppose that, as in the optical spectra, the O and P levels are only partially filled.

A third quantum number had already been introduced by Sommerfeld in 1920 in order to account for the composite character or 'multiplicity' of lines, such as the sodium doublet, which could not be explained by means of the first two quantum numbers. Sommerfeld's 'inner' quantum number j can have integral values when there are *two* valency electrons which can move from orbit to orbit during the absorption or emission of light by the atom, as in the alkaline earths; but when there is only *one* of these electrons it becomes a half-integer, and its value is given by the relation $j = k_2 - \frac{1}{2}$. This third quantum number is evidently magnetic in origin, since it also explains the multiplicity which is developed when spectral lines are emitted in a strong magnetic field as observed by Zeeman in 1896. Under these conditions a single line is resolved into $2j+1$ components, where j is the inner quantum number.

Thus if j is an integer, the lines break up into an odd number of components, but into an even number if j has a half-integral value.

The significance of the third quantum number becomes clear only when a quantised spin is given to the electron. The magnetic moment s of the spinning electron can then be either positive or negative; but, since there is no intermediate resting state, only a single quantum separates the two states. For the sake of symmetry, therefore, these states are written $s = \pm\frac{1}{2}$ for each electron, and we have at once a plausible explanation of those half-quantum numbers which have so often caused the sceptical to scoff. The total magnetic moment j of a planetary electron is then made up of two parts, the magnetic moment of the orbit l and of the spin s, so that $j = l \pm s$, since the moments may either work together or oppose one another. The magnetic moment l of the orbit is a function of the second or 'subsidiary' quantum number k, and is given by the simple relation $l = k - 1$. Thus if $k = 1$ (as in the S terms of a spectroscopic series) $l = 0$; and since $j = l + s$ cannot be negative, the only possible value of the 'inner' quantum number when $s = \pm\frac{1}{2}$ is $j = \frac{1}{2}$. If, however, $k = 2$ (as in the P terms of a spectroscopic series), then $l = 1$, and $j = l + s$ can have the *two* valves $j = \frac{1}{2}$ or $j = \frac{3}{2}$. An electron-fall from a 2_2 to a 1_1 orbit can thus give rise to the yellow doublet of sodium, since the falling electron may be spinning either in the same sense as its revolution in the orbit or in the opposite sense.

The introduction of the second quantum number had the effect of breaking up the main groups of 2, 8, 18, 32 electrons into sub-groups of 2, 2+6, 2+6+10, and 2+6+10+14 electrons. The third quantum number has the effect of breaking up these sub-groups into tiny grouplets containing small even numbers of electrons. Thus Bohr's big group of 32 N electrons is resolved into the following grouplets:

4_{11}	4_{21}	4_{22}	4_{32}	4_{33}	4_{43}	4_{44}
2	2	4	4	6	6	8 ;

and the 54 electrons of xenon are now distributed amongst 17 grouplets as follows: 2, 2+2+4, 2+2+4+4+6, 2+2+4+4+6, 2+2+4. This has the effect of emphasising more strongly than ever the significance of the duplet or pair of electrons, since each completed grouplet is magnetically inert; but the octet is relegated to a subsidiary position as a mere summation of the first three grouplets in a group which contains $2n - 1$ of these tiny clusters.

In order to complete this process of resolution, we must now proceed to consider the fourth quantum number m, which represents the various settings of the atom in an external magnetic field. This fourth quantum number changes by one unit at a time from $+j$ to $-j$, and may therefore be either integral or half-integral. The number of settings for a given value of j is given by the formula $2j + 1$; thus if $j = \frac{1}{2}$, $m = \pm\frac{1}{2}$ and has *two* values; if $j = 1$, $m = -1$, 0, $+1$ and has *three* values; whilst if $j = \frac{3}{2}$, $m = -\frac{3}{2}$, $-\frac{1}{2}$, $+\frac{1}{2}$, $+\frac{3}{2}$ and has *four* values. The total number of settings of the *four* quantum numbers n, l, j, and m is then found to agree exactly with the maximum number of electrons that can be collected in groups, sub-groups, and grouplets round the nucleus. We are therefore at last in a position to appreciate Pauli's 'exclusion rule,' according to which no two electrons in an atom can have the same four quantum numbers, n, l, j, and m. A sample of the table which expresses this rule is reproduced below:

				Number of Settings.
$n = 1, 2, 3, 4, 5, 6.$	$l = 0$	$j = \frac{1}{2}$	$m = -\frac{1}{2}, +\frac{1}{2}$	2
				2
$n = 2, 3, 4, 5, 6.$	$l = 1$	$j = \frac{1}{2}$	$m = -\frac{1}{2}, +\frac{1}{2}$	2
		$j = \frac{3}{2}$	$m = -\frac{3}{2}, -\frac{1}{2}, +\frac{1}{2}, +\frac{3}{2}$	4
$n = 3, 4, 5, 6.$	$l = 2$	$j = \frac{3}{2}$	$m = -\frac{3}{2}, -\frac{1}{2}, +\frac{1}{2}, +\frac{3}{2}$	4
		$j = \frac{5}{2}$	$m = -\frac{5}{2}, -\frac{3}{2}, -\frac{1}{2}, +\frac{1}{2}, +\frac{3}{2}, +\frac{5}{2}$	6
$n = 4, 5, 6.$	$l = 3$	$j = \frac{5}{2}$	$m = -\frac{5}{2}, -\frac{3}{2}, -\frac{1}{2}, +\frac{1}{2}, +\frac{3}{2}, +\frac{5}{2}$	6
		$j = \frac{7}{2}$	$m = -\frac{7}{2}, -\frac{5}{2}, -\frac{3}{2}, -\frac{1}{2}, +\frac{1}{2}, +\frac{3}{2}, +\frac{5}{2}, +\frac{7}{2}$	8

2 2 → 8; 2 6 → 8; 4 6 → 10; 6 8 → 14; 8 10 → 18; 18 14 → 32

This table gives a picture of the periodic classification from which all individuality is excluded, since exactly the same sequence recurs when $n = 2$, 3, 4, etc. It thus represents one of the main characteristics of the elements perfectly, namely, the recurrence of types such as the halogens, noble gases, and alkalis at appropriate intervals; but in practice the elements of a given family are far from uniform in their behaviour, so that even the formal valencies vary erratically in a family such as copper, silver, gold. It is therefore satisfactory to find that the spectroscopic evidence, when examined in detail, gives similar indications of more complex developments. Thus it is found experimentally that, in the elements of the *first* transition series, the grouplet 4_{11} of the N level is occupied by *two* electrons (except in chromium and copper) so that all these elements readily form bivalent ions. In the same way, the first two elements (yttrium, zirconium) of the *second* transition series have *two* electrons in the 5_{11} grouplet of the O level; but at this stage there is an abrupt change, since the following elements (niobium, *et seq.*) have only *one* electron in the 5_{11} grouplet, and palladium actually has *none*. In the next group of transition elements tungsten appears to have *two* electrons in the 6_{11} grouplet; but no conclusion can be drawn in reference to the other elements of this transition series, since the relevant spectroscopic data are not yet available. These unforeseen 'anomalies' are of peculiar interest, since they show that the individuality of the elements, which makes inorganic chemistry appear so much less systematic than organic chemistry, is manifested also in their spectroscopic behaviour, which may therefore be expected to provide a clue to the common origin of these physical and chemical anomalies in the electronic configuration of the atom.

A particularly interesting comparison can be made between nickel, palladium, and platinum. The structure of these three elements could be represented most easily by assigning an outer

shell of 18 electrons to each metal, as in the scheme:

	K.	L.	M.	N.	O.	
Ni	2	8	18			= 28
Pd	2	8	18	18		= 46
Pt	2	8	18	32	18	= 78

This structure is correct in the case of palladium, which appears to contain a series of complete grouplets, since it is only feebly paramagnetic and gives a spectrum with some of the characteristics of a noble gas; but it is no longer true for nickel and platinum, the spectra of which are more like those of the alkaline earths, so that their structure may be represented more efficiently by the schemes $2+8+16+2$ and $2+8+18+32+16+2$.

The spectroscopic data thus explain the typical bivalency of nickel and its resemblance to the bivalent transition elements with which it is associated; but they do not throw much light on the chemistry of palladium and platinum, since these two metals do not show any analogous contrast in their chemical behaviour. If, however, we consider the coinage metals of the succeeding family, Cu = 29, Ag = 47, Au = 79, the value of the spectroscopic data is at once seen. Thus, since palladium contains only completed groups or sub-groups of electrons, and has therefore a very stable electronic configuration, it is natural that silver should exhibit the simple spectrum and rigid univalency of an alkali metal, as expressed in the scheme $Ag = 2+8+18+18+1$. In the case of copper, the univalency of the element in its cuprous salts is similarly expressed in the scheme $Cu = 2+8+18+1$. In strict conformity with this scheme, the cuprous ion, $Cu^{+} = 2+8+18$, which has three levels completely filled, is diamagnetic; but the cupric ion, which possesses an incomplete shell $Cu^{++} = 2+8+17$ is paramagnetic. Since copper is usually bivalent, we might expect to find spectroscopic evidence of a configuration $Cu = 2+8+17+2$, corresponding with $Ni = 2+8+16+2$, with two electrons in the 4_{11} grouplet, but this does not appear to have been observed. On the contrary, the presence of quadruplet groups in the spectrum of copper indicates the presence of *three* unpaired electrons round the central nucleus. This brings the metal into line with nickel, but in a different way, since the stable core of electrons has $2+8+16$ electrons in each case; but it is not in accord with the chemical properties of the element, which may be univalent but is never tervalent.

The univalency of gold finds expression in the configurations

$$Au = 2+8+18+32+18+1,$$
$$Au^{+} = 2+8+18+32+18,$$

which show the presence of *one* easily detached electron in the *P* level. Its tervalency can be deduced from the analogy between the spectra of platinum and those of the alkaline earths with *two* easily detached electrons, since this indicates the existence of a stable core with 16 *O*-electrons as in the scheme

$$Au^{+++} = 2+8+18+32+16,$$
$$\text{compare } Pt = 2+8+18+32+16+2.$$

In this connexion, the univalency of thallium, which finds expression in the scheme $Tl^{+} = 2+8+18+32+18+2$, is of interest, since it provides further evidence of the stability of the outer sub-group of two 6_1 electrons which has already been deduced from the spectroscopic data for platinum.

The introduction of sub-groups of elements has the interesting effect of removing carbon and silicon from the central position which they have long occupied in the minds of chemists as the middle

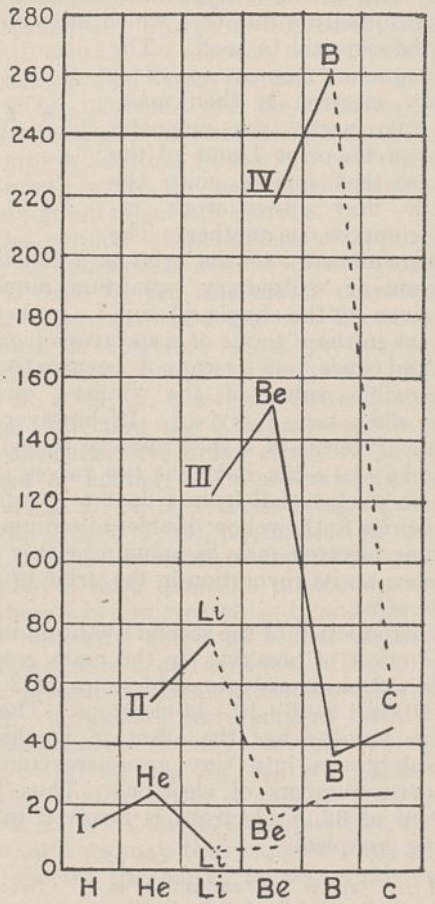

FIG. 1.—Diagram showing the ionisation potentials required to remove 1, 2, 3, or 4 electrons from the first six elements.

members of the two short periods of elements. From the spectroscopist's point of view, however, a sub-group 2_1 or 3_1 has been completed at beryllium and magnesium, and it only remains to build up the six electrons of the 2_2 or 3_2 sub-groups in order to give the configuration of a noble gas. In this process, nitrogen and phosphorus usurp the median positions, and this is revealed by an unexpected symmetry in the spectroscopic terms of the elements on either side. Thus the spectrum of magnesium shows some resemblance to that of argon, whilst aluminium and chlorine, and silicon and sulphur form similar pairs, in which the electrons which are present in one element are represented by gaps in the other. A similar symmetry is seen on either side of manganese in the transition elements of the first long period,

where the 3_3 sub-group is being filled up; but in this case the symmetry is marred by the fact that chromium and copper have only *one* outer electron instead of two in the 4_{11} grouplet. In the elements of the rare earths, where the 4_4 sub-group is being filled with fourteen electrons, gadolinium occupies a central position in a series of fifteen elements ranging from lanthanum to cassiopeium; but in this case the central element is characterised by an extraordinary maximum of multiplicity, $r=17$, which is far in excess of the previous maximum values, namely, $r=4$ for nitrogen and phosphorus, and $r=6$ for manganese, or $r=7$ for the anomalous spectrum of chromium.

The culminating feature of Messrs. Lessheim and Samuel's monograph, in our experience, is found in a diagram of ionisation potentials (Fig. 1), which provides the most convincing proof of the real existence of electron-groups. The minima at Li^+, Be^{++}, B^{+++}, and C^{++++} show how easy it is to remove the whole of the electrons from the L level in lithium, beryllium, boron, and carbon; but, on attempting to remove one more electron, an immense resistance is at once encountered to the disintegration of the still complete K-shell, and the ionisation potential leaps up to a maximum. When once this shell is broken, however, only a feeble resistance is offered to its complete removal. Thus the two L electrons can be removed from an atom of beryllium by two increments of about 8 and 7 volts, but the removal of the two K electrons requires the successive addition of 138 and 46 volts to the previous total of about 15 volts. The most striking feature of these numbers is the drop of nearly 100 volts in the extra work that is required to strip the nucleus bare by the removal of one more electron when once the K-shell has been broken. Even the tiny duplet of the 2_{11} grouplet appears, however, to put up an appreciable resistance to disruption, since rather less extra work is required to remove an electron from the ion Be^+ than from the neutral atom Be. Facts such as these provide ideal evidence in support of the main thesis of the electronic theory of valency, that chemical affinity in all its various manifestations depends on the superior stability of certain numerical groups of electrons when under the influence of a positively charged nucleus. In our opinion, this thesis now rests on an impregnable rock of experimental proof. T. M. LOWRY.

Christian Huygens, 1629–95.

OF all men of science whose lives were passed within the compass of the seventeenth century, none has a more lasting reputation than the Dutch mathematician, natural philosopher, and inventor, Christian Huygens. Born on April 14, 1629, three hundred years ago, at a time when the work of Kepler, Galileo, Napier, Gilbert, and Harvey was slowly gaining acceptance, he lived to read Newton's "Principia," and during the course of his career saw the rise of experimental science, the erection of famous observatories, and the foundation of our greatest scientific societies, the Royal Society and the Paris Academy of Sciences, of the latter of which he was the first foreign associate.

