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Edward Jenner.

ON January 26, 1823, Dr. Edward Jenner, the discoverer of protective vaccination against smallpox, died in his home at Berkeley—a village of Gloucestershire—where he had lived long and practised as a country doctor. For centuries before, smallpox had been a terrible scourge in all countries and vast numbers of people had been swept away in every generation. Based on the observation that one attack of the disease confers, on those who recover, a lifelong immunity, an attempt had been made to imitate the natural disease by artificial inoculation of smallpox, in the hope that the artificially-produced disease might be mild, while creating at the same time a lasting immunity. In England this ancient process of inoculation, or as it was called variolisation, was introduced from Turkey early in the eighteenth century through the instrumentality of Lady Mary Wortley Montagu (1689–1762) and rapidly became widely disseminated. Its disadvantages were two-fold. In the first place, it was impossible to gauge how severe would be the effects of the inoculation, which in many cases were severe or even fatal; and in the second place, the disease produced was smallpox which, like the natural disease, was highly contagious, and although the inoculated person might survive and become immune he might disseminate the disease to others.

Jenner's discovery entirely removed these difficulties. Following up the country tradition that milkers who contract cowpox on their hands from infected animals are not capable of contracting smallpox, Jenner made experiments in which matter was taken from infected persons or directly from the cow itself, and he inoculated this into human beings, who developed what is called vaccinia. That these persons become immune to smallpox was shown by Jenner, who subsequently variolated them without being able to induce smallpox. More remarkable still, he showed that vaccinia can be transmitted from person to person in series without losing its properties. Jennerian vaccination is in its essence different from smallpox inoculation as previously practised, for the disease produced is mild and is not contagious.

Jenner's first experiments were made in 1796, and his famous "Inquiry into the Causes and Effects of the Variolae vaccinae" was published in 1798. The process of vaccination was instantly recognised as a great advance and rapidly attained a world-wide dissemination, largely through Jenner's own untiring efforts. A century has established the fact that Jenner's wonderful discovery must rank among the most beneficent known in the history of mankind, and although he has had and still has detractors, the vast mass of opinion of those most entitled to form a judgment of its merits would be in agreement with that of the learned August Hirsch, that "it can only be folly or stupidity that would seek nowadays to minimise or to question the immortal merits of Jenner."

When Jenner died Louis Pasteur was a month-old babe. Thus two great lives were linked: one immortal for a single great empirical discovery, the other destined to carry on the torch and found a science. It is doubtful if even yet the precise relationships of smallpox to cowpox are fully understood, in spite of the great mass of experimental work devoted to the problem during the past hundred years, nor can we point to any great advance in knowledge of the exact nature of the viruses concerned. Opinion, however, has quite definitely crystallised on one point, namely, that cowpox—now a great rarity in nature—is no spontaneous disease of the cow but is simply the bovine response to accidental infection with smallpox virus or vaccinia, conveyed by the hand of the milker. The evidence on which this statement is based rests fairly securely (1) on the successful results of experimental transference of variola to the cow, (2) the benign nature of the resultant lesions, and (3) the undoubted immunity to smallpox which the bovine disease confers when retransferred to man. It is true that, in the past century, schools of dualists and unicists have engaged in acrimonious discussion, but the spoils of the battle rest with the latter. Cowpox or vaccinia is simply an attenuated form of smallpox, and were there no smallpox there would be no naturally occurring cowpox. Further, with none of the other eruptive lesions in the domestic animals (horse-pox, sheep-pox, etc.) can smallpox be brought into similar relationship. These others are independent infections.

The diversity of response to one and the same virus by various animal species has been a fruitful field of speculation since Pasteur's time, and we know that Pasteur's chief concern was to expand Jenner's discovery so as to secure, for immunisation purposes, some strain of other living viruses, which, with the property of virulence removed or at least depressed, would yet adequately perform the function of immunising against the fully virulent variety. In swine erysipelas, Pasteur claimed to have secured the desired attenuation by passage through another species—a result on all fours with Jenner's observation as we now understand and interpret it. These normal immunities and explanations of them will doubtless for long be the subject of research, and in the present issue we take the opportunity of reprinting the main part of a recent address by Prof. J. C. G. Ledingham, who discusses the present state of knowledge in relation to normal immunity of species to various infections, and the factors on which such immunities have been alleged to depend.

Science in Secondary Schools.

THE committees appointed to consider the position of Natural Science, Modern Languages, Classics, and English in the educational system of Great Britain have now formulated their reports, and the Board of Education has issued a circular (No. 1294, December 6, 1922) in which some of the consequences of these reports are discussed. One of these is the question of the amount of time to be given to the teaching of individual subjects, and as the result a time-table has been provisionally drawn up which provides for 35 to 37 teaching periods of 45 minutes each per week in school, and not including time necessary for exercises and preparation. The Science Committee considers that not less than six periods per week should be given to that subject. This means about three-quarters of an hour per day, and no science teacher will be disposed to consider that too much for boys between the ages of 13 and 16.

The main point for consideration relates to the subjects which should be taught in the course of the school life, say altogether eight or nine years. As usually arranged, the course begins with nature study, followed by physics and chemistry, and no time is provided for subjects like astronomy and the elements of geology, which are necessary for the apprehension of common terrestrial phenomena. In considering such a question, regard should be had to the objects to be kept in view in teaching natural science at school. The first consideration should not be the usefulness of the applications of science, but its purpose should be to furnish the mind and supply some kind of clue to the phenomena of the physical world into which man is introduced at birth.

It is further necessary to cultivate habits of attentive observation and careful reasoning, so that some at least of the delusions to which all are exposed should be less deadly. It is, however, not necessary or desirable that all the subjects referred to should be taught at the same time, and they need not be taught with the same degree of thoroughness. Much general information may be imparted in a well-chosen series of lessons in nature study, while chemistry and physics, begun later, should be carried on to the end of school days. Many illustrations of facts relating to other subjects may be introduced in a less formal manner, not as school lessons but with the aid of the lantern and a sort of popular lecture, not to be followed by any examination or other test which only frightens young people away.

The circular from the Board of Education contains the remark that with "four periods of 45 minutes in the morning and three in the afternoon for five days per week, a full week consists of thirty-five periods." But it will be found that these thirty-five periods for instruction include two for physical exercises, two for manual work, two for drawing, and one for music, or seven periods altogether, and some of these may be interrupted or replaced temporarily without loss. Thus when games are properly organised they may replace physical exercises, and manual work may, to some extent, be replaced by experimental work in the physical or chemical laboratory at the suitable age. These are questions which will not be settled immediately, and with others they might well be considered at a meeting of the Science Masters' Association, especially with reference to the question as to how many of the science periods should be given to physical and how many to biological studies, the latter being often totally neglected.

Archæology and Technology of Carpets.

Hand-woven Carpets: Oriental and European. By A. F. Kendrick and C. E. C. Tattersall. Vol. 1. Pp. xi+198. Vol. 2. Pp. xi+205 plates. (Benn Bros., Ltd., 1922.) 105*s.* net.

THE pile carpet, though now an essential element in European domestic economy, is of foreign origin. Weaving is one of the most ancient and widespread of arts, and to produce a pattern by interlacing continuous threads is a natural development from it. From this to using threads of different colours is an easy transition. But to set the threads in a vast number of short lengths upon end, and to pack them so tight that they keep that position, entails so much skill and uses so much material that they can only have been originally produced in response to very special conditions.

Those conditions are encountered in the life of the nomads of Central Asia. The extreme changes of temperature in that part of the world, the demand of the nomadic life for portable and non-conducting fabrics, and the ample supply of wool available to these herdsmen, fit in with the archæological findings. Central Asia is thus designated as the home of the pile carpet. Recent excavations in that region have brought to light small fragments of such ancient carpets. Most curiously, however, the earliest complete pile carpet known is of European manufacture. It was prepared toward the end of the twelfth century in a nunnery at Quedlinburg in the Harz Mountains, and represents the well-known medieval theme of the "Marriage of Mercury and Philology." Oriental literary influence was very strong in Europe at that period. The art of carpet-weaving may well have come to Europe at this time along with "Arabian" science.

The earliest carpet of which a detailed description has come down to us, was made for the Persian Chosroes (531–579), and his successors used it until the last Sassanian king, Jazdegerd (632–651), pursued by the Arabs, was assassinated at Merv. The Persians are said to have had two loves, gardens and drinking, and this carpet was used for the drinking feasts in the stormy winter season when it was impossible to stay in the garden. The carpet was designed to portray a garden and was called "The Spring of Chosroes." It was woven as though planted with trees and spring flowers, intersected by brooks and pathways. Several very ancient Persian carpets, with a design which recalls that of Chosroes, have survived.

India was much later in the field than Persia, and does not appear to have produced pile carpets until the sixteenth century. Pile carpets were devised to meet the needs of colder climates than India, and in such climates suitable wool for making them can more easily be grown. The export trade in Indian carpets began in the seventeenth century, and has now reached very considerable proportions. After the middle of the nineteenth century carpet-knotting was begun in the jails, and many of these "jail-carpets" are now on the market. They are mostly copied from old patterns.

In Turkey the carpet industry was stimulated in the early part of the sixteenth century, when Selim I. in 1514, and again Suleiman I. in 1534 entered Tabriz and carried off craftsmen to Asia Minor. Much earlier, however, an export trade between the Anatolian ports and Europe—especially Venice—had been opened up and carpets began to come westward. Few of these have survived, but a number are represented in the works of Dutch and Italian artists, Jan van Eyck, Memlinc, Van der Goes, Holbein, Ghirlandajo, Pinturicchio, and others.

The first European country to develop a carpet industry was Spain, which was producing carpets of similar design to the Turkish in the fifteenth century. In England little was known of carpets until at least a century later. Paul Hentzer, a German who came to London in 1598, states that Queen Elizabeth's presence-chamber at Greenwich was strewn with hay. Even rush-matting, though used by the French from the beginning of the fifteenth century, does not seem to have come into general use in this country till the reign of James I. Pile carpets, however, were beginning to be imported into England from the East about the middle of the sixteenth century, and the actual making of them here was not long delayed. A carpet represented on a fine plate in this volume has in the middle the arms of England with the initials of Queen Elizabeth and the date 1570.

Before the end of Elizabeth's reign the English

Turkey Company had begun direct trading with the Eastern Mediterranean, and carpets were more easily obtained. Some of these were copied more or less faithfully in England. A "Turkey" carpet of English manufacture is in the Victoria and Albert Museum bearing the inscription, "Feare God and keepe his commandements made in the yeare 1603." Some light is thrown on the manufacture of such carpets by a chapter in Hakluyt's "Voyages": "Certaine directions . . . to M. Morgan Hubblethorne, Dier, sent into Persia 1579," where we read: "In Persia you shall finde carpets of coarse thrummed wool, the best of the world, and excellently coloured: those cities and towns you must repair to, and you must use means to learn all the order of the dying of those thrums, which are so dyed as neither rain, wine, nor yet vinegar can stain. . . . If before you return you could procure a singular good workman in the art of Turkish carpet-making you should bring the art into this realm."

These magnificently illustrated volumes provide a complete key not only to the history of carpetry, but also to the technology and identification of carpets both ancient and modern. The text is lucidly and attractively written. The illustrations are largely drawn from the collection at the Victoria and Albert Museum, to which have been added many of the plates from Neugebauer and Orandi's "Handbuch der orientalischen Teppichkunde" and other sources. The authors, printers, and publishers are to be congratulated heartily on this singularly attractive production.

CHARLES SINGER.

Vitalism and Anti-Vitalism.

Grundlagen einer Biodynamik. von Prof. Dr. Johannes Reinke. (Abhandlungen zur theoretischen Biologie. Herausgegeben von Prof. Dr. Julius Schaxel, Heft 16.) Pp. v+160. (Berlin: Gebrüder Borntraeger, 1922.) 12*s*.

Handbuch der Pflanzenanatomie. Herausgegeben von Prof. K. Linsbauer. 1 Abteilung, 1 Teil: Cytologie. Band 1: Zelle und Cytoplasma. Von Henrik Lundegårdh. Pp. xii+193-402. (Berlin: Gebrüder Borntraeger, 1922.) 24*s*.

L'Organisation de la matière dans ses rapports avec la vie: études d'anatomie générale et de morphologie expérimentale sur le tissu conjonctif et le nerf. Par Prof. Jean Nageotte. Pp. vi+560+4 planches. (Paris: Félix Alcan, 1922.) 50 francs.

THESE three books all deal with the fundamental question of the relation of the activities denoted by the term "life" to the constitution of the matter in which they are exhibited. When living matter is analysed (and necessarily killed in the process) it is found to consist of proteids, fats, carbohydrates together with certain metallic salts. What has made this mixture "alive"? Is there, as Verworn supposed, a living substance *par excellence* for which the other materials in protoplasm constitute an environment? Verworn named his hypothetical substance "biogen," and "life" was supposed to consist of the characteristic reactions of this substance with surrounding materials; reactions by which the biogen molecule was partially destroyed, but as the result of which a residue was left from which a new biogen molecule was reconstituted, and so the continuity of life was maintained. If, on the other hand, the difficulties involved in the supposition of a specific biogen molecule are too great to be overcome, life may be supposed to consist in the mutual reactions of a characteristic mixture of substances, and no single substance viewed apart from the others can be considered alive. In this case all depends on the specificity of the mixture—in a word, *on the physical structure of the living matter.* We may phrase it in another way if we say that life depends on the *juxtaposition in a definite way of unlike substances.* But how is this physical structure maintained? Is there a reduced copy of the frog in the frog's egg? That no typical physical structure will explain living phenomena has been clearly proved by Driesch. No imaginable "constellation of parts" would survive the changes described by Driesch in his account of his experiments and yet yield the same typical result which was given by the original mixture.

Now the authors of the three books before us all agree in rejecting the biogen theory: the first falls back with some hesitation and the use of different words on an explanation which is closely akin to the entelechy of Driesch, the second ignores the difficulties raised by the view that protoplasm is a mixture, but Prof. Nageotte vehemently denounces vitalism. The only reason, he asserts, that we believe in such an empty concept is the unfortunate circumstance that we ourselves are alive, and our life is the "accidental" result of our organisation—a phrase which "gives us furiously to think." It is not quite clear how on Prof. Nageotte's view science itself can exist, and how an "accidental result of our organisation" can either acquire or impart "knowledge" of phenomena outside us. But as we shall see, Prof. Nageotte, while like Balaam he begins with the intention of cursing vitalism, is led like the prophet to bless it altogether—although he is not conscious of the fact.

Prof. Reinke's book is an attempt to make a comprehensive survey of the characteristic peculiarities of animals and plants and so to deduce general laws governing life. The laws which he formulates are three in number, namely, (1) All life begins from pre-existing life; (2) There is a tendency to the restitution and maintenance of typical form in spite of its continual destruction by catabolism; (3) Psychic phenomena are only manifested in connexion with living material. But, according to Reinke, it is by no means allowable to attribute a "psyche" to all forms of living matter; it is a contradiction in words to imagine a "psyche" where there is no evidence of sensation; and so he is unable to attribute feeling to plants. Since, however, the protoplasm of plants obeys the same laws as that of animals, and its activities are not explicable on any conceivable theory of physical structure, he invents the word "diaphysical" to denote the basis of these activities. (It is a pity that he seems to be unacquainted with the work of Sir Bahadur Bose.) "The peculiar combination of 'elementary mechanisms' in the organism constitutes its being and is of diaphysical nature." He pours scorn, which we think is deserved, on "materialistic vitalism." By this phrase is meant the attempt to escape from the impasse created by the impossibility of explaining life by physical structure, through the invention of an imaginary series of units many thousands of times smaller than the electron, to which are attributed imaginary properties so as to account for living phenomena. He states, "By assimilation as by other chemical processes (cf. the formation of chlorophyll and enzyme) we only obtain lifeless substances. The 'vitalising' of these substances takes place only by their insertion in the framework of protoplasm"—and this essentially vital step he terms "epiplasty."

As might be expected, Prof. Reinke encounters the Mendelian "gene" and in our opinion takes it far too seriously. A gene he considers to be a vital unit "which controls energy, material, and pattern; out of which definite form develops." It is becoming every day clearer *that a "gene" is not a definite unit of structure at all, but simply the measure of the amount of pathological damage which the hereditary substance has undergone.* It is a measure, in a word, of the "imperfection of regulation." The differences between two allied natural races are not measurable in genes but in different adaptations; the overwhelming majority of Mendelian mutations arise under the unhealthy circumstances of domestication: they are nearly all recessive to the parent strain, from which they differ not only in special diagnostic marks but in weaker constitutions; in the few cases where they are dominant to the normal form they are generally so virulently pathological that when crossed with their like the results are lethal.

It seems to us after careful perusal that all that Prof. Reinke states as to the peculiarity of living processes has been said many times before. Reinke's influence of "the whole on the parts," and his "dominants" are simply Driesch's entelechy in other language—while so long ago as the early 'eighties Tyndall stated that it was not the nature of the forces manifested in living matter but their combination which constituted the miracle of life. The importance of the book consists in the tardy recognition, by a leading botanist, of the impossibility of explaining life by physics and chemistry alone.

Prof. Lundegårdh's "Zelle und Cytoplasma" is one of a series of text-books devoted to the elucidation of the anatomy of plants, and consequently it is concerned almost exclusively with the cytology of vegetable cells.

It is beautifully illustrated, and so far as plants are concerned the information contained in it is well up-to-date; but the author seems to be less well informed on the most recent advances in animal cytology. It is a characteristic botanical point of view to attempt to deny, as he does, the all-importance of the nucleus in the transmission of hereditary qualities. According to him the nucleus derives its importance only from containing in it some links in the chain of chemical reactions which make up metabolism. Nature's critical experiment in the formation of the animal spermatozoon is ignored by him. When we find that in animals the sole contribution of the father which contains the basis of all his hereditarily transmissible qualities is a condensed nucleus, the question as to the function of the nucleus seems to be decisively answered.

Lundegårdh agrees with Reinke in considering protoplasm to be a mixture of various colloids of different chemical composition. He emphasises the enormous variety of chemical changes which such a constitution would entail, and with the perpetual change from sol to gel and *vice versa*; he shows that the visible structure must be continually altering and that the granular theory of the constitution of protoplasm propounded by Altmann, the filar theory of Flemming, and the foam-work theory of Bütschli, may all be to a certain extent true under certain conditions, but that under other conditions there may be no visible structure at all, and that the living material may present the appearance of a homogeneous fluid. He, like Reinke, will have nothing to do with a hypothetical ultramicroscopical constitution of invisible units as an explanation of life. He condemns with equal severity the supposed difference between "idioplasm" and "somatoplasm," and he sharply criticises the unthinking acceptance of what can be seen in preserved specimens as a true indication of what exists during life. It is here that his arguments would be very much reinforced by a better acquaintance with the results obtained by Chambers and Seifert in the microdissection of living cells. The attempt to constitute the mysterious mitochondria into permanent cell-organs is equally opposed; he asserts that they are secondary formations, and that in the growing point of Anthoceros the youngest cells are devoid of them but that they appear in the older cells.

The great defect of Lundegårdh's exposition seems to us to be his failure to show how a mixture of substances with their consequent reactions can be an explanation of the typical character and persistence of living phenomena. When a mixture of substances is enclosed in a test-tube definite reactions are set up which progress towards a state of eventual equilibrium, and an end-state is reached with a mixture of different substances and in different proportions from that with which we started. In protoplasm, on the contrary, the typical nature and proportions of the mixture must somehow be maintained even in spite of increase in quantity—and these facts cannot be explained by any purely physical and chemical analysis.

Prof. Nageotte's book is widely different from the other two. Although it professedly deals with the relation of matter to life, it really consists of the record of a series of fascinating experiments on animal grafts. The results obtained are new and startling, but they are illustrated by what can only be termed an extremely bad series of figures. These are prints from photographs, hazy and very insufficiently lettered, and we can only deplore that such good work should be misrepresented by such feeble illustrations.

We have said that Nageotte begins by condemning vitalism. He states that the essential peculiarity of living things is not their chemical constitution, but a certain order in what he terms the micellar structure, the micellæ being supra-molecular complexes. Agreed; but it is precisely the genesis and maintenance of this order which is the inexplicable fact in living things. Nageotte even tries to prove that there is a transition between dead proteid and living protoplasm, and as the principal support of his anti-vitalistic attitude is based on this supposed transition we must examine it in some detail. He proceeds as follows: Some dog's blood collected in a test-tube is enclosed in a capsule of collodion open at one point. This is introduced into the peritoneal cavity of another dog, the open end of the capsule being in contact with the peritoneum. At the end of eight days the capsule is found to be completely encysted: the blood has clotted by the formation of radiating fibres of fibrin, but the opening of the capsule is plugged by a cork of fibrous tissue richly supplied by the host's blood-vessels. Now Nageotte maintains that the regularly arranged bundles of fibres of the fibrous tissue are produced by the gradual transformation of the radiating fibrin fibres; that the immigration of fibroblasts (*i.e.* connective tissue cells) is secondary, and finally that these elementary fibres can grow by intussusception from the fluid surrounding them. The whole of the supposed transition is based on the arbitrary inclusion of intercellular substance in the term living matter. Nageotte protests vehemently against what he terms the "exoplasmic theory," *i.e.* the view that this substance is the product of the secretion or bodily alteration of the exoplasm of the connective tissue cells; he terms it "the internal medium." But if he were an embryologist instead of merely a surgeon and an anatomist, he would see clearly that historically there is no other possible origin for his internal medium except the secretion of the surrounding cells: and he himself admits that subsequent changes in it only take place under the influence of living cells in the neighbourhood. Whether this influence is exercised, as he supposes, by the emission of ferments or by the production of secretion is a minor matter. If in company with the vast majority of histologists we regard the intercellular material as dead, then the validity of the supposed transition is destroyed.

Among the most startling of Nageotte's results is the discovery that it is possible to graft into a living animal a piece of connective tissue which has been preserved in alcohol or formaline. A piece of tendon thus treated introduced under the skin of the ear of a rabbit becomes invaded by the surrounding "fibroblasts"; its bundles of fibres become connected up at their ends with the surrounding connective tissue, and thus definitely incorporated in the skeletal framework of the ear. When a piece of dead cartilage is similarly treated still more curious results ensue. The neighbouring "fibroblasts" surround it and form a new perichondrium. These cells invade the capsules of the cartilage laid open by the section. These invading tongues burrow into the cartilaginous substance, forming cavities which they surround by newly formed *bone*, although there is normally no bone whatever found in the rabbit's ear.

