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Research on Foot-and-Mouth Disease.

SINCE Loeffler and Frosch in 1897 reported the striking fact that the fluid from the vesicles which form the main outward lesion of foot-and-mouth disease in bovines, could, after dilution with water, be passed through kieselguhr filters without suffering loss of potency, it has been customary to regard the virus of this, perhaps the most contagious of all animal diseases, as belonging to the group of ultra-visible or filter-passing viruses. This demonstration by Loeffler and Frosch was, indeed, the first indication that an animal disease might be associated with a virus the minute size of which permitted it to pass with ease through filters which retained the ordinary microscopic bacterial forms.

On the Continent, especially in France, Germany, and Holland, where foot-and-mouth disease has long maintained a strong foothold, experimental research has been very intensely and continuously prosecuted, largely with a view towards the elaboration of specific methods of prevention and cure. Though much information with regard to the properties of the virus emerged from these investigations, it cannot be said that any decisive solution of the problem of prophylaxis was reached which would be applicable, at any rate, to a country such as Great Britain, which is liable only to occasional outbreaks readily controlled, as a rule, by wholesale slaughter of affected animals and contacts. Further, the accumulated research data have been to some extent of uncertain quality, probably because of the expense involved in carrying out experiments on bovines on a sufficiently grand scale. It came, therefore, as something of a surprise when Waldmann and Pape in 1920 showed that guinea-pigs could be infected with the virus of foot-and-mouth disease. Loeffler's earlier results in this connexion had been negative and the non-susceptibility of small animals had long been regarded as a *chose jugée*.

The new knowledge, as might have been expected, immediately opened up a new and readily exploitable field for further experimental investigations of the foot-and-mouth virus. In April 1924, Frosch and Dahmen, working in Berlin, announced that they had succeeded in cultivating the virus through many generations on an artificial medium and that by a photographic process they had been able to render the virus visible.

It was at this juncture that the Ministry of Agriculture in Great Britain, faced with the severe and continuing prevalence of foot-and-mouth disease in the country, took the enlightened step of appointing a research committee of ten medical and veterinary experts, with Sir William Leishman as chairman, "to initiate, direct and conduct investigations into Foot and Mouth disease either in this country or elsewhere,

with a view to discovering means whereby the invasions of the disease may be rendered less harmful to agriculture." The first progress report[1] of this research committee has just appeared. It contains no dramatic discoveries, but there is abundant evidence of carefully conducted work leading to decisive conclusions in regard to many hitherto obscure points connected with the properties of the foot-and-mouth virus. So far, the research has been conducted in two establishments, at the Lister Institute, where several workers specially engaged by the committee are being directed by Dr. J. A. Arkwright, a member of the committee, and at the Ministry's laboratories at New Haw, Weybridge, where the work is under the immediate supervision of Sir Stewart Stockman.

Both groups have been working on very similar lines, and both have been employing the guinea-pig as the test animal with great success. The method of choice for inoculating this animal with the foot-and-mouth virus is the intracutaneous, in the hairless pads of the hind feet. In twenty to twenty-four hours redness and swelling at the site of inoculation give place to extensive formation of vesicles locally, and this is followed by generalisation of the virus throughout the body, as evidenced by the presence of minute vesicles in the fore feet and tongue and by the infectivity of the blood. The energies of the workers were devoted in the first instance to traversing the claims of Frosch and Dahmen, but with the exception of one or two results of dubious interpretation, no confirmation whatever of the claims of the German workers was obtained. In Germany also, Frosch and Dahmen's claims do not appear to have received any acceptation. It has been apparent, in fact, that the virus tends to die out rapidly, in a matter of hours, when kept at 37° C. on a variety of artificial media. Low temperatures, on the other hand, have favoured its survival.

Always, therefore, with the view of ultimate successful culture, efforts have been concentrated on testing the most suitable conditions for survival of the virus at a temperature of 37° C., and it has been found, for example, that in phosphate solution of *p*H 7·6 the virus can remain active for four or five days at 37° C. The virus shows a surprisingly high resistance to chloroform and alcohol. In 60 per cent. alcohol, for example, it preserves its potency for eighteen hours at room temperature, while organisms like *B. coli* and *S. pyogenes aureus* are killed in one minute under the same conditions.

Many attempts have been made to infect with the virus other small animals such as rats and mice. Accurate knowledge on this point was desirable, in view of the obscurity that not infrequently surrounds the paths of dissemination of foot-and-mouth disease. White rats, wild rats, white mice, and house mice only very occasionally give evidence of susceptibility to experimental inoculation. On the other hand, the long-tailed field mouse (*Apodemus sylvaticus*), twelve of which were tested, could be infected with ease. No evidence has emerged, however, to show that, either under laboratory or field conditions, foot-and-mouth disease can spread among these small animals.