Huygens' birth, and his death on June 8, 1695, both took place at the Hague, and his tomb, like that of his illustrious countryman, Boerhaave, is there in St. Peter's Church. With advantages of birth, education, wealth, and position, Huygens possessed a studious and industrious mind, and an even and cheerful temper, and by the exercise of his brilliant intellect he raised himself to pre-eminence among his contemporaries. Trained in the law and for a short time attached to a Dutch embassy, he was all his life free to follow his own bent, and his long sojourn in Paris, where he enjoyed the seclusion of the Bibliothèque Roi, and his visits to England, no less than his investigations, discoveries, and inventions, led to his being esteemed by a wide circle of friends.

The life and works of Huygens have been published and republished, but reference can be made to only one or two of his great contributions to the advancement of knowledge. Attracted in his youth, like many of his fellows, to the construction and improvement of telescopes, on Mar. 25, 1655, Huygens discovered Titan, the sixth, but the first seen, of the satellites of Saturn, and then gave the true explanation of the curious appearance of the 'triple planet.' This discovery of Saturn's ring he made known in the form of a logogriph, which is reproduced by Grant in his "History of Physical Astronomy." In after years Huygens presented to the Royal Society an object glass of 122 feet focal length for an 'aerial telescope,' for the mounting of which Halley was commissioned by the Society to "view the scaffolding of St. Paul's Church" to see if it could be used for erecting the object glass.

From astronomy and telescopes Huygens turned to clocks, and on June 16, 1657, presented the first pendulum clock to the States General. Described later in his famous work "Horologium Oscillatorium," of 1673, a replica of the clock is to be seen in the Science Museum. Of that famous work, it has been said that it contained original discoveries sufficient to have furnished material for half a dozen striking disquisitions, while "the theorems on the composition of forces in circular motion with which it concluded formed the true prelude to Newton's 'Principia' and would alone suffice to establish the claim of Huygens to the highest rank among mechnaical inventors." This work, like his "Traité de la Lumière," in which he enunciated the undulatory theory of light, was written while he lived in Paris.

Returning to his native country in 1681, Huygens continued his writings, and his last work, "Cosmotheoros," was in the printers' hands when he was attacked by the illness which proved fatal. It is said that Flamstead recommended the "Cosmotheoros" to Dr. Plume, archdeacon of Rochester, who was so struck with it that he left £1800 to found the well-known Plumian professorship of astronomy at Cambridge.

Obituary.

DR. ALEX HILL.

DR. ALEX HILL, whose death was recently recorded in NATURE, was born at Loughton, Essex, and educated at University College School and at Downing College, Cambridge; in 1880 he was elected a fellow of the College, from 1888 to 1907 he was Master of Downing, and from 1897 to 1899 Vice-Chancellor of the University. He studied medicine and surgery at St. Bartholomew's Hospital; in 1884–85 he was Hunterian professor of the Royal College of Surgeons.

The greater part of Dr. Hill's life was spent in the advancement of learning; his services, not being confined to the routine of academic life, were given widely to educational causes. He assisted in the formation of the National Home Reading Union, of which he was the chairman from 1888 to 1908. He served as president of the Teachers' Guild of Great Britain, and was a member of various educational committees, including the Welsh Colleges Committee, 1907–8, and the Advisory Committee of the Treasury on Universities, 1901–6.

A versatile and an attractive writer, Dr. Hill was the author of several books and papers on physiology and on other subjects connected with the profession for which he had been trained. His geniality, personal charm, and eloquence attracted crowded audiences in various parts of the country, when as a Gilchrist Lecturer he dealt with physiological and psychological subjects such as "Man under the Microscope" and "Dual Personality." His literary gifts were evident in his series of lectures on Browning and in his interpretation of the poet in his "Notes on Browning."

Dr. Hill was zealous in his advocacy of university education, and having formed the conception of university institutions as centres of educational influence in areas not already served by universities, he strove to put his ideals into practice. With this aim in view he accepted an urgent appeal to become the Principal of University College, Southampton, a position which he took up in January 1913. His task was not an easy one, but he entered on it with characteristic enthusiasm; his winsome personality had an immediate effect on all branches of the College activities, and he was able to secure support for the new College buildings which had been planned for the present site at Highfield. The outbreak of the War so soon after he had entered upon his duties was a serious blow to the growing College; a large number of the staff and students joined the forces, and the new buildings were occupied as a war hospital. Dr. Hill's own residence at Highfield Hall, which he had taken as a centre for the social activities of the College, he gave up to the Red Cross Society, and lived in a house near it in order to be able to assist the work of the hospital. Always a hard worker, his energy during the War was boundless, for in addition to carrying on his duties as Principal of the College, he took on himself the work of the Universities Bureau when his assistant secretary joined the forces. His recreation was in the garden attached to Highfield Hall, and even at this strenuous period of his life he rose early each morning to work in the garden, where he grew vegetables and flowers for the wounded soldiers in the hospital.

The work with which Dr. Hill especially identified himself since 1912 was that of secretary of the Universities Bureau of the British Empire. The Bureau owes its inception to Dr. Hill, who, when he resigned his position as Principal of the University College, Southampton, told the writer that there were two claims both very dear to him, those of the College and the Bureau; but whilst he felt that others could carry on the work of the College, the Bureau was his own child, and his one aim in life was to nurse it and to bring it to maturity.

A man of broad sympathies and wide vision, Dr. Hill endeared himself to those who knew him. His tour with his family, so well described in his book "Round the British Empire," strengthened his vision and he felt more intensely that the work which he was undertaking was a means of cementing more firmly the bonds of Empire. Since 1920, although his work was mainly in London, his home was in Southampton, and his connexion with the College maintained by his election as a vice-president. He died at 'Granta,' Upper Bassett, Southampton, on Feb. 27, and leaves a widow, a son, and a daughter. J. EUSTICE.

WE regret to announce the following deaths:

M. J. Boussinesq, member of the Section of Mechanics of the Paris Academy of Sciences and author of a mathematical work on the theory of light, on Feb. 19, aged eighty-six years.

Sir Anthony Bowlby, Bart., K.C.B., K.C.M.G., K.C.V.O., a past president of the Royal College of Surgeons of England, on April 7, aged seventy-three years.

Dr. Jonathan Dwight, president in 1923–26 of the American Ornithological Union, on Feb. 22, aged seventy years.

Dr. H. B. Gray, formerly warden of Bradfield College, and president in 1909 of Section L (Educational Science) of the British Association, on April 5, aged seventy-seven years.

Sir George Knibbs, C.M.G., Commonwealth statistician from 1906 until 1921, and president in 1923–24 of the Australasian Association for the Advancement of Science, aged seventy years.

Dr. Thomas B. Osborne, since 1886 research chemist in the Connecticut Experiment Station, who was an honorary fellow of the Chemical Society of London, and was distinguished for his work on the chemistry of the vegetable proteins and related subjects, on Jan. 29, aged sixty-nine years.

Sir Henry Rew, K.C.B., sometime Assistant Secretary, Ministry of Agriculture, and a past president of the Royal Statistical Society and of Section M (Agriculture) of the British Association, on April 7, aged seventy years.

Dr. Thomas Scott, associated for many years with the Scottish Fishery Board Laboratory and known for his work on the smaller marine crustacea, especially copepoda, in recognition of which the University of St. Andrews conferred on him the honorary degree of LL.D., on Feb. 25, aged eighty-eight years.

News and Views.

There are two thinkers in England just now working on very similar lines, investigating the relations of science and art. Both are 'emeritus' professors, Lloyd Morgan of Bristol, Alexander of Manchester, and every reader of any of their publications on the subject must be struck by the earnestness and penetration of their work and the palpable and complete sincerity of their minds. It is much to be hoped that they will persevere and that Prof. Alexander, who has already several lectures and pamphlets on the subject to his credit, will soon be able to bring out the systematic volume which he has in mind. Prof. Lloyd Morgan gave two lectures at Bristol last November entitled "Science and Drama" (University of Bristol), which really deal with the same topic. He uses the term 'drama' in the widest possible sense in order to cover all forms of 'agency,' and while in the first he considers the question of 'agency' in respect of natural phenomena which are studied in science, in the second he examines in detail what Alexander has already said about the action of the mind in art, on the whole accepting it and adding certain 'glosses' of his own.

Prof. Lloyd Morgan's second lecture sums up and gives the author's own point of view in his now familiar phrase of 'emergence.' Science and art, he tells us, both give entry to a realm which is transformed in contrast with the world of naïve perception. The square box, for example, which we see as we move about in a room is transformed by the most elementary operation of science into a cube. We never see it as a cube but we think so consistently in a transformed mental attitude that we always say that what we see is really a cube. The difference in this respect between the man of science and the artist is that for the latter it is always the appearance which in his sense is the real. There is, however, in both cases the scientific and the artistic result, something added by the thinker or the artist. In the latter case the artist transforms the real as he perceives it into something having an 'art-value,' and it is in this process of transformation, whether of the artist himself or of those who follow him in appreciating his work, that Prof. Lloyd Morgan finds the new or 'emergent' attitude of mind which is the keystone of his philosophy. It is the turning-point in mental development, and probably not attained by the animal or the little child. Then comes a careful and stimulating analysis of Alexander's account of the same process. The two philosophers by no means agree on all the points which arise, and it is this comparison of results which makes the discussion so interesting. English writers have not hitherto equalled the best of the German, Italian, or French philosophers who have studied æsthetic, and it is therefore the more gratifying to find a pair of subtle and mature minds engaged in friendly competition to fathom the depths of one of the most fundamental problems of thought. Both, it should be noted, agree in placing the decisive element in the thinking mind.

In a recent leading article in Nature (Feb. 16, p. 233) the connexion between forests and agriculture as considered in the Report of the Royal Commission on Agriculture in India was considered. In different parts of India, a study of the history of the past sixty years or so has resulted in the steady growth of an opinion which recognises that there is a definite relation between unchecked abuses in the forest (by axe, fire, and overgrazing) and subsequent forest degradation, erosion, drying up of the waters and covering up of valuable agricultural lands. Those who have studied these problems in India will not, perhaps, be aware how widespread and important they have become in other parts of the world. Recently (Feb. 27–Mar. 1) a three days' joint session of the American Forestry Association and the Florida Forestry Association was held at Jacksonville, Fla., to discuss the position of the southern forests and their industrial, conservational and recreational significance to the United States. The main object of the meeting, according to a *Daily Service News Bulletin* issued by Science Service, Washington, D.C., was a consideration of the steps to be taken "to reclaim for full production the vast tracts of southern land that are better adapted for forest crops than for any other purpose." One of the sessions was devoted to a consideration of the fire evil. "Forest fires in the south," it is said, "are different from those in other parts of the country in that most of them are deliberately started by cattle owners under the mistaken impression that burning improves pasture. How to persuade these people that they are burning money out of their own pockets is one of the most pressing problems confronting southern forestry men." Forestry men in India have been engaged upon this problem for sixty years and more, and Florida foresters could doubtless study the work of the past in India with profit.

Mr. E. A. Sherman, of the United States Forest Service, in dealing with the important problem of soil exhaustion and erosion as a result of the destruction of the forests, said: "Our fields have been robbed of their fertility almost beyond human comprehension. Millions of acres have, through our ignorance, been rendered relatively worthless. . . . The far-sighted thrift upon which was founded that part of the common law which places a taboo upon waste is still sufficiently inherent in our people to assure us that it will be applied as soon as the man in the street realises the presence of that waste and its extent. He will insist upon prohibiting forms of agriculture that result in a permanent shrinkage in our total agricultural domain. Economic pressure and the pressure of public opinion will combine to exclude certain classes of land from cultivation until such time as such use justified the investment necessary to adapt them for permanent tillage. Meanwhile such lands may serve a useful and very valuable purpose as forests. Forestry use not only safeguards the fertility of the soil from destruction, but actually contributes to its upbuilding." Mr. Sherman in the above words

might have been speaking for many parts of the British Empire where problems of the kind, through mismanagement or ignorance in the past, are urgently demanding a solution.

AT the quarterly meeting of the Grand Council of the British Empire Cancer Campaign held on Monday, April 8, the summary of the recommendations made by the Committee of the International Cancer Conference held last July was passed to the Investigation Committee of the Campaign to take action in initiating executive action on the proposals. In the matter of radium and X-rays, the Committee stresses the necessity for the institution of standardised records of results of patients treated by radium and X-rays, and urges that the Campaign, in collaboration with the Medical Research Council and the Ministry of Health, should invite all institutions using radium and X-rays to utilise an agreed form of record. The Grand Council received the final reports on the subject of the Garton Prize, which has been instituted by the British Empire Cancer Campaign for the purposes of promoting investigations into the nature, causes, prevention, and treatment of cancer. It was announced that a medal, with an honorarium of £500, will be awarded to the person, or group of persons, who shall submit the essay embodying the results of original investigations which, in the opinion of the judges appointed by the Grand Council, is the best contribution towards "The Early Diagnosis of Cancer."

THE recent presentation by Messrs. Thos. W. Ward, of Sheffield, to the North-Eastern Railway Museum at York, of some old rack rails and wheels from the Wylam wagon way has attracted considerable attention in the Press, and the Wylam wagon way has been referred to as the earliest railroad in the world. On such matters there is often confusion of thought, and it should be remembered that railroads existed a very long time before locomotives were introduced. Longitudinal wooden timbers were adopted on roads in mining districts in the fifteenth century and their use in the north of England was a factor in the development of our coal industry. By the beginning of the nineteenth century they were in general use, but all haulage was by horses. Cast-iron plates or edge rails were introduced towards the end of the eighteenth century. All such railroads were, however, private concerns, and the first public railroad was the Surrey Iron Railway, which was completed to Croydon in 1803 and to Merstham in 1805, but was never carried as far as Portsmouth, which was its intended destination. The Wylam line is of course bound up with the introduction of the steam railway about ten years later.

IN a paper read to the Newcomen Society on Mar. 27, Mr. W. A. Benton dealt with the subject of weighing heavy loads, and especially with the invention of the compound lever machines by John Wyatt of Birmingham. Peoples of oriental or classical antiquity possessed no other weighing machines except those of the equal-armed balance and the steelyard, and the maximum capacity of such machines during the Middle Ages does not appear to have exceeded one or two tons. One such high-capacity wooden beam has survived at Neisse, in Prussia. The claims sometimes made that the compound-lever weighing machine was first used by the Italian physician, Santori Santoria (1561–1636) do not appear to be substantiated, though he introduced the practice of weighing his patients. During the eighteenth century huge steelyards were introduced for weighing loaded carts, two specimens of which still exist in England, one at Soham, Cambridgeshire, and the other at Woodbridge, Suffolk. Wyatt's invention was made about 1744, and the machines with compound levers are described in encyclopædias at the end of the century. An examination of the Wyatt manuscripts, however, Mr. Benton said, failed to throw much light on the early history of Wyatt's invention, which forms the basis of all platform weighing machines to-day. A carpenter by trade, Wyatt was born near Lichfield in 1700 and died on Nov. 29, 1766, his tomb being in the churchyard of St. Phillip's, Birmingham. Mr. Benton was able to illustrate his paper with lantern slides and models, some of the latter coming from the historical museum of Messrs. W. and T. Avery, Ltd., Birmingham, whose works occupy the site of Boulton and Watt's famous Soho Foundry.