If a segment of an artery of one dog preserved in alcohol be inserted between the cut ends of the artery of another dog, it becomes clothed with an endothelium: its layers of elastic and connective tissue become continuous with those of the artery of the other dog at both ends; and it becomes provided with new smooth muscle fibres, which appear from the transitional forms observed to be modifications of connective tissue cells.

We pass now to Nageotte's experiments with cut and regenerating nerves and nerve grafts. As all are aware, there have been two leading theories of nerve structure. According to the older, nerves are formed by chains of cells the protoplasm of which becomes differentiated in place into nervous fibrils. According to the newer and almost universally accepted view, first firmly established by Ramon y Cajal, the nerve fibre or axon throughout all its length is the outgrowth of a single cell, the neurone or neuroblast. When it is cut the distal portion of the fibre, being separated from the influence of the nucleus contained in the neuroblast, undergoes "Wallerian" degeneration: the proximal stump grows out again into the old sheath, and so the fibre is regenerated. According to Nageotte, both theories are true. The axon, or, as he terms it, the "neurite," is the outgrowth of the neuron, but it can only grow along chains of ectoderm cells which constitute the sheath of Schwann. The only exception to this rule is when the axon reaches the ectoderm itself; in this medium it grows as a "naked" fibre. The medullary sheath belongs to the axon itself; it is produced by the confluence of mitochondria, and it is broken up and absorbed when the axon degenerates. When a nerve has been cut and the axons have degenerated, there ensues a rapid proliferation of the bands of ectoderm cells both at the proximal and distal sides of the cut: these bands form networks, and both cut ends may assume the aspects of swollen knobs. The upper of these is termed by Nageotte the "neurome," the lower the "gliome." The neurome becomes invaded by new axons; many of these get into lateral branches of the ectodermal network and never reach their destinations, but when neurome and gliome meet, as they eventually do, some axons penetrate the lower part of the nerve and so function is restored.

Nageotte has also established the remarkable fact that if a piece of a nerve be cut out and employed as a subcutaneous graft it becomes the centre of a nodule of firm, tough connective tissue, evidently showing that the cells of Schwann emit some substance which acts as a stimulus to the production of this kind of tissue. For this reason, when a long portion of a nerve has been lost and a graft is necessary to restore continuity, a graft of dead artery or tendon is often more effective than one of dead nerve.

The outstanding result of Nageotte's researches seems to us to be that the connective tissue cells have the power of acting as bone-cells, cartilaginous cells, "fibroblasts," or even smooth muscle fibres, according to the circumstances in which they are placed; that in Driesch's words the prospective fate of a cell is determined not by its nature but by its position—that "Ein jedes jedes kann" and this is a vitalistic conception, not a chemical or physical one.

E. W. MACBRIDE.

Early Mathematical Instruments in Oxford.

Early Science in Oxford. By R. T. Gunther. Part 2: Mathematics. Pp. 101. (London: Oxford University Press, 1922.) 10*s*. 6*d*. net.

THREE years ago a very interesting exhibition of early scientific instruments in Oxford was held at the Bodleian Library. A small printed list or catalogue of the exhibits was prepared at the time by Mr. Gunther, to whom all those interested in early scientific instruments are much indebted for bringing together the various early examples existing in the colleges of the University of Oxford, and making them available for inspection. It was intended that this small catalogue should form the basis of a more comprehensive work dealing with the history of science at Oxford, chiefly on the instrumental side. The first instalment (Chemistry) of this larger work was printed as a booklet in 1920 and afterwards published (see NATURE, March 3, 1921, p. 13). The second instalment, dealing with mathematics, has now been issued.

The stated object of Mr. Gunther's work is "to draw attention to such material objects of value as still remain to us, with a view to their better preservation, and to reviving the memory of the clever men who really helped science forward by the invention of practical methods, and by the cunning of their craftsmanship."

The first part of the booklet consists of "Notes on Early Mathematicians." One of the first mathematicians connected with Oxford was Daniel of Morley, who resided there in the year 1180, but went to the mathematical school at Toledo to complete his studies, and afterwards returned to this country as a teacher. The best known mathematician of this early period was the Yorkshireman, John of Holywood (Sacrobosco), who died in 1244. In the fourteenth century Richard of Wallingford, Thomas Bradwardine, John Maudith, Simon Bredon, John Ashenden, William Rede, and others, raised Oxford mathematics to a high level, and at that time "Oxford could boast more Mathematicians than any other country in Europe."

During the next century the study of mathematics was at a low ebb; in the middle of the century the only mathematical subjects required at Oxford for the master's degree in the *quadrivium* were the first two books of Euclid and the astronomy of Ptolemy. Cuthbert Tonstall (1474–1559) and Robert Recorde (1510?–1558), the only two English mathematicians of note during the first half of the sixteenth century, commenced their studies at Oxford, but found that they could continue them better at Cambridge, and

Mr. Gunther regards them as "the founders of what has been the most brilliantly successful mathematical school in the world."

Considerable space is given to Recorde's work, and it is remarked that "although Recorde was a Fellow of All Souls, yet two years back his name was quite unknown there, and not one of his numerous printed books is in the College Library." It has been possible, however, from existing documents, to reconstruct the catalogue of Recorde's private library, and this is given. The first section closes with references to the work of Edmund Gunter (1581–1626), William Oughtred (1574–1660)—not an Oxford man, but a clever mathematician who "appears to have given private tuition in mathematics to many Oxford men,"—Christopher Wren (1632–1723), Seth Ward (1617–1689), John Wallis (1616–1703), and Nathaniel Bliss, who was Savilian professor of geometry from 1742 to 1765.

The second part consists of a descriptive list of early mathematical instruments belonging to the University and colleges of Oxford, including some allied instruments in the collections of the Royal Society, Mr. Lewis Evans—whose large and valuable collection, at present exhibited in the Bodleian, is now offered as a gift to the University (see NATURE, December 9 and 16, 1922, pp. 783, 828),—and a few others. Of special interest is the seventeenth-century oak chest—*cista mathematica* (Fig. 1)—in the Bodleian Portrait Gallery, which originally contained the various demonstration models of the Savilian professors, as detailed in the 1697 catalogue of the Bodleian Library. In spite of its three different locks, the only portions of the original equipment now remaining are two small beechwood spheres. Other interesting objects described are the "Circles of Proportion" of Oughtred, and the instruments from the Orrery collection in Christ Church College. This collection, which consists of elegant examples of the work of John Rowley and others at the beginning of the eighteenth century, has been "shut up in a cupboard" since 1731, the year in which it came to Christ Church as part of a bequest of Charles Boyle, fourth Earl of Orrery.

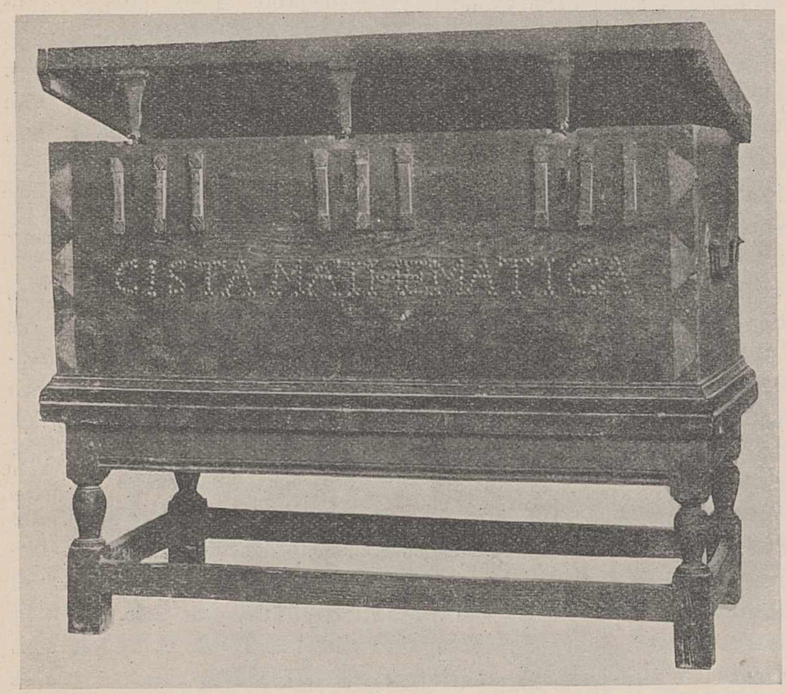

FIG. 1.—Cista Mathematica. By the courtesy of the Librarian of the Bodleian Library.

The excellent condition of most of these instruments affords ample testimony to the efficiency, in this instance, of the "shut cupboard" method of preservation. Unfortunately, this happy result is exceptional, the more usual experience being of the Mother Hubbard type. Such collections, formed so that posterity may be able to see actual examples of the fine work performed by makers in the past, in some way or other often dwindle, disperse, or disappear. Various causes—war, fire, the carelessness or ignorance of a custodian, exigencies of space required for other purposes, the transference of such objects from one department to another concerned only with modern developments and with no sense of the high value of actual early instruments as original documents—tend to produce such a result. Experience in all countries shows that the safest and most efficient way to preserve such specimens of the work of men who have played a big part in the development of modern civilisation is to exhibit them under the proper conditions of security afforded by a national museum, so as to be available continuously for inspection. A Museum of Science should be rich in such objects, which testify in a very real manner to the state of advancement in past times in the art of constructing scientific instruments.

The last part of Mr. Gunther's book consists of short notes, arranged in chronological order, on mathematical instrument makers from the latter part of the sixteenth to the early part of the nineteenth century. We look forward with interest to the publication of the next instalment, which will deal with astronomy at Oxford.

Our Bookshelf.

Principles and Practice of Butter-Making. By Dr. G. L. McKay and Prof. C. Larsen. Third edition, largely rewritten. Pp. xiv+405. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 15*s.* net.

THE volume under notice is the third edition of one of the best-known American books on commercial butter-making; it deals with the subject with great thoroughness, and contains information which has been collected from the best sources. The introductory chapters give an account of the composition of milk, its secretion, and the conditions which influence secretion. Next come the properties of milk, and these are followed by an account of the changes which milk undergoes when heated. In an account of the peculiarities of butter fat, stress is laid upon the great value of this fat in nutrition, owing to its content of the fat soluble vitamin A. There are chapters on the enzymes and bacteria found in milk, and the causes which induce variations in the percentage of fat.

Sampling and testing of milk and cream, both from the point of view of fat content and suitability for butter-making, are dealt with, and the best creamery methods for the estimation of fat in butter are given, while there are also chapters dealing with modes of payment for milk and cream delivered to the factory.

The various types of separators and the best means of separating milk naturally occupy a prominent place, and the preparation of the cream for churning is fully discussed. Excellent chapters are written upon the churning, working, washing, and finishing of butter from the point of view of creamery practice. Packing and marketing of butter; defects and their causes; judging and grading; storing, particularly cold storage (descriptions of the plant are also given), are all dealt with fully.

Handbook of Commercial Geography. By Geo. G. Chisholm. New edition. Pp. xvi+824. (London: Longmans, Green and Co., 1922.) 25*s.* net.

ALL geographers and economists will welcome this new edition of Mr. Chisholm's well-known work with its scrupulous accuracy of detail. The previous edition was published eleven years ago: the present, a ninth edition, was almost ready when war broke out in 1914. The necessary delay in publication has enabled Mr. Chisholm to revise the book according to the present condition of the world. The book has been reset throughout, which has allowed the incorporation in the proper places in the text of the matter in several of the introductions of earlier editions, and the chapter on trade routes. The section on the British Isles has been extended considerably. Several new maps have been added including rainfall and actual temperature charts. The valuable statistical appendices have been revised to 1913 and increased in number. A new feature is a long list of alternative geographical names. While the book has grown, its well-known features remain unchanged, and few works of reference are better arranged or indexed than this standard volume on commercial geography. It is a monument of painstaking research, clear thinking, and encyclopædic knowledge, indispensable not only to every serious student of geography and economics, but also to all engaged in trade and commerce.

The Canary Islands: Their History, Natural History, and Scenery: An Account of an Ornithologist's Camping Trip in the Archipelago. By D. A. Bannerman. Pp. xvi+365+pl. (London: Gurney and Jackson, 1922.) 30*s.* net.

THE problems presented by insular faunas and floras are of the greatest interest both to the student of geographical distribution and to the geographer. Chapters V. and VI. of this rather uncomfortably heavy book deal respectively with the affinities and origin of the Canarian flora, the modes of dispersal of the trees and plants, the distribution of animal and bird life in the Canary Islands, and some problems which they suggest. The author gives numerous examples of the influence of complete isolation on the differentiation of birds no longer able to interbreed with the continental stock from which they sprang; and in some cases, *e.g.* that of the Fuerteventura bustard, is able to suggest how the local conditions may have contributed towards the selection of geographical subspecies. The chapters on the origin, geology, and physical characteristics of the islands are convenient summaries for the general reader, while references to larger works and original papers will enable those who wish to consult the first-hand authorities.

Les Maladies parasitaires des plantes (Infestation-Infection). Par M. Nicolle et J. Magrou. Pp. 199. (Paris: Masson et Cie, 1922.) 8 francs.

TWO doctors of the Pasteur Institute have collaborated on the production of a text-book chiefly for the benefit of the medical profession. The ground covered is very wide, including diseases due to both insects and fungi. Part I. deals largely with gall formation, with short chapters on acarids and nematodes. The remaining parts give an outline of the diseases due to phanerogams, fungi, and bacteria, with a general discussion of such questions as virulence of attack and resistance to disease. The complete absence of illustrations is a very serious drawback, even though it be considered necessary on account of cost. A further disadvantage is the lack of a bibliography, which would partly have compensated for the very brief treatment of each subject. In other ways the book is well produced and will serve a useful purpose in making information on plant diseases available to medical men.

Clocks and Watches. By G. L. Overton. (Pitman's Common Commodities and Industries Series.) Pp. ix+127. (London: Sir Isaac Pitman and Sons, Ltd., 1922.) 3*s.* net.

MR. OVERTON has given us a most useful and interesting volume, describing the gradual evolution of time-pieces from the early water clocks, through the balance clock, down to the modern pendulum clocks and chronometers. There are many illustrations, and the various methods of compensating for temperature are described in plain non-technical language. In addition there are details, probably new to many readers, relating to the striking mechanism of clocks and of repeater watches. The latter are stated to have come to an end when the introduction of lucifer matches made it easy to read an ordinary watch at night. There is a chapter dealing with the artistic side of the subject, and describing several clocks and watches of special interest and beauty. It is altogether a book that will appeal to the general reader quite as much as to those specially interested in time-determination.

A. C. D. C.

Anthracite and the Anthracite Industry. By A. Leonard Summers. (Pitman's Common Commodities and Industries Series.) Pp. x+126. (London: Sir Isaac Pitman and Sons, Ltd., 1922.) 3*s*. net.

THIS book seems to be a combination of a scientific manual and a coal-dealer's propaganda circular. With some useful information about anthracite, we find other matter—on p. 26 a statement that in 1921 the South Wales coal-owners were losing 25,000,000*l*. a year because of "unwanted young men—'hot-heads' and agitators" in the mines—an example of "what the industry is up against"; on p. 69 we have a series of testimonials in the approved style, and "tourist facilities in the beautiful anthracite district" in Chapter II. The printing of advertisements on the reverse of the title-page is also distracting. When information about anthracite is encountered in the book it proves interesting, but some patience is required to find it. "Tar," we are told on p. 112, "also contains chemicals, such as carbolic acid and saccharine."

Polarity. By Geoffrey Sainsbury. Pp. 48. (London: The Favil Press, Peel Street, W. 8., 1922.) 3*s*. 6*d*.

MR. SAINSBURY'S artistically printed little book consists of a series of short essays on sex, religion, education, society, and ethics. The point of view of the author is unusual and independent, and it demands that the reader's mind should free itself from many placidly accepted concepts. Polarity, the author thinks, has never been adequately considered, as man invariably tries to bring the problem of life and all attendant problems down to a single issue. Polar conflict is to be seen everywhere, and innumerable problems hinge upon this relationship and to none of this type can there be any final answer. There is also a plea for a willingness to see knowledge from a more general, instead of the extremely specialised, point of view. There will be many readers who will dissent from the views here set forward, which will certainly stimulate thought.

Man—The Animal. By Prof. W. M. Smallwood. Pp. xv+223. (New York: The Macmillan Co.; London: Macmillan & Co. Ltd., 1922.) 12*s*. net.

PROF. SMALLWOOD'S little book is interesting but confessedly "popular," and therefore fraught with the difficulties that are inseparable from all "popular" presentations. Its object is to summarise the discoveries of recent years, to indicate some of their relations to the more fundamental problems of man's physical existence, and to give a deeper insight into the characteristics which man has in common with all life, and which exercise a profound influence on his entire existence. The chapters on reproduction, heredity, the problem of learning, and biology and progress are especially well done. The whole book, though not absolutely free of error, is worth reading, and will be especially appreciated by readers possessed of biological knowledge.

Chemistry and its Uses. A Text-Book for Secondary Schools. By W. McPherson and W. E. Henderson. Pp. viii+447. (London: Ginn and Co., 1922.) 7*s*. 6*d*. net.

THE text-book before us is intended for use in American high-schools, and would probably be very suitable for that purpose. It is written from the point of view of the patriotic American, and naturally refers principally to American conditions. There are some reproductions of portraits of well-known chemists. Each chapter is provided with exercises, and a rough equality of division is adopted between pure and applied chemistry (including organic chemistry, treated very superficially). There are numerous illustrations of labelled bottles: even assuming that these contained what is represented when they were photographed, the value of the pictures is not at all clear. Surely it is not intended that they shall replace actual acquaintance with real substances? The actual text is clear and accurate, so far as it was examined, and the book would interest English teachers.

Chemistry for Beginners and Schools (with Glossary). By C. T. Kingzett. Fourth edition. Pp. vii+237. (London: Baillière, Tindall and Cox, 1922.) 5*s*. net.

THE continued demand for Mr. Kingzett's book indicates that it is serviceable to numbers of readers. It is clearly written, and contains many interesting experiments. The glossary will also be found useful by beginners; surely, however, "lixiviate" is commoner than "lixurate" (p. 212)? The section on "Force and Energy" (pp. 34-52) requires revision. It is very much out-of-date in parts, and not up to the standard of the rest of the book: the statement that "electricity, like heat and light, is a form of force" (p. 45), although it may have been true for Faraday, is not so to-day. The book is scarcely suitable for schools, as it provides no systematic course—the experiments are introduced at random.

Concrete and Reinforced Concrete. By W. N. Twelvetrees. (Pitman's Common Commodities and Industries Series.) Pp. x+137. (London: Sir Isaac Pitman and Sons, Ltd., n.d.) 3*s*. net.

THE general reader will find a great deal of interesting matter in this book, which is explanatory and practically free from calculations. Sufficient is given to make clear the nature of the materials employed and their combination, and the author has included a number of examples of finished work which convey a very good impression of the extent to which concrete and reinforced concrete have been employed, and of their possibilities. There are some historical notes, from which we gather that the ancient Egyptians were thoroughly familiar with concrete, as is proved by a fresco in the temple of Ammon at Thebes, depicting hieroglyphically the making and use of concrete in the year 1950 B.C.

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.*]

On the Missing Element of Atomic Number 72.

SINCE Moseley's discovery of the fundamental laws of the X-ray emission, it has become quite clear that the most simple and conclusive characteristic of a chemical element is given by its X-ray spectrum. In addition, Moseley's laws allow us to calculate very accurately the wave-lengths of the X-ray spectral lines for any element in the periodic table, if those of the elements in its neighbourhood are known. Taking into account that the presence of a very small proportion of a definite element in any chemical substance suffices to give a good X-ray spectrum of this element, it is quite evident that for the eventual discovery of any unknown element X-ray spectroscopy, especially as it has been developed by Siegbahn, represents the most effective method.

In the *Comptes rendus* of the Paris Academy of Sciences for May 22, 1922, Dauvillier announced the detection by means of X-ray spectroscopy of the element 72 in a mixture of rare-earth metals. This element was identified by Urbain with a rare-earth element, which he called celtium, the presence of which he had previously suspected in the same sample. For different reasons, however, we think that Dauvillier's and Urbain's conclusions are not justified. It appears from Dauvillier's paper that at any rate the quantity of the element 72 in the sample, if present, must have been so small that it seems very improbable that the element 72 should be identical with the element which in former papers Urbain claims to have detected in the same sample by investigation of the optical spectrum and of the magnetic properties. The only lines which Dauvillier claims to have detected are the lines $L\alpha_1$ and $L\beta_2$, both of which he finds to be extremely faint (*extrêmement faible*). The wave-lengths he gives, however, for these lines are about 4 X.u. (1 X.u. $=10^{-11}$ cm.) smaller than those which are obtained by a rational interpolation in the wave-lengths tables of Hjalmar and Coster, for the elements in the neighbourhood of 72.

From a theoretical point of view it appears very doubtful that the element 72 should be a rare-earth. It was announced in 1895 by Julius Thomsen from Copenhagen that from general consideration of the laws of the periodic system we must expect between tantalum, which in many compounds possesses 5 valencies, and the trivalent rare-earths, a tetravalent element homologous to zirconium. The same view has also recently been put forward by Bury on the basis of chemical considerations, and by Bohr on the basis of his theory of atomic structure. It is one of the most striking results of the latter theory, that a rational interpretation of the appearance of the rare-earth metals in the periodic system could be given. For these elements, according to Bohr, we witness the gradual development of the group of 4-quantum electrons from a group containing 18 electrons into a group of 32 electrons, the numbers of electrons in the groups of 5- and 6-quantum electrons remaining unchanged. Bohr was able to conclude that in the element lutecium (71) the group of 4-quantum electrons is complete, and we consequently must expect that in the neutral atom of the next element (72) the number of electrons moving in 5- and 6-quantum orbits must exceed that in the rare-earths by one. The element 72 can therefore not be a rare-earth but must be an homologue of zirconium.