Recently the Cattle Testing Station at Pirbright has been adapted for experimental work with cattle, sheep, and pigs, every precaution being taken to prevent the entrance or escape of infection. At this station, only, will such experiments be permitted. While research on foot-and-mouth virus with the guinea-pig as test animal is proceeding at approved institutes, the new experimental station will prove a most valuable adjunct for the final testing of varied material on bovines.

[1] First Progress Report of the Foot-and-Mouth Disease Research Committee. Ministry of Agriculture and Fisheries. (London: H.M. Stationery Office, 1925.) 1*s.* 3*d.* net.

The People of Europe.

Racial Realities in Europe. By Dr. Lothrop Stoddard. Pp. v+252+3 maps. (London: C. Scribner's Sons, 1924.) 12*s.* 6*d.* net.

READERS of Dr. Stoddard's "Rising Tide of Color" or his "Revolt against Civilisation" will know what to expect of the essay at present under notice. "More and more we are coming to realise the fundamental importance of race in human affairs" (p. 3); and the superficial similarity of the civilisation of European countries should not obscure the racial differences between their populations. Climate and soil may account for much, but "are not so universal in their effects as race, which subtly but inevitably influences every phase of human existence" (p. 5). Since on Dr. Stoddard's race-map, accepted without change from Madison Grant's "Passing of the Great Race," "we see a Europe inhabited by three races [Nordic, Alpine, and Mediterranean], Europe's seemingly tangled history grows much simpler, while present-day conditions become more understandable" (p. 5): especially as "Europe is a striking example of the persistence of race" (p. 8), and "even in those regions where racial mixture has been most prolonged and general we find populations not fused into new intermediate varieties with harmonious, stably blended qualities but composed of obviously mixed individuals"—a rather ambiguous phrase—"most of whom can be classified as belonging mainly to one or other of the ancestral types" (p. 9). The reason given for this is "another law of races—the tendency to breed out alien strains when these are not too numerous, so that such strains ultimately vanish, and never reappear in the stock." It is argued

that since "these three races differ markedly from one another, not merely in physical appearance, but also in intellectual and emotional qualities" (p. 6), circumstances such as war or industrialism, less favourable to one race, or more so to another, produce the profound social effects which we know, by altering the racial composition of the peoples exposed to them; and the citizens and statesmen momentarily concerned with understanding and alleviating the troubles that ensue, are warned to take account of these anthropological factors, and will disregard them at their peril.

So long as the argument remains in general terms of this kind, it may claim general concurrence. It is only when this kind of applied anthropology begins to be applied to particular cases, that difficulties and objections occur. Even if it be granted that "practically pure-blooded Alpines" are really to be found, for example (as Dr. Stoddard says, p. 15, cf. 170) in "the early Russians" and "the other Slav tribes," do the "Alpine qualities of tenacity, instructive solidarity, and dogged endurance," that "very passiveness" which "has helped to give them the ultimate victory," quite explain the process by which the Slav peoples imposed themselves on the large areas of eastern Europe during their historic periods of migration? And were the "early Russians" or any other Slavs "practically pure-blooded Alpines" at all, when they entered those regions? And if they were, how does Dr. Stoddard know this? Ripley, whose racial theories Dr. Stoddard follows in the main, says that the Alpine type "becomes less pure in proportion as we go east from the Carpathians across the great plains of European Russia" ("Races of Europe," p. 128). In the same way, is it through the "instinctive solidarity" or the "very passiveness" of Alpine temperament that "the Balkan peoples, who are of course mainly Alpines, are always quarrelling and fighting among themselves" (p. 15); and further, in what sense are the Bulgarians "mainly Alpine," or were their Finnish ancestors from far up the Volga themselves "mainly Alpine," and if so, once again, how does Dr. Stoddard know?

In spite of their "tenacity, instinctive solidarity," and so forth, Dr. Stoddard does not wholly approve of "Alpines"; at all events he says (p. 16) that this race "has contributed little that is truly great to politics, art, or ideas," and that "the total absence of Alpine blood in the British Isles is undoubtedly one of the chief reasons for the high qualities of its inhabitants." It is comforting to be assured of our high qualities, still more to learn that there is such a simple reason for them—though it is to be hoped that no British reader of "Racial Realities" will so far practise applied anthropology as to knock on the head as an alien enemy the next Alpine he meets. But, once again, how does Dr. Stoddard know? Still more surprising, though no less complimentary to ourselves, is his insistence on our "predominantly Nordic" quality, and his association of Scotland with England in this respect, in contrast with Wales and Ireland. If "Nordic" in this context means the same thing as in the chapter on the "Nordic North," described as making Scandinavia "to-day the brightest spot on the Continent of Europe," does it mean a group of mental qualities, or a homogeneous physical type? Unless it means both of these, what becomes of Dr. Stoddard's thesis of the coherence of physical types with mental qualities? Even in Sweden there are only about 54 per cent. of pure blonds.