AMERICAN museums continue to make great advances in their efforts to reach and teach the people. In connexion with the Brooklyn Children's Museum, a new building—larger and finer than many of the local museums of Britain—has just been opened to the public, and the increase of space has suggested many improvements in the storing and lending of material. The library section, in addition to its books which are open to inspection by the children, possesses 8000 lantern slides catalogued on the Dewey system, a file of 5000 pictures so indexed that any teacher or child may borrow a set of them for special school work, and a collection of excerpts from the *National Geographic Magazine*, arranged according to subject and also available for borrowing. It is still more interesting to learn that from the hall in which the Hooper Memorial Loan Collections are displayed children may borrow and take home small cases containing mounted birds, which they take off the shelves just as they might borrow a book. A new type of history room is to be created at the Brooklyn Children's Museum as the result of a gift of 15,000 dollars by Mrs. John Mills. The room will contain a unique collection of twenty-five historical scenes in miniature, illustrating significant events in the progress of the human race. They will begin with the cave men and will show that ideas, rather than wars and weapons, have been responsible for the progress of mankind. Further groups will tell of the discovery of painting, the development of the drama, the science of navigation, the application of steam and electricity, and the conquest of the air. Mr. Dwight Franklin, of New York, who is already well known for this class of work, will prepare the historical groups, and it is expected that the creation of the twenty-five groups will occupy about two years.

IN paper mills and rubber factories trouble often arises from large sparks due to the statical electricity

generated by the running machinery. Various remedies have been suggested for reducing the fire risk due to this effect. In a recent *Daily Science News Bulletin*, issued by Science Service of Washington, D.C., a somewhat novel method used by a large Russian rubber factory is described for avoiding the danger of fire. In the factory, when the rubber solution flows over the fabric base and dries on it, large charges of static electricity are produced by the friction of the rubber-covered fabric with parts of the drying machinery. When the stress at the surface gets greater than the electric strength of air, a hot 'fat' spark is produced similar to the ignition spark of a magneto, and this may start a fire, or cause an explosion as the air in the drying room is always saturated with highly explosive vapours. A usual method in Great Britain is to use a fine wire brush to collect the charges and let them pass to earth, but sparks cannot be altogether prevented in this way. In the Russian State factory in Leningrad a capsule of radium is placed near the point where the electricity is generated. The radiations from the radium ionise the air, and so the electric charges flow through it harmlessly to the earth. The cost of the installation is very low, as one milligram of radium is quite sufficient to prevent sparks from taking place, and it will doubtless last for many years. The method has been known for a long time, but this industrial application is a useful one.

THE first Young Farmers' Club in Great Britain was formed by United Diaries, Ltd., at Hemyock in Devon in 1921, and from the start the movement has been remarkably successful. Whereas in 1924 there were only about 30 clubs and 600 members, now there are 100 clubs with a membership of about 2000. A fresh indication of enterprise is the recent issue of a monthly illustrated journal entitled *The Young Farmer* (National Association of the Young Farmers' Clubs, 26 Bedford Square, London, W.C.1; price 3*s*. a year). Much interesting information is given in the first issue by various authors concerning the aims, growth, and activities of the movement. From the outset it was realised that though it was ideal for the organisation to be independent and self-supporting, yet some outside help would be necessary for a start. In 1924 the Ministry of Agriculture accepted a measure of responsibility, and now the support of the National Council of Social Science has been secured; and a National Association of Young Farmers' Clubs has been formed under its auspices. Such centralisation, together with the help of the new journal, should do much towards creating corporate feeling between the individual clubs. Titles of articles in the first issue, such as "My Experiences at the Dairy Show in 1928," "Coaching an International Cow Judging Team," "Boys and Girls in Rural Ontario," "A Year's Work in a Bee Club," serve to indicate the varied nature of the contents.

THE considerable extension of fur-farming in Great Britain during the last few years suggests that the attention of inquirers should be directed to a leaflet just issued by the United States Department of Agriculture, "Recommendations to Beginners in Fur-farming." In gives in summary form, with references to further literature, general information on how to make a start, areas suitable for farming, species suitable for propagation, where to obtain breeding stock. The instruction is scanty, but it may be readily supplemented by consultation of the special publications of the Department, which are mentioned.

THE Czechoslovak National Research Council, which is incorporated in the International Research Council, concluded its fifth year's activity at a general meeting held in Prague on Mar. 16. The president, Prof. Syllaba, opened the meeting by defining the functions of the International Research Council and the Czechoslovak National Research Council, which latter is an offspring of the Czech Academy of Sciences. In conclusion, Prof. B. Němec delivered an interesting lecture on "International Aspects of Czech Science," in which he pointed out the twofold duties of scientific workers of a small nation, namely, to cultivate their national science and to present their achievements before the international world. The annual report, which has recently been published, describes the activities of the ten sections of natural sciences, medicine, and engineering, and gives the names of the 82 members.

BY an Act of Congress the United States of America have established a Gorgas Memorial Institute of Tropical and Preventive Medicine in Panama, and the memorial laboratory has just been opened. Surgeon-General William C. Gorgas, who died in 1920, went to the isthmus of Panama to report on the sanitary conditions of the Canal Zone in 1904; he was appointed chief health officer for the region, which was then notorious for malaria and yellow fever. His work there, a monument to scientific and administrative hygiene, made the Canal Zone an inhabitable and even healthy area. The first director of the new laboratory is Dr. Herbert C. Clark, who was with General Gorgas in the Canal Zone for several years. Congress has authorised a permanent appropriation of 50,000 dollars a year for maintenance, and Latin-American governments have been invited to contribute up to 75 per cent of the amount given by the United States.

THE Bureau for Contraceptive Advice, Baltimore, Maryland, has issued its first statistical report, compiled by Prof. Raymond Pearl. The number of women (all married), attending was 168, their average age was just under 31 years, and the average duration of marriage 12·3 years. One-half of the women who attended the Bureau had been pregnant more than six times and had borne five or more children before they came. Such reproductive rates are not conducive to either private or public health, and the figures given demonstrate the value of such a clinic as a health measure and lend no support to some of the objections that have been advanced against contraceptive measures.

A LEADING article in the latest number of the *Scottish Naturalist* entitled "More Opportunities for

Naturalists: Natural History as a Profession," points out the need for the creation of trained biologists to fill the increasing number of posts available in Great Britain and its colonies. "There never has been a time when so many opportunities offered themselves for young men who desire to follow natural history as a career, nor a time when so few men could be found to fill the posts that await them." It is shown that the posts in question cover a wide variety of work, giving scope for outdoor observation and opportunities for biological research, and an indication is given of the scales of salary which may be expected here and abroad.

THE "Report on the Health of the Army" for the year 1927 has recently been issued (London: H.M.S.O.). The incidence of sickness among soldiers during the year was somewhat higher than that of the preceding year, being 467·7 per 1000 of the strength, accounted for by the high incidence of infection during the early months of the defensive occupation of Shanghai. The principal causes of admission to hospital were malaria, 9265 cases; venereal diseases, 9186 cases; and inflammation of tonsils, 6322 cases. The high incidence of tonsillitis still remains unexplained. As in the previous year, inflammation of the middle ear heads the list as cause of invaliding. Diphtheria was comparatively prevalent with 317 admissions, while the enteric groups of fevers numbered only 239 cases for the whole army, including India, a remarkable record.

PROF. PIETER ZEEMAN, of the University of Amsterdam, has been elected an honorary fellow of the Physical Society of London.

THE George Darwin Lecture of the Royal Astronomical Society will be delivered at the meeting of the Society on May 10, by Prof. E. Hertzsprung, who will take as his subject "The Pleiades."

PROF. F. O. BOWER, emeritus professor of botany in the University of Glasgow, will give the Huxley Memorial Lecture at the Imperial College of Science and Technology, London, S.W.7, on May 3 at 5.30 P.M. His subject will be "The Origin of a Land Flora reviewed Twenty-one Years after Publication."

THE fourteenth Guthrie Lecture will be given before the Physical Society by Prof. P. W. Bridgman, Hollis professor of mathematics and natural philosophy in Harvard University, on the properties of the elements under high pressures, at 5 o'clock on April 19, in the Imperial College of Science, Imperial Institute Road, South Kensington. Admission is free without ticket.

IT was announced by the president of the Linnean Society of London, at the meeting held on April 4, that the Linnean Medal, which "is awarded each year to an eminent biologist as an expression of the Society's estimate of his services to science," is to be given to Prof. Hugo de Vries, the veteran emeritus professor of botany in the University of Amsterdam, who is best known for his mutation theory of the origin of species.

THE gold medal of the Institution of Mining and Metallurgy has been awarded conjointly to the Hon. William Lawrence Baillieu and William Sydney Robinson "in recognition of their services in the development of the mineral resources of the Empire, with special reference to the zinc and lead industries of Australia." The medal (in duplicate) will be presented at the annual general meeting of the Institution to be held at Burlington House on Thursday, May 16.

THE following office-bearers were elected at the meeting of the Royal Philosophical Society of Glasgow on Mar. 27:—*Vice-President:* Mr. Robert A. Burr; *Members of Council:* Prof. E. P. Cathcart, Dr. James W. French, Mr. Thomas Henderson, Mr. Andrew A. Mitchell; *Hon. Treasurer:* Sir John Mann; *Hon. Librarian:* Dr. James Knight; *Hon. Secretary:* Dr. Charles R. Gibson; *Hon. Auditors:* Mr. Alex. Murdoch, Mr. John T. Tulloch; *Acting Secretary:* Dr. James M. Macaulay.

A SPECIAL feature of the first annual conference of the International Society of Experimental Phonetics, to be held at Hamburg on July 24–31, will be the provision for practical demonstrations and exercises in the study of speech by the graphic method. Each participant will have an opportunity of becoming familiar with this method of investigating language, dialects, speech defects, the speech of the deaf, and nervous diseases. This method is that of the Abbé Rousselot with the later improvements. Information concerning the conference can be obtained from Prof. E. W. Scripture, Strudelhofgasse 4, Vienna.

AT the annual general meeting of the Ray Society held on Mar. 21, the following officers were re-elected: *President:* Prof. W. C. M'Intosh; *Treasurer:* Sir Sidney F. Harmer; *Secretary:* Dr. W. T. Calman. Dr. R. W. T. Gunther was elected a vice-president, and Mr. R. Adkin and Mr. R. Gurney were elected new members of council. In the report of the council it was announced that the third and final volume of the "British Hydracarina," by Mr. C. D. Soar and Mr. W. Williamson, would shortly be published, and that the issue to subscribers for 1929 would be a volume on "The Planktonic Diatoms of Northern Seas," by Dr. Marie V. Lebour. A work on "The Aquatic Stages of British Dragonflies," by Mr. W. J. Lucas, was announced as being in preparation for publication at a later date.

AMONG recent appointments in scientific and technical departments made by the Secretary of State for the Colonies are the following: Mr. G. N. Herington has been appointed agricultural instructor in the Education Department, Nigeria. Mr. A. W. Anderson, recently one of the Ministry of Agriculture and Fisheries' advisory officers, is to be a superintendent of agriculture, Nigeria, and to take charge of the new stock-breeding farm at Samaru. Mr. D. A. Langdon has been appointed a produce inspector, Nigeria, and Mr. T. D. Lloyd-Jones a veterinary officer in the same Colony. Mr. N. R. Reid has been appointed a veterinary officer in Tanganyika Territory. Among the recent transfers and promotions are the following: Mr. J. R. Ainslie, senior conservator, to be deputy director of forests, Nigeria, and Mr. C. F. Vetch, conservator of forests, Nigeria, has been appointed to succeed him as senior conservator. Mr.

D. D'Emmerez de Charmoy, assistant director, has been appointed director of agriculture, Mauritius.

Messrs. Bernard Quaritch, Ltd., 11 Grafton Street, W.1, have just issued an important catalogue (No. 424) of some 1800 works relating to science, mainly of zoological and geological interest. As is usual with lists circulated by this house, many rare items and long runs of serials are included. The catalogue is one that should interest collectors and librarians.

The new catalogue of engineering and industrial instruments issued by Messrs. Negretti and Zambra is a well-illustrated quarto volume of 460 pages. It deals to a large extent with thermometers of all kinds, from spirit thermometers to electrical thermometers, suitable for near or distant stations, and gives a considerable amount of very useful information about the principles on which they work and the precautions necessary in setting them up and caring for them in use. Barometers, pressure gauges, tank gauges, hydrometers, and hygrometers receive similar treatment and a thumb index facilitates quick reference.

Applications are invited for the following appointments, on or before the dates mentioned:—Temporary assistant quantity surveyors under the Mines Department—The Under-Secretary for Mines, Establishment Branch, Mines Department, Dean Stanley Street, S.W.1 (April 18). An assistant bacteriologist for the city of Liverpool—The Town Clerk, Municipal Offices, Liverpool (April 22). A temporary assistant bacteriologist for research in fabric materials—The Secretary, Admiralty (C.E. Branch), Whitehall, S.W.1 (April 27). An education secretary for the borough of Cambridge—The Town Clerk and Clerk to the Local Education Authority, The Guildhall, Cambridge (April 27). A chief assistant and two other assistants for the Scottish Society for Research in Plant-Breeding under the Society's scheme of research into virus disease of potatoes—The Secretary, Scottish Society for Research in Plant-Breeding, 3 George IV. Bridge, Edinburgh (April 30). A lecturer in education in the University of Sheffield—The Registrar, The University, Sheffield (April 30). A lecturer in mathematics at the Heriot-Watt College, Edinburgh—The Principal, Heriot-Watt College, Edinburgh (May 1). An assistant at the Commonwealth of Australia Solar Observatory, near Canberra—The High Commissioner for Australia, Australia House, Strand, W.C.2 (May 2). A junior technical officer at the Royal Aircraft Establishment, to assist in the experimental development of electrical equipment for use in aircraft—The Chief Superintendent, R.A. Establishment, South Farnborough, Hants (May 3). A principal of the Paisley Technical College—The Secretaries of the College, 3 County Place, Paisley (May 3). A demonstrator in physics, a demonstrator in zoology, and a demonstrator in inorganic and physical chemistry at Bedford College for Women—The Secretary, Bedford College for Women, Regent's Park, N.W.1 (May 4). A director of museums of the City of Liverpool—The Town Clerk, Municipal Offices, Liverpool (May 7). A professor of zoology in the Egyptian University, Cairo—The Dean of the Faculty of Science, Egyptian University, Cairo (May 19). A laboratory assistant at the College, Cheltenham—The Senior Science Master, The College, Cheltenham.