In view of the great theoretical importance of the question we have tried to settle it by an experimental investigation of the X-ray spectrum of extractions of zirconium minerals. We have succeeded in detecting six lines which must be ascribed to the element 72 (in Siegbahn's notation $L\alpha_1$, α_2, β_1, β_2, β_3, and γ_1). The complication was met that the lines $L\alpha_1$ and α_2 lie almost exactly in the place corresponding in the spectrum to the zirconium $K\alpha_1$, and α_2, lines in the second order. Difficulties which might arise from this fact may easily be avoided by keeping the tension on the tube between the critical tension of the zirconium K-lines (18,000 volts) and that of the L-lines of the missing element (10,000 volts). Besides, the relative intensity of the $K\alpha$ lines is so different from that of the two $L\alpha$ lines that any ambiguity is already thereby excluded. Not only the $L\alpha$ lines but also the lines $L\beta_1$, β_2, and β_3 were, as regards their mutual distance and their relative intensity, in exact agreement with the expectation. The values which we obtained for the wave-lengths of the six mentioned lines all agree within one X.u. with those found by interpolation. Between our values for the lines $L\alpha_1$ and $L\beta_2$, and those published by Dauvillier, however, there exists the discrepancy referred to of about 4 X.u. (in general for other elements which have been measured by Dauvillier and by Coster the discrepancy is never more than 2 X.u.). Exposures under different conditions as well as a thorough discussion of the plates showed that the new lines found during our investigation cannot be ascribed to the first or higher order spectrum of any other known element. Our provisional results are: $L\alpha_1=1565{\cdot}5$; $\alpha_2=1576$; $\beta_1=1371{\cdot}4$; $\beta_2=1323{\cdot}7$; $\beta_3=1350{\cdot}2$; $\gamma_1=1177$ X.u. More accurate and complete data as well as photographs of the spectrum will soon be published.

In a Norwegian zirconium mineral the new lines were so intense that we estimate the quantity of the element 72 present in it to be at least equal to one per cent. Besides we investigated with low tension on the tube a sample of "pure zirconiumoxyde." Also with this specimen the $L\alpha$ lines were found, but very faint. It seems to be very probable that ordinary zirconium contains at least from 0·01 to 0·1 per cent. of the new element. Especially the latter circumstance proves that the element 72 is chemically homologous to zirconium. Experiments are in progress to isolate the new element and to determine its chemical properties.

For the new element we propose the name Hafnium (Hafniae = Copenhagen).

D. COSTER.
G. HEVESY.
Universitets Institut for teoretisk Fysik,
Copenhagen, January 2.

Continental Flotation and Drift.

THE theory that the continents have shifted their positions during geological time and, possibly, are still in motion has lately excited much discussion. The principal obstacle to its acceptance is the difficulty of adducing a force adequate to bring about the movements. Many years ago Osmond Fisher ("Physics of the Earth's Crust" p. 339) ascribed general continental movements of this kind (accounting for the Atlantic rift, etc.) to the disturbance of the Pacific basin due to the genesis of the moon, on Darwin's well-known theory. Lately, Wegener has brought forward much evidence in favour of continental movements. But I do not think he has discovered any adequate source of the motion. The *polefluchtkraft* is too feeble; it is purely meridional in direction and is inconsistent with the existing distribution of the land. It is probably ineffective. A differential soli-lunar attraction on the emergent features of the continents is obviously inadequate. The fact is Wegener works out the theory on the basis of a westerly drift of the continents. In doing so I think he is in error. An adequate force appears available provided an easterly drift is postulated; and so far as I can see the theory grows in probability when examined from the new point of view.

According to Sir George Darwin, the tidal effects of sun and moon acting on "a stiff yet viscous planet" ("The Tides," p. 277) must produce a retardation of the surface crust relatively to the interior. He states that this is speculative as regards the earth; but this was written twenty-five years ago. The great fact of the isostatic compensation of the continents, proving their flotation in a viscous magma, was not then supported by such strong evidence as Hayford and others have since adduced. I assume that the differential motion exists (or formerly existed) and that the floating continents possess a slightly less rotational velocity than the deeper parts of the underlying magma, the velocity of which continues to increase downwards until a more rigid interior is reached.

The consequence of this assumption is that the eastern velocity of every land area on the globe depends to some extent upon its downward penetration into the sustaining magma. A continent upon which a great geosynclinal loading is progressing becomes acted upon by the faster moving layers and is exposed to a force which is continuous and relentless, and the intensity of which depends on the area and depth of the protuberance. Whether the resultant motion of the continent will be due east, relative to the surface crust, or whether it will take up a turning or rotational motion, will depend on the location of the applied force. If excentric a rotational movement must ensue. If uniform over the continental area—as in the case of a great "revolution" or oceanic invasion—the drift will be towards the east.

According to this view, America did not leave Europe and Africa but was left behind by them. Their increased easterly velocity was, possibly, ascribable to the great Laramide submergence of South Europe, South Asia, and North Africa. (The tidal effect is greatest in equatorial regions.) In a similar manner New Zealand left Australia: the force in this case being plainly referable to the isostatic compensation demanded by the lofty ranges of New Zealand. So also Ceylon was torn from Peninsular India; the fracture line of the eastern Asiatic coast was produced, etc.

As regards mountain elevation it is evident that, while from the present point of view mountain building is in every case ultimately referable to tidal forces, mountains may develop in different circumstances. They may, in central continental areas, be conditioned partly by magmatic pressure from beneath, partly by crustal pressure. In such a case as the western mountains of America the magmatic pressure eastwards must be the principal agent. The continental movement gives rise, in this case, to a depression of the bordering ocean floor—a "wake." But, again, continental movements may give rise to mountain chains by the direct pressure between land masses. In this manner the Himalayan chains probably originated. The force arising out of the compensation required by the great and lofty central plateaus of Asia sufficiently accounts for a turning movement around the more stationary features of Peninsular India and the Arabian Plateau. This is in harmony with the current view that the fold-mountains of Asia were diverted by the resistance of those massive earth blocks.

J. JOLY.

Trinity College,
Dublin, December 31.

SINCE my return from the Falkland Islands a few months ago I have followed with great interest the course of the discussion in the columns of NATURE which has ensued upon the publication by Prof. Wegener of his revolutionary views on the flotation and drifting of continental masses. During my recent geological survey of the Falkland Islands I was very greatly impressed by the extraordinary similarity of the geology of the Islands to that of Cape Colony. The geological succession comprises rocks ranging in age from Archæan to Permo-Carboniferous, although rocks of Cambrian, Ordovician, and Silurian age appear to be absent. The oldest rocks closely resemble some of the Archæan rocks of Cape Colony; and from the Devonian to the Permo-Carboniferous the lithological and palæontological succession is practically identical in the two areas. The post-Triassic dolerite dykes of the Falklands are also very like the intrusions of the same age in Cape Colony. The east and west folding so evident in the southern part of Cape Colony makes the most conspicuous feature in the Falkland Islands. The only notable point of difference in the two areas is that whereas in Cape Colony the lowest division of the Cape System (Devonian), namely the Table Mountain Series, is much folded, the corresponding rocks in the Falkland Islands have escaped such disturbance and lie almost horizontal, or with only a gentle dip, over an area of many square miles. The equivalents of the middle and upper members of the Cape System (Bokkeveld Series and Witteberg Series) are, however, intensely folded in the Falkland Islands.

From the orthodox point of view one has to believe in the persistence, in minute detail, of a stratigraphical sequence representing the passage of a great period of geological time, across the 5000 miles of ocean which separate Cape Colony from the Falkland Islands, and, in face of the array of facts marshalled into such an orderly and effective host by Wegener and again by Du Toit, this becomes, on a sudden, an unexpected strain upon one's faith.

In discussing the ice-fields of Gondwanaland in his very interesting paper, "Land Connections between the Other Continents and South Africa in the Past" (*S. Afr. Journ. Sci.*, pp. 120-140, Dec. 1921), Dr. Du Toit states that in the Falkland Islands the centre of origin of the ice is unknown. I was able, during my survey of the Islands, to note that wherever the glacial tillite at the base of the Permo-Carboniferous sequence was adequately exposed it was always possible to collect a varied assortment of rocks occurring as erratic boulders in the deposit, and certain types, such as pegmatite, a coarse granite, and a pink quartzite, never failed to occur. The one and only exposure of Archæan rocks in the Colony occurs at Cape Meredith, the southernmost point of West Falkland, and when I examined that area I readily recognised the pegmatite, granite and quartzite occurring there as similar to the ubiquitous boulders of the tillite. Subsequent microscopic examination confirmed the identity of the rocks.

With regard to the direction of the striæ on glaciated surfaces underlying the tillite, I never came across a really convincing exposure, but in a few places on both East and West Falkland I noted, on the smoothed surface of the quartzite beneath the tillite, what I regarded (although with some doubt) as glacial striæ, and in every case the markings ran about N. and S. (magnetic). The evidence suggests movement of the ice from south to north, but we have no knowledge as to whether there did not exist, in Palæozoic times, an exposed mass of ancient rocks to the northward of the present Islands.

HERBERT A. BAKER
(late Government Geologist for the Falkland Islands).
Wood View, Grosmont Road,
Plumstead Common, London, S.E.18,
January 3.

The Determination of *p*H of Microscopic Bodies.

NEUTRAL red has the almost unique property of being both an intra-vitam stain and a fairly good indicator. It has also low salt and protein errors, as Homer has shown (1917, *Biochem. Journ.* 11, p. 283).

If therefore cells are stained with neutral red, the colour of the stain as observed with the microscope enables one to judge roughly the *p*H within the cell.

Working on certain marine protozoa, I have found a method of greater accuracy than that of merely judging the colour as seen down the microscope. The method is simple and, so far as I am aware, has not been recorded before.

A series of tubes containing solutions of increasing *p*H is made up in the ordinary way, and a few drops of neutral red are added as indicator. A stout cardboard strip is taken and holes are cut in it at intervals so that the strip will carry the series of tubes (each tube fitting tightly).

The strip with the tubes hanging freely below it is now suspended in the window. With the aid of the microscope condenser the series is focussed sharply in the plane of the object which is being examined.

The appearance down the microscope now consists of the stained object and by its side the image of the series of tubes: both are seen against the same background of sky. By simply tilting the mirror the images of successive tubes of different *p*H can be brought into juxtaposition with the object examined. In this way the *p*H of the stained body can be determined by direct comparison.

I have found that the *p*H determined by the above method can be checked roughly as follows. The mirror is tilted so that the image of one of the tubes forms a background against which the object is seen. In these circumstances the object is illuminated by light of the particular quality corresponding to the colour of the tube. A succession of tubes is used in this manner as a background for the object.

When the background transmits the same quality of light as the stained object, the latter appears relatively light and transparent: this occurs when the colour of the object and the background correspond to the same *p*H. If the object is illuminated by light from a tube of higher or lower *p*H, the object appears darker owing to the fact that the light transmitted by the background is not exactly of the same quality as the light transmitted by the object. The *p*H of the background tube against which the object appears lightest corresponds to the *p*H of the object.

It must be admitted that the colour change with the *p*H in the case of neutral red does not render the latter an ideal indicator for the second method, but the effect is quite good enough to be used as a check. Perhaps a better intra-vitam indicator will be discovered in the future, and in that case the method might be developed to a fair degree of accuracy.

In all this work a good achromatic condenser is essential, for the diaphragm must be widely open in order that the colours of both the object and the image of the tubes may be well defined.

When the light is bad or when artificial light is used, the definition of the colours is greatly increased if the light is first filtered through a dilute solution of copper sulphate. Using this filter, the red tint due to the presence of acid appears darker and is more easily seen in lightly stained bodies.

C. F. A. PANTIN.
The Marine Biological Laboratory,
Citadel Hill, Plymouth, December 14.

Divided Composite Eyes.

IT would appear from Mr. Mallock's letter (NATURE, December 9) that our knowledge of the Aleyrodidæ or "White Flies" is not so exact as it might be. This, however, takes too pessimistic a view of the situation. Whilst, undoubtedly, much remains to be done, even with some of the British species, the specific limits of those to which he refers are quite well known to students of the group. Indeed, as a result of my own researches I have been able, in recent communications to the *Entomologist* and the *Vasculum*, to assign our British species to no fewer than four distinct genera, Aleyrodes, Tetralicia, Aleurochiton, and Asterochiton, and the forms mentioned by Mr. Mallock reveal themselves as comprising two genera and three species, namely, *Aleyrodes proletella* L., *A. brassicæ* Walk., and *Asterochiton vaporariorum* West.

Clearly, as no hint is given that any of his insects were bred from *Chelidonium majus*, the figures given cannot represent *A. proletella* as indicated by the legend; they must be referred either to *Aleyrodes brassicæ* or to *Asterochiton vaporariorum*. If *A. brassicæ* is the insect intended, then as a larva it feeds on cabbage, as a pupa it lacks well-developed dorsal papillæ, and in the perfect condition has spotted wings with the median nervure appearing as a short spur. On the contrary, the larvæ of *Asterochiton vaporariorum* can be collected from any of the plants enumerated, its pupæ have dorsal papillæ, and its imago possesses immaculate wings displaying no trace of the media.

To the latter insect belongs the notoriety gained by the so-called "White" or "Tomato" fly during the past twenty years. Unfortunately, this Aleyrodid, although a native of neotropical regions, is so adaptable in its food habits as to be nearly polyphagous and, furthermore, has acquired the habit of wintering at ordinary air temperatures even in this rather bleak locality on the north-east coast. A colony with which I was experimenting in 1921 successfully withstood all the frosts of the winter of 1921–22, the first brood of the present season emerging in May.

A further point I cannot understand is Mr. Mallock's comparison of the life-cycle of the Aleyrodidæ with that of the Aphididæ. So different are the two cycles that I feel sure that some mistake has arisen here. In every detail of their structure and life history their affinities lie rather with the Psyllidæ (particularly with some of the Triozæ possessing scale-like larvæ) or toward the Coccidæ.

Finally, I should like to point out that I am preparing a monograph of the British Aleyrodidæ and should therefore be extremely glad to receive species of the group, more especially if they are accompanied by their respective larvæ and pupæ.

J. W. HESLOP HARRISON.
Armstrong College, Newcastle-upon-Tyne,
December 12.

I AM obliged to Dr. Harrison for remarking on the mistake in my letter in NATURE of December 9 where in one place "Aphides" was written instead of "Coccidæ." The specific name *proletella*, placed under the outline sketch in Fig. 1 *a*, was given on the authority of a well-known entomologist to whom specimens were sent for identification. Dr. Harrison would name this *brassicæ*.

With regard to the number of genera and species to which he refers, the present tendency seems to be to multiply both unnecessarily. Among the various Aleyrodids which I examined there appeared to be considerable variation, and it was possible to collect from the same plant specimens differing in size from large to small through many gradations and having wing spots either well marked or nearly evanescent.

The difference between "species" and "variety" is one of degree, but specific difference may be claimed for races which have so diverged that a fertile mixed race cannot be produced from them. Whether this condition is satisfied in any particular case can only be determined by rather laborious trials, but in the absence of evidence of this kind it would be more correct, and certainly more convenient, while noting small differences (which may be constant in certain circumstances and localities) to treat them as varieties. A. MALLOCK.

9 Baring Crescent, Exeter,
December 21.

Science and Armaments.

I DESIRE to direct the attention of readers of NATURE to a matter which I think to be of importance. During the war of 1914–18 a great number of scientific men, other than those in the medical service, were engaged on work which was devoted entirely to military ends.

Since the armistice there has been some tendency, not unnatural perhaps, to confuse this war work with other researches carried out directly in the service of science. In the Science Library, South Kensington, cheek by jowl with works on atomic theories or relativity, are found such books as one on the organisation of the Army Signal Service, and another on poison gas warfare which adopts most successfully the language of a scientific text-book. In the publications of certain learned societies, nominally concerned with purely scientific aims, are found descriptions of instruments and investigations of almost purely military interest. The collection of war material at the Crystal Palace is shortly to displace the priceless collection of historical apparatus and instruments from the Western Galleries of the Science Museum; the instruments are to go into storage, in a place where they will be inaccessible to the general public, for an indefinite period.

The lamentable implication seems to be that the development of armaments now holds a recognised place as one of the worthiest aims of science, but that is a doctrine which, I trust, is still very much open to question. It is more probable that we simply lack good taste and a proper appreciation of relative values.

I venture to suggest that science would be best served by keeping these things separate. If necessary, let the Government extend a military museum to house such of the material from the War Museum as possesses real interest from the military point of view; it should not be allowed to displace a single instrument from the historical collections. Let us also refrain from filling our library shelves with matter of the kind previously indicated. So may the temple of science be kept free from echoes of human quarrels.

The example of the British expedition sent, in spite of the war, to test the Einstein effect has often been quoted as an outstanding example of the wonderfully dispassionate internationalism of science, but it scarcely bears comparison with the events of a hundred years ago when Davy, taking Faraday as his assistant, travelled to Paris to lecture during the height of the Napoleonic wars. We have gone far since those days—In which direction? L. C. MARTIN.

Imperial College of Science, South Kensington.

Waterspouts.

WITH reference to the letter from Dr. Hale Carpenter (NATURE, September 23, p. 414) describing an interesting waterspout seen over Lake Victoria, a letter has been received in the Meteorological Office from Mr. H. E. Wood, of the Union Observatory, Johannesburg, describing the development of a cloud pendant seen by him on the afternoon of November 19, 1922. The following extract from Mr. Wood's letter describes the occurrence:

"The day was a particularly calm one, the morning was hot with a fairly clear sky, but early in the afternoon there were many cumulo-nimbus clouds in the sky. I noticed particularly the uniformity in the base-level of all the clouds. Just about 3 P.M. I noticed a little pendent cone under one of these clouds and, having seen a waterspout here once before (in 1910) thought this might become one and decided to watch it. The waterspout developed rapidly and I got Mrs. Wood to make a series of drawings of it. Unfortunately the waterspout was rather too far away for photography—it would have been very small taken with an ordinary camera and I had no telephotographic lens available. The interesting feature of the waterspout seemed to me to be the detail of the earth-end (as shown in Fig. 1 reproduced

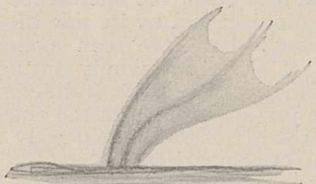

FIG. 1.

from a sketch made at 3.15 P.M.): there was a well-marked "core" surrounded by a less dense sheath. It did not rain in the vicinity of this spout until some time afterward; so that the lower part would probably consist of dust. Later we saw a series of waterspouts in the same vicinity. We estimated (when this particular cloud became an active thunderstorm) that the distance of the waterspouts was about 8 miles and hence that the length of the column or height of the cloud base was about 3700 feet."

The phenomenon noted by Mr. Wood is very similar to that noted by Dr. Hale Carpenter, except that in the present case the part shown in the sketch is probably due mainly to dust raised by the whirl. It is possible, however, that the greater density of the central core is due to condensation of water vapour.

D. BRUNT.

Meteorological Office, Air Ministry,
December 23.

I STOOD watching the effects of an ordinary small whirlwind when a Swahili volunteered the information that similar phenomena were at times to be seen over the sea, but that, in those cases, what one saw was God (*Muungu*) drawing a whale (*nyamgum*) aloft.

Most Swahilis have only a shadowy conception of what a whale is; to them it is a great snake which devours men and even boats. When God is angry with one of these beasts, he lets down a rope by which the monster is caught and drawn struggling to heaven. H. E. HORNBY.

Mpapua, Tanganyika Territory,
November 21.

The Cause of Anticyclones.

IN NATURE of December 23, 1922, p. 845, Mr. W. H. Dines points out that the main features of the pressure distribution of the atmosphere are of a permanent character, and, strange to say, the great areas of low pressure are over the cold poles, while the two belts of high pressure are on both sides of the equator in latitudes 30° or thereabouts; and, so far as the troposphere is concerned, the atmosphere is warm over areas of high pressure. Mr. Dines remarks, "The difficulty should be faced and not ignored."

At the Royal Society, on November 23 last, I had the pleasure of hearing a paper read by Lindemann and Dobson, who have succeeded in determining the temperature of the upper atmosphere (stratosphere) by observations of the luminosity of meteors. They estimate that at a height of 60 km. the temperature of the air is in the neighbourhood of 300° Abs.

In a paper communicated to the *Phil. Mag.* (vol. xxxv., March 1918, p. 233) I gave a diagram showing the probable temperature of the atmosphere between the poles and the equator up to heights of 70 km. This diagram was constructed by plotting the temperatures ascertained by sending up self-registering balloons, and extrapolating for greater heights. At the poles the temperature arrived at was about 285° Abs. at 60 km. In the paper referred to I concluded that the stratosphere over the poles and equator is much hotter than it is over the high pressure belts at latitudes 30° N. and S. of the equator —20° C. or more—and suggested that the winds of the earth are very largely affected by these differences of temperature.

The temperature values found by Lindemann and Dobson showed considerable variations when the results obtained by one falling star were compared with another. I would suggest that the several results they obtained be plotted on a diagram, the ordinates being temperatures at 60 km. and the abscissæ barometric pressures. Knowing the time and position of each falling star, the pressures could be obtained from meteorological charts. My suggestion was that the upper atmosphere is hotter over low pressure areas than it is over high pressure areas.

R. M. DEELEY.

Tintagil, Kew Gardens Road, Kew, Surrey,
December 27.

Soil Reaction, Water Snails, and Liver Flukes.

IN NATURE of November 25, p. 701, Dr. Monica Taylor mentions that the distribution of *Limnæa truncatula* in S.W. Scotland is very local, being rare or altogether absent from certain districts in which sheep are known to be infected with liver flukes. In such districts *L. peregra* is found infected with perfectly developed cercariæ of *Fasciola hepatica*. Free active cercariæ of the latter are also found.

In NATURE of December 23, p. 845, Mr. R. Hedger Wallace directs attention to the prevalence of liver fluke disease in the Swansea valley, where rough pastures have been limed. He asks, "Does liming a wet sour pasture make it more congenial to the water snail?"

For the past year, as occasion permitted, we have been engaged upon the study of the distribution of snail species in relation to the hydrogen ion concentration of the soil and water. A very striking limitation is found for certain species, and but few are found in the more acid habitats. Thus, over quartzite at pH4·8, nothing but a few Hyalinias could be found, whereas around pH7 numerous species exist, including *L. truncatula*. Fewer species are found at pH8, but those that do are often in great numbers, *Helicella caperata* and more especially *H. virgata*. Upland peat soil is usually close to pH4·6, and rough pastures may be between that and pH5·4 or somewhat over, so it seems highly probable that liming such land, by bringing it to the neighbourhood of pH7, does make the conditions more favourable for the snails concerned in the transmission of the disease.

In cases where certain sheep in a flock are infected, it would seem advisable to drive the flock to the most acid soil available, provided it is strongly acid, for in such a site the infected sheep will not be able to infect others, and so the disease may be stamped out or reduced in amount.

Where the neutral or slightly acid soil which appears to favour the occurrence of liver fluke disease is wanting, transference to chalk or limestone soil, at about pH8, may perhaps be equally effective; but it must be remembered that, owing to leaching by rain, the steep places in such districts may be less alkaline, or even acid.

It is very desirable that the limits of distribution of *L. truncatula* and *L. peregra* should be defined in relation to the reaction of the soil and water, and the writers would be glad to receive samples of soil from infected and uninfected localities.