The truth is, that the three-race theory of European ethnology, popularised both in Britain and in the United States by Ripley's brilliant "Races of Europe" some twenty-five years ago, needs a good deal of supplement and qualification before it can be applied to modern nationalities in the way Dr. Stoddard and other recent writers, mostly American, propose. Not only has there been, as Ripley himself frankly admitted, a great deal of interbreeding—so that "in the greater number of cases no invariable association of traits occurs" ("Races of Europe," p. 105), but a chaos of dysharmony—but this interbreeding has in all probability gone so far as to permit the establishment of well-defined secondary types; the so-called "prospectors" along ancient zones of contact between Alpine and Mediterranean populations, and their northern counterparts, the "beaker-folk," as interpreted for example by Sir Arthur Keith, along the margin between Alpine and Nordic areas. There is also cumulative evidence of the persistence of very ancient strains, linking the men of the Plynlimmon moorland with Aurignacian man, the early inhabitants of the Upper Danube basin with peninsular Italy, and so forth, in a fashion which complicates the interpretation of all brunet-longheaded "races." It has also to be remembered that all the three "great races" are themselves abstractions and generalisations from observed coherences or associations of a few easily recognisable characters—head-form, pigmentation, and the like—which are observed, however, in infinitely varying degrees in a vast number of individuals. Among Alpines, for example, and in respect of headform alone, there is marked difference between the Cevenole, the Tyrolese, the Albanian, and the Armenoid types; and some reason already to believe that concurrent processes of differentiation and dispersal are recognisable, around a geographical centre in the Near East, which may turn out to be a cradle historically.

What has to be remembered, in the writings of Dr. Stoddard, Madison Grant, and others, is that, as so often

in the past, anthropology has had its opportunities made for it by the political situation. Some of us can remember Max Müller's contributions to the literature of the Russo-Turkish War of 1878, some even the controversy opened by de Quatrefages in his pamphlet "La Race Prussienne." A more recent example is Houston Chamberlain's version of the "racial realities" of Europe-before-the-War. Latterly, the practical difficulties of Americanising large masses of immigrants, from southern and eastern Europe, have led to desperate remedies, and the need to justify them before both American opinion and that of European countries; and this emergency, like all such, has come at a particular phase of anthropological discovery and ethnological theory. But between the canny criticisms of modern European temperaments and predicaments, which are the really interesting part of Dr. Stoddard's book, and the theoretical explanation which he offers us in his diagram of European race-distribution, there are weak links. The kingdom of truth suffereth violence, and the violent take it by force. Oversimplified as it is, Dr. Stoddard's masterkey is a skeleton key; if it turns the bolt, it is not by fitting the wards. J. L. M.

The Investigation of Colour-Vision.

Colour-Blindness: with a Comparison of Different Methods of Testing Colour-Blindness. By Dr. Mary Collins. (International Library of Psychology, Philosophy and Scientific Method.) Pp. xxxi + 237. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1925.) 12*s.* 6*d.* net.

THAT theories are useful servants but bad masters is borne out by a study of this book. It embodies "the results of research on red-green colour-blind subjects," and "the tests were carried out unbiased by any preconceived theory and no rigid classification was attempted during the experiments themselves." A mass of observations on ten excellent subjects, eight being students attending the graduating course in experimental psychology, and two science students, has been accumulated. All will admit that such material is of great value, but that alone it is unlikely to afford an explanation of the complex problem under investigation. Its ultimate value will depend upon the deductions drawn from it, and these must necessarily involve theoretical considerations which may support or be adverse to previous theories. In this respect it is essential that the investigator should be fully cognisant of the facts which have been elicited by previous observers, whether they support any such theory or not.

The author states that, "as the facts accumulated, the explanation stood out clearly that the subjects were not all suffering from total blindness to red and green, and that in their inability to discern these colours they could be graded as in a scale." Further, "one other interesting result which emerged from the tests was the indication of the existence of two neutral bands—one in the blue-green region of the spectrum, the other beyond the spectrum in the complementary purple." On the first point Dr. Drever says, in the introduction, "This highly significant fact would seem to involve some modification of most existing colour theories"; on the second point, "Perhaps nothing could throw into clearer relief the inadequacy of a study of colour-blindness based on the spectrum, or the dangers lying in wait for the theorist who fails to distinguish between physical colour and physiological or psychological colour."