Our Astronomical Column.

The April Meteors.—These meteors are due on April 20 or 21, but the moon, being full on April 23, will be a bright object at the time and obscure small meteors. However, the shower occasionally exhibits brilliant objects, so that it may be well worth looking for though the character of its display this year cannot be definitely foretold. The period of revolution of its supposed parent comet was computed to be more than 400 years, but rich showers of Lyrids were witnessed in 1803, 1851, 1863, and other years, so that a short period apparently corresponds with some of the most abundant returns of the meteors. It is important to note the strength of the annual displays, so that the time of revolution of its more active returns may be determined. Its radiant is at 271° + 33° on the night of maximum, but the centre of radiation travels eastwards one degree per day.

The Nuclei of Planetary Nebulæ.—Mr. van Maanen deduced the trigonometrical parallaxes of a number of nuclei of planetary nebulæ from photographs taken at Mt. Wilson. He derived the mean parallax 0·012″, and the mean absolute magnitude 8·1 for the nucleus. Mr. B. P. Gerasimovic notes in *Harvard Bulletin* No. 864 that such data as exist for the proper motions and radial velocities of the planetary nebulæ indicate a considerably greater mean distance than that found by van Maanen. He makes several different estimates of their mean distance; (1) by their mean galactic latitude, which is assumed to be due to the sun's departure from the galactic plane, (2) by applying Oort's results on galactic rotation, (3) by using the analogy between the nebular nuclei and novæ, (4) by combining the proper motions found by van Maanen with the mean radial velocity of planetary nebulæ found at the Lick Observatory, which is 37 km./sec. The mean absolute magnitudes found by these methods are 4·3, 4·6, 4·0, 5·9 respectively: the weighted mean is 4·9, which is more than 3 magnitudes brighter than van Maanen's value; there is therefore good reason for thinking that his parallaxes for these objects are four times too large, though no explanation of this error has been found.

The Orbit of Eta Coronæ.—*Astr. Nach.* 5615 contains an exhaustive study of the orbit of this star by E. Silbernagel, who has devoted himself for some years to the re-determination of the orbits of binaries. The duplicity was discovered in 1781 by Sir W. Herschel, and as the period is less than 42 years, $3\frac{1}{2}$ revolutions have been completed since then. About 500 observations are employed, and the personal equations of the observers are determined. The following is the final orbit:

T	1892·385	n	8·6490°
Ω	23·717°	a	0·907″
i	59·025		
ω	219·907	Period	41·623 y.
e	0·2763		

Research Items.

FESTIVALS OF THE HOS OF KOLHAN.—Mr. D. N. Majumdar describes in the *Journal and Proceedings of the Asiatic Society of Bengal*, N.S., vol. 23, No. 3, the seven important worship festivals of the Hos which take place at different seasons of the year. It is noteworthy that in certain feudatory states in Orissa, where the Hos live in close association with the Oriya-speaking peoples, while the latter take part in the festivals of the Hos, they are not allowed to take part in their dances, when men and women mingle freely, as intermarriage is not allowed. The festivals are not held at fixed dates, but depend upon economic conditions. When the granaries are full and the Hos are free from other engagements, the priest fixes a day for a festival, each village deciding for itself, so that any given celebration may extend over as much as two months, when the whole area of Kolhan is taken into account. The principal festival is the Maghe, which is held in January and February. Its meaning is obscure, but it seems to be connected with fertility. All villagers, even if working in remote districts, must return to take part. It entails five days of ritual observances, with *pujas* and sacrifices to the village deity. On the first day the sacrifice is connected with the cattle, on the second rice-beer is offered by the priest and his wife. The third day is purificatory, in preparation for the marriage festival of the fourth day, which is the main function of the celebration. On this day the priest is escorted to take a ceremonial bath. He then sacrifices a cock and hen. A second hen, which is offered to the god, is not sacrificed by the priest, but is stoned to death by the villagers. In the dance which follows obscene songs are sung and obscene practices observed for the purpose of increasing the procreative power of the tribe. On the fifth day the expulsion of spirits takes place, when the villagers arm themselves with sticks, four or five feet long, and hunt the spirits throughout the village with invocations which are unintelligible even to themselves.

EARLY PERSIAN ZOOLOGY.—The earliest exposition of Persian zoology is contained in a compendium of science, the "Nuzhatu-i-Qulûb," written by Mustaufi about A.D. 1340. One of the few extant zoological treatises of the Islamic East, apparently the only one the primary object of which was scientific rather than literary or philological, its chapters are of much interest as illustrating the level of zoological knowledge at the time, and indicating the sources from which that knowledge sprung. In a learned treatise upon the subject (*Isis*, vol. 11, December 1928), Dr. John Stephenson traces the influences which are apparent in Mustaufi's zoology, gives examples of the treatment of real and fabulous zoology, of the bearing of the work upon medicine, and of the surgical uses of animals and their several parts. In an interesting comparison with European zoological works of the same period, he points out striking resemblances with the zoological text-book of Christianity in medieval times, the "Physiologus," and, since direct borrowing may be ruled out of the question, he regards these similarities as due to the descent of tradition from a common source. The general level of knowledge is much the same as that displayed by the thirteenth-century English Franciscan, Bartholomew de Glanvilla, who borrowed from the "Physiologus," and, like the Persian author, had his mythical creations, mermaids, fauns, and satyrs, as well as more realistic monsters, such as the omocentaur, offspring of the bull and the ass.

EVOLUTION OF HUMAN TOOLS.—An unusual study in human evolution has been made by Mildred Fairchild and Dr. Hornell Hart (*Scientific Monthly*, January 1929), in which they trace in a general way the development of cutting tools from the earliest chipped flints to the machines of the present day. The existence of such tools from the early stages of man's development affords the longest and most complete series of data available for the estimation of man's cultural progress. The tools present five variables upon which efficiency depends: (1) keenness and durability of the cutting edge, (2) differentiation and specialisation, (3) effectiveness of mechanisms employed to apply the blade to the materials to be cut, (4) utilisation of auxiliary power, and (5) mastery displayed in the technique of manufacture. Reducing these elements of efficiency to a numerical basis, and combining all in a graph of progress, the authors produce a curve which, showing little rise over a long period, makes a sudden and rapidly increasing ascent during the past 8000 years. Whereas in earliest times thousands of years indicated the unit of progress, now each decade or each year shows swift advancement. The more and more rapid acquisition of new elements is not due to our lack of knowledge of early portions of the series; the increasing speed of invention is an unmistakable feature of the series itself.

BIRDS OF INNER LONDON.—Much has been written about the birds of London, and the lists published by the committee in charge of the bird sanctuaries in the Royal Parks furnish useful notes on fluctuations of species from year to year. But no attempt has hitherto been made to compile a complete list of the birds which have been seen in Inner London as a whole. The area selected by A. Holte Macpherson for his interesting article on the subject (*British Birds*, March 1929) extends 2½ miles due north and south of Charing Cross and 4 miles due east and west of that point. Within this district the author is able to record a list of 126 species, of which 21 breed regularly, 8 others have been known to breed during the present century, and the remainder are visitors, 20 of which may be regarded as regular and 77 as putting in only an occasional appearance. Perhaps the most striking feature of the list is the variety of ducks and waders recorded. The occurrence of such as whimbrel, common and jack snipe, and woodcock, and of gadwall, scaup, and scoter, suggests that the mud-banks of the Thames at low water may yet reveal further additions to the list, now that so satisfactory a basis has been laid for future observations.

NEW AQUATIC RODENT FROM AFRICA.—Until the expedition organised by the Field Museum and the *Chicago Daily News* returned from its explorations in Abyssinia, only one aquatic rodent was known from Africa, namely, *Dasymys*. Now a second murine rodent, with rather pronounced aquatic modifications, has been found in a small mountain stream near the source of the Blue Nile. Its adaptations more closely resemble those of aquatic rodents in other parts of the world than of *Dasymys*, and since it shows no special affinities to the latter, the two African 'water-rats' probably had independent origins. For this outstanding form Wilfred H. Osgood has created a new genus and species, *Nilopegamys plumbeus* (*Field Mus. Nat. Hist., Publication* 250, November 1928). Its particular adaptations for aquatic life are mainly in the character of the fur, the reduction of the external ears and the enlargement of the hind feet;

and in these respects it is reminiscent of the South American *Ichthyomys*, to which also it bears some resemblance in its skull. But the skull is not greatly modified and the suggestion made is that the new 'water-rat' may have been derived at no very remote period from one of the common types widely distributed in central Africa.

GRAFTING EXPERIMENTS IN TWO-DAY CHICKS.—P. D. F. Murray (*Aust. Jour. Exp. Biol.*, vol. 5, part 4, Dec. 1928) has made chorio-allantoic grafts of lateral pieces of two-day chicks, taken from the region forming the posterior limb by making an anterior transverse cut posterior to the hindmost somite then formed, a posterior cut in front of the anterior end of the primitive streak, a longitudinal median cut lateral to the vertebral plate. The grafts show cartilaginous structures interpreted as attempts at limb-formation, and it is concluded that no essential influence is exerted by the somites on the development of limbs, and the author adduces reasons for the view that if the limb rudiment at two days could be completely isolated self-differentiation would occur, that is, the rudiment of the hind limb is already determined at this stage. The nervous system exerts no essential influence on the development of the limbs of the chick. In three cases the endodermal and splanchnopleural components of the grafts have given rise to short pieces of intestine with epithelium, corium, circular and longitudinal muscle layers, hence small pieces of the region of the alimentary tract are able to develop in the absence of the other regions of the tract.

INTESTINAL MUSCLE OF THE CRANE FLY.—S. Maziarski (*Bull. Int. Acad. Polonaise Sc. Lettres*, 7 B ; 1928) has investigated the histology of the muscle of the alimentary tract of several species of *Tipula* (crane fly). Opinions as to the nature of the muscular elements—whether they are smooth or striated—have been contradictory, but the author states that undoubtedly all the muscular elements of the intestine are in the category of striped muscle. All the contractile elements and their ramifications by which they anastomose exhibit a characteristic longitudinal and transverse striation, the longitudinal due to the myofibrillæ in the sarcoplasm. The elongate muscular elements, each with a single nucleus and a sarcolemma sheath, exhibit numerous ramifications either terminal or lateral, some short and others apparently composed of a single myofibril, which anastomose directly with neighbouring fibres to form a network. The anastomosis always takes place at the level of the membrane of Krause, which confirms the view already expressed by many other histologists that this is distinct from the contractile substance and represents a more plastic and more resistant supporting material. The intimate relations between the fibres (cells) suggest that the contractile elements have lost their individuality and form a muscular syncytium.

COTTON.—The reports received from experiment stations during 1927–28 have been issued by the Empire Cotton Growing Corporation in a bulky volume of some 270 pages, plus photographs, diagrams, etc. This lengthy document is preceded by a very valuable, concise summary of its contents by Dr. J. C. Willis. Dr. Willis points out the inevitable difficulty of the field experimenter in that his rainfall practically always departs from the average (and the same may be said of every measurable climatic factor), and thus in the twenty climatic records from ten cotton experiment stations in the last two seasons, five may be classed as good years, ten medium, and five bad. Some experiment stations are probably situated in climates which are not well suited for existing varieties of cotton, and here, as at Fiji, where the weather is probably unusually wet for cotton, something may be done by hybridisation and selection to produce a new variety more suitable to the climate. In South Africa, the immediate problem has been the production of a variety showing resistance to the jassid pest, and remarkable progress appears to have been made with the selection and multiplication of suitably resistant strains. These strains, developed at the Barberton Station, seem likely also to be successful in Rhodesia. In Queensland good progress seems to have been made in dealing with the pink boll-worm, whilst in Fiji it is very interesting to learn that the boll-worm pest is apparently kept in check by its parasitic enemies. Boll-shedding before the crop is mature is often a great source of trouble with cotton, and in Uganda definite progress seems to have been made with the breeding of varieties with lower rates of boll shedding. All who are interested in any phase of the field study of the cotton plant, its growth, the control of its parasitic enemies, the breeding of new strains, etc., will find the Report of interest and value. It is published by the Empire Cotton Growing Corporation, Millbank House, Millbank, London, S.W.1.

GLADIOLUS.—The wide range of species of *Gladiolus* in South Africa is illustrated to some extent in the beautiful coloured plates accompanying the article by Mrs. Bolus on this genus in the *Journal of the Botanical Society of South Africa*, part 14, 1928. In the notes on p. 3 of the same journal, attention is directed to the horticultural possibilities that are suggested by experiments in hybridisation with some of this species. Thus at present there are no scented and no blue forms among the *Gladiolus* hybrids under cultivation, whilst amongst the South African species blue-flowered ones occur and some of the wild species have a powerful and delicious fragrance. Such hybridisation experiments would seem very suitable work to be carried out at the National Botanic Gardens, Kirstenbosch, but unfortunately the income of the Gardens does not permit the possession of any scientific or technical staff whatever, so that such experiments in the Gardens could only be carried out to the detriment of other work. In the same number of the journal, Mr. J. W. Mathews, curator of the Gardens, contributes some notes on the cultivation of the native South African gladioli.

NEW PROJECTION FOR WORLD MAPS.—In the *Geographical Journal* for March, Mr. S. W. Baggs describes a new equal-area projection that should be useful in statistical maps. It is an equal-area projection which is an arithmetical mean between the sinusoidal equal-area projection of Sanson and the elliptical equal-area projection of Mollweide. Inequality in linear scales near the equator is scarcely noticeable, and the same is true between latitudes of, say, 60° and 75°. This feature is an improvement on Mollweide. Angular distortion is less than in Sanson in latitudes below 62° ; above 68° or thereabout the angular distortion is less than in Mollweide. The author describes it as a 'eumorphic equal area projection.' He points out that this projection, like those of Sanson and Mollweide, having straight parallels and converging meridians, lends itself to 'interrupted' construction in gores or lobes which much enhances its value for distributional maps.

EARTH MOVEMENTS IN CALIFORNIA.—The United States Coast and Geodetic Survey is continuing its researches into earth movements in the western United States by comparing the position of stations as determined by old and new triangulation. In *Special Publication* No. 151, Dr. W. Bowie discusses the results

of recent work in California. The comparison is generally between determinations made prior to 1900 and those made between 1922 and 1925. Many stations show no movement. The greatest movements have occurred close to the fault line of the earthquake of 1906. Stations more than twenty miles from the fault were affected but only slightly. The differences are small and seldom exceed one metre. The trend of the changes is to the south-eastward, on the east of the fault where they are most noticeable. Dr. Bowie suggests that investigations of this nature should in the future be done by means of short arcs of triangulation extending across the fault line or zone to a distance of about twenty-five miles on both sides. The accuracy can be made great enough to detect movements of about one-tenth of a foot in a mile. He prefers this method to that of measurements between monuments placed across the fault zone in a straight line. This plan involves the difficulty of measuring with tapes over broken ground.