The distribution of snails in relation to soil reaction is similar to that of plants, and it may be added that there is a widespread belief in the west of Ireland that liver fluke disease is caused by eating a certain plant found in fields where the disease has been known to occur. The Gaelic name of the plant was mentioned to one of us, but, unfortunately, it has been forgotten. The distribution of the plant may serve as a guide to the distribution of the snails in question.

W. R. G. ATKINS.
M. V. LEBOUR.

Marine Biological Laboratory, Plymouth,
December 28.

Amber and the Dammar of Living Bees.

IN the issue of NATURE for June 3, 1922 (vol. 109, p. 713), a letter is published from Prof. T. D. A. Cockerell, of the University of Colorado, on "Fossils in Burmese Amber." This refers mainly to amber obtained from the amber mines in the Hukong Valley, which I visited in February 1921. In that letter Prof. Cockerell, after investigating the insects preserved in specimens of the amber, agrees with me in placing the age of the amber-bearing beds as the earlier part of the middle Eocene, there being no doubt that the Nummulites found by me are actually *Nummulites biaritzensis* d'Arch.

In the second part of his letter, however, Prof. Cockerell introduces a new problem. In addition to the specimens from the Hukong Valley amber mines, he mentions a number of beads of extremely pale and pellucid amber which he afterwards received from Mr. R. C. J. Swinhoe, of Mandalay. These contained well-preserved insects all different from those identified in the amber from the Hukong Valley mines. Mr. Swinhoe was uncertain whether these beads were Burmese amber or whether they had been imported from China. Prof. Cockerell, after identifying the included insects in this pale amber, came to the conclusion "that this light amber (or copal) is of very recent origin, not earlier than Pleistocene, and contains a fauna which doubtless consists mainly (at least) of species still living." The point of great interest to me is that among these representatives of still living species he found "a small bee which seems not to differ at all from the common living *Trigona læviceps* Smith."

Now *Trigona læviceps*, or, as it is sometimes called, *Melipona læviceps*, is the actual, or at least chief, source of the common resinous substance known as Dammar (Burmese—Pwé-nyet). These bees build in hollows within trees, crevices among rocks, etc., and line the interior surfaces of their nests with a massive resinous substance. This resinous substance is the common Dammar of the Burmese bazaars, and is used largely by the Burmese for the caulking of boats. Hooper (*Rep. Labor. Ind. Mus.*, 1904–5, 23-4) reports on two samples examined by him. It seems to be the general opinion that it is largely constructed by the bees from the oil and resin of Dipterocarpus.

It seems to me, therefore, that the light amber beads examined by Prof. Cockerell may quite likely be fossil Dammar, or in other words, Dammar deposited in crevices and holes in the earth or rocks by Melipona, which has afterwards been buried up and entombed and fossilised. The inclusion of a specimen of the actual bee in this fossil Dammar would be not only possible but highly probable if such is the case.

Although I do not know the place from which the pale Chinese amber comes, I offer the above suggestion as to its origin; and from what I saw of the actual occurrence of the Burmese amber in the Hukong Valley amber mines it seems to me not unlikely that some such method may be the explanation of its origin also, though in this case one would not expect the depositing insect to be the same species as that depositing Dammar at the present day.

Murray Stuart.

Indo-Burma Oilfields, Ltd., Thayetmyo,
Burma, December 8.

Modern Psilotaceæ and Archaic Terrestrial Plants.

With the establishment of an early Devonian group of vascular cryptogams showing fundamental resemblances with the modern Psilotaceæ, the controversy over the essentially primitive or reduced nature of the latter family may be said to be closed. In spite of important points of difference, the resemblances appear to suffice to link the Psilotaceæ with the most archaic types of terrestrial plants of which the structure is known at all adequately. The object of the present note is to record another piece of evidence pointing in the same direction.

As Kidston and Lang say, "In its anatomy Asteroxylon is most closely comparable with the Psilotaceæ and with Lycopodium" ("Old Red Sandstone Plants," etc., Part III., 1920, p. 667). So far as the leafy shoot is concerned, however, the hollow stele of the Psilotaceæ, as generally described, does not readily fall into line with that of Asteroxylon or Lycopodium, in which the centre is occupied by a more or less compact mass of cauline xylem. It is therefore of some interest to note that one or more cauline strands devoid of protoxylem are normally present in the pith of *Tmesipteris Vieillardi* Dang., an erect terrestrial form said to be endemic in New Caledonia. The medullary strands generally arise from the ring of peripheral strands in the transitional region between the rhizome and aerial shoot, and when traced distally as a rule end blindly in the pith, although they sometimes merge into the peripheral strands. They show a good deal of variation in the degree of their development, generally not extending very far up into the leafy shoot, but their presence is a normal feature of the anatomy.

In this respect, therefore, *Tm. Vieillardi* facilitates the comparison of the Psilotaceæ with the Devonian genus Asteroxylon, and also serves to strengthen their lycopod affinity, already established on other grounds. In a paper read before the Cambridge Philosophical Society (see Nature, June 13, 1918, vol. 101, p. 299) I directed attention to this and other features, in view of which I regarded *Tm. Vieillardi* as the most primitive member of the Psilotaceæ; but the discovery of Asteroxylon adds point to the conclusion there arrived at. It is natural to regard the poorly developed and variable medullary xylem of *Tm. Vieillardi* as a stage in the disintegration of a once continuous and solid cylinder of cauline xylem extending throughout the length of the axis; the hollow steles of *Tm. tannensis* and of Psilotum would thus form the next stage in the reduction. This reduction within the group, however, need not affect the essentially primitive nature of the Psilotaceæ as a whole.

I must add that medullary xylem had previously been recorded in Tmesipteris on two occasions: (i.) by C. E. Bertrand, 1885, "Recherches sur les Tmésiptéridées," p. 248, Fig. 215 (A); and (ii.) by P. A. Dangeard, *Le Botaniste*, 1890–91, p. 17, Pl. XI. Fig. 1. But the nature of the material at their disposal (herbarium specimens) appears to have precluded a detailed investigation by the French authors; they make only a passing reference to the feature in question, apparently considered by them to be only a rare occurrence.

B. Sahni.

Botany Department,
University of Lucknow, India,
December 7.

Action of Cutting Tools.

It is true, as Prof. Andrade points out in Nature of December 30 (vol. 110, p. 876), that I am "not altogether familiar with the work that has already been done on the subject": indeed it is obvious. And after glancing through the 82 pages of bibliography at the end of Prof. E. C. Bingham's "Fluidity and Plasticity," I feel certain that I shall remain in this state. Tresca's Memoirs, however, are very well known among engineers, and they have been quoted and digested by several writers of engineering text-books and papers, but it is doubtful if the practical use of cutting tools has been much influenced by Tresca's work, beautiful and interesting though it is.

The important problem which faces the user of cutting tools is the preservation of the cutting edge under heavy loads, and while Taylor's work is the outstanding contribution on the matter, Mr. Mallock's explanation of the influence of friction on the upper surface of the tool is invaluable to the machinist. The study of the shaving, while perhaps uninteresting to the physicist, is vitally important to the engineer, for, on one hand, the machinist watches the behaviour of the tool very much in the shaving, and, on the other, the plastic flow on the back of the shaving, which produces flat-backed shavings from round-nosed tools, is probably a principal cause of the undesirable heating of the tool, and an important factor in the frictional phenomena involved.

H. S. Rowell,
Director of Research.
Research Association of British Motor and
Allied Manufacturers,
15 Bolton Road, W.4, January 4.

Natural Resistance and the Study of Normal Defence Mechanisms.[1]

By Prof. J. C. G. LEDINGHAM, C.M.G., F.R.S.

CERTAIN aspects of immunity have long baffled the experimental pathologist and are certain to receive in the future more adequate consideration when the fundamentals of the science of immunity, like those of all experimental sciences, come to be relaid.

The phenomena to which I would direct attention come in the category of what is known as natural immunity or natural resistance—a subject vast and many sided—and I would propose to consider simply what amount of light has been thrown on the elucidation of certain well-known instances of natural immunity to bacterial infection, by the study of the bactericidal functions of body cells and fluids. The infection I would choose for illustrative purposes is that of anthrax, largely because it has been in connexion with the peculiar and fascinating divergencies of susceptibility exhibited by animal species towards this infection, that defence mechanisms have been tested with a view of their elucidation.

When one considers the enormous output of literature on immunity which, since the beginning of the century, has followed regularly the discovery of some new defence mechanism, one has reason to feel that some sufficient explanation might have been vouchsafed us for the existence of these peculiar resistances, but as I hope to show you now, there is no subject in immunity which has been so persistently and yet so inadequately explored. The discovery of a new immunity mechanism has led in the first instance, as a rule, to its intensive exploitation for diagnostic or therapeutic purposes, and rightly so in the main. Some mechanisms have lent themselves more readily than others to such exploitation. Many again have failed to attract anything but a passing fancy and they have been promptly forgotten or ignored, while the great flood of freshly gathered facts and fictions has continued to roll on uninterrupted. And yet if it be true, as I believe, that knowledge is best grasped in its historical setting, then surely these half-forgotten theses must claim the attention of the serious investigator. With the colossal mass of literature on pathology, bacteriology, and immunity on our shelves, it is no easy task to comply with the historical method, but I maintain that the ambition should ever be to build truly on the historical past so that when the time comes for synthesis the old bricks may simply require relaying. The real expert must aim at being a man of vision with a working knowledge of and a pride in a glorious historical accomplishment. A mastery of technique is often, in my opinion, of much less relative value.

Natural immunity remains a dark corner in our edifice. Immunology as an essentially experimental science has undoubtedly gained its chief triumphs in the domain of acquired immunity. It has sought with marked success not only to imitate the immunity that is seen to follow successful combat with the actual disease naturally contracted, but also to transfer the chief bearer of that immunity from the immune subject, be it recovered human or immunised horse, to the acute case. In some notable instances we seem to know with certainty what we are doing in so acting, that, for example, the passive fluid injected represents simply so many units of an accurately titrated substance suspended, we shall say, in a vehicle of serum. So far as we are able to judge experimentally, the vehicle itself might be indifferent. In other cases in which the passive transference of immune serum is followed by undoubted success, as, for example, in anthrax, it has so far been impossible to determine precisely what particular principle in the serum so injected is responsible for the success. In other infections again, such as the coccal septicæmias, the success achieved has been but partial and fortuitous. Either the systems of titration on an *in vitro* basis have been unsatisfactory or, when biological titration has been partially possible, the existing great variety of coccal types both in man and animals and their contrary affinities for various animal species will doubtless for long militate against the elaboration of any rational and stereotyped scheme of serotherapy in these infections. We may learn, however, from our difficulties. We can see that Nature specifically unaided can successfully circumscribe the sphere of operation of a coccal or even an anthrax infection while she may fail to control a general invasion. We note also that Nature not infrequently appears to derive much assistance in the control of infection from the inoculation, for example, of a normal serum or from the inoculation of some type of colloid fluid circumspectly administered. Possibly the not infrequently observed phenomenon of the incompatibility of double infections may be placed in the same category of facts. In any case there would appear to be abundant justification at the present stage of immunological research for the closest study of the normal defence mechanisms.

THE MECHANISMS OF DEFENCE.

It is a strange circumstance that those curious instances of normal resistance which are referred to in all the text-books should rest on such an insecure basis of fact from what one might call the quantitative point of view. They, and the alleged explanatory mechanisms, appeared to fascinate the earlier workers intensely, but it does not appear that the experimental work devoted to their solution can now be regarded as authoritative in the light of present knowledge. It would seem that as each new mechanism of defence was discovered it was immediately tested and generally found to explain the observed resistance to the satisfaction of the discoverer. In what follows I shall illustrate what has happened in the case of anthrax and draw certain inferences as to future lines of progress. Put succinctly, the problem is simply this: Is the mechanism of a certain case of natural resistance capable of full and satisfactory expression in terms of test-tube analysis? Or must other mechanisms than those with which we are familiar be called in to explain the phenomenon?

The mechanisms are not many, and it would appear advisable to summarise them briefly before discussing their application to the problem in question. What contributions to the mechanism of defence were made by the great masters of general pathology and cytology

[1] From the presidential address delivered before the Section of Pathology of the Royal Society of Medicine on October 17.

of the past half-century? I need not discuss the various doctrines and conceptions of inflammation that formed the basis of pathological teaching of possibly most of us, but it is very obvious from even cursory analysis of the works of the great masters that the phenomena of inflammation gradually but surely came to be regarded in the light of natural defence mechanisms. That this was so is abundantly evident at the commencement of the present century, and in illustration I might cite the inaugural address of Marchand, a valued teacher of my own, on assuming the chair of Cohnheim at Leipzig in 1900. The title of his address was "Die natürlichen Schutzmittel des Organismus," and it was an attempt to summarise in the sense of defence mechanisms the various changes produced in the course of the inflammatory process. These changes he regarded as essentially defence mechanisms depending on the reactivity of the local tissues.

On the whole I receive the impression from reading the works of these masters that their methods of work were too local and circumscribed to render the results capable of general applicability to the phenomena of bacterial invasion. They had little conception then of the vast potentialities for defence residing not only in the fluids circulating in the inflamed part but also in the emigrated leucocytes and possibly also in the fixed tissue cells. Since those days the immunologist has had his innings, but I am of opinion that again we shall return to the consideration on ampler lines of local condition and function in the widest sense if we are to understand thoroughly the rationale of natural immunity. Already one sees a tendency towards the combined histological and serological attack on these problems.

I pass to Metchnikoff, whose attempt to extend the sphere of phagocytic action from the physiological to the pathological field, and to read into it the idea of a protective mechanism with an application to all higher animals possessing circulating amœboid elements, constituted the first large-scale conception calculated to raise the lore of inflammation from one of purely local to one of the most general application. It was, in fact, the commencement of immunity as a general science. To him the leucocyte came to be endowed with particular qualities and properties according to the reactivity of the host. It was, moreover, the source *par excellence* of any and all bactericidal substances that might be present in cell-free fluids of the body. The constant polemics into which his rigid adherence to the conception of the all-sufficiency of the phagocyte led him are now matters of history, but it has to be remembered that these very polemics with the rising school of humoralists led by Nuttall, Buchner, and a host of others, gave the stimulus to uncounted researches on the properties and sources of growth-inhibitory and bactericidal bodies in tissues and fluids. Metchnikoff sought to retrieve the position of the phagocyte by many ingeniously contrived experiments, but it was obvious that opinion was definitely ranged alongside the newer humoral ideas, while the ultimate source of the alexin and the intermediary body or *substance sensibilisatrice*, the co-operative action of which with a thermolabile alexin was later demonstrated, were left more or less open questions. The final demonstration by Denys and Leclef, Mennes, and others, showing the dependence of phagocytic action in immune serum on the presence of a *substance sensibilisatrice*, and the extension of the principle to normal serum by Wright and Douglas, constituted a reasonable enough compromise between the opposing views. We know, however, that absolutely independent phagocytic action cannot be excluded as a defence factor, especially when organisms of low virulence are in question, and researches on spontaneous phagocytosis have demonstrated that in a given collection of leucocytes exposed to organisms some individuals undoubtedly appear to possess much higher phagocytic powers than others. We have not reached the end of this particular problem.

After the phagocyte came the alexin of the cell-free fluids. The complex nature of the normal alexin and its presence both in plasma and in cell-free serum are now fairly generally accepted facts. It should be noted, however, that the complex nature of the normal alexin is much more difficult to demonstrate than that of the so-called bacteriolysin in immune serum, and, as we shall see, there is now evidence that certain normal sera possess considerable bactericidal and growth-inhibitory effects which are not destroyed by the usual inactivation temperatures. In fact, the test-organism in all these matters is of prime importance. Here it is sufficient to note that the normal alexin can kill or dissolve certain organisms while others are unaffected or at most suffer growth inhibition.

I pass to the leukins or the bactericidal substances present in extracts of leucocytes. The study of these arose largely out of the views expressed by Buchner and Metchnikoff that the source of the alexin might possibly be found in such. The chief work on this defence mechanism, which has not attracted perhaps the attention it deserves, has been that of Hahn, Schattenfroh, Petterson, Kling, Manwaring, Schneider, and Petrie. I would note simply that these extracts do not lose their power of killing certain test organisms after heating, say, at 60° F. They can resist very much higher temperatures, even up to 80° F. The constitution of these leukins or endolysins is still uncertain. Some have attempted to show that they possess complementing powers in the presence of inactivated sera, but others have entirely failed to confirm such action. Petterson would say that these extracts contain both an alcohol-soluble and an alcohol-insoluble fraction, and that the one can inhibit the action of the other. These effects, however, are almost certainly to be reckoned in the category of inhibition phenomena explicable on colloidal principles. The chief interest of the leukins lies in the effects they produce on different groups of organisms, and in the similarity of such effects to those produced by very analogous extracts prepared from tissues, which were demonstrated twenty years ago by Conradi, Korschun and Morgenroth, Tarassewitsch, and others. These leukins have, as a rule, been tested against organisms of the typhoid-coli group and organisms of the subtilis group, to which anthrax belongs.

Curious differences have been shown by extracts of leucocytes of various animal species in their action on bacterial types. Thus guinea-pig leucocytic extracts are said to possess little or no bactericidal action on *B. typhosus*, while those from the rabbit are distinctly potent. Petrie, however, using extracts prepared from leucocytes triturated at a temperature of liquid air, failed to demonstrate bactericidal bodies for *B. typhosus* in rabbit leucocytes. The leucocytic extracts of the hen have, according to Schneider, no action on *B. typhosus*, but a very considerable action on *B. anthracis*. On the other hand, the serum of the hen can kill *B. typhosus*, but has little action on *B. anthracis*, so that it would seem that absence of bactericidal property in the extract of a cell might be compensated by its presence in the surrounding fluid, and *vice versa*. The study of bactericidal bodies in tissue extracts and body secretions is again being actively pursued in connexion with bactériophage problems. In the so-called bacteriophage, from whatever source it may be obtained, there is exhibited the same thermostability and *the same limitation of action to certain bacterial groups*. Rapidity of action of these leucocytic extracts on organisms of the subtilis group and slowness of action on organisms like *B. typhosus*, with subsequent over-growth of presumably resistant organisms, are features which recall those noted in investigations connected with the bacteriophage and with the bactericidal bodies present in egg-white as demonstrated by Rettger and Fleming.

I may close this subject by noting the existence of the thermostable bactericidal body in rat serum. This body has been carefully tested by Pirenne against organisms of the subtilis group, and also organisms like *B. coli* and *B. pyocyaneus*. Plating experiments have shown that organisms like *B. mycoides*, *B. megatherium*, *B. subtilis* are rapidly killed off, while *B. proteus*, *B. coli*, and *B. pyocyaneus* multiply freely. The cholera vibrio is also killed off, but this action was found to be due to the ordinary thermolabile alexin in the rat serum and it disappeared after inactivation of the serum.

There remain only the proteolytic bodies contained in leucocytes, which have been studied by many workers chiefly in connexion with the so-called antitryptic action of serum. We know little or nothing of their action on bacteria, and indeed it would be difficult to separate any such action exhibited from that due to the more generally studied endolysins. I may just mention the alleged existence of bactericidal bodies in platelets, a subject introduced by Gruber and Futaki in 1907, and but little studied since. These authors came to the conclusion that the bactericidal action on anthrax of normal rabbit serum (a highly susceptible animal) depended on substances derived from the platelets. Barreau, who continued this work, found that the serum of the dog (a highly resistant animal to anthrax) had no action on anthrax nor had its platelets. He concluded, however, that the platelet bactericidal bodies or plakins probably did not play much part in natural resistance, as the rat, for example, a resistant animal, was rich in plakins, while the rabbit, a susceptible animal, was equally so. It is possible that the recent work on the purely mechanical function of blood platelets in removing suspended organisms by virtue of their adhesive properties may throw a different light on these alleged bactericidal substances in platelets.

Animal Experiments.

The application of these defence mechanisms to the elucidation of natural resistance to anthrax can now be very shortly considered. The resistant animals chiefly studied have been the frog, the fowl (especially the hen and pigeon), the rat, and the dog, but we have no accurate data of a quantitative kind as to the extent of this resistance in most cases. There is no doubt that the frog presents an extraordinary resistance to anthrax infection—a resistance which in the early days was attributed to its low body temperature. Attempts were made to infect frogs kept at 37° C., and in these circumstances the animals readily succumbed. Metchnikoff attributed the deaths in these cases to diminished phagocytic action, whereas in the frog whose temperature was not interfered with, exuberant phagocytosis at the seat of inoculation afforded sufficient explanation of the immunity. The humoralists, however, maintained that the immunity was due to the bactericidal properties of the local lymph (Nuttall, Baumgarten, Petruschky, etc.). Metchnikoff countered this by showing that *B. anthracis* could grow readily in frog plasma. Galli-Valerio favoured the combined action of phagocytosis and bactericidal property of lymph as the most likely explanation. The matter remains quite obscure, and a more recent worker, Ditthorn, simply states that anthrax rods inoculated in any way into frogs show degenerative changes in a few days and lose their contours. The test organisms may, of course, play a decisive rôle in view of the fact that Dieudonné, for example, cultivated a race of anthrax growing abundantly at 12° C., and with it succeeded in killing frogs readily. These experiments require confirmation.

With regard to fowls, the hen and pigeon, and particularly the former, are known to possess high resistance, and in the classical experiments of Pasteur and Joubert, in 1878, the immunity was attributed to the high body temperature of the fowl. By immersing the fowl in cold water infection took place. The death in such circumstances has been attributed by later workers to a general lowering of resistance, and not to an inability on the part of *B. anthracis* to grow at the high temperature of the fowl. Metchnikoff maintained that phagocytosis in the normal hen was rapid and complete, and in the cooled hen very poor. Later, Thiltges stated that phagocytosis was not in evidence, and that the immunity was due to the bactericidal action of the plasma, a property which Gengou denied. Thiltges agreed, however, with Metchnikoff in the matter of the pigeon. Bail and Petterson and Schneider ascribe the resistance to the action of the hen leukins, which act very powerfully on *B. anthracis*, while the serum has relatively little action. Donati in a more recent communication ascribes the immunity of the fowl simply to a local invasion of leucocytes, which hinder capsule formation, and by virtue of bactericidal substances secreted by them, and not by phagocytosis, secure the removal of the invaders.