The reader could scarcely deduce from these remarks that both facts have long been well known. So long ago as 1895, Sir William Abney, in his Tyndall Lectures at the Royal Institution, demonstrated the "neutral band" in the purple. "The green, he calls white, *as he also does the purple*" ("Colour Vision," p. 71, 1895). *Pace* Dr. Drever, these are the observations of a physicist, who worked almost entirely with the pure spectrum. It is, in fact, an immediate deduction from the Young theory, for if the green appears white to the colour-blind person, it is obvious that its complementary purple must also appear white. Further, it should have been well known to the author and to Dr. Drever that Abney long ago actually measured the amounts of the deficiencies in terms of the Young theory in different observers (see especially Abney and Watson, Proc. Roy. Soc., A, 88, 410, 1913), thus fully recognising degrees of the defect.

The author's opening statement that "the study of colour-blindness has been somewhat retarded by the concomitant study of colour theories" is really astounding. It may be true that "the majority of investigators have started out unduly biased by their favourite theory, and have examined colour-blinds from this prejudiced standpoint," but it cannot be doubted that most of the facts of colour-blindness have been elicited by these observers, and that the contentions of the supporters of the Young and Hering theories acted as a great impetus to the study of the subject. It is true that the psychologically inaccurate nomenclature of adherents to the Young hypothesis, *e.g.* "red-blind," "green-blind," etc., has led to much confusion. Even so, let him who is without sin cast the first stone. We have no reliable knowledge whatever as to how a colour-blind person actually sees the colour of the spectrum; yet Dr. Drever, a psychologist, writes: "The red-green blind sees blues and yellows. Hence a yellowish-

red or a yellowish-green will be seen as yellow. . . . Purples will be blue, if there is sufficient blue in them to be apprehended. . . . The results obtained by Dr. Collins enable us to form a fairly accurate idea of the colours of this world."

Dr. Drever says that "colour-vision is primarily the field of the psychologist," but natural phenomena are not divided into these water-tight compartments. Psychology, except as a mass of philosophical speculations, is based upon physiology, which itself is based on chemistry and physics. The psychologist who is not adequately equipped with knowledge of physics is even less likely to succeed in solving problems of colour-vision than the physicist. We agree that vision, including colour-vision, should be the particular study of psychologists, for upon vision more than upon any other sense the advance of the primates to man depended. Psychologists have contributed far less than physicists and physiologists to our present knowledge of colour-vision, and are likely to continue to do so until they realise that the approach to psychology must be from the biological rather than the philosophical side.

Historic British Scientific Instruments.

Historic Instruments for the Advancement of Science: a Handbook to the Oxford Collections prepared for the opening of the Lewis Evans Collection on May 5, 1925. By R. T. Gunther. Pp. iv+90. (London: Oxford University Press, 1925.) 2*s.* 6*d.* net.

FEW of those who use scientific instruments realise the important part which Great Britain has played in their development; although not written at all from this point of view, it is easy to see from Dr. Gunther's book many examples of the contributions of the British makers and men of science. He points out, for example, that among nautical instruments, the backstaff, which was a great improvement on the fore-staff for the determination of the sun's altitude, was invented by an English captain, John Davis, in 1590, to avoid having to look directly at the sun; then there were the improved quadrants of Edmund Gunter of Oxford, and of Sisson; lastly, the reflecting octants of Newton and Hadley—the immediate predecessors of the modern sextant.

The theodolite, the chief surveying instrument, was the invention of Leonard Digges, of University College, Oxford, and was described by his son in 1571. The accurate dividing of a circle was carried out by Ramsden with his dividing engine in 1763, who thus led the way in the construction of surveying instruments of all kinds.

Of mathematical instruments, Dr. Gunther quotes Stone's remark in his translation of Bion (1758): "The making of good mathematical instruments is almost peculiar to the English." Napier following his invention of logarithms, devised his "Bones" by which multiplication could be performed mechanically. Shortly after, Gunter (1620) made his "line" and Oughtred his "circle of proportion" (1630), from which the slide rule has descended.

Turning to the telescope, Gregory and Newton devised the reflecting telescopes called after them, and of much greater importance, the refracting telescope was suddenly brought from a clumsy and very defective instrument, a hundred or more feet in length, to an almost perfect instrument through the discovery of achromatism, first by Chester Moor Hall (in 1733), and then by the careful experiments of John Dolland in 1658; the telescopes Dolland made were for their size little inferior to those of the present day.