INDIAN JURASSIC AMMONITES.—The third part of Dr. L. F. Spath's "Revision of the Jurassic Cephalopod Fauna of Kachh (Cutch)" (*Palæont. Indica*, N.S., vol. 9, mem. 2, pp. 163-278, plates 20-47, 1928) deals with the super-family Stephanoceratidæ, represented by about 500 specimens. This is divided into five families: the Macrocephalitidæ with 7 genera; the Eucycloceratidæ with 4 genera; the Pachyceratidæ with 2 genera; the Mayaitidæ with 5 genera; and the Reineckeidæ with 6 genera.

JAPANESE PALÆONTOLOGY.—The rich fauna of the Lower Tertiary of the island of Kyûshû, Japan, has been described by T. Nagao (*Sci. Rep. Tôhoku Imp. Univ. Sendai*, ser. 2, Geol. 12, 1, 1928, pp. 11-140, plates i-xvii). It consists mainly of lamellibranchs and gasteropods, but some foraminifera, echinoids, nautiloids, crabs, and fishes are also found. Three horizons are recognised. The lowest is regarded as Ypresian or Lutetian in age; the middle as Upper Eocene; the upper as Oligocene. In the same publication (pp. 141-152, plates xviii-xxiii) H. Yabe and S. Toyama give an account of the rock-forming algæ from the Jurassic and Cretaceous deposits of Japan. Some of the species are referred to genera found in England (*Girvanella*, *Solenopora*); others belong to new genera.

VACUUM TECHNIQUE.—Several attempts have been made to find a substitute for mercury for use in high-vacuum pumps, but they have not hitherto met with any conspicuous success; metals other than mercury have undesirable properties, and it had been thought that organic substances were too liable to decomposition to be of use. C. R. Burch, of the Metropolitan-Vickers Company, states, however, in the issue of the *Proceedings of the Royal Society* for Mar. 6, that it is possible to run a condensation pump satisfactorily with some of the fractions obtained in the vacuum distillation of petroleum jelly, when both the speed of pumping and the degree of vacuum reached compare favourably with those obtained when mercury is employed. The petroleum products have the additional advantage that their vapour pressures are decidedly less than that of mercury at room temperatures. The author has also isolated a number of greases, the vapour pressure of which is less than a microbar at 300° C., which should be extremely valuable for the lubrication of ground joints in vacuum apparatus which does not require to be heated.

STARK EFFECT.—Prof. Stark's discovery of an electrical analogue of the Zeeman magnetic effect for spectral lines, although less widely applied in spectrum analysis, has recently become of importance in connexion with the wave-mechanics. The distribution of intensities in the Stark patterns for the Balmer series of atomic hydrogen has been predicted by Schrödinger, and experiments to test his theory have now been made by J. S. Foster and L. Chalk (*Proceedings of the Royal Society*, Mar. 6), and by H. Mark and R. Wierl (*Zeitschrift für Physik*, Feb. 25). Dr. Foster has made use of the natural electric fields in the cathode dark space of a discharge tube, and finds distributions of intensities which agree with those predicted by theory. The other investigation was made upon the light emitted from a beam of positive rays passing through an auxiliary electric field, and the agreement between theory and experiment is less good. The origin of these discrepancies is not clear, but it may be, as H. Mark and R. Wierl suggest, that the experimental conditions employed do not conform completely with those contemplated in the theoretical analysis. Dr. Foster has contributed a second paper, on the Stark effect in neon, to the same issue of the *Proceedings*, which also contains a paper by J. K. L. MacDonald on the Stark effect for some lines in the violet part of the secondary spectrum of hydrogen.

COMBUSTION OF CARBON MONOXIDE.—Prof. W. A. Bone's experiments on the combustion of dry mixtures of carbon monoxide and oxygen have been subjected to a certain amount of criticism on the grounds that inadequate precautions had been taken to remove occluded hydrogen from the platinum electrodes between which the igniting spark was passed. These objections appear to have been met satisfactorily in the reply which he has published in the issue of the *Proceedings of the Royal Society* for Mar. 6, and some new experiments which are described there, in which the drying was, if possible, even more drastic than before, confirm his earlier result that the intensively dried mixture can be induced to react if only sufficient energy is supplied to initiate the explosion wave. Prof. Bone and his collaborators consider that the limit of intensive drying by phosphorus pentoxide is reached in about six months in small glass vessels such as those they have employed. The energy required to start the explosion seems to depend both upon the nature of the electrodes used and upon the composition of the detonating mixture, but the numbers which are mentioned in this paper are all in the neighbourhood of one joule.

ACTION OF ACETYLENE ON SELENIUM.—Only very few accounts of experiments on the direct action of non-metallic elements on organic compounds have as yet appeared in chemical literature. The formation of thiophthen, $C_6H_4S_2$, by the interaction of acetylene and molten sulphur was observed by Capelle and confirmed by Oechsner de Coninck (1908), whereas, according to Meyer and Jacobson's "Lehrbuch," Sandmeyer established the formation of thiophen under such conditions. In the *Rendiconti* of the Naples Academy of Physical and Mathematical Sciences for September–December 1927 (just received), Mazza and Solazzo give the results of an investigation on the action of acetylene on selenium. Passage of the pure, dry gas over selenium heated to 250°-300° C. yields an oily product, which may be resolved by fractional distillation into two compounds: (1) Selenophen, C_4H_4Se, b.pt. 113°-114°, which is identical with the product obtained by Foà in 1909 by the action of phosphorus selenide on sodium succinate; (2) a new compound, selenonaphthen, C_8H_6Se, m.pt. 53°-54°, b.pt. 207°-209°, which is the selenium analogue of thionaphthen and has an intensely nauseous odour. This compound crystallises well and forms a golden-yellow, crystalline, slightly soluble picrate.

Research on Water Pollution.

A COMMITTEE has been set up, under the chairmanship of Sir Horace Monro, to deal with the legislative and administrative aspects of questions relating to river pollution. This committee considers that present legislative enactments are sufficient, and recommends the setting up of River Boards in the various watersheds of England. Such Boards, having a call upon the rates, would be in a financial position to apply the laws against pollution, a costly activity which rarely appeals to private individuals. They would be in a position to employ a technical adviser conversant with local conditions and with known means of dealing with noxious effluents. It remains to be seen whether county councils will act on this advice and set up a series of Boards throughout Great Britain, similar to that in the West Riding of Yorkshire.

Although much has been done recently in surveying rivers and locating sources of pollution, many of which could be stopped or at least ameliorated without putting undue burdens upon the rates or upon individual industries, there are also numerous questions which, in the interests of the public, have still to be worked out.

With this aim in view, the Water Pollution Research Board was formed in June 1927, with Sir Robert Robertson as chairman and Dr. H. Calvert, chemical Inspector of the Ministry of Health, as part-time director of research. They have undertaken the three-fold task: "To collect and collate all pertinent scientific and technical information, so that it may be readily available for practical application by those who are concerned with water supply and the disposal of polluting liquids; to encourage and co-ordinate relevant scientific research in this country; and to undertake such investigations as are necessary in the public interest and not otherwise provided for."

A good start has been made. The monthly summaries of current literature, of which some seventy copies are distributed, are excellent and will be of material assistance not only to those concerned with water purification and wastes disposal but also to many workers in hydrobiology. In the report of the Board for the year 1927–1928 (H.M. Stationery Office, 6*d*.) an account is given of investigations now proceeding and of plans for the near future.

The disposal of effluent waters from beet sugar factories presents a problem which had early in the year been 'farmed out' by the Ministry of Agriculture and Fisheries for investigation at Rothamsted. Each factory uses some 3½ million gallons of water daily, of which nearly half a million gallons are discharged containing putrifiable matter comparable to 0·2 per cent sucrose. It is found that by sprinkling this water over a biological filter at a rate of 100 gallons per square yard daily, its putresibility is reduced by some 80 per cent. Trial filters were erected at the Colwick factory and filled with different media. Two were seeded with active growth from a sewage filter, but this inoculation had no observable effect on the maturing of the filters. The growth on coarse gravel consisted of thickly matted fungi, while on the finer media the growth was soft and composed chiefly of bacteria; the flora and fauna on the filters differed and were distinct from the flora and fauna of ordinary sewage filters. The purification attained cannot be regarded as sufficient to meet the most exacting requirements, but still better results are expected from the past winter's campaign.

It is anticipated that the effluents may be made fit for re-use in the factory, a practice which is already in operation in some cases, so that the daily discharge into the rivers will be reduced to a reasonable amount for treatment on biological filters.

A biologist has been appointed to work under the direction of Prof. Topley at the London School of Hygiene and Tropical Medicine, on the processes involved in the treatment of sewage by 'activated sludge.' The solids of sewage after aeration become capable of flocculating colloidal matter and removing dissolved organic substances from further volumes of sewage. In doing so the aerated solids, or 'activated sludge,' lose their activity, which can, however, be restored by further aeration. There is, however, little exact knowledge of the process and it is yet uncertain whether it is physico-chemical or the direct effect of micro-organisms. The de-watering and the production of gas from sludge or sewage also engage the attention of the board.

It is considered that a general biological and chemical survey of a typically polluted river would furnish information of general value as well as local information. Such a survey should yield much new knowledge of river conditions generally, of the interaction between the river and the various effluents —their direct or indirect effect upon the flora and fauna. The Tees is suggested as a suitable watershed, the river having been under examination for several years and useful data already collected. Undoubted damage has been done by pollution, but the nature of the damage and the various causes still offer a wide field for investigation.

In all these matters the main part is played by micro-organisms—the unpaid scavengers of every borough. How they are best harnessed to destroy unwanted organic matter most efficiently, and even to break down naphthalene in coke-oven effluents, provide outstanding problems.

Compared with some continental countries, England is behindhand in providing facilities for the general study of freshwater biology and hydrology. These subjects are no longer of academic interest only, for they enter into many economic problems within the Empire. Mosquito control and tropical lake fishery investigations, for example, are in present need of information and recruits, which should normally come from an English freshwater biological laboratory, similar to the marine laboratory at Plymouth, where more than twenty visitors are at times working on varied researches during the university vacations. That the Rivers Pollution Research Board will act as a valuable clearing-house for information is assured. We hope it may encourage the institution of a laboratory for post-graduate workers near pools, lakes, and a river—a facility for which there is a present demand. The study of aquatic life and of the breakdown of organic matter by micro-organisms is not merely of domestic interest.

The Board has also arranged for the investigation of the softening of water by the process in which it is allowed to trickle through beds of natural or artificial zeolite containing sodium in chemical combinations. The sodium is displaced by the calcium and magnesium of the hard water, and the beds are finally rejuvenated by displacing the calcium and magnesium held by them with a solution of common salt. The mode of action of the base-exchanges is very imperfectly understood from the physico-chemical point of view. The process is in extensive use, but is little used by water-supply authorities as yet.

High-Voltage Alternators for the Grid.

THE developments of engineering seem to be unending. The manufacturer craves after mass production and standardisation, but his wishes are seldom gratified. The progress of development sooner or later necessitates change. One of these changes was pointed out by Sir Charles Parsons and Mr. J. Rosen in a paper read to the Institution of Electrical Engineers on Mar. 21. They give in their paper reasons for thinking that very high voltage generators can be made which can be directly connected with the grid network without the necessity of using transformers. The possibility of making very high voltage alternators has been known for many years. So far back as 1905 the engineers of the Ganz company constructed several 30,000-volt alternators for use in the hydroelectric power station at Subiaco, 34 miles from Rome. Credit must be given to the engineers for this early pioneering work, and the successful running of these machines show that they had overcome the difficulties of insulating these high voltages.

Engineering history often illustrates the change of procedure brought about by new developments. In the early days of marine propulsion, for example, the use of step-up gearing between the prime mover and the propeller was a necessity. When triple-expansion reciprocating engines came into use it was found possible to operate without gearing. For modern steam turbines and some types of Diesel engine, speed reduction gears are now necessary. Just as mechanical gear forms the link between the engine and the propeller, so in electrical power distribution at high pressure the transformer has for many years been a necessary link between the generator and the network, and also between the network and the lighting and motor load.

Sir Charles Parsons and Mr. Rosen propose to abolish the step-up transformers by using very high voltage generators which can be connected directly with the mains.

They point out that the continually increasing size of the generator units now make the conditions favourable to the introduction of these generators. They consider the design of a 94,000-kilovolt ampere, 11,000-volt, three-phase generator. In this case the current at each terminal is about 4900 amperes. Much space is required to accommodate the many cables mounted below the alternator terminals in a cable tunnel through the concrete. With so many cables grouped together, difficulties are experienced with the girders which reinforce the concrete. The maximum output from the cables also is rarely obtained. The authors show that not only are most of these difficulties overcome but considerable economies are also effected by using an alternator of a higher voltage. If the pressure is increased to 33 kilovolts, the output current is reduced to 1640 amperes, and instead of six cables per phase only two are required.

One great advantage of raising the pressure is the reduction in the cost of the leads and switchgear which it effects. In very large units the enormous currents developed are very difficult to control and operation becomes almost impossible. The General Electric Co. of Schenectady when designing a 208,000-kilowatt unit for the State line station near Hammond, Ind., found it necessary to reduce the current. This was done by raising the pressure from 18 to 22 kilovolts.

Details are given by Sir Charles Parsons and Mr. Rosen of the design of a 33,000-volt, 25,000-kilowatt alternator which has been working at the Brimsdown power station in north London since August 1928. A very novel feature in the design is the use of triple-concentric mains for the armature conductors. By this means they are able to reduce the maximum electric stresses to which the dielectric would otherwise be subjected. This formation of conductor also is mechanically very strong. The three conductors are called the 'bull,' 'inner,' and 'outer' respectively. The bull conductors of each phase are connected in series; they are then connected with the 'inners' in series and finally with the outers. The whole arrangement is connected in star and the star point is connected with the earth.

The test results obtained with this machine were very satisfactory. The shape of the voltage wave was practically the same as that of a sine curve. The machine when running at its normal speed of 3000 revolutions per minute was suddenly short-circuited. The short-circuit current was less than five times the normal full load current. It seemed to function satisfactorily under these conditions, the end conductors showing no sign of having moved mechanically. The efficiency on a load of 25 kilowatts was 96·5 per cent. Even when the load was so low as 10 kilowatts the efficiency was 93·5 per cent. For the last six months it has operated continuously up to its maximum load at voltages varying from 34 to 35 kilovolts, and it has withstood without showing any sign of distress the sudden loads thrown on it when severe faults have developed on the large overhead and underground network to which it is coupled.

The first step in the process of getting rid of the step-up transformers connecting the generators to the grid network has been made. The standard pressures of transmission in Great Britain are 33, 66, and 132 kilovolts. Manufacturers can now make 33-kilovolt generators, and doubtless 66-kilovolt generators will soon be made. In the meantime, however, these pressure generators can be advantageously used on 33-kilovolt circuits. Although the authors in this paper confine themselves to high-voltage generators, it is obvious that the ever-increasing size of motors, motor generators, and synchronous condensers will enable them soon to be economically designed so as to be coupled directly to the network without the use of intermediate transformers. Sir Charles Parsons and his associates are to be congratulated on having initiated a new and very promising development in electrical engineering.