It is notorious that the adult dog can tolerate without inconvenience the inoculation of large quantities of bacilli, and, as one might expect, this immunity has been attributed by Metchnikoff to phagocytosis at the site of inoculation. Hektoen later showed that in the presence of dog serum dog leucocytes readily took up *B. anthracis*. It would appear that the serum of the dog has but little or no anthracidal action as compared, for example, with that of the rabbit, which is, on the contrary, a fairly highly susceptible animal. While without action on *B. anthracis*, dog serum, according to Petrie, has a powerful action on *B. typhosus*. Hektoen attributes some importance also to the leukins of the dog. Petrie, however, found none.

The rat presents a more interesting problem, though it has to be remembered that there is no absolute immunity in this species. Behring, in 1888, showed that rat serum was anthracidal, while Metchnikoff found that the main defence was the phagocytic response. The thermostability of the bactericidal body in rat serum, as shown by Pirenne and Horton, is a most interesting feature. It acts equally well at 18° C. as at 0° C., and remains active for fairly long periods in the cold.

SUMMARY.

To summarise, it must be confessed that the curiously contradictory and yet perhaps genuinely reasonable explanatory theses give us very little that is solid to grasp. No one example of normal immunity has yet been investigated as a complete problem. Partial mechanisms only have been studied. It might be concluded from the above that dogs are immune because dogs are dogs, and so for rats, fowls, and frogs, but that would not be quite the impression I should like to make. If a certain animal is immune to a particular experimental infection, such as anthrax, one ought to be able to explain fully what local phenomena have occurred to prevent a general invasion by the organism. To do so effectively must involve the testing of each possible mechanism separately and in conjunction, and it must involve a return to the cytological study of the changes which the invading organism undergoes *in situ*. The problem must be attacked not only by methods which derive their authority from long experience with the bactericidal properties of cells and fluids, but also by methods which reflect the trend of present-day studies on general metabolism both of parasite and host. With regard to the former much has been made of the capsule, but the data on the point are contradictory. In every set of experiments strict attention must be paid to the maintenance of virulence. It may, indeed, be found that by experimental selection a test organism which has once proved virulent for one individual of a resistant species may prove equally so for all individuals of the species. Strains of *B. anthracis* have been thus selected which are alleged to have killed fowls, rats, and frogs, but the experiments lack confirmation.

Another important aspect of the subject which has recently been brought to the forefront by Besredka relates to the site of inoculation of the test organism. In the course of his researches on the production of immunity by vaccinating that portion only of the body which is most susceptible, Besredka has turned his attention to anthrax infection in the guinea-pig, an animal notoriously difficult to protect by any method of vaccination. He shows experimentally what, by the way, had been amply demonstrated twenty years ago by Noetzel, that animals like the rabbit and guinea-pig can tolerate easily doses of virulent anthrax if introduced directly into the circulation or into the peritoneal cavity without contaminating the cutaneous tissues. This can be avoided by a special and careful technique. According to Besredka the skin of the guinea-pig is the only susceptible portion of the guinea-pig's anatomy, and if it had no skin it would be a highly refractory animal instead of being, as it is, one of the most susceptible. He further demonstrated the possibility of securing solid immunity to anthrax, by whatever route inoculated, by vaccination of the skin with the attenuated Pasteurian vaccines. I do not wholly accept much of the evidence adduced so far in support of the conception of partial or local immunities or susceptibilities, but I believe the matter is worth the fullest investigation. In any case it is obvious that future work on natural resistance must take count of the possibility of very diverse immunities or susceptibilities apparently combined in one immune whole.

I have dealt with species resistance solely, but it has to be remembered that there are racial variations of resistance within the species. For this reason the study of the mechanism of normal immunity will doubtless demand the services of the geneticist, who will be responsible for securing pedigreed stock for experimental purposes. This is no fanciful suggestion. In connexion with these most promising developments in experimental epidemiology which are being carried out in this country and in America the services of the geneticist must be invaluable. The dietetic factor, too, may prove of supreme importance in experiments on natural resistance, and there is already a body of evidence pointing in this direction. It is possible also that we may learn from comparative observations on the rationale of natural immunity in plants to fungal infections. In a recent address by Blackman some of these mechanisms reveal extraordinarily interesting relationships between the attacking fungus and the cells of the immune host.

Helium in the United States.

By Dr. RICHARD B. MOORE, Chief Chemist, U.S. Bureau of Mines.

ONE of the projects started in the United States during the war and since continued, is the extraction of helium from natural gas for use in balloons and dirigibles. In 1907, Cady and McFarland published a report on the presence of helium in a number of natural gases, mainly from Kansas, U.S.A. Some of the samples tested ran as high as 1½ per cent. helium by volume, although the majority of them were considerably below this figure.

Early in 1915 the present writer received a letter from Sir William Ramsay, written under date of February 28. In that letter it was stated that the British Government was interested in new sources of helium other than the atmosphere, in the hope that a sufficient amount could be obtained for use in dirigibles. It was only during my recent visit to England last summer that I learned of Sir Richard Threlfall's intimate connexion with the origin of this demand for a supply of helium by the British Government.

American Government officials heard no more of the project until after the United States entered the war. A few days after that event, I suggested at the meeting of the American Chemical Society in Kansas City that helium could be, and should be, extracted from natural gas, and the project was afterwards taken to the U.S. Army by Col. G. A. Burrell and myself. Col. Chas. De F. Chandler in charge of the lighter-than-air branch of the Air Service, was immediately interested. The Army and Navy jointly asked the Bureau of Mines to undertake the experimental development of the project, and three plants were built in Texas in connexion with the supply of natural gas derived from the Petrolia, Texas field, used in the cities of Fort Worth and Dallas. Two of these plants were situated at Fort Worth (Fig. 1), and one at Petrolia. The plants at Fort Worth used the Linde and Claude systems respectively. The plant at Petrolia was equipped with the new Jefferies-Norton system of refrigeration.

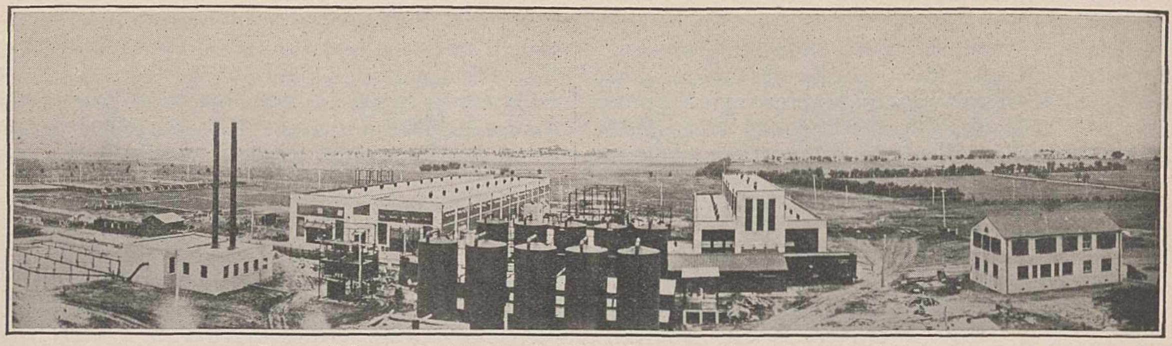

FIG. 1.—Helium production plant, Fort Worth, Texas, operating at the present time.

FIG. 2.—Experimental plant No. 1 (Linde system) built and used during the war. Inside a compressor building.

During the preliminary stages of the work, Col. Burrell acted for the Bureau of Mines, but shortly afterwards I was assigned by the director of the Bureau to take general charge of the three plants. Others who were connected with the work in the early stages were Dr. Van H. Manning, director of the Bureau of Mines, Dr. F. G. Cottrell, assistant director, and Commanders A. K. Atkins and H. T. Dyer, and Mr. G.

O. Carter, of the U.S. Navy. It was not known at that time that the British Government, through Prof. J. C. McLennan, of the University of Toronto, was carrying out experimental work with the same object in view in Canada.

The U.S. Government had the active co-operation of the Linde Company, the Air Reduction Company, and the Jefferies-Norton Company, and the engineers of the first two companies actually operated their plants. Whatever success was achieved in the commercial production of helium was to a very considerable extent due to the ability of the engineers of the companies mentioned.

Plant No. 1 (Fig. 2), using the Linde process, commenced to work on March 6, 1918, and made its first helium on April 8, 1918, when some gas analysing 27 per cent. helium was obtained. This purity was increased after a few months until in the early part of July a grade of above 70 per cent. was obtained, and in September the plant was operating very consistently, producing an average of from 4000 to 6000 cubic feet of 70 per cent. helium during each operating day. It was necessary to re-process the gas in order to raise this purity to more than 90 per cent.

Plant No. 2, using the Claude system, began to operate on May 1, 1918, and very quickly obtained some helium. On May 13 some gas of a grade between 60 and 70 per cent. helium was produced. The operations of Plant 2, however, were not as a whole so successful as those of Plant 1.

Plant No. 3, using the Jefferies-Norton process, started operations in the late fall of 1918. It was hoped that this plant would show some economies which could not be hoped for from the other two more or less standardised processes. Whereas helium was produced at various times by Plant No. 3, it was never able to produce helium steadily or consistently, and was finally permanently shut down during July 1921.

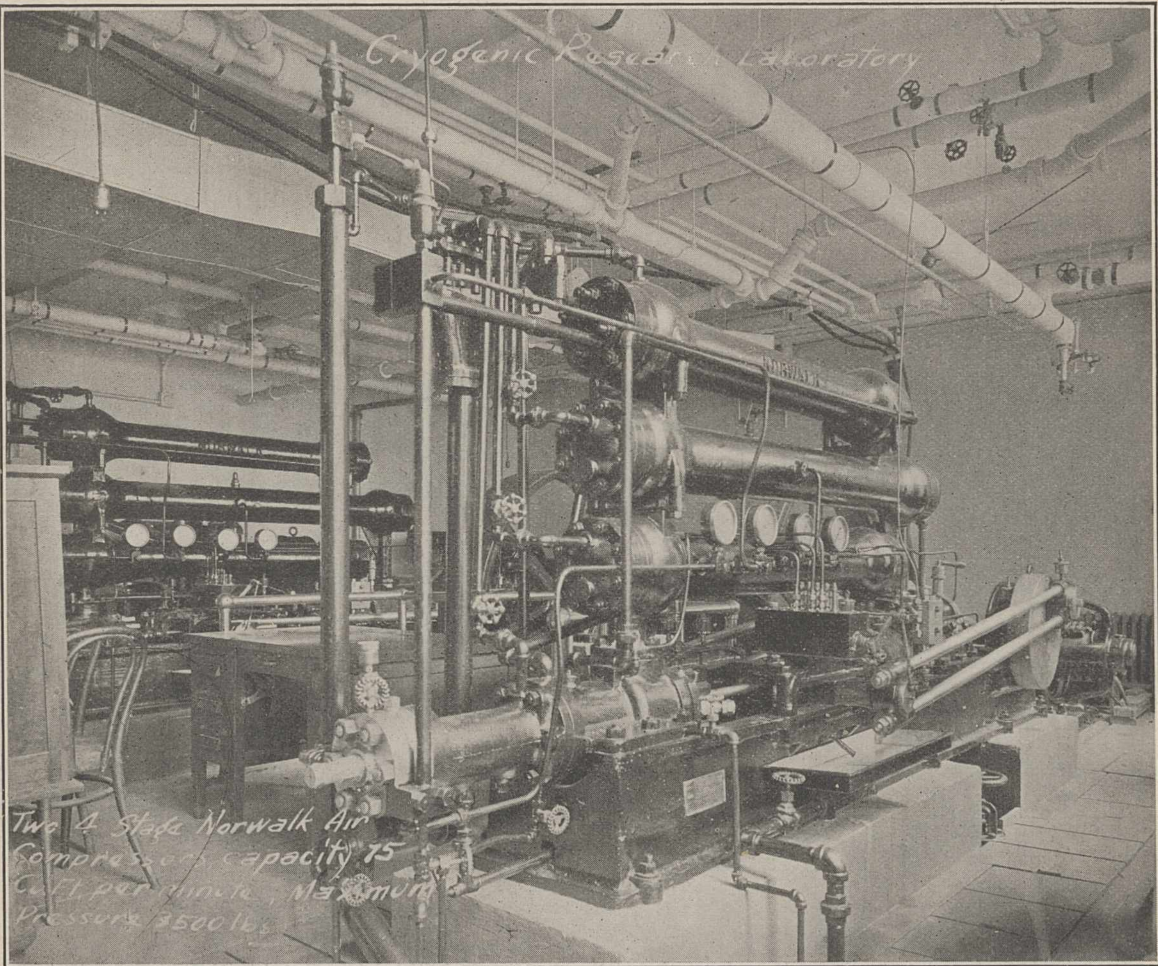

FIG. 3.—Compressors for experimental work in Cryogenic Laboratory, U.S. Bureau of Mines.

The Linde plant showed the most rapid progress, and it was decided in the fall of 1918 to build a large production plant using the Linde process. This plant was completed in the spring of 1920, and operated for a few months during that year. Most of the time, however, was spent on testing out the equipment. About two million cubic feet of helium averaging 94 to 95 per cent. was produced, and this, with the helium obtained during the experimental work with the smaller plants, gave a total production up to this year of 2,300,000 cubic feet. Congress has furnished a fairly satisfactory sum for operations during the present fiscal year, July 1, 1922 to June 30, 1923, and the plant is now producing about 15,000 cubic feet of 93 to 95 per cent. helium per day.

Some small changes have to be made, and after these have been installed, it is expected that this production will be considerably increased. When all the units are operating efficiently, the plant will probably have a capacity of from 35,000 to 40,000 cubic feet per day.

An important part of the work has been the investigation of the natural gas supplies of the United States for their helium content. This work was originally started during the war, and Mr. G. S. Rogers, of the U.S. Geological Survey, was transferred to the Bureau of Mines to carry on the work. A preliminary report was published by the Survey in 1921 (U.S. Geol. Sur. Professional Paper 121, by G. Sherburne Rogers).

Since 1919 the present writer has supervised the field work along with other helium activities; and the Bureau maintained a full force and laboratory for this particular purpose for nearly two years. Every gas field in the United States has been sampled, and at the present time undoubtedly more than five hundred million cubic feet of helium is going to waste annually in connexion with the natural gas of the United States. A considerable proportion of this is widely scattered in gas-wells that have a small helium content, of only 0·1-0·2 per cent., but a considerable amount of it is concentrated in large fields which have an average of more than 0·5 per cent. helium in the gas, and some of the wells go above 1·0 per cent. and even 1½ per cent. In general, the helium belt extends from Texas through Oklahoma, south-eastern Kansas, southern Illinois, and from there through Ohio into Pennsylvania and New York. There is also helium-bearing gas in Indiana, Kentucky, and West Virginia. The belt seems to go from south-west to north-east, generally speaking, the richest gas being in Texas, Oklahoma, and Kansas.

Though helium is being produced successfully commercially, we are not satisfied with the present development or costs. A considerable amount of research work is being carried out, therefore, with the main object of getting greater efficiency and reduction in cost.

The low-temperature laboratory (Fig. 3) is attached to the Bureau of Mines in Washington, with a force of about fifteen chemists, physicists, engineers, and mechanics. A thoroughly adequate equipment is available. A good deal of fundamental research work is being carried on and applied to the commercial production of helium. A consulting board of engineers consists of Mr. M. H. Roberts, Prof. W. L. De Baufre, and Dr. R. C. Tolman. This board is giving efficient and valuable help on plant design. It is assisted by Mr. J. W. Davis of the Bureau of Mines, and other members of the technical force. Mr. C. W. Seibel, Dr. A. G. Loomis, Dr. Leo Finkelstein, and Mr. W. V. Cullison have been with the work for a considerable time, and are giving valuable service.

Two repurification plants are being constructed by the Bureau of Mines for the U.S. Army. The object of these plants is to repurify the helium after it has been used in a balloon or dirigible. One of these plants is situated at Langley (Aviation) Field, Va., and uses the ordinary combination of low temperature and high pressure in order to step up the purity of the gas. Dr. H. N. Davis has acted in a consulting capacity for this plant. The present writer felt from the early start of the project that the use of charcoal at low temperatures would be of value, and, therefore, a considerable amount of research work has been carried out, and has culminated in a repurification plant in two railroad cars. One of these cars is equipped with a self-contained power unit, and the other contains the necessary compressors, refrigeration outfit, and charcoal purifiers. By means of charcoal, a purity of practically 100 per cent. can be obtained. Both these plants will be ready for operation within a very short time.

At the present time the Helium Board which handles the whole project consists of Col. I. F. Fravel, Commander S. M. Kraus, and myself. Others beside those already mentioned in this statement who have been intimately connected with the work are Major O. Westover, Major P. E. Van Nostrand, and Lieut. R. S. Olmsted, of the U.S. Army.

Current Topics and Events.

THE following presidents and recorders of the various sections of the British Association have been appointed for the Liverpool meeting to be held in September next under the presidency of Sir Ernest Rutherford:—*Section A* (*Mathematical and Physical Science*): Prof. J. C. McLennan; Prof. A. O. Rankine, Imperial College of Science and Technology, S.W.7. *Section B* (*Chemistry*): Prof. F. G. Donnan; Prof. C. H. Desch, The University, Sheffield. *Section C* (*Geology*): Dr. Gertrude Elles; Dr. A. R. Dwerryhouse, Toots, Darell Road, Caversham, Reading. *Section D* (*Zoology*): Prof. J. H. Ashworth; Prof. R. D. Laurie, University College, Aberystwyth. *Section E* (*Geography*): Dr. Vaughan Cornish; Dr. R. N. Rudmose Brown, The University, Sheffield. *Section F* (*Economics*): Sir W. H. Beveridge; Prof. H. M. Hallsworth, Armstrong College, Newcastle-on-Tyne. *Section G* (*Engineering*): Sir H. Fowler; Prof. G. W. O. Howe, The University, Glasgow. *Section H* (*Anthropology*): Mr. P. E. Newberry; Mr. E. N. Fallaize, Vinchelez, Chase Court Gardens, Enfield, Middlesex. *Section I* (*Physiology*): Prof. G. H. F. Nuttall; Prof. C. Lovatt Evans, Physiological Laboratory, St. Bartholomew's Medical College, E.C.1. *Section J* (*Psychology*): Mr. C. Burt; Recorder not yet appointed. *Section K* (*Botany*): Mr. A. G. Tansley; Mr. F. T. Brooks, 31 Tenison Avenue, Cambridge. *Section L* (*Educational Science*): Prof. T. P. Nunn; Mr. D. Berridge, The College, Malvern. *Section M* (*Agriculture*): Dr. C. Crowther; Mr. C. G. T. Morison, School of Rural Economy, Oxford.

THE Buys Ballot medal founded in 1888 in commemoration of the work of C. H. D. Buys Ballot, the famous meteorologist of the Netherlands, to be awarded by the Royal Academy of Science at Amsterdam first in 1893, and afterwards every tenth year, to the person who is judged to have made the most valuable contributions to the science of meteorology, is to be given this year to Sir Napier Shaw, professor of meteorology in the Royal College of Science, late director of the Meteorological Office, for contributions to all branches of the science, and specially for his work as president of the International Meteorological Committee. The previous awards were: 1893, Dr. Julius Hann, of Vienna; 1903, Dr. R. Assmann and Dr. A. Berson, of Berlin, jointly; 1913, Dr. H. Hergesell, of Strasbourg.

MR. E. A. REEVES, map curator of the Royal Geographical Society and director of the society's School of Surveying, has been awarded the Cullum Gold Medal for 1922 of the American Geographical Society. The inscription on the reverse side of the medal reads as follows:—"Edward A. Reeves, 1922. In honour of his substantial achievements in geographical surveying. By devising and improving instruments and methods he created new standards in the field of scientific exploration." Mr. Reeves has now been in charge of the Royal Geographical Society's courses of instruction in map construction and surveying for twenty years, and during that period almost every British explorer, as well as many from other countries, have had the advantage of his practical knowledge and precise methods. One of these pupils was Dr. Hamilton Rice, vice-president of the American Geographical Society, who worked through the course some years ago and obtained the diploma. This society is starting a survey school for travellers and explorers under Dr. Rice's direction, and the future instructor, Mr. Weld Arnold, late Austin teaching fellow in astronomy at Harvard University, is now passing through the Royal Geographical Society's course. The award to Mr. Reeves is no doubt in some measure a mark of recognition of his valuable services in connexion with these developments.

The annual council meeting of the National Union of Scientific Workers was held at the Caxton Hall, Westminster, on January 13. Dr. A. A. Griffith, who presided, gave an address on "The Support and Utilisation of Science," in which he stated that it was the general opinion of men of science that the support of science in Great Britain is quite inadequate considering the needs of the country. He regarded it as absurd that science, the greatest and most permanently valuable of all the learned professions, is also the worst paid, and outlined a general policy for adoption by the Union which aims at remedying this condition of affairs. Scientific workers themselves must be held largely to blame for their present unenviable position, and would only prove their value to the community when they undertook a greater share of responsibility in the control of the product of their labours. Unity among men of science is the first essential of success, he declared. Dame Helen Gwynne-Vaughan was unanimously elected president for the ensuing year, and the following were elected members of the executive committee: Profs. J. McLean Thompson and H. Levy; Drs. H. Jeffreys, G. Senter, J. H. Vincent; Messrs. W. L. Baillie, E. G. Bilham, F. T. Brooks, L. D. Goldsmith, R. McKinnon-Wood, S. W. Melsom, and H. V. Taylor.

AT a large gathering of Whitworth scholars and exhibitioners held at the Institution of Mechanical Engineers on Friday, January 12, the Whitworth Society came into being. The president of the Institution—Dr. Hele-Shaw, himself an old Whitworth scholar—welcomed those present, and took the chair. There had been great difficulty in getting into touch with Whitworth men, but more than three hundred had indicated their desire to support a society if formed, and about 120 were present at the meeting. The new society will enable old scholars, exhibitioners and the prizemen who will come into being under the new scheme of award to keep in touch with one another. It has no connexion with any existing institutions, although there is no doubt that these will welcome its advent. Dr. Hele-Shaw was elected president of the new society, and a provisional committee was appointed. It will assist greatly if any such who have not already received communications would send their names and addresses to the secretary, the Whitworth Society, Institution of Mechanical Engineers, Storey's Gate, London, S.W.1. It is proposed to have an annual social function on the anniversary of Sir Joseph Whitworth's birth—December 21—and the committee has been asked to organise if possible a similar function to take place within the next three months. An interesting feature of the meeting was the number of men, many occupying prominent positions in their professions, who bore testimony in speech and in letters to the value which Sir Joseph Whitworth's generosity had been to them in their educational training in engineering.

ACCORDING to the *Journal officiel de la République Française*, the "Croix de chevalier du Mérite Agricole" has recently been awarded by the French Ministry of Agriculture to 287 agriculturists, both men and women, whose families have dwelt on the same agricultural holding for more than one hundred years and who are themselves still carrying on the working of the land. Exceptional interest attaches to two cases on account of the long association of the families of the recipients with the property. M. André Dupont, of Lacoux (Ain), traces his descent back for eight hundred and twenty-two years on the same holding; he himself has devoted his life to practical agriculture, and for the last thirty-five years has done much to extend agricultural co-operation. M. Pierre Lascassies-Poublan, of Lucgarrier (Basses-Pyrénées), is also an excellent farmer and is president of various co-operative societies connected with agriculture. In this case the family has been uninterruptedly associated with the same land over a period of eight hundred and eighty-nine years.

THE Royal Scottish Society of Arts has awarded the following prizes for communications read or reported on during the session 1921–22: Keith prizes to Principal A. P. Laurie for his paper on "The 'Pier Method' of Building Brick Walls," and to Dr. Henry Briggs for his paper on "A New Mine Rescue Apparatus"; Makdougall-Brisbane medals to Andrew H. Baird for his paper on "The Universal Bosshead-Clamp," and to Dr. Dawson Turner and

D. M. R. Crombie for their paper on "An Investigation of the Ionised Atmosphere around Flames by means of an Electrified Pith Ball"; and a Hepburn medal to Basil A. Pilkington for his paper on "A Readily-Destructible Material suitable for the Conveyance of Confidential Communications."

IN connexion with the work of the School of Meteorology of the Royal College of Science, Sir Napier Shaw, professor of meteorology at the College, will give a course of ten lectures on "Forecasting Weather," at the Meteorological Office, South Kensington, during the current term. The lectures are on Fridays at 3 P.M., beginning on Friday, January 19. Admission is free by ticket to be obtained from the Registrar of the Imperial College of Science, South Kensington, S.W.7.

OWING to the exceptional demand for tickets for his lecture on January 23, Prof. W. M. Flinders Petrie has consented to repeat the lecture on "Royal Burials in Egypt" on Saturday, February 3, at 2.30 P.M., at University College, London. The lecture, which will be illustrated by lantern slides, will have special reference to the recent excavations in Egypt. The proceeds will be devoted to the St. Christopher's Working Boys' Club, which is connected with the Union Society and Women's Union of the College. A leaflet containing full particulars as to the prices of the tickets can be obtained by sending a stamped addressed envelope to Dr. Walter Seton, University College, London (Gower Street, W.C.1.).

THE council of the Geological Society has this year made the following awards:—Wollaston Medal, Mr. W. Whitaker; Murchison Medal, Dr. J. Joly; Lyell Medal, Mr. G. F. Dollfus; Bigsby Medal, Mr. E. B. Bailey; Wollaston Fund, Mr. H. H. Read; Murchison Fund, Mr. T. H. Withers; Lyell Fund, Dr. W. T. Gordon and Dr. W. N. Benson.

WHAT is claimed to be the first deliberately organised radio-telephone conversation between Great Britain and the United States is recorded in the *Times* of January 16. In the early hours of the morning of January 15, Mr. H. B. Thayer, president of the American Telephone and Telegraph Company, succeeded in addressing a party of press representatives and others at the New Southgate (Middlesex) works of the Western Electric Company, Limited, from his office at 195 Broadway, New York. Communication was maintained for two hours. The demonstration was carried out by the American Telephone and Telegraph Company and the Radio Corporation of America, which had installed a transmitting apparatus for the purpose at Rocky Mount, Long Island. The transmitter was connected with New York by telephone wires. The power used is stated as "several hundred" kilowatts and the wave-length was approximately 5350 metres. At New Southgate a special receiving set with eight valves was employed, with an indoor frame aerial about six feet square. It is stated that most of the words spoken by Mr. Thayer and others who followed him were heard both by means of head telephones and also by a "loud-speaker" so clearly that it was possible to recognise one of the speakers by his intonation. The success of this experiment in transmitting the spoken word from the New to the Old World is a noteworthy step in the progress of practical radio-telephony.

THE annual general meeting of the Institute of Metals will be held on Wednesday and Thursday, March 7 and 8, at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1, commencing at 10.30 A.M. each day. The council is arranging a special ballot on February 22 for the election of members in time for this meeting, and candidates who are elected will enjoy the privileges of membership for the extended period ending June 30, 1924. With the view of developing the membership of the Institute Overseas, the council has recently appointed a British Empire Committee on which the Overseas Dominions are represented by distinguished metallurgists in London possessing an intimate knowledge of Overseas conditions. A local section of the Institute has just been formed in Swansea as a sequel to the autumn meeting of the Institute held there in September last. Thus the Institute now has sections in Birmingham, Newcastle-on-Tyne, London, Sheffield, Glasgow, and Swansea.

A SPECIAL exhibit of epiphytic ferns belonging to the genus Platycerium and some species of the genus Polypodium has been arranged in the Tropical Fern House at the Royal Botanic Gardens, Kew. These ferns live mainly in the air attached to tree trunks, and they have developed either specially modified bases to their leaves—as, for example, *Polypodium Heracleum*, *P. conjugatum*, and *P. Meyenianum*—or special "shield" or "collecting" leaves, as in *P. quercifolium*, *P. Vidgeni*, and *P. rigidulum* var. *Whitei*, which serve to collect the humus and detritus washed down the trunks. In the case of the Stag's Horn Ferns (Platycerium) the collecting leaves are specialised organs which wrap round the tree trunks, and the roots grow out into the pockets so formed. The shield-like base of the frond of *Polypodium Heracleum* remains green, as does also the whole shield-leaf in *Platycerium grande* and *P. Veitchii*, while in *Polypodium quercifolium* etc., *Platycerium alcicorne*, *P. æthiopicum*, and *P. Willinckii*, etc., the shield-leaf turns brown and functions only as a collecting leaf, the frond which remains green and bears the sporangia or reproductive bodies being a separate frond. The Bird's Nest Fern, *Asplenium Nidus*, and other ferns which tend to make pockets with their leaves may be compared with these Polypodiums and Platyceriums, and are also exhibited near them.

USEFUL work is being done by the various trade and technical committees of the British Empire Exhibition to be held at Wembley in 1924. It is to these committees that the executive council and the management committee have delegated the task of organising representative exhibits of the particular trades with which they are concerned. The larger industries are being organised entirely by their own trade associations, including the British Engineers' Association for mechanical engineering exhibits, the British Electrical and Allied Manufacturers' Association for all electrical exhibits, and the Association of British Chemical Manufacturers; but in the case of many other trades about fifty representative committees have been set up to work in conjunction with the exhibition officials, and they are now holding regular monthly or fortnightly meetings, with the object of inviting exhibitors, individually or in groups, securing the requisite amount of space, and arranging and classifying the exhibits. The committees are getting into communication with all traders in the different trades. Some of the smaller traders, it is thought, may desire to economise by exhibiting in groups. Provision for this will therefore be arranged. Sir Lawrence Weaver, director of the United Kingdom Exhibits Section, is attending the meetings of these committees, in order to explain the nature of the work, and to see that the committees are enlarged, where necessary, to ensure their representative character. He has explained also that the executive committee, desiring to evolve unified schemes of decoration for each section, has obtained the services of a panel of eminent architects who will advise committees in regard to decorative schemes.

THE annual meeting of the Circle of Scientific, Technical, and Trade Journalists was held in the Hall of the Institute of Journalists on January 9, when Sir Richard Gregory was elected chairman in succession to Mr. L. Gaster (32 Victoria Street, London, S.W.1), who has been chairman for the past eight years and has now consented to serve as secretary. In opening a discussion on "Reviews and Reviewers," Sir Richard Gregory referred to the distinctions between the points of view of publisher, author, and editor. The first concern of an editor is, however, the interests of his readers. So many books are received for review by leading journals that it is impossible to find space to notice them all, and a selection has, therefore, to be made. Books may be selected for special notice on account of (1) wide interest of subject, (2) eminence of author, (3) outstanding importance. The most readable review, if written with expert knowledge of the subject, is editorially the most acceptable and probably best directs attention to the book noticed. A mere statement of contents is not a review, though a descriptive synopsis may serve a useful purpose. Readers are not interested in long lists of errors, and it is preferable to send such lists to publishers or authors instead of printing them. Books not selected for special reviews may be dealt with in short notices, but, on account of limitations of space, many can be mentioned only in lists of books received. It was the general opinion of the editors of different types of technical journals who took part in the discussion that while an unsigned review might be subjected to a certain amount of editing, no essential change should be made in a signed review. Custom has sanctioned the principle that a book noticed by a reviewer becomes his property, and the view was expressed that, provided a reasonable period had elapsed since the date of publication, books merely announced might be sold or disposed of in any way.

Our Astronomical Column.

THE DRAYSON PARADOX.—A pamphlet by Mr. A. H. Barley on "The Drayson Problem" shows that this curious paradox has still a considerable vogue. It had its origin solely in the somewhat loose language of certain text-books which described the motion of the pole of the equator as circular, the pole of the ecliptic being in the centre. This description would be correct if only the solar and lunar precessions were concerned, but planetary perturbations cause the plane of the ecliptic (and hence its pole) to shift, thus causing a variation in the radius of the circle. Drayson, without carefully studying the evidence for the shifting ecliptic, asserted that it was really fixed among the stars, and that the centre of the north pole's motion was 6° away from the ecliptic pole, thus bringing about a very large change in the obliquity, which he supposed to be near its minimum at present. It would reach 35° at its maximum, when Drayson considered an Ice-age would occur. Drayson's supporters slur over the fact that all the planetary orbit planes are changing, owing to mutual perturbations, theory and observation being in good agreement. Further, they claim to account for stellar proper motions by their revised precessions, omitting apparently to note that motions due to a mere change in the earth's axis would affect all the stars in the same region of space alike, whereas the actual motions differ from star to star, as can readily be verified from stellar photographs. If the Draysonians would study the full collection of modern observations of sun, planets, and stars, instead of wresting a few isolated observations to suit their preconceived views, they would soon be convinced that their hypothesis is not consistent with the facts, but that the ecliptic is actually shifting through an angle of some 47″ per century.

PARALLAXES OF FIFTY STARS.—The Sproul Observatory has just issued No. 6 of its publications, a continuation of numbers 4 and 5, which contains a third list of trigonometrical parallaxes of 50 stars. The observational work has been spread over the years 1915–1921 and the results were obtained through the efforts of several persons named in the volume. The list includes stars of various types of spectra and magnitudes, the latter ranging from 2·81 to 10·5. This list is very opportune, as the values will assist in the researches now being carried out in the determination of parallaxes by the spectroscopic method.

VARIABLE STAR MAXIMA AND MINIMA FOR 1923.—Variable star observers will find the Harvard College Observatory's Circular No. 241 very useful. Dr. Leon Campbell publishes in it the predicted dates of maxima and minima for variable stars of long period. The dates for 366 variables are inserted in the table. The information is given in the following form: first, six figures which denote the Right Ascension and Declination of the star; next, the name of the star according to the new nomenclature instituted by the International Astronomical Union; and, lastly, the dates of the maxima and minima showing the months and days of the month. Thus, for example, o Ceti or "Mira" with R.A. 2^h 14^m and Dec. $-3°$ reaches a maximum on April 2 and a minimum on October 23.

Research Items.

KENT'S CAVERN ANTHROPOLOGY AND THE ICE AGE.—In the Journal of the Torquay Natural History Society (vol. iii. No. 2, 1922), Mr. H. J. Lowe gives a full account of the questions connected with the exploration of Kent's Cavern. The first exploration was made by MacEnnery in 1825, but the success attained was due to the labours of W. Pengelly, who spent sixteen years in excavating and recording his discoveries. Probably the greatest service Pengelly did for anthropology was when, with a keen appreciation of the importance of the results already attained, he secured the right to investigate a newly found cavern at Brixham, across the bay from Torquay. The writer, comparing the results of excavation at Kent's Cavern, Brixham, and Tor Bryan caves, with those of a Belgian cavern in about the same latitude, as noted by Schmerling, advances the theory that their floors mark periods of climatic severity that destroyed life so far south, at least, as the latitude in which they occur; and inferentially that they may be regarded as indications of cosmical changes that need to be discovered in order to explain the phenomenal coincidences.

SHRUNK HUMAN HEADS.—The *Lancet* (November 11, 1922) publishes an address, entitled "Spolia Nemoralia: Shrunk Heads, Ear-plugs, and Labrets," delivered by Sir John Bland-Sutton before the Royal Society of Medicine. The art of producing these shrunk heads is found among Indians dwelling in the dense forests bordering the section of the Amazon known as Marañon. The specimens exhibited were collected by the lecturer on a visit to the Amazon, and further information has been acquired by Mr. G. M. Dyott in a recent adventurous journey. As a rule a corpse is flung into the river, but when a man is killed in combat his body is mummified, wrapped in bark, and placed on a stand in the centre of the hut as an object of veneration. After the skull is removed the flesh of the head is stuffed with hot pebbles or hot sand and carefully dried in the sun. When this rude taxidermic process is complete, the flesh shrinks to the size of an orange, preserving the features. It is clear that Amazonian Indians, as well as the natives of East Africa, like surgeons in civilised countries, are familiar with the elastic properties of the human skin.

DISTRIBUTION OF THE BOTULISM ORGANISM.—A good deal of interest was aroused last year over the outbreak of food poisoning at Loch Maree in Scotland, where a number of fatalities followed the eating of some potted meat in which, for the first time in this country, the *Bacillus botulinus* was identified as the causative agent. The last number of the *Journal of Infectious Diseases* (vol. xxxi. No. 2) contains a series of papers from the University of California by Prof. K. F. Meyer and his colleagues on the distribution of this organism. In 624 samples of soil, vegetables, fruit, feeding stuffs, etc., collected in California, the bacillus was found in about 30 per cent., and, contrary to the common assumption, more abundantly in virgin mountain and forest soils than in cultivated places. By serological reactions two types, A and B, may be distinguished, and it is the former that is particularly associated with wild places. Extending their studies more widely, they have found it in earth all over the United States, more abundantly and more generally of type A in the west than the east, in Canada, Belgium, Denmark, Holland, England, Switzerland, China, and Hawaii. The bacillus seems indeed to be a common soil anaerobe; like other bacteria, it has a world-wide distribution, either because it is easily transported or because it is ancient. It is not, like the tetanus bacillus, specially associated with the intestinal tract and with soil contaminated by excreta, but man must very frequently come into contact with it and take it in with food. The conditions under which it will grow in foods and produce enough toxin to cause symptoms in man have not yet been defined, but they must evidently be seldom realised, for botulism is, and always has been, quite a rare disease.

DEVELOPMENT OF SOME ABERRANT CTENOPHORES.—Prof. T. Komai has recently published studies on two aberrant ctenophores—Cœloplana and Gastrodes (Kyoto; 102 pp.). He has had abundant material of three species of Cœloplana which need no longer be considered a zoological rarity, for the author was able to obtain 50 or 60 *C. bocki* creeping, after the fashion of a planarian, on a single colony of Dendronephthya. He gives a careful account of the anatomy and histology, and shows that the pharynx, at first like that of a Cydippe, becomes divided into two parts—a dorsal, which persists as the pharynx of the adult, and a ventral part which spreads out and forms the surface on which the animal creeps. The eggs are kept under the body of the parent, where they develop and finally hatch as cydippiform larvæ with mouth, pharynx, and canal system. After swimming for about a day the larva begins to remain at the bottom and adheres by or glides on the everted external portion of the pharynx. The cilia of the comb-plates degenerate and the animal, which is henceforward incapable of swimming, gradually becomes flattened. Cœloplana is an extremely modified ctenophore adapted to a creeping mode of life, and its resemblance to a planarian is due to convergence. Prof. Komai has obtained 120 examples of Gastrodes, which lives as a parasite in the mantle of Salpa, and has shown that it enters the Salpa as a planula and grows there into a cydippiform ctenophore about 3 mm. in diameter. It is believed that at this stage it is liberated and sheds its eggs.

FIXATION OF NITROGEN BY THE WHEAT PLANT.—Lipman and Taylor announce (*Science*, November 24) that they have proved conclusively that wheat plants can fix nitrogen from the air in amounts up to 21 per cent. of the total nitrogen content of the plant. The publication of the evidence upon which this startling announcement is made will be eagerly awaited by agricultural research workers, modifying as it does much of the theory upon which current practice in the use of nitrogenous fertilisers is based. The classic researches of Lawes and Gilbert in the eighties of last century have long been deemed to have proved conclusively that the Leguminosæ alone of cultivated plants have the faculty of fixing atmospheric nitrogen, a power which they exercise not directly but through the agency of the nodule organisms on their roots. In their preliminary note in *Science*, the authors recall that one of the heresies maintained many years ago by Jamieson was that all green plants have the power of fixing atmospheric nitrogen (Rept. Agr. Res. Assn., Aberdeen, 1905). It is interesting to note that another of the heterodox views held by this veteran worker was that plants have the power of directly absorbing "insoluble" phosphates. The availability of such substances as plant food is no longer in doubt, and, whatever the mechanism of their entry may be, it is now admitted by botanists and soil chemists that many substances insoluble in water can find their way into plant tissues. Jamieson's facts, therefore, appear to have been right in this case also, although his deductions from them may have been unsound.

TEMPERATURE-RADIATION FROM CLOUDS.—The temperature-radiation from clouds at night is discussed by A. Defant in *Geografiska Annaler* (1922 H. 1.). Some of the radiation that leaves the cloud is absorbed during its descent to the measuring instrument, which is placed on the ground. At the same time the intervening clear air sends out its own temperature-radiation, some of which reaches the instrument. By making allowance for these complications, Defant calculates that a uniform stratus cloud radiates from its lower surface with an intensity almost the same as (actually $2\frac{1}{2}$ per cent. greater than) that of a "full" radiator at the temperature of the cloud. His calculation involves the assumption that the only constituent of the clear atmosphere which radiates energy is the water-vapour. He also reduces observations of the nocturnal cooling of the air at various observatories, and finds that:

(the cooling per hour when w tenths of sky are clouded) = (same quantity when sky clear) $(1 - 0{\cdot}76\, w/10)$.

WATER POWER IN INDIA.—The issue of the Journal of the Royal Society of Arts for December 15 contains the report of a meeting at which a paper by Mr. J. W. Meares on "The Development of Water Power in India" was read and discussed. The paper was largely a condensed account of information collected by the Hydro-Electric Survey of India and published *in extenso* in the Triennial Report of last year. Mr. Meares, as Electrical Adviser to the Indian Government, was associated, first with the late Mr. G. T. Barlow, and later with Mr. F. E. Bull, successively Chief Engineers of the Survey, in the preparation of the report, and in the analysis of data for potential hydro-electric development schemes. The salient results of the investigation were as follows. In the year 1921, some 350,000 e.h.p. had been developed, or was in course of realisation. Sites had been examined which gave satisfactory evidence of a further $1\frac{1}{2}$ million e.h.p. continuously throughout the year. Other sites, not fully examined, were reasonably expected to yield a further $1\frac{1}{2}$ million e.h.p. continuously. Finally, there were sites of which little was known but their existence, the capacity of which was speculatively, but cautiously, reckoned at 4 million e.h.p., so that "it is perfectly safe to say that at least 7 million e.h.p. is in sight on the most conservative estimate and on the basis of *absolute* minimum continuous power." In announcing these results, Mr. Meares deplored the fact that he was practically in the position of delivering a funeral oration on the Survey, which was moribund for lack of financial assistance.

AN ELECTRIC MICROSCOPE LAMP.—We have received from Messrs. Ogilvy and Co., 18 Bloomsbury Sq., W.C.1, a new form of electric microscope lamp, specially designed for research work. An opal electric bulb of the half-watt type is enclosed within a cylindrical metal hood which is practically light proof, though well ventilated. The holder of the electric bulb is provided with a push-bar switch. The base of the metal hood is detachable, and a slot cut in it fitting over a clamping screw with milled head ensures replacement in the correct position. The hood runs on an upright pillar supported on a heavy tripod base, which gives complete stability, and can be clamped by screws with milled heads in any position of elevation and inclination. The light passes through a circular window cut in the metal hood; this is provided with an iris diaphragm, by means of which the size of the source of light may be regulated. A small prismatic optical bench is attached to the front of the base of the metal hood; this carries two adjustable supports on saddle stands. On one of these is a condensing system, provided with centring screws and iris diaphragm, which is hinged so that if required it may be swung out of the optic axis. The other support is a holder for a cell or light filters. By these arrangements perfect centration of the light and "critical" illumination are obtainable. The instrument is beautifully finished and fulfils the purpose claimed for it; the price (12*l*. 10*s*.) is reasonable, though we fear beyond the reach of most microscopists.

AN ARC RECTIFIER.—At the meeting of the French Physical Society on June 16, MM. L. Dunoyer and P. Toulon gave an account of their experiments on the passage of current through an alternating electric arc with one of the electrodes cooled by the circulation of water through it. They find that whatever the material of the cooled electrode the current only flows when that electrode is the anode. They explain this result as due to the inability of the cooled electrode when it is the cathode to emit the electrons necessary to carry the current. The same effect is obtained between a third cooled electrode and either of the two electrodes of an ordinary alternating arc into which it is introduced. With this arrangement it has been possible from an alternating arc at 110 volts taking 2·5 amperes to obtain by means of a transformer in circuit applying an average of 95 volts to a cooled third electrode a rectified current of 90 amperes. The rectified arc is stable, but the rectified current is not yet steady enough for many industrial purposes.

THE GAUMONT LOUD-SPEAKING TELEPHONE.—At the meeting of the Paris Academy of Sciences on November 27, M. L. Gaumont gave an account of his new loud-speaking telephone, and an illustrated article on it appears in *La Nature* for December 16. The vibrating part of the instrument consists of a silk cone of angle 90° on which is coiled from base to summit a fine wire of aluminium, through which the telephonic current is sent. The cone is placed between cone-shaped poles of an electromagnet and its base is attached to one pole by a collar. As the vibrating cone possesses no period of its own, its motions reproduce without distortion those of the membrane which produced the current. These motions are communicated to the air around the instrument through holes bored in one of the pole pieces and through a trumpet-shaped mouthpiece. With a silk cone of 5·5 cm. diameter weighing 1 gram it was possible to make an ordinary speaking voice heard throughout a room holding 6000 persons without any distortion of the sounds. By introducing a triode valve in the circuit the apparatus transmitted the sound 300 metres.