The New Acoustics.[1]

RAYLEIGH'S "Theory of Sound," published more than fifty years ago, may be taken as representing the whole range of the physical acoustics of that period, and the much-enlarged second edition, published eighteen years later, gave, in conjunction with Helmholtz's "Sensations of Tone," a fairly complete view of the acoustics of a generation ago. Subsequent treatises have followed the classical methods thus established, and show little trace of the revolution which has occurred during the past decade in consequence of the influence of electrical theory and practice. These changes have been stimulated by needs arising partly out of the War, but still more out of broadcasting.

On the experimental side, much new apparatus of an electrical character has become available. The

[1] Summary of presidential address delivered to the Physical Society on Mar. 22, 1929, by Dr. W. H. Eccles, F.R.S.

condenser microphone enables sound to be converted into its equivalent electrical current with the minimum of distortion and, in conjunction with the triode amplifier, enables vibrations to be detected and measured which, though of audio-frequency, are inaudibly weak. The triode can also be used for the production of sounds the amplitude and frequency of which are widely variable and can be maintained very constant. The electric filter circuit has provided a powerful method of purifying and sifting oscillations of mixed frequencies. The conversion of sound into electrical oscillations enables the whole range of electrical methods of measurement to be used.

On the theoretical side, the technique which has been developed for the study of impedance networks has been applied to the solution of acoustical problems. For example, the squeaking of a slate pencil is analogous to electric relaxation phenomena, such as the flashing of a shunted neon lamp.

Architectural acoustics has benefited by the availability of loud, filtered monotone sounds and distortionless sound-detectors. The decay of sound due to absorption in the walls of an auditorium, first studied by Sabine, has been accurately measured by electrical methods, with great advantages for the regulation of reverberation in buildings, both by architectural design and by the development of sound-proof materials.

In the realm of physiological acoustics, such interesting facts have emerged as that a change in intensity of a monotone must reach ten per cent to be noticeable. Accurate results have also been obtained for the range of pressure and amplitude within which a sound must lie to be audible, and for the masking of one sound by another of different pitch.

One practical outcome of these researches has been the development of public address apparatus, by means of which an orator can address an audience of a million persons. Many problems of distortion have had to be solved in the working out of this apparently simple system, which comprises a microphone, amplifiers, and loud-speakers. The intensities of the sounds to be dealt with vary in the ratio of 1 to 1500 in the case of speech and 1 to 100,000 in the case of music; and it is found that if all the harmonics of a given sound be amplified equally, the resultant sound appears to be distorted, owing, presumably, to the non-linear response of the ear.

Conceptions and nomenclature developed in connexion with electrical impedance networks have been carried over into acoustics. The 'motional impedance' of a telephone diaphragm was implicitly recognised in earlier works, but in the hands of Kennelly and Pierce, who introduced the nomenclature, Hahnemann, Hecht, Webster, and others, the representation in electrical terms of the inertia, resilience and energy dissipation in mechanical parts has yielded valuable results. Thus, it has been found that the impedance of a horn approaches pure resistivity (yielding maximum efficiency) at frequencies above a lower cut-off frequency which is very much lower for an exponential than for a conical horn. The conception of motional impedance can be applied to clarify substantially the design of complicated electro-acoustic combinations such as that which is constituted by a loud-speaker: a detailed example was given by the lecturer.

In measuring the subjective loudness of sounds, telephone engineers have introduced the conception of the 800-cycle standard mile: this corresponds to the difference in aural sensations derived from telephones at the beginning and end of a mile of standard cable at 800 ~, and roughly to a 25 per cent difference in power. It has consequently been proposed that the increase ratio $10^{0.1}$ or 1·259 of power should be standardised for all frequencies, this ratio being known as a 'transmission unit.' Thus, if the power of an auditory stimulus were increased 1000 times, the sensation would increase by 30 transmission units. Since pitch also increases according to the logarithm of frequency, the most human way of representing acoustical relations graphically is to plot transmission units against the logarithm of the frequency.

The address concluded with a suggestion that the new acoustics should find a place in college courses and examination syllabuses. C. W. H.

Natural Hybrids in Plants.

SINCE Darwin directed attention to the problem of the evolution of a species, there has been considerable interest in the extent to which the individuals of such a species form fertile offspring when crossed with other organisms not included in the species. Obviously, if such attempts at hybridisation were ineffective under natural conditions or yielded infertile offspring, then the maintenance of the species as a distinct race was readily intelligible, however difficult it might be to understand how varieties crossing readily with one another had in course of time devolved into distinct species which had lost the power of interbreeding.

During the recent discussion upon natural hybrids of plants at the Linnean Society of London on Feb. 28, the president, Sir Sidney Harmer, and Mr. M. A. C. Hinton, pointed out that amongst the wild mammals, naturally occurring hybrids are almost unrecorded. It will be remembered that Huxley always regarded this property of fertility within its ranks and failure to breed outside them as one of the most characteristic features of the natural species, and therefore as the outstanding feature which distinguished it from a race of cultivated animals or plants produced by artificial selection. The latter is often as distinct in structure and form as many a good natural species, but continued to breed freely with other races within the same domesticated species.

Darwin in the "Origin" clearly recognised that natural affinity, as expressed in a natural classification, included the sum of all characteristics of the organisms, including those connected with fertilisation mechanisms, so that natural affinity was usually an index to capacity to interbreed. As a general rule, therefore, varieties crossed more freely than species, and species than genera, yet the diverse factors associated with reproduction in the organism varied from type to type so that some varieties failed to interbreed, whilst in other cases genera might yield intergeneric hybrids and species would only ripen seed if crossed by foreign pollen.

Since the days when the significance of these natural hybrids to the study of evolution were grasped, our knowledge of their occurrence has considerably advanced, as was well illustrated by the discussion at the Linnean Society. Dr. A. W. Hill dealt with the New Zealand flora, in which some 290 groups of wild hybrids have now been noted, belonging to 42 families and 92 genera. In some genera, as *Phormium*, which includes the New Zealand flax plant, these plants open up questions of great economic importance.

A remarkable series of *Gaultheria* hybrids were exhibited by Dr. Hill, which showed a gradual transition from *G. oppositifolia* to *G. antipoda* and *G. rupestris*, and thence to *G. perplexa*, also series between *G. perplexa* and *antipoda* and *rupestris* and

antipoda. The species *oppositifolia* and *rupestris* have a dry capsular fruit without fleshy calyx segments, in *antipoda* the calyx becomes thick and fleshy as the fruit ripens, whilst in *perplexa*, in addition, the fruit is a fleshy berry. Most of these hybrid Gaultherias produce viable seeds. Messrs. E. M. Marsden-Jones and W. B. Turrill described genetical experiments and field observations on certain British genera. They conclude that the polymorphism of such a genus as *Centaurea* owes much to hybridisation, which is thus one, but only one, of the factors in organic evolution.

Prof. C. E. Moss described some of the natural hybrids of *Clematis*, *Anemone*, and *Gerbera* occurring in the Transvaal. The study of such natural hybrids leads Prof. Moss to the conclusion that bigeneric hybrids occur in Nature and may be fertile. Similarly, fertile hybrids occur between well-defined species. Hybrids of either of these classes are not common; they are often striking plants and are easily detected. On the other hand, between closely allied species, fertile hybrids may readily occur in abundance and may give rise to that polymorphism in some groups of species which is so perplexing to the systematist. Prof. Moss stated that he had met no case of the occurrence of natural hybrids in the field, which led him to think that natural hybrids gave rise to species.

Dr. Lloyd Praeger pointed out that, of some fifty species of *Sempervivum* in the Canary Islands, some thirty-five were known to hybridise; amongst the hybrid offspring barrenness is very general. Dr. O. Stapf, speaking from the point of view of a systematist, agreed that hybrids are abundant in many plant families in Nature, and thought that the isolation of a hybrid progeny may lead to the appearance of a new species.

Dr. J. P. Lotsy is the champion of the theory that hybridisation is the main instrument of species evolution, and Dr. C. L. Huskins pointed out that this theory includes the possibility of 'hybridisation' within a single nucleus. Obviously the problem will in the future be taken further as this wealth of natural hybrid material is submitted to cytological examination; the data as yet available from such cytological work were utilised by Dr. E. J. Collins in his contribution to the discussion.

University and Educational Intelligence.

APPLICATIONS are invited by the London County Council for two Robert Blair fellowships, each of the annual value of £450, tenable for one year. The fellowships are for advanced study or research in applied science and technology, and are tenable in the Dominions, the United States or other foreign countries. Further particulars and application forms (T.3)/300 may be obtained from the Education Officer (T.3), The County Hall, S.E.1. The completed forms must be returned by June 18.

THE St. Andrews Committee for the Training of Teachers is organising a summer school, to be held at the United College, St. Andrews, on July 8–26. Courses of lectures on modern advances in physical science, by Prof. H. Stanley Allen, on the teaching of physics and chemistry, by Messrs. J. W. Bispham and R. H. Dickinson, and on rural science, by Mr. M. R. Gillanders, are included in the programme. Particulars can be obtained from the Director of Studies, Training College, Park Place, Dundee; applications to attend must be sent in not later than May 1.

THE recently published Annual Report of the Carnegie Trust for the Universities of Scotland is of more than ordinary interest, including, as it does, statements showing the working during the five years 1923–28 of the Trust's various schemes for encouraging the pursuit of scientific research. Under the scheme of postgraduate study and research, which has been in operation for twenty-five years, 478 awards were made in the quinquennium at a cost of £51,047. Closely associated with this scheme is the provision made by the Trust since 1923–24 for 'teaching fellowships' for university lecturers and assistants, who hold them subject to the condition of devoting not less than half their time to research. Forty-one such fellows have been at work at a cost to the Trust of £20,023. Detailed reports, classified under subject headings, of the work done under these schemes and of researches, subsidised by the Trust, in the laboratory of the Royal College of Physicians, cover about eighty pages. Of more general interest are the reviews by the Trust's expert advisers. Reviewing the work done in (1) physics and chemistry and (2) biology and medicine, Profs. Arthur Smithells and J. T. Wilson both comment on the increasing demand for scientific assistance in industrial concerns. There is a greater demand for trained chemists than has ever been known in Great Britain, and the lure of industrial appointments has led in many instances to the curtailment of the period of tenure of fellowships and scholarships. The Trust's research schemes function, says Prof. Wilson, as a sort of unofficial Scottish staff college for research, from which are recruited personnel not only for university staffs, but also for staffs of other public laboratories and institutions. They cost the Trust £82,700 during the quinquennium. Its grants to universities and extra-mural institutions for 1925–30 amount to £231,225; assistance to Scottish students in the payment of university class fees in the one year 1927–28 amounted to £57,772.

THE University of Leeds gives, in its report for 1927–28, an account of important additions, costing upwards of £150,000, to its buildings. Increased accommodation was thus provided for the medical, dental, mining, and textile departments and for the residence of men and women students. Plans were also approved for new buildings for the physics and chemistry departments. Statistical tables appended to the report show that during the five years 1923–28 the number of full-time day-students has continuously declined from 1475 to 1296. It is, however, still nearly twice the number (663) in 1913–14. The decrease in 1927–28, compared with the preceding year, was chiefly among men students in the faculties of technology and medicine, and women students in the faculty of arts. Facilities for research were substantially increased during the year, notably by (1) the acquisition of an estate suitable for the pursuit of cancer research, and including a convenient residence for the professor of experimental pathology; (2) a grant by the Clothworkers' Company of £3000 a year for four years, enabling the University to appoint a lecturer in textile physics with a research assistant and to award eight fellowships for investigators in the textile industries and dyeing departments; (3) the recognition of researches conducted in the laboratories at Torridon of the British Research Association for the Woollen and Worsted Industries as qualifying for the University's research degrees. It has been decided to publish annually, in a separate pamphlet, short summaries of unpublished research work and references to published work accepted for higher degrees, and to include in the pamphlet the list, hitherto published as an appendix to the annual general report, of works, original papers, etc., by members of the University. Among gifts to the University during the year was one by Messrs. Briggs, Son and Co., of a scholarship of £150 a year for five years, tenable in the Mining Department.

Calendar of Patent Records.

April 14, 1720.—The 'stoving' process of seasoning timber for shipbuilding—in which the timber is heated in wet sand—was the invention of John Cumberland, whose patent is dated April 14, 1720. The process, which was reported by the Admiralty to be much superior to the old method of charring that it displaced, was used in the Royal dockyards for some years, an allowance of £200 a year being guaranteed to the inventor. An application for a prolongation of the grant was dismissed.

April 17, 1882.—The 'telpher' system of transportation—in which goods are carried by electrically operated and automatically controlled trolleys travelling on a mono-rail—was the invention of Prof. Fleeming Jenkin, his patent being dated April 17, 1882. The first commercial installation in England was opened in 1885 for carrying clay from the pits at Glynde in Sussex to the railway.

April 18, 1707.—On April 18, 1707, there was granted to the first Abraham Darby a patent for his invention of "casting iron bellied potts and other iron bellied ware in sand only without loam or clay," which greatly increased the use of iron for founding purposes. Previous to this invention, such articles were only made in the more costly brass, iron castings being confined to the production of simpler articles such as fire-backs and grave-slabs. Abraham Darby's name is an honoured one in the history of the iron industry, for it was he who, about 1710, first discovered and put into practice a satisfactory process for the smelting of iron with coke.

April 18, 1818.—The omnibus dates from the French patent granted to De Berckem of Paris on April 18, 1818, for what he called a 'Parisienne,' carrying eighteen persons. A previous attempt—with which Blaise Pascal was associated—had been made to run public vehicles of this kind in Paris, but it was not successful and was soon abandoned.

April 18, 1838.—William Barnett's patent, dated April 18, 1838, is an important milestone in the history of the gas engine, for it was in this that the advantages of compressing the combustible mixture before igniting it were first pointed out. In Barnett's engine the air and gas were compressed separately and were mixed in the cylinder at the beginning of each stroke. A special ignition cock, which remained long in use, was also a feature of the invention.

April 18, 1885.—One of the early suggestions for utilising the principle of the gyroscope to replace that of the magnetic needle in the mariner's compass was the invention of two Dutchmen, Gerardus van den Bos and Barend Janse, whose German patent was applied for on April 18, 1885.

April 19, 1758.—The achromatic telescope of John Dollond was patented on April 19, 1758. No action seems to have been taken by the Privy Council on a petition signed by most of the instrument-makers of London, alleging that object-glasses in accordance with Dollond's patent had been made and publicly sold before the date of the grant and praying for the revocation of the patent, and the patent was afterwards upheld in the Courts in an action for infringement. But there seems to be little doubt that Chester Moor Hall was the first inventor.