LARGE THERMIONIC VALVES.—At the Institution of Electrical Engineers on December 7 there was an interesting exhibition of 10 kilowatt vacuum tubes, which are recent developments of the thermionic rectifying valve described by Prof. Fleming in 1904. The large 10 k.w. tubes are used for radio transmission and are of two types, the rectifier (two electrodes) and the oscillator or amplifier (three electrodes). The tubes have water-cooled anodes consisting of a copper tube which is fused to the glass bulb by means of a special copper-glass seal. When in action the tube is mounted so that the anode is surrounded by a metal joint through which cooling water circulates. In the 10 k.w. tube the filament current is 24 amperes, the filament voltage is 32, and the normal plate voltage is 10,000. The power taken by the tube, including the losses inside the tube, is 15 kilowatts and the output power delivered from the tube is 10 kilowatts. The perfecting of these large valves will have a great influence on the future development of radio-communication.

Belgian Botany: a Record of War Time.

THE Botanical Institute, close to the Botanic Gardens in Brussels, which bears the name of that distinguished Belgian botanist, Léo Errera, has resumed its activities since the war and is again under the guidance of Prof. Jean Massart of the University of Brussels. A large volume, Part 2 of vol. 10 of the collected papers of the Institute, has recently appeared, published in Brussels, with many plates, text-figures, charts, and maps, together with a list of the communications published in the earlier volumes. Most of the papers have previously appeared in scientific journals in France or Belgium, but we note as apparently new contributions a brief note by Henri Micheels, comparing the effect upon seedling germination of the anions Cl and NO_3 and the cations K and Na, a note reporting the presence of calcium thiosulphate in *Achromatium oxaliferum* Schew by Germaine Hannevart, and a continuation of phenological observations by E. Vanderlinden, meteorologist to the Belgian Royal Meteorological Institute, which is lavishly illustrated by charts, and a description of the vegetation succeeding upon the war-time inundations of the Yser and upon the ruins of Nieuport.

Prof. Massart's earlier studies of the vegetation of the Belgian littoral make him the natural chronicler of the intense subsidiary struggle waged among the vegetation of this region and maintained long after the armistice of 1918. Behind the dunes bordering the Belgian coast there lies a long stretch of country, the level of which is intermediate between the level of the high and low tides of the sea. On October 29, 1914, the Belgian engineers opened the locks at high tide and allowed the sea to flow over this portion of their front, thus preventing the farther advance of the German forces, and giving their own heroic troops a well-earned respite. For four long years these inundations remained upon the land, fully maintained in winter by the natural rainfall and humid atmosphere, in the drier season assisted by the regulated influx of the sea controlled by the Belgian engineer service. Prof. Massart, aided by official photographs and maps, gives a vivid account of the effect of these conditions upon the vegetation, and, by further striking photographs of his own, records the rapid recovery of the vegetation of the region since the salt-water invasion finally ceased at the close of the war (Figs. 1 and 2).

FIG. 1.—Raised footpath near Ramscapelle after retreat of floods, May 1919. Only vegetation, tufts of *Phragmites communis* in distance.

FIG. 2.—Same path in September 1920. Some of supports of original planking left, ground covered with *Aster tripolium* in flower, especially around shell holes on foreground on right.

The vegetation of this region, once wrested from the sea, rapidly succumbed before the salt water—willows, poplars, elms, etc., all dying as the salt tide reached their roots. At Blankaert, where the waters of the Yser diluted the salt water, Massart figures an interesting group of willows which, inundated for more than a metre above their normal root level, have developed a fresh crop of roots at the new water level, increasing the girth of their trunks above this new fringe of roots.

Very few plants replaced the displaced vegetation, and when the water retreated the mud was left bare and desolate. Massart describes the red alga, *Porphyra laciniata*, growing in the brackish water of a shell-hole, but no longer red in colour. Fringing the salt inundation were typical halophytes like *Aster tripolium*, *Atriplex littoralis*, etc. As the waters receded and the former denizens returned to the attack these plants have to retreat—in 1919 in the ascendant throughout the region, 1920 finds them fighting desperately for a foothold upon the salt-incrusted edge of many a shell-hole. Active in the attack upon these war-time invaders is *Agropyrum repens*, a plant the fighting qualities of which are known to many an allotment holder. *Phragmites communis* had maintained itself during the inundation upon occasional islets rising above the general flood level, where it dispossessed practically all other inhabitants trying to maintain themselves before the salt flood. As the mud dries, long slender rhizomes descend from these little knolls and Phragmites eagerly advances to recover its old domain. An interesting observation made by Massart is that as the yellow-flowered halophyte *Aster tripolium*, typical of the salt marsh, recedes before the reconquering flora of the fertile Belgian plain of peace, there is a fringe of the form of this aster with purple-ray florets to be found maintaining itself for a time upon the more fertile, less saline soil. This occurrence of the purple form is being made the subject of further study in a biological laboratory installed upon the Yser.

Another result of the war is that some of the earlier scientific communications, republished from French scientific journals, give the observations made by Prof. Massart in his enforced exile during those tragic years, including a most interesting discussion of the striking features of the Riviera vegetation as they appear to a Belgian ecologist. The reprinting of Prof. Massart's polemical contribution to the *Revue de Paris* of October 1918, "Les Intellectuels Allemands et la Recherche de la Vérité," seems inappropriate in a volume of this nature, but the perusal of this article may be recommended to any British botanists who may have so far failed to realise the difficulties that still lie in the way of any genuine international Botanical Congress, of the type that would have been held in London before the present date if the war had not intervened.

Methods and Costs of Coal-mine Haulage.[1]

By Prof. HENRY LOUIS.

THE series of bulletins issued under the authority of the University of Illinois has achieved an enviable reputation among mining engineers in this country, and the latest addition fully sustains this reputation. Its origin differs slightly from preceding bulletins, inasmuch as it has been prepared under a co-operative agreement between the Engineering Experiment Station of the University of Illinois, the Illinois State Geological Survey, and the United States Bureau of Mines. Incidentally, such a method of work may be recommended to the serious attention of universities in this country; some of them have indeed moved in this direction, but none has gone so far as has the University of Illinois.

The present bulletin could scarcely come at a more opportune moment, seeing that attention in this country is being focussed upon the possibilities of electric locomotive haulage in collieries, and the pamphlet under review contains a full and authoritative exposition of what is being done in one of the most important of the coal-mining regions of the United States, Illinois ranking in coal output next to Pennsylvania, with an annual production exceeding one-third of that of Great Britain. Individual mines, moreover, are very large, seeing that in some of them, as is here stated, "6000 or more tons of coal per day are hoisted in 5-ton capacity cars and that 1200 or more cars per day, or 150 per hour," must be concentrated at the shaft bottom from various parts of the mine; there is nothing on the same scale in this country.

The bulletin is divided into six chapters. The first contains merely a brief introduction and explanation of the scope of the subject. The second chapter deals briefly with the evolution of mine haulage and shows how great has been the change in practice within the last twenty years: "In 1899, 87·1 per cent. of the tonnage in Illinois coal-mines was handled by animal haulage. Locomotives hauled 2·5 per cent., ropes 7·9 per cent., and tramming 2·5 per cent., but in 1921 it appears that both ropes and tramming were practically obsolete and that 91·2 per cent. of the coal was moved by locomotives, and only 8·8 per cent. by animals."

Of the locomotives, by far the greatest number are electric; considerable attention is now being paid to the track, 45- to 60-pound rails being used on the main roads. It appears that the first electric locomotive was tried in a colliery in Illinois so far back as 1888, but their introduction on any scale only came eleven years later. These locomotives were trolley locomotives and could only run on main roads; gathering from the coal face was still mainly done by mules, but in 1900 the cable locomotive was introduced, consisting of a locomotive furnished with a long flexible conducting cable carried on a reel, which enabled it to run on rails not equipped with trolley wires. For steep dips crab locomotives have been used, consisting of a locomotive with a separate motor driving a drum carrying a steel winding rope, by means of which cars could be hoisted up gradients too steep for the locomotive to travel. Another method of getting over the latter difficulty was the introduction of the rack-rail locomotive, similar to the type used on certain mountain railways.

Storage battery locomotives were introduced about 1899, and they have gradually been improved until their use is now very general; they are so built that they are considered quite safe for operation even in gassy mines. Other types of locomotives that are, or have been, used are steam locomotives, compressed air locomotives, and petrol locomotives; curiously enough, the so-called fireless locomotive using superheated water, which is quite popular in German collieries, appears never to have been even considered, although it no doubt presents certain advantages in fiery mines.

The third chapter of the bulletin deals with the lay-out of the shaft bottom; this section is of com-

[1] Engineering Experiment Station, University of Illinois. Bulletin No. 132: "A Study of Coal-mine Haulage in Illinois," by H. H. Stoek, J. R. Fleming, A. J. Hoskin.

paratively little interest to engineers in this country, as the underground arrangements differ so widely from what they do in America. Perhaps the most important point is the reference to skip hoisting, which has been introduced at several important shaft mines since 1918, the skips carrying loads of between 10 and 12 tons. At one of these mines a trial record of 1000 tons was hoisted in an hour, but all appeared to be capable of hoisting 7000 to 8000 tons daily. It must, however, be remembered that Illinois shafts are shallow, the average depth being only 225 ft.

The fourth chapter deals with details of methods of haulage, both on main lines and by gathering locomotives, which travel between the working face and the "partings" on the main lines; where locomotives are used for gathering, the length of secondary haulage ranges from 800 to 2000 ft. The operations are given in much detail and illustrated by tables of running times. It is shown, for example, that in a large colliery, where the average distance hauled on the main track is 4562 ft., a 15-ton locomotive hauls on the average 1035 ton-miles of coal per day and travels 24 miles. Gathering locomotives necessarily do very much less work than a main-line locomotive, the ton-mileage of the former being approximately $\frac{1}{18}$th of that of the latter. This chapter further contains much useful information upon the construction of mine cars, and directs attention to the efforts that have been made to standardise car design and construction. It is interesting to note that an Illinois mine requires about one car for every four tons of coal hoisted per day; in comparing this with British figures, the larger size of the American car and the shorter length of the main roadways must be taken into account. The construction of the colliery track both on main lines and also for secondary haulage is given in some detail.

Underground haulage costs are carefully dissected in the fifth chapter. There is some difficulty in comparing these costs with costs in this country, because in America costs of hoisting appear frequently to be included with those of haulage, under one head of transportation. It should also be noted in studying this chapter that the items of interest on plant and depreciation are not included. There is thus no real comparison possible between the cost of locomotive haulage and that of animal haulage, which in America always means mule haulage. The last chapter deals with accidents, and the importance of the subject is clear from the opening statement that "For the past ten years haulage fatalities have been second in importance only to those from falls." A dissection of the fatalities shows that the greatest number by far is due to men being caught and run over by cars or locomotives; it is interesting to note that in 1920 thirty-five deaths were due directly to the employment of electricity and four to animals, a proportion of approximately nearly 9 to 1, whereas it has been shown that in 1921 there was more than ten times as much coal moved by locomotives, the vast majority of which are electric, as was moved by animals, so that, contrary to what might have been expected, the danger to life attending the use of the two methods may be said to be about equal. The section concludes with recommendations for the prevention of accidents and a series of safety rules for underground haulage.

It will be fairly obvious from the above summary that this bulletin is one of very real value to the mining community, and deserves the most careful study and attention from coal-mining engineers in this country.

Science Teachers in Conference.

SCIENCE MASTERS' ASSOCIATION.

NEARLY 350 members of the Science Masters' Association assembled for their annual general meeting at Cambridge on Tuesday, January 2, when, by the kindness of the University authorities, they took up residence in Trinity and St. John's Colleges. In the evening the members assembled in the Large Examination Hall, where the general meeting and presidential address opened a crowded programme of scientific lectures and demonstrations. Responding to a general desire that the president should address the Association on some aspect of that branch of science which is so closely identified with his name, Sir Ernest Rutherford delivered an address on "A Decade in the History of the Electron." He reminded his audience of the characteristic and peculiar behaviour of the alpha particle and the evolution of our present ideas of atomic structure arising from the work of such investigators as Bohr, Laue, Moseley, and others. After referring to the essential features of radioactive disintegration, he passed to the consideration of the effect of the bombardment of atoms with swiftly moving alpha particles and concluded by outlining some more recent work in which he had been engaged: this aimed at throwing light on the mechanism by which electrons are captured, and released, by such particles.

A vote of thanks was proposed by Prof. Smithells, president-elect of the Association, and seconded by Sir Richard Gregory, and the meeting then passed to the election of officers for the ensuing year.

The following two days were largely absorbed by lectures, demonstrations in the various University laboratories, and visits to the University observatory, farm, and colleges; and if the parties visiting the colleges under the guidance of Sir Arthur Shipley, Dr. Rouse Ball, and others, were small, it must be attributed to the concentration of the scientific programme arranged, rather than to a lack of appreciation of the kindness of these gentlemen.

In addition to the presidential address, four lectures were delivered to the Association as a whole. On Wednesday morning, January 3, Prof. Seward, the Master of Downing College, lectured on "A Summer in Greenland," in the course of which he described his experiences during the summer of 1921 when on a tour of the coastal fringe of Greenland for the purposes of studying some of the botanical and geological features. Lantern illustrations accompanied his remarks on the evolution of icebergs, on dyke formations, on Eskimo life, and on the characteristic flora of the country. Prof. Seward, in addition to his description of topographical features, pointed out the remarkable sinkage in the land, and also the probable resemblance between Greenland to-day and England in the Ice Age.

On Wednesday evening the Chemical Lecture Theatre was crowded to hear Sir William Pope on the subject of "Crystalline Liquids." Prefacing his lecture by a short résumé of the properties associated with crystalline structure in the solid form, Sir William Pope proceeded to demonstrate, by the aid of the lantern-microscope, the existence of such a fundamentally crystalline property as double refraction in certain substances in the liquid condition, *e.g.* *p*-azoxyphenetole, *p*-azoxyanisole, and esters of cholesterol. The facile manipulation of these substances and the beauty of the polarisation effects shown on the screen were much appreciated.

Reference was made to the possible connexion between the molecular structure and the exhibition of anisotropic properties, and to the various theories that have been advanced to explain the peculiar properties of these somewhat unfortunately named liquids.

Thursday's activities were inaugurated by a lecture by the Master of Trinity on "The Electron in Chemistry." Sir J. J. Thomson apologised, as a physicist, for encroaching on the domain of the chemist, but added that the difference between chemistry and physics was due to want of knowledge, and that the problem of chemical combination was one of the most outstanding problems in physics. Dalton's Atomic Theory, as such, took no account of the intrinsic structure of discrete particles, and the modern conception of the internal arrangements of the atom dated from the discovery of the electron in 1897. The necessity of postulating a central positive nucleus and the possible arrangements of electrons around this was then discussed, and with the aid of diagrams and data thrown on the screen Sir Joseph reviewed existing knowledge of atomic structure, adequately deduced the existence of two forms of nitrogen, and showed that electrostatic considerations limited the number of electrons in a stable ring to eight. The latter part of his paper was devoted to the fascinating but somewhat intricate problem of chemical combination and the idea of "activated" molecules.

In addition to these lectures members of the Association divided to hear the very interesting and amusing lecture on "The Acoustics of Public Buildings," by Mr. A. Wood, and a lecture, equally attractive in its illustration, on "Coral Reefs in the Pacific," by Mr. F. A. Potts.

The scientific interests of the members were further selectively absorbed on Thursday by a lecture in the Anatomical Department by Dr. H. Hartridge on "Physiological Limits to the Accuracy of Visual Measurements"—a lecture of great interest to physicists among others—proceeding simultaneously with a lecture by Mr. E. K. Rideal on "Molecular Orientation on Plane Surfaces": in this, interesting deductions were made from the assumption that surface energy effects are restricted to a film of unimolecular thickness.

The visitors to the Cavendish Laboratory enjoyed Dr. Searle's demonstration of novel methods of determining physical quantities as well as the exhibit of apparatus used by Maxwell, Raleigh, Kelvin, Stokes, and other pioneer physicists. Prof. Marr prefaced his conducted tour of the Sedgwick Museum by a short lecture on some geological considerations suitable for school treatment, while demonstrations of great interest to those engaged in the teaching of science were set up in the laboratories devoted to chemistry, physical chemistry, metallurgy, botany, physiology, experimental psychology, zoology, mineralogy, and in the new Department of Engineering.

A conversazione in the Large Examination Hall on Thursday evening officially terminated the meeting (although the laboratories were opening on the Friday to provide further opportunities for those desiring to visit them): on this occasion Mr. R. E. Priestley lectured on "Antarctic Exploration with Shackleton and Scott." Mr. Priestley's amusing and thrilling lecture, accompanied by lantern illustration that won frequent applause, provided an appropriate conclusion to a richly stimulating meeting.

It remains to be mentioned that well-known firms held an exhibition of books and apparatus in the Arts School.

Association of Women Science Teachers.

At the annual meeting of the Association of Women Science Teachers held at University College, London, on January 6, a report was received from the subcommittee appointed to investigate the possibility of getting into touch with Colonial and foreign teachers of science. An appeal was made for members to correspond with teachers in other countries, and especially to send scientific journals to them. It is hoped that this movement may be further developed and become a useful part of international co-operation.

In her presidential address Miss M. B. Thomas reviewed the criticisms which have recently been made against methods of teaching science in schools. She pointed out that it was impracticable, under existing conditions, to combine preparation for university entrance examinations with the wide and more generalised scientific instruction which was so generally felt to be desirable, and pleaded for greater co-ordination between the subjects taught in schools. It was obvious that Science, and Languages, English, etc., could be mutually helpful, and that a closer co-operation between the mistresses teaching these subjects would result in advantage to all the subjects.

In the afternoon a large and appreciative audience heard a lecture by Dr. Dorothy Wrinch on "Relativity and Scientific Method." The lecturer gave an exposition of this difficult subject which was so clear that even her non-mathematical hearers could follow the argument. She pointed out that the old dynamics had rested entirely upon the idea of measurement relative to a rigid and stationary standard, and that if the standard moved with a uniform velocity the position of affairs was altered. Examples were quoted in which the new equation for the composition of velocities has solved long-standing problems. Dr. Wrinch then proceeded to apply the principle to various kinds of scientific problems, which must not be approached on the assumption that the old laws would hold good but with the possibility in view that some law of the same nature as that of relativity might be the governing principle. To sum up, it must be remembered that if such apparent fundamentals as time and distance have been shown to depend on velocity, then velocity is a relevant variable in all scientific method.

Hail and Sleet in Meteorological Terminology.

AT intervals there appears in the meteorological literature of various countries a discussion concerning the proper designation of the smaller and softer forms of hail which are common in all European countries during the winter or spring months. A recent contribution to the subject by R. Giacomelli, appearing in the issue for May and June of *La Meteorologia pratica*, the organ of the observatory of Montecassino, near Naples, is illuminating from certain points of view, without really settling the question. It is pointed out that the French and German terms, *grésil* and *gräupel* respectively, have the root idea of little pellets or grains, and that the real Italian equivalent, *gragnola*, is meteorologically a better descriptive term since it means "little hail." In full keeping, moreover, with the almost amusing richness of the Italian language in diminutive terms, one may use in place of *gragnola* the words *granzola, granuschia, gragnolischia,* all of which are derived from *grandinola* (*grandine,* hail), and each of which is locally favoured in various parts of central Italy, where such forms of frozen precipitation are fairly frequent in the spring period, March and April.

In English we have no distinctive word, nor, as it is hoped to show in this note, do we really need one. The familiar word "sleet" appears to follow the German *Schlacken* in denoting a mixture of rain and snow in the British Isles; but in the United States "sleet" is officially reserved for true frozen rain, that is to say, drops which congeal into clear ice spherules by passing through a cold surface stratum of air. This kind of hail, as one would categorise it in England, is a common winter phenomenon in the eastern States, because there the contrasts of temperature between the equatorial and polar currents in cyclones, though not more frequent than in England, are more violent, so that a warm rain more often than here alights on a frozen soil. But, on the other hand, various forms of wintry hail falling in showers in moderately cold polar currents during the winter and spring are distinctly common in England, and these show almost every gradation from the little soft white opaque pellets, which are really hardened snowflakes and might be called "snow-hail," to something very like the real hail more typically associated with summer thunderstorms. It is clear that ambiguity would arise if "sleet" were used for any of these forms in this country. In fact, the British official practice of comprising all forms of frozen precipitation other than snow under the term "hail" is philosophically sound, and no regret need really be felt that we have no word to correspond to *grésil, gräupel,* or *gragnola.* It would appear that the only real solution of this terminological difficulty is to recognise but three fundamental species of precipitation: "rain," the liquid form; "snow," the frozen form in flakes or dust; and "hail," the frozen form in stones or pellets.

Actually, the different varieties of hail scarcely differ more from one another than do the different varieties of snow, or even of rain, and no difficulty need be felt on that score. Doubtful forms, such as the "snow-hail" referred to above, had best be entered in a register to both species; and in the case of the mixture of rain and snow, which in this country we call "sleet," this is habitually done. The double-entry plan has the advantage of tending to eliminate the effect of personal bias on the part of an observer, a factor which probably affects quite seriously the comparability of snow-frequency statistics in different localities. L. C. W. B.

The International Astronomical Union.

VOLUME I. of the Transactions of the International Astronomical Union, giving an account of the first general assembly held at Rome, May last, is edited by Prof. A. Fowler (London: Imperial College Bookstall, Prince Consort Road, S.W.7; price 15*s*.). It is an indispensable book of reference for astronomical workers, which contains the agenda of the thirty-two commissions, including important proposals for the co-ordination of methods of observing and mapping out of the fields of work to avoid useless duplication. The spectroscopic data are particularly full: the Draper spectral notation has been slightly modified and considerably extended in the light of increased knowledge. The letter Q is assigned to novæ, and the well-known stages in the development of the nova spectrum are indicated by suffixes. There is also a list of wave-lengths of iron, neon, and other lines suggested as standards.

Some of the decisions may be given briefly. The Latin names of the constellations are to be used, and a set of 3-letter abbreviations of these names was agreed to. The kilometre is to be used for line-of-sight velocities and for dimensions of bodies, the astronomical unit for planetary distances, the parsec for stellar distances. Absolute magnitude is defined as the magnitude at a distance of 10 parsecs. Certain letters were formerly used with several different meanings; they are now distinguished thus: [A] = a line in the spectrum, A̲ or *A* (ital.) = Argon, A = a stellar spectral type.

The *Conn. des Temps* list of Fundamental Stars and the *Carte du Ciel* list of intermediary stars were adopted as standards, and 1925·0 is to be used as the standard equinox up to 1940. M. Andoyer undertook to reduce the latest positions of the fundamental stars to this equinox.

It was recommended that the short-period variations in solar radiation, announced by Abbot, should be studied as widely as possible, and their correlation with weather changes investigated.

Photometric work on minor planets was recommended. In stellar-parallax work it was recommended that plates of each field should be repeated after 10 years, to obtain the proper motions of the comparison stars.

A central bureau for double-star work was recommended, and various decisions for securing uniformity of method were passed. A variable star bureau or centre in each country is desirable (one has been established at Lyons). The Cracow Observatory undertakes the preparation of ephemerides of Algol stars.

The commission on calendar reform recommended (1) a perpetual calendar, with a 52-week year and one or two days outside week and month, (2) the lengths of the months in each quarter should be 30, 30, 31 days, and (3) that the year should begin at the winter solstice.

The volume is thus a noteworthy record of important decisions, embracing nearly every branch of astronomy.

The Haber Process.

THE lecture delivered by Prof. F. Haber on the award of the Nobel Prize at Stockholm on June 1, 1920, is printed in *Die Naturwissenschaften* for December 8. Prof. Haber dealt first with the work done on the synthesis of ammonia before his first research in 1905. Practically nothing of importance had come to light, and the very small yields at ordinary pressures did not hold out much promise of technical application.

The early experiments of Haber, like most of those which have served as the foundations of great industrial undertakings, were made with a purely scientific object, and with no technical applications in view. The results obtained, however, soon made it clear that the basis of an important technical process could be found in ammonia synthesis, and further work was undertaken with this end in sight.

In 1908 the Badische Gesellschaft placed at Haber's disposal all the means requisite for the further progress of the research on the synthesis of nitric oxide in the electric arc which he had begun in 1907, but his proposal to undertake research on the synthesis of ammonia was received with open doubts as to the potential value of the method. The nitric oxide syntheses, in cooled arcs under reduced pressure, and in flames and explosions, were not found suitable for technical application, and attention was then turned to the stone which the builders had rejected. The judgment of the technical chemists of the Badische Gesellschaft had been at fault, since ammonia synthesis was ultimately a very real solution of the problem of the economic utilisation of atmospheric nitrogen.

Ramsay and Young in 1884 had found that with nitrogen and hydrogen in presence of iron at 800° C. no ammonia was produced. This was found to be incorrect, and traces of ammonia were detected. Other catalysts were tried, and from the results it was evident that an equilibrium state was attained, from which it was possible to calculate the yields at other temperatures and pressures. No further progress was made, however, since it was judged by the technical experts to be impossible to carry out the reaction on the large scale at the temperatures required under the very high pressures indicated by the calculations.

In 1906 measurements under pressure were for the first time carried out by Nernst and Jellinek (these are not referred to by Haber), and in 1908 Haber in conjunction with Dr. Le Rossignol began experiments at higher pressures. The work of Le Rossignol (a British subject) is spoken of with great approbation, although his part in the achievement of success has perhaps not always received full credit in some quarters. The technical chemists were still unfavourably inclined towards the process, although practical yields had now been reached: it was clear that "es eines eindrucksvollen Fortschrittes bedurfte, um das technische Interesse für das Gegenstand zu wecken." By the use of new catalysts the temperature was lowered to 500-600° under a pressure of 200 atmospheres. In 1913 the process was taken up by the Badische Gesellschaft, but an account of the main scientific results was also published. The work of Dr. Bosch speedily led to the successful introduction of the synthetic ammonia process, and in the period 1913–1920 the capacities of the German factories rose from *nil* to 35,000 tons per annum in 1914, 850,000 tons in 1918, and 1,500,000 tons in 1920.

University and Educational Intelligence.

CAMBRIDGE.—The annual report of the General Board of Studies on certain University departments shows much useful work being done both in instruction and research. Here we must limit ourselves to some of the new features. (1) It is announced that the enlargement of the Small Animal Breeding Research Institute with help from the Ministry of Agriculture has been followed by a proposal to place at Cambridge a Horticultural Research Station set up by the Ministry in conjunction with the growers. (2) The formation of the Cambridge Architects' Club to unite former members of the University within the profession in support of the School of Architecture is not valuable merely to the department concerned, but may react favourably in several ways on all departments of the University. (3) Research work is being carried out on aerial surveying, also on the measurement from aeroplanes of the altitude of the sun by means of gravity-controlled sextants, the aeroplanes and pilots being provided by the Air Ministry for work under the direction of the professor of aeronautical engineering. (4) The exhibit made by the School of Forestry at the Royal Agricultural Society's Show was awarded the Society's special gold medal.

LONDON.—A number of free public lectures have been arranged for the Lent term at King's College, Strand. A course of eight lectures, on Wednesdays, at 5.30 P.M., commencing January 24, on "Some Aspects of Natural Philosophy," will be given, and the following, in the order named, have promised to lecture: Prof. A. N. Whitehead, Sir Frank Dyson, Dr. J. S. Haldane, Dr. Dukinfield Scott, Prof. F. Soddy, Principal L. P. Jacks, Sir Herbert Jackson, and Sir Richard Gregory. Prof. H. Wildon Carr is giving six lectures on "Physical Causality and Modern Science" on Tuesdays, at 5.30 P.M., beginning February 20. In the department of psychology, Dr. William Brown is giving a course of three lectures on "Psychology and Psychotherapy" on Mondays at 5.30 P.M., commencing February 19. There is also a course of six lectures by Prof. V. Barthold, of the University of Petrograd, on "The Nomads of Central Asia," on Thursdays, which commenced on January 18, and three lectures, by Dr. J. H. Orton, on February 20, 22, and 23, at 5.15 P.M., on "The Bionomics of Marine Animals."

At University College, a course of ten public lectures on "The Micro-organic Population of the Soil" will be given by Sir John Russell and the staff of the Rothamsted Experimental Station in the lecture theatre of the Botanical department of the College, at 5 o'clock on February 5, 7, 12, 14, 19, 21, 27, and March 1, 5, and 7. Dr. G. Anrep is also to deliver a course of eight public lectures at the College, at 5 o'clock, on January 26, February 2, 9, 16, 23, and March 2, 9, and 16, on "The Physiology of the Cortex as investigated by the Method of Conditioned Reflexes." No tickets will be required for either of these courses.

THE Board of Education announces that the Imperial Education Conference is to be held in London in June next. The last meeting was held in London in 1911, and, but for the war, the conference would have met in 1915. The conference will be attended by official representatives from the Education Departments of the self-governing Dominions and Colonies and the British Isles, and various matters of common interest will be discussed, including the question of the interchange of teachers within the Empire.

THE trustees of the Albert Kahn Travelling Fellowships will elect one fellow in May or June next. These fellowships were established by M. Albert Kahn, of Paris, in order to enable suitable persons to undertake a year's travel round the world with the view of obtaining an unprejudiced survey of various civilisations and the acquisition of a generous and philosophic outlook on life. The value of the award for this year will be between 900*l.* and 1000*l.*, the exact amount being decided at the time of election. Candidates may be of either sex, but must be British subjects and graduates of a university of Great Britain or Ireland. The vice-chancellors of these universities, and the presidents of the Royal Society and the British Academy, may each nominate one candidate. Nominations must be sent in by February 28.

PROF. BOHUSLAV BRAUNER writes:—"John Gerald Frederick Druce, senior science master at Battersea Grammar School, London, has obtained the important degree of 'Doctor Rerum Naturalium' of the Charles' University, Prague, after having passed his examinations, which were conducted in English and French, 'summa cum laude.' Dr. Druce is the first Englishman to take this degree in the Charles' (Bohemian) University of Prague. This is the beginning of new scientific connexions between the Czech and English nations. *Vivant sequentes.*"

Societies and Academies.

LONDON.

Royal Microscopical Society, December 20.—Prof. F. J. Cheshire, president, in the chair.—J. E. **Barnard**: Sub-bacteria. The name "Sub-bacteria" is suggested for that group of presumably living organisms which are usually referred to as "filter passers" or "ultra-microscopical viruses." The term may be justified on the grounds that such organisms are of the same order of size as colloidal particles known as sub-microns. Filters are of variable and often unknown porosity, and it is therefore more satisfactory to let the microscopical limits of resolution be the standard beyond which the title suggested may be applied. For the investigation of bodies beyond the limits of microscopical resolution but still within the limits of visibility by suitable illumination, the improbability of any staining method proving of value was insisted on, particularly those involving prolonged fixation processes in which the so-called staining is in reality a deposition of material on the exterior of the object.—H. J. **Denham**: A micrometric slide rule. When one or more micrometer eyepieces are employed with several objectives, a simple nomograph may be used to convert the eyepiece measurements into known units of length. The slide rule described consists of such a nomograph fitted with a movable cursor, which is engraved with an eyepiece scale enlarged ten times. Oblique rulings on the body of the scale represent the rulings of a stage micrometer. The scale is calibrated by trial of the various combinations of eyepiece and objective likely to be used (at standard tube length) on a graduated stage micrometer: to use it, the movable cursor is set to the predetermined position for the combination of eyepiece and objective employed, and the eyepiece measurement is read off in terms of the stage micrometer, while the magnification may be read off the graduated lower edge of the rule. Correction for alterations in tube length without recalibration may be made by the help of a second nomograph on the back of the slide rule.—J. R. **Norman**: Methods and technique of reconstruction. Some of the methods employed for building up a model of any object which has previously been cut into sections in a definite plane are described. The Graham Kerr method consists in making coloured drawings of the sections on ground-glass plates; the plates are then fitted together, and a model obtained by rendering them transparent by immersion in a suitable medium. In the so-called "plastic" method invented by Born, which appears to be in general use, the sections are drawn on plates made of some form of wax, their outlines cut out, and the wax sections fixed together to form a solid model. The technique of preparing the models is described and a new wax mixture formulated.

PARIS.

Academy of Sciences, December 26.—M. Emile Bertin in the chair.—Pierre **Termier**: The structure of the eastern Alps; origin of the superalpine sheet; the problem of the age of the large strata.—A. **Blondel**: The electro-phonographic method and its use for the registration of sounds. The author described in 1911 a method of sound recording based on the combination of the microphone and oscillograph, and this was modified in 1915 for use under war conditions. An imperfect form of this was utilised, without acknowledgment, by the French army.—C. **Guichard**: Conjugated networks.—Edouard **Imbeaux**: The fountain of youth (Silver Spring). A description (with photograph) of Silver Spring, Florida, with a geological section showing its relationship with Blue Spring, 26 miles distant.—Alf. **Guldberg**: Some inequalities in the calculus of probabilities.—Bertrand **Gambier**: Linear systems of plane curves admitting a given system of base points.—Georges **Bouligand**: A concept of linear geometry.—Nilos **Sakellariou**: Polar figures.—A. **Petot**: Motor-cars with transmission by a longitudinal Cardan shaft.—M. **Maggini**: Anomalous dispersion in stellar spectra. Studies on anomalous dispersion may serve as a qualitative test of the theories of Lockyer and Schuster on the evolution of stars.—J. **Le Roux**: Newton's mechanics is not an approximation of that of Einstein.—F. **van Aalst**: The maintenance of electrical oscillations by a lamp with three electrodes. Experiments confirming the formula expressing the necessary condition for the maintenance of oscillations.—A. **Druault**: The diffraction spectra produced by round corpuscles irregularly distributed. Three classes of round corpuscles were used in these experiments, lycopodium grains, powder from diseased wheat, and red-blood corpuscles. The existence of a maximum of diffracted light not predicted theoretically is shown.—H. **Weiss** and P. **Henry**: Diffusion in solid solutions. A study of the interdiffusion of gold and silver at temperatures of 935° C., 885° C., and 835° C. The diffusion constant found agrees well with the earlier figure of Fraenkel and Houben at 870° C.—F. **Bourion** and E. **Rouyer**: The application of the method of continuous variations to boiling-point phenomena for the determination of double salts in solution.—Marcel **Delépine**: The *cis* and *trans* iridio-dichloro-dioxalates. The optical resolution of the *cis* potassium salt.—Marcel **Godchot** and Pierre **Bedos**: The oxide of Δ_3-methylcyclohexene and the dimethylcyclohexanols. The ether oxide can be obtained from the hydrocarbon Δ_3-methylcyclohexene either by direct oxidation with perbenzoic acid or by conversion into the iodohydrin and subsequent treatment with caustic potash. The ether oxide is converted into the corresponding diol by heating with water for six hours at 130° C.—Paul **Gaubert**: The polymorphism of antipyrine, vanillin, and the erythrites.—M. **Lecointre**: The palæozoic strata of the region north-west of Zaër (Western Morocco).—Georges **Corroy**: The Valanginian of the eastern border of the Paris basin.—M. **Boit**: The morphology of the Bas-Morvan.—Marc **Dechevrens**: Two categories of earth currents. A discussion of various observations from 1851 onwards from the point of view of the influence on the moon on telluric currents.—C. **Dauzère**: Researches on natural coloration effected at the Pic du Midi according to the experiments of J. Bouget. The intense colorations of flowers at high altitudes are ascribed to the same cause as the permanent coloration of glass exposed in similar positions.—Ph. **Flajolet**: Perturbation of the magnetic declination at Lyons during the year 1921–22.—R. **Dongier**: Magnetic measurements in the south-east of France (left bank of the Rhône).—L. **Blaringhem**: Hereditary mosaic in the pea (*Pisum sativum*).—René **Souèges**: The embryology of the Malvaceæ. The development of the embryo in *Malva rotundifolia*.—E. and G. **Nicolas**: The influence of formaldehyde on the higher plants. When chlorophyll is absent, or present in insufficient quantity, formaldehyde exerts a toxic action on plants: when the chlorophyll can act as a photocatalyst the influence becomes favourable to growth.—Manuel **Sánchez y Sánchez**: The nature and function of the reticular apparatus of Golgi. The process of oxidation in the plant cell and the development of the network of Golgi increase together;

hence it appears probable that in the Golgi apparatus ferments indispensable to the nutrition and development of the cell are produced.—H. **Colin** and H. **Belval**: The genesis of the carbohydrates in wheat. The presence of levulosanes in the stem.—C. **Champy**: The fluctuating appearance of the male sexual characters in the female *Triton alpestris*.—Edouard **Chatton** and André **Levoff**: The evolution of the infusoria of the lamellibranchs. Relations between the Sphenophryidæ and the Hypocomidæ.

Official Publications Received.

Bulletin of the Imperial Earthquake Investigation Committee. Vol. 8, No. 6: The Sakura-jima Eruptions and Earthquakes, VI. By F. Omori. Pp. 465-525+plates 88-107. (Tokyo.)

Bulletin of the Geological Institution of the University of Upsala. Vol. 18. Edited by Hj. Sjogren. Pp. xxvii+269+6 plates. (Uppsala: Almquist and Wiksells Boktryckeri-Aktiebolag.)

Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 11, Part 2: Flora of the Island of Paramushir. By Yushun Kudo. Pp. 23-183. (Sapporo.)

The Work of the Chemical Examiner's Department in the Punjab. By Lt.-Col. J. A. Black. Pp. 23. (Lahore: Civil and Military Gazette Press.)

The Marine Biological Station at Port Erin: Being the Thirty-Sixth Annual Report of the former Liverpool Marine Biology Committee, now the Oceanography Department of the University of Liverpool. Drawn up by Prof. Jas. Johnstone. Pp. 52. (Liverpool.)

Meteorology in Mysore for 1921: Being the Results of Observations at Bangalore, Mysore, Hassan and Chitaldrug. Twenty-ninth Annual Report. By N. Venkatesa Iyengar. Pp. iii+15. (Bangalore: Government Press.)

Mysore Government: Meteorological Department. Report on Rainfall Registration in Mysore for 1921. By N. Venkatesa Iyengar. Pp. xvii+35. (Bangalore: Government Press.)

Diary of Societies.

SATURDAY, JANUARY 20.

BRITISH MYCOLOGICAL SOCIETY (in Botany Department, University College), at 11 A.M.—Dr. W. Brown and Dr. A. S. Horne: Fusarium.—J. Ramsbottom: Berkeley and Broome.—Miss W. Ridler: The Fungus present in *Lunularia cruciata*.—Dr. H. Wormald: Crown-Gall in Nursery Stock.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Walford Davies: Speech Rhythm in Vocal Music (1).

MONDAY, JANUARY 22.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—P. Lake: Wegener's Hypothesis of Continental Drift.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—A. G. Warren and others: Discussion on Insulators and Insulating Materials.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section), at 7.—Informal Discussion on The Value of College Training to Engineers.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—R. Knott and W. E. Riley: The London County Hall.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—Sir William Willcox and others: Discussion on Dental Sepsis as an Ætiological Factor in Disease of other Organs.

TUESDAY, JANUARY 23.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. F. G. Donnan: Semi-Permeable Membranes and Colloid Chemistry (2). Relation to Problems of Colloid Chemistry and Biology.

INSTITUTION OF CIVIL ENGINEERS, at 6.

INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—Film illustrating Industrial Works.—Messrs. Beardmore, Ltd.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—F. C. Tilney: Address.

ROYAL ANTHROPOLOGICAL INSTITUTE (Anniversary Meeting), at 8.15.

WEDNESDAY, JANUARY 24.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Rev. C. Overy: The Glacial Succession in the Thames Catchment-Basin.—Dr. S. H. Haughton: Reptilian Remains from the Karroo Beds of East Africa.

WOMEN'S ENGINEERING SOCIETY (at 26 George Street, Hanover Square), at 6.15.—Miss V. Holmes: Mechanical Injection of Fuel as applied to Diesel Engines (to be followed by a Discussion).

ROYAL MICROSCOPICAL SOCIETY (Section dealing with the Industrial Applications of the Microscope), at 7.—Inaugural Meeting.—Prof. F. J. Cheshire: Opening Address.—Dr. F. J. Brislee: Training in Practical Microscopy and the Necessity of providing Facilities for more Definite Instruction.—Dr. J. S. Owens: Atmospheric Pollution.—Demonstrations.—Exhibits.

ROYAL SOCIETY OF ARTS, at 8.—Sir William Henry Bragg: The New Methods of Crystal Analysis, and their Bearing on Pure and Applied Science ("Trueman Wood" Lecture).

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (at Royal Society of Medicine, 1 Wimpole Street), at 8.30.—Dr. W. Brown: Autosuggestion and Transference.

THURSDAY, JANUARY 25.

ROYAL SOCIETY, at 4.30.—*Probable Papers.*—Prof. A. V. Hill: The Potential Difference occurring in a Donnan Equilibrium and the Theory of Colloidal Behaviour.—Dr. E. F. Armstrong and T. P. Hilditch: A Study of Catalytic Actions at Solid Surfaces. X. The Interaction of Carbon Monoxide and Hydrogen as conditioned by Nickel at relatively low Temperatures. A Practical Synthesis of Methane.—Dr. J. Holker: The Periodic Opacity of certain Colloids in progressively increasing Concentrations of Electrolytes.—E. K. Rideal and R. G. W. Norrish: The Photochemistry of Potassium Permanganate. Part I. The Application of the Potentiometer to the Study of Photochemical Change. Part II. On the Energetics of the Photo-decomposition of Potassium Permanganate.—E. A. Fisher: Some Moisture Relations of Colloids. I. A Comparative Study of the Rates of Evaporation of Water from Wool, Sand, and Clay.—R. Whytlaw-Gray, J. B. Speakman, and J. H. P. Campbell: Smokes—A Study of their Behaviour and a Method of determining the Number of Particles they contain.—R. Whytlaw-Gray and J. B. Speakman: A Method of determining the Size of the Particles in Smokes. Part II.—R. C. Ray: The Effect of Long Grinding on Quartz (Silver Sand).

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—W. Day: The Birth of Cinematography and its Antecedents.

INSTITUTION OF STRUCTURAL ENGINEERS (at 296 Vauxhall Bridge Road), at 7.30.—W. J. H. Leverton: The Relations between the Architect and the Engineer.

CAMERA CLUB, at 8.15.—W. Wrench: Our Old Village Churches and their Story.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—Clinical and Pathological Meeting.

FRIDAY, JANUARY 26.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botanical Lecture Theatre, Imperial College of Science and Technology), at 2.30.—Prof. R. T. Leiper: The Study of Helminthology.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 5.—Special Clinical Meeting.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—J. J. Manley: A Further Improvement in the Sprengel Pump.—Dr. C. Chree: A Supposed Relationship between Sunspot Frequency and the Potential-Gradient of Atmospheric Electricity.—Dr. D. Owen: Null Methods of Measurement of Power-Factor and Effective Resistance in Alternate-Current Circuits by the Quadrant Electrometer.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—G. F. Shotter: K.V.A. and its Measurement.

ROYAL SOCIETY OF MEDICINE, at 8.30.—Special Meeting to commemorate the Centenary of the Death of Edward Jenner.—Sir W. Hale-White: Jenner and his Work.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Almroth Wright: The Machinery of Anti-Bacterial Defence.

SATURDAY, JANUARY 27.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Walford Davies: Speech Rhythm in Vocal Music (2).

PUBLIC LECTURES.

MONDAY, JANUARY 22.

IMPERIAL INSTITUTE, at 3.—Miss Edith Browne: West Africa and Empire Production. (Succeeding Lecture on January 29.)

TUESDAY, JANUARY 23.

IMPERIAL INSTITUTE, at 3.—Col. M. C. Nangle: The Empire in the Far East. (Succeeding Lectures on January 24, 30, 31, February 6, 7, 13, 14, 20, 21, 27, 28, March 6, 7, 13, 14, 20, 21, 27, and 28.)

SOCIOLOGICAL SOCIETY (at 65 Belgrave Road), at 4.45.—Dr. C. W. Saleeby: Sunlight and City Life.

KING'S COLLEGE, at 5.30.—Miss Hilda D. Oakley: The Enigma of Socrates. (Succeeding Lectures on January 30 and February 6 and 13.)

GRESHAM COLLEGE, at 6.—Sir Robert Armstrong-Jones: Physic. (Succeeding Lectures on January 24, 25, and 26.

WEDNESDAY, JANUARY 24.

KING'S COLLEGE, at 5.30.—Dr. A. N. Whitehead: The Quest of Science To-day, and as exemplified in its History.

FRIDAY, JANUARY 26.

METEOROLOGICAL OFFICE (South Kensington), at 3.—Sir Napier Shaw: Forecasting Weather. (Succeeding Lectures on February 2, 9, 16, 23, and March 2, 9, 16, 23.)

UNIVERSITY COLLEGE, at 5.—Dr. G. Anrep: The Physiology of the Cortex as investigated by the Method of Conditioned Reflexes. (Succeeding Lectures on February 2, 9, 16, 23, and March 2, 9, and 16.)

SATURDAY, JANUARY 27.

HORNIMAN MUSEUM (Forest Hill), at 3.30. Capt. W. H. Date: Wireless Telephony and Broadcasting.