On the same day, April 19, 1758, there was granted to Jedediah Strutt a patent for the rib-stitch hosiery frame, which was the first important modification of Lee's stocking frame. Strutt invented the rib-stitch machine for his hosier brother-in-law, William Woollatt, and the two started what became very successful works at Derby and Nottingham.

Societies and Academies.

London.

Mineralogical Society, Mar. 19.—**A. W. Groves** and **A. E. Mourant**: Inclusions in the apatities of some igneous rocks. Apatite crystals with dark cores of inclusions have been observed among the heavy minerals of some English sedimentary rocks, but there are few records of such apatites in igneous rocks. The authors record several such occurrences in granites and in volcanic rocks from Normandy, Jersey, and Brittany. Five different types are distinguished in the granite of northern Brittany alone. In one type with a definitely pleochroic core the inclusions appear to consist of biotite or chlorite, but in other types it has not been possible to determine their nature.—**L. A. Narayana Iyer**: Calc-gneisses and cordierite-sillimanite-gneisses of Coimbatore, Madras Pres., and similar occurrences in India. The paper dealt with a suite of crystalline gneisses in the ancient Archæan complex of India of Dharwar age (Huronian), consisting of the above two facies, which are in close association. Similar suites of rock occur in different parts of India, forming a definite stratigraphic horizon. The author considers their formation as due to thermal or 'infra-plutonic' metamorphism followed or accompanied by regional or dynamo-thermal metamorphism of pelitic schists and calcareous sediments.—**F. A. Bannister**: A relation between the density and refractive index of silicate glasses with application to the determination of imitation gem-stones. The study of simple glass families leads to a relation between the refractive index and density which can be applied in a modified form to the determination of imitation gem-stones. $(n-N)/(d-D)$, where N and D are the refractive index and density of silica glass, is plotted against n by a simple graphical method, whereupon the various imitations separate into groups; the members comprising any one group are chemically similar. Doubtful cases can be solved by measuring in addition the relative dispersion.—**H. E. Buckley**: The crystallisation of potash-alum. The author described the results of experiments on the differences of crystal habit obtained under varying conditions of cooling and evaporation, and in the presence of various substances in solution such as strong acids, $AlCl_3$, FCl_3, amyl alcohol, Bismarck Brown, etc.

Paris.

Academy of Sciences, Mar. 4.—**A. Deslandres**: Simple relations between the most intense and highest radiations of the chemical elements in the photosphere of the sun. In previous communications it was shown that the frequencies of the highest and most brilliant lines of the sun were multiples of a constant d_1, 1062·5. Additional data showing the importance of this constant are given.—**Charles Moureu, Charles Dufraisse**, and **Léon Enderlin**: Researches on rubrene. The action of acids. The liberation of iodine from hydriodic acid by rubrene, with decolorisation of the hydrocarbon, has been studied in detail. Except possibly in ether solution, there is no evidence of any hydrogenation: the colourless hydrocarbon produced appears to be isomeric with rubrene.—**J. Favard**: Problems of extremums relative to convex curves.—**Maurice Janet**: The ratio of the mean values of the squares of two differentials of consecutive order.—**Mandelbrojt**: How several theorems of Taylor's series can be transformed into Dirichlet's series.—**J. Delsarte**: Symmetroid nuclei.—**L. Ahlfors**: The number of asymptotic values for an integral function of finite order.—**M. Lavrentieff**: A problem of P. Montel.—**Gr. C. Moisil**: Functional groups.—**D.**

Rosenthal: Assemblages connected by lateral bands tested in extension and in compression.—Maris Bossolasco: The ellipticity of the terrestrial equator.—Foch: The maintenance of the vibrations of a fluid column by change in the regime of flow. From Reynolds's definition of the critical velocity an equation is derived which has been applied to the cases of vibrating flames, the chemical harmonicon, and notes emitted by certain hot-water systems.—T. Pecsalski and J. Chichocki: The thermionic emission of copper tubes filled with salts.—J. Peltier: The magnetic testing of the shafts of machines.—R. Coustal and F. Prevet: A new method of preparing phosphorescent zinc sulphide. Zinc (in impalpable powder) and sulphur are heated together, with or without the addition of foreign substances. The reaction is explosive and must be controlled by reducing the proportion of zinc.—R. de Mallemann: The theory of optical activity in a homogeneous medium.—René Delaplace: Some chemical phenomena connected with the contraction of hydrogen in discharge tubes. Discharges through tubes of Pyrex glass, not fitted with taps or ground glass connexions, produce measurable amounts of carbon monoxide and methene. These may be attributed to the dissociation of the glass under the influence of radiations emitted by the tube.—Raymond Delaby and Pierre Dubois: The preparation of allyl alcohol. The method described permits of a yield of 435 grams of allyl alcohol per kilogram of glycerol.—Mlles. Jeanne Lévy and Frajda Gombinska: The dehydration of some symmetrically substituted α-glycols and the isomerisation of the corresponding ethylene oxides. The influence of the relative affinitary capacities of the cyclic and acyclic radicals.—A. Seyewetz and J. Blanc: The fluorescence of colouring matters in Wood's light. The principal dyes of each class have been submitted to Wood's light in powder, in solution, and on fibres, in order to see whether they would present any fluorescence sufficiently characteristic for use in analysis. Preliminary results are given.—Assar Hadding and René van Rubel: The structure of the crystalline uraninite of Katanga (Belgian Congo). The X-ray method of P. Debye has been applied to Katanga uraninite. Its crystalline network is that of a face-centred tube.—P. Fallot: The date of the latest orogenic phenomena in the sub-Betic and Betic zones at the height of Caravaca.—Jean Lacoste: The extension of the Cretaceous in the southern region of the western Rif.—Edouard Roch: New observations on the Stephanian of western Morocco.—Ch. Maurain and E. Salles: Atmospheric ionisation.—Albert Nodon: Researches on electromagnetic perturbations, seismic and solar. The results obtained at the Santiago Observatory (Chile) confirm work previously published by the author, and show that close relations exist between electromagnetic, seismic, telluric, atmospheric, and solar phenomena. It is possible from the indications of the magnetograph to predict earthquakes some hours in advance.—C. I. Popesco: The influence of grafting on the development of some Papilionaceæ.—Mme. L. Randoin and Mlle. A. Michaux: The comparative variations of the proportion of water in the blood and of the globular resistance in the normal guinea-pig and in the guinea-pig submitted to a regime deprived of the antiscorbutic vitamin.—Mme. M. L. Verrier: The biology and peculiarities of the respiratory apparatus of an isopod from the Sahara, *Hemilepistus Reaumuri*.—J. Magrou, Mme. M. Magrou, and Mlle. F. Choucroun: The action at a distance of *Bacterium tumefaciens* on the development of the egg of the sea-urchin. New experiments.—E. Roubaud: Autogenous cycle of waiting and hidden active winter generations in the common mosquito. *Culex pipiens* can have two different biological methods of adaptation to the winter. In one, well known, the females hibernate at low temperatures; in the other, described in the present communication, both sexes survive if the temperature is maintained above 20° C. in presence of water. Reproduction is continuous during the winter without food being taken.—Marcel Labbé, F. Nepveux, and Hejda: The ammonia of human blood in normal and pathological conditions. In cases of jaundice, cirrhosis of the liver, and diabetes, the proportion of ammonia in the blood varies very slightly from the normal: the amount is increased to a marked extent in pulmonary tuberculosis.—H. Bierry: Biochemical researches on the specificity and transformations of the proteids of the blood plasma.—L. Hugounenq and E. Couture: The photochemical action of sterols of various origins.—A. Dorier: *Gordius* as a parasite of myriapods.—A. and R. Sartory, Marcel and Jacques Meyer: Contribution to the study of the mycetones. A new case of actinomycosis with yellow pustules.

ROME.

Royal National Academy of the Lincei, Dec. 16.—T. Levi-Cività: Addition to the note on the motion of a body of variable mass.—Gino Fano: Congruences Ω_0 of rational curves, and Cremonian transformations inherent in a linear complex.—A. Russo: Nuclear divisions in *Cryptochilum echini* Mps. In this organism the processes of nuclear division are dependent on the category of the individuals to which the nuclei belong, since the nuclei of one category (A) divide by mitosis, and those of another (B) by amitosis. These two categories being distinguished by different quantities of nuclear substance, with which correspond particular activities of the whole individual, it appears that the special division of the nucleus is determined by internal factors which regulate the process.—L. A. Herrera: Further investigations on the imitation of organic forms with albumin. Structures obtained by means of egg-albumin and closely resembling *Croococcus*, *Botrydina vulgaris*, *Desmidium Grevilli*, *Bulbochæte*, *Vaucheria*, and *Nitella flexilis*, are illustrated.—U. Cassina: The conception of limits. A short, elementary account is given of the results of the author's historical and critical investigation into the conceptions expressed by the term 'limit.'—L. Fantappié: Functional operators and the calculus of infinite matrices in the theory of quanta (1).—M. Picone: Demonstration of a theorem of analysis, of which use is made in plane physics.—G. Supino: Certain limitations valid for derivates of a harmonic function.—L. Toscano: Reciprocal matrix equations.—G. Vranceanu: Second fundamental quadratic form of an anolonomous variety and its applications.—V. Glivenko: The law of high numbers in functional spaces.—A. de Mira Fernandes: Isoclinic transports and associated directions.—F. Lamberti: A third cardinal equation in the dynamics of material systems.—E. Gugino: The extension to continuous motion of the Lagrange-Bertrand theorem relating to impulsive motion.—G. Silva: The definition of normal gravity.—E. Benedetti: Experiments on the amplification and detection of bio-electric currents by means of thermionic valves (2). The photographic registration of the curves of the amplified currents. Use is made of a ray reflected by a mirror set in motion by an electrodynamic complex similar to those used to move the membranes of 'loud speakers.'—Clara Forti: The action of vapours of ethyl and methyl alcohols, ethyl ether, and chloroform, and of lighting gas on leucocytes isolated from the organism. The vapour evolved by minimum quantities (0·1-0·5 c.c.) of ethyl or methyl alcohol, ether or chloroform suffices to paralyse

the amœboid activity of the leucocytes of toad-blood within a few minutes. The action of illuminating gas is slow and results first in an increase in the vivacity of movement of the leucocytes, but later to a gradual retardation of the motion, which is completely arrested after exposure to the gas for eight or nine hours. These effects may be either transient or permanent, according to the duration of action of the reagent.—G. Galatà: Investigations on the circulatory effects of increases in the atrial pressure.—R. Margaria and E. Sapegno: Blood mass, red corpuscles, and hæmoglobin, in acclimatised individuals, in the mountains and on the plain. The observations described were made on ten individuals, first, in August 1927 at Col d'Olen (altitude 2901 metres), and, secondly, in the autumn and winter of 1927–28 at Turin, the temperatures in both cases being 10°-13°. At Col d'Olen, increases in the number of red corpuscles and in the hæmoglobin-content of the blood were invariably found. The extents of these increases varied markedly in different individuals, the mean values being 12·8 per cent for the corpuscles and about 4 per cent. for the hæmoglobin. There is, therefore, a diminution in the hæmoglobin-content of the red corpuscles, which may be the expression of the immission into circulation of young red corpuscles less rich in hæmoglobin—a phenomenon perfectly analogous to that observed after blood-letting. As regards the mass of the blood, determined by Haldane and Smith's method, the variations found amounted only to about 5 per cent, which corresponds with the limit of error for a single experiment; there is a mean increase of 1·8 per cent, which indicates that there is a slight increase in the mass of the blood following a sojourn of 15-25 days in the mountains, this being possibly due to the improved hygienic conditions.—R. Grandori: Embryological studies on polyvoltine races of the mulberry *Bombyx*.

VIENNA.

Academy of Sciences, Jan. 10.—R. Holzapfel: Results of radiation and polarisation experiments on the Hochobir in the summer of 1927 at an altitude of 2040 metres.—E. Philippi and E. Galter: The action of ammonia and amines on the esters of unsaturated acids.—E. Philippi: Memoranda for the preparation of some aliphatic unsaturated acids and esters.—F. Hernler: The three isomeric tolyl-1-dimethyl-3, 5-triazole-1,2,4 and some of their salts.—G. Grekowitz: A meningitis producer from the Pasteurella group. In three cases of middle ear discharge a germ was isolated, a small coccus-like bacterium easily stained with the usual aniline dyes, but not with Gram. A faint smell is characteristic of the colonies. Gelatine was not liquefied. Milk sugar and mannite were neither acidified nor fermented.—F. Werner: Scientific results of a journey of exploration to Western Algeria and Morocco. Snakes, lizards, and scorpions are recorded.—E. Bersa: The culture and nutrition physiology of the genus *Pilobolus*. Easily cultivated on horse-dung decoction agar. Of nitrogen sources leucine and peptone, of carbon sources xylan, gum arabic, galactose, starch do best. A wheat straw extract with peptone and agar proved a good culture medium, also Liebig-extract-agar-peptone.—K. Menger: On the sum of regular curves.—K. Przibram: Coloration of rock-salt by radium rays and re-crystallisation. Apparently rock-salt on compression undergoes re-crystallisation, the more rapid when pressure is greater. After such re-crystallisation the blue colour and the capacity of turning blue have vanished.—O. Watzl, K. Swoboda, and R. Singer: Report on a botanical and geological expedition in the Caucasus. The Caucasian Alpine Society supplied intelligence. The Dongusorun glacier pass (3200 metres) was difficult. The Chodschal mountain group (3309 metres) was examined. Valleys choked with thick primitive forest were difficult to penetrate, the few paths being mostly on slopes above the tree limit. Collections were made of Rhododendron and other shrubs and of the very rich fungus flora.

Official Publications Received.

BRITISH.

The Scientific Proceedings of the Royal Dublin Society. Vol. 19 (N.S.), No. 18: The Photo-Electric Measurement of the Illumination in Buildings. By Dr. W. R. G. Atkins and Dr. H. H. Poole. Pp. 173-188. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 1*s*.

Transactions of the Royal Society of Edinburgh. Vol. 56, Part 1, No. 9; On the Feeding Mechanism of the Syncarid Crustacea. By Dr. H. Graham Cannon and Miss S. M. Manton. Pp. 175-189. 2*s*. Vol. 56, Part 1, No. 10: A Human Blastocyst *in situ*. By Dr. C. Witherington Stump. Pp. 191-202+10 plates. 5*s*. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Education in Kent during the Five Years 1923–1928. Pp. xi+314. (Maidstone: Kent Education Committee.)

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 67, No. 387, March 1929. Pp. 317-436+xxxvi. (London: E. and F. N. Spon, Ltd.) 10*s*. 6*d*.

Report of the Medical Research Council for the Year 1927–1928. (Cmd. 3276.) Pp. 165. (London: H.M. Stationery Office.) 3*s*. net.

Dove Marine Laboratory, Cullercoats, Northumberland. Report for the Year ending June 30th, 1928. Edited by Prof. Alexander Meek. (New Series 17.) Pp. 50. (Cullercoats.) 5*s*.

Department of Scientific and Industrial Research: Gas Cylinders Research Committee. Ordinary Commercial Cylinders for the "Permanent" Gases. Summary of Recommendations (revised). Pp. iii+7. (London: H.M. Stationery Office.) 4*d*. net.

The New Education Fellowship (English Section). Annual Report, 1928. Pp. 19. (London.)

The Federation of Lancashire and Cheshire Museums. First Annual Report, 1928, adopted at the Annual General Meeting, January 30th, 1929. Pp. 11. (Liverpool.)

Annual Report of the Calcutta School of Tropical Medicine, Institute of Hygiene and the Carmichael Hospital for Tropical Diseases, 1928. Pp. 103+3 plates. (Calcutta: Bengal Government Press.)

Journal and Proceedings of the Asiatic Society of Bengal. New Series, Vol. 23, 1927, No. 3. Pp. 249-560+plates 6-13. (Calcutta.)

The Education Question and the General Election: being the Annual Report of the National Education Association presented to the Annual Meeting on Tuesday, January 22nd, 1929. Pp. 12. (London.) 3*d*.

The British Mycological Society. Transactions. Edited by Carleton Rea and J. Ramsbottom. Vol. 14, Parts 1 and 2, March 11. Pp. 178. (Cambridge: At the University Press.) 15*s*.

The Proceedings of the Physical Society. Vol. 41, Part 2, No. 227, February 15. Pp. viii+113-179. (London.) 7*s*. net.

Department of Scientific and Industrial Research. Building Science Abstracts. Compiled by the Building Research Station and published in conjunction with the Institute of Builders. Vol. 2, (New Series), No. 1, January. Abstracts Nos. 1-200. Pp. ii+54. (London: H.M. Stationery Office.) 9*d*.

Transactions and Proceedings of the Perthshire Society of Natural Science. Vol. 8, Part 5, 1927–28. Pp. 235-264+li-lx+plates 35-46. (Perth.) 3*s*. 6*d*.; to Members, 2*s*. 6*d*.

Air Ministry: Aeronautical Research Committee. Reports and Memoranda. No. 1189 (Ae. 351): Notes on Longitudinal Stability at Stalling in Gliding Flight. By S. B. Gates. (T. 2647.) Pp. 7+5 plates. 6*d*. net. No. 1191 (Ae. 353): Full Scale Tests of a Standard Bristol Fighter Aeroplane fitted with "Pilot Planes" at the Wing Tips. By W. G. Jennings. (T. 2663.) Pp. 5+3 plates. 6*d*. net. (London: H.M. Stationery Office.)

St. Andrews Provincial Committee for the Training of Teachers. Summer School, St. Andrews, July 8th to July 26th, 1929. Pp. 20. (St. Andrews.)

FOREIGN

Transactions of the San Diego Society of Natural History. Vol. 5, No. 14: Discocyclina in California. By Hubert G. Schenck. Pp. 211-240+plates 27-30. Vol. 5, No. 15: A new Pocket Gopher and a new Antelope Ground Squirrel from Lower California, Mexico. By Laurence M. Huey. Pp. 241-244. (San Diego, Calif.)

Bulletin of the American Museum of Natural History. Vol. 58, Art. 5: Functional Adaptations of the Pelvis in Marsupials. By Herbert Oliver Elftman. Pp. 189-232+plates 9-14. (New York City.)

Veröffentlichungen des Instituts für Meereskunde an der Universität Berlin. Neue Folge, A: Geographisch-naturwissenschaftliche Reihe. Heft 19: Stabile Lagerung ozeanischer Wasserkörper und dazugehörige Stromsysteme. Von A. Defant. Pp. 83. Heft 20: Schichtung und Tiefenzirkulation des pazifischen Ozeans auf Grund zweier Längsschnitte. Von Georg Wüst. Pp. 64+4 Tafeln. (Berlin: E. S. Mittler und Sohn.)

Ministry of Agriculture, Egypt. The Agricultural Journal of Egypt. New Annual Series, 1924 and 1925. Pp. ii+166. (Cairo: Government Publications Office.) 5 P.T.

Annual Report of the Meteorological Observatory of the Government-General of Tyôsen for the Year 1926. Pp. v+154. (Zinsen.)

R. Osservatorio Astrofisico di Catania. Annuario 1929. Pp. iii+39. (Catania.)

Japanese Journal of Engineering. Abstracts. Vol. 6. Pp. x+89. (Tokyo: National Research Council of Japan.)

Proceedings of the American Philosophical Society held at Philadelphia for Promoting Useful Knowledge. Vol. 67, No. 4, 1928. Pp. xx+319-384. (Philadelphia, Pa.)

Forty-first Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, 1919–1924. With Accompanying Papers: Coiled Basketry in British Columbia and surrounding Region, by H. K. Haeberlin, James A. Teit and Helen H. Roberts, under the direction of Franz Boas; Two Prehistoric Villages in Middle Tennessee, by William Edward Meyer. Pp. ix + 626 + 138 plates. (Washington, D.C.: Government Printing Office.) 2.50 dollars.

Smithsonian Institution: United States National Museum. Bulletin 145: A Revision of the North American Species of Buprestid Beetles belonging to the Genus Agrilus. By W. S. Fisher. Pp. v+345+11 plates. 65 cents. Report on the Progress and Condition of the United States National Museum for the Year ended June 30, 1928. Pp. ix+216. 25 cents. (Washington, D.C.: Government Printing Office.)

U.S. Department of the Interior. Forty-ninth Annual Report of the Director of the Geological Survey to the Secretary of the Interior, 1928. Pp. ii+77. (Washington, D.C.: Government Printing Office.)

Department of the Interior: U.S. Geological Survey. Water-Supply Paper 586: Surface Water Supply of the United States, 1924. Part 6: Missouri River Basin. Pp. viii+343. 50 cents. Water-Supply Paper 588: Surface Water Supply of the United States, 1924. Part 8: Western Gulf of Mexico Basins. Pp. vi+229. 25 cents. (Washington, D.C.: Government Printing Office.)

Cornell University Agricultural Experiment Station. Memoir 116: Rural Population of New York, 1855 to 1925. By Bruce L. Melvin. Pp. 121. Memoir 117: Chromosome Numbers in Zea Mays L. By L. F. Randolph. Pp. 44. (Ithaca, N.Y.)

Department of Commerce: Bureau of Standards. Bureau of Standards Journal of Research, Vol. 2, No. 1, January: Fire Resistance of Hollow Load-bearing Wall Tile. By S. H. Ingberg and H. D. Foster. Pp. 334+42 plates. (Washington, D.C.: Government Printing Office.)

Smithsonian Miscellaneous Collections. Vol. 81, No. 7: Recent Archaeological Developments in the Vicinity of El Paso, Texas. By Frank H. H. Roberts, Jr. (Publication 3009.) Pp. 14+5 plates. (Washington, D.C.: Smithsonian Institution.)

National Research Council. Organization and Members, 1928–1929. Pp. 63. (Washington, D.C.: National Academy of Sciences.)

Reprint and Circular Series of the National Research Council. No. 85: Report of the Committee on Sedimentation, 1927–1928. Pp. 83. 1 dollar. No. 86: Doctorates conferred in the Sciences by American Universities, 1927–1928. Compiled by Callie Hull and Clarence J. West. Pp. 38. 50 cents. (Washington, D.C.: National Academy of Sciences.)

Bulletin of the National Research Council. No. 65: Bibliography of Bibliographies on Psychology, 1900–1927. Compiled by C. M. Louttit. Pp. 108. 1.50 dollars. No. 66: Funds available in the United States for the Support and Encouragement of Research in Science and its Technologies. Compiled by Callie Hull and Clarence J. West. Second edition. Pp. 90. 1 dollar. (Washington, D.C.: National Academy of Sciences.)

CATALOGUES.

A Catalogue of Important and Rare Books on Zoology, Geology and Palæontology. (No. 424.) Pp. 128. (London: Bernard Quaritch, Ltd.)

Catalogue No. 167: Astronomy, Chemistry, Entomology, Fishes, General Natural History, Geology, Mathematics, Ornithology, Physics, Sundials, etc. Pp. 48. (London: Dulau and Co., Ltd.)

Surveying, Drawing and Nautical Instruments. (Catalogue S.M. Section.) Pp. 121. (London: J. H. Steward, Ltd.)

Diary of Societies.

FRIDAY, APRIL 12.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—A. T. Cooper: Recent Electrical Developments in India.

ROYAL ASTRONOMICAL SOCIETY, at 5.—L. Rosenhead: The Annual Variation of Latitude.—E. A. Kreiken: On the Dwarf Nature of the Spectroscopic Binaries.—H. Horrocks: The Longitude of the Royal Observatory, Cape of Good Hope, from Wireless Signals, Oct.–Nov. 1926.—S. A. Mitchell: Atlas Stellarum Variabilium, Series VII.

MALACOLOGICAL SOCIETY (at University College), at 6.

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (Annual General Meeting) (at Engineers' Club, Manchester), at 7.—T. R. Woolaston: Suggestions in Steam Raising.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—F. E. F. Durham: Pumping Plant.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—H. W. Bennett: Sulphide Toning.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—B. V. Lambert: The Collection of Fine Dust arising from Metallurgical and other Processes.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—E. J. Wayland: The Later Geological History of the Equatorial Lakes in Uganda.

OIL AND COLOUR CHEMISTS' ASSOCIATION (Manchester Section) (at Milton Hall, Manchester), at 7.30.—Annual General Meeting.

INSTITUTE OF TRANSPORT (at Y.M.C.A., Newcastle-upon-Tyne), at 7.30.

SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (jointly with Chemical Engineering Group) (at Engineers' Club, Birmingham).—Dr. C. M. Walter: The Design and Operation of Gas Heated Furnaces.

SATURDAY, APRIL 13.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (jointly with Yorkshire and North-Western Districts) (in College of Technology, Manchester), at 2.30.—W. J. Hadfield: The Local Government Bill, with Particular Reference to the Road Clauses.

MONDAY, APRIL 15.

SOCIETY FOR THE PRESERVATION OF THE FAUNA OF THE EMPIRE (at Zoological Society of London) (Annual General Meeting), at 4.—Earl of Onslow: Presidential Address.—Exhibition of Lantern Slides of the Kruger National Park, South Africa.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—M. G. Tweedie and others: Discussion on Power Supply and Railway Electrical Signalling.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—Hon. Sir Charles A. Parsons and J. Rosen: Direct Generation of Alternating Current at High Voltages.

ROYAL SOCIETY OF ARTS, at 8.—Sir E. Denison Ross: Nomadic Movements in Asia (Cantor Lectures) (I.).

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Dr. V. Stefansson: Some Problems of Arctic Travel: After a Crash.

TUESDAY, APRIL 16.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Colour Group), at 7.—F. J. Tritton: Colour Snapshots.

ILLUMINATING ENGINEERING SOCIETY.—Dr. J. F. Crowley: The Use of Intermittent Light for Revealing Moving Machinery.

WEDNESDAY, APRIL 17.

ROYAL METEOROLOGICAL SOCIETY, at 5.—The late W. H. Dines and L. H. G. Dines: Monthly Mean Values of Radiation from Various Parts of the Sky at Benson, Oxfordshire.—L. H. G. Dines: An Analysis of the Changes of Temperature with Height in the Stratosphere over the British Isles.—H. A. Hunt: A Basis for Seasonal Forecasting in Australia.

INSTITUTION OF CIVIL ENGINEERS (Informal Meeting), at 6.—E. T. Painton: Problems involved in the Design of Overhead Transmission-Lines.

INSTITUTE OF METALS (Swansea Local Section) (at Thomas' Café, Swansea), at 7.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.—F. H. Rosencrants: Practice and Progress in Combustion of Coal as applied to Steam Generation.

ROYAL SOCIETY OF ARTS, at 8.—F. E. Lamplough: Vita Glass.

FOLK-LORE SOCIETY (at University College), at 8.—Miss Beatrice Blackwood: Folk-Tales of the Chippewa Indians.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Prof. E. Ghosh: Two New Suctoria from Sewer Water.—Dr. P. L. Li, Dr. H. S. D. Garven, and Dr. R. H. Mole: The Microscopic Anatomy of the Vascular System of the Dog's Spleen.—Dr. D. S. Spence: A Method of Finding the Refractive Index of a Drop of Mounting Medium.

SOCIETY OF GLASS TECHNOLOGY (Annual General Meeting and Ordinary Meeting) (at Sheffield).—W. Butterworth, senr.: The History of Glass Cutting (Lecture).

THURSDAY, APRIL 18.

LINNEAN SOCIETY OF LONDON, at 5.—Dr. G. C. Druce: The Botany of Cyprus.—Dr. G. S. Carter and L. C. Beadle: The Fauna of the Swamps of the Paraguayan Chaco in Relation to its Environment. II. Respiratory Adaptations in the Fishes.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—R. A. Chattock: The Modern Use of Pulverised Fuel in Power Stations.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—Col. V. C. Richmond: R. 101.

INSTITUTION OF AUTOMOBILE ENGINEERS (Guildford Centre) (at Technical Institute, Guildford), at 7.—H. W. Pitt: Central Lubrication of Chassis Bearings.

INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre—Dublin) (at Trinity College, Dublin), at 7.45.—J. D. Ferguson: Electric Time Signalling.

BRITISH INSTITUTE OF RADIOLOGY, at 8.30.—R. S. Paterson: The Less Common Diverticula of the Upper Alimentary Tract.—J. V. Sparks: The Difficulties of Comparative Radiography of the Chest.

FRIDAY, APRIL 19.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—Presentation of the Guthrie Medal to Dr. C. E. Guillaume.—Prof. W. R. Bridgman: The Properties of the Elements under High Pressures (Guthrie Lecture).

BRITISH INSTITUTE OF RADIOLOGY (Medical), at 5.—Informal Discussion on Bone-Diseases (especially Multiple Myeloma).

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—W. Reavell: The Standardisation of Keys and Keyways.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section) (Annual General Meeting), at 6.15.—V. E. Connor: The Manufacturing and Testing of Submarine Cables.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—B. Chambers and F. W. Sharp: Carbon and Carbro.

SOCIETY OF DYERS AND COLOURISTS (Glasgow Section) (at 7 Gordon Street, Glasgow), at 7.15.—Annual General Meeting.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Lt.-Col. J. T. C. Moore-Brabazon: Early Aviation (Lecture).

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Dr. S. G. Scott: Myeloma—Differential Diagnosis.—Dr. J. D. White: Bone Lesions in Tropical Diseases.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. Owen T. Jones: History of the Grand Canyon, Yellowstone National Park.

SOCIETY OF DYERS AND COLOURISTS (Manchester Section) (at Manchester).—Annual General Meeting.

SATURDAY, APRIL 20.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Southern District) (at Council House, Bristol), at 10.30 A.M.—H. F. Proctor: Description of the New Power Station, Portishead.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Newcastle-upon-Tyne), at 2.30.

MINING INSTITUTE OF SCOTLAND (at Royal Technical College, Glasgow).—Annual Meeting.