Lastly, the most important of all scientific instruments, the microscope, from the time of Hooke, who described and illustrated his famous instrument in his "Microhraphia" in 1665 (the date 1667 mentioned by Dr. Gunther is the date of the second edition) down to nearly the end of last century, owes all the chief improvements to the British makers. The microscopes of Marshall, Culpepper, Cuff, Adams, Dolland, Nairne, are briefly referred to by Dr. Gunther.

In the Science Museum at South Kensington there is a fairly representative collection of scientific instruments if we include the portion of the fine collection of these old instruments formed by Thomas H. Court during the last thirty years, which has been on loan there so many years; but even including these there are many gaps, especially in the instruments produced during the latter end of the seventeenth and the early years of the eighteenth centuries—a most important period in the development of scientific instruments, as it was during this period that so many of the features that still persist were first introduced.

Oxford has in Dr. Gunther another man of enthusiasm, who seems determined to build up a representative collection there. He has been fortunate in starting with a nucleus of three unique collections—the Orrery collection, made by a grand-nephew of Hon. Robert Boyle *c.* 1700; the Oriel collection of instruments dated about a hundred years later, mostly constructed by Nairne; and the Lewis Evans collection, recently presented to Oxford.

Dr. Gunther has already published three finely illustrated volumes descriptive of some of the more interesting and important of the instruments, but these are necessarily expensive, while the little book that has now appeared is within the reach of all, and it gives in brief outline a general survey of the collection together with sufficient historic notes to place the instruments

in their true perspective, and to enable the general reader to form some appreciation of the interest and value of the collection.

The University of London has established a degree in the history of science, and it is possible that other universities will follow suit; if so, collections in which students can follow the development step by step will be necessary for any proper appreciation of the subject. As these old instruments—not so much the antiques which are probably safe, but the intermediate links—are being broken up every day by those ignorant of their importance, no time should be lost by other universities, especially the sister University of Cambridge, in forming a similar collection.

Introduction to Biology.

(1) *Allgemeine Biologie: eine Einführung in die Lehre vom Leben.* Von Prof. Dr. Max Hartmann. Erster Teil: Zelle, Statik, Dynamik und Stoffwechsel. Pp. vi+262. (Jena: Gustav Fischer, 1925.) 12 gold marks.

(2) *Outlines of General Zoology.* By Prof. H. H. Newman. Pp. xvi+480. (New York: The Macmillan Co., 1924.) 16*s*. net.

(3) *A Text-Book of Biology: for Students in General, Medical and Technical Courses.* By Prof. W. M. Smallwood. Fifth edition, thoroughly revised. Pp. 393. (London: Baillière, Tindall and Cox, 1925.) 16*s*. net.

NOT the least evident of the signs that biology is finding its place in a general education is the crop of books intended to introduce the student to it which is now appearing. Three such are before us.

(1) Prof. Max Hartmann publishes the first of two parts of a work founded on his lectures on general biology in the University of Berlin. This is in title and manner an introduction, it is true, but it is an introduction on an ample scale, and suited only to serious students. It is broadly and philosophically conceived, and worked out very systematically in the German way. Prof. Hartmann begins at the beginning. In an opening section he considers the philosophical prolegomena of the subject—the position of biology in the system of the natural sciences, the methodology of the biological sciences, and the scope of general biology.

In treating of methodology, Prof. Hartmann gives an interesting and very judicious exposition of the respective functions of generalising and exact induction, and of the part played by hypothesis and experiment in the development of the science. As might have been expected, he views general biology as primarily the study of cell life, and begins his exposition of its principles with a survey of our knowledge of the cell. He draws the very necessary distinction between cell and energid, but unfortunately adheres to a use of the former term which compels him to apply it to the whole body of various organisms, from bacteria to Caulerpa, which are much better described as non-cellular. It is a pity thus to reduce to absurdity a conception which, rightly used, is of much value. Upon the question of "generative chromidia," which is briefly discussed in this section, the recent observations of Sister Monica Taylor on the life-history of Amœba throw some further light. A survey of the various skeletal and formative structures of cells follows, and then a section upon various types of motion. Here some allusion to recent English and American work on amœboid movement might perhaps have been made. Muscular contractility and the organs which subserve it are discussed in an excellent summary.

Part I. of the work ends with an admirable survey of the interchange of matter and energy between the organism and its surroundings, illustrated by an elaborate tabular statement. The style throughout is clear, and the illustrations plentiful and well printed. We are promised Part II., which will complete the book, in the course of next year.

(2) and (3) The other two books are ordinary enough examples of a common type—the introductory text-book for elementary students. Prof. Smallwood writes for students of biology, Prof. Newman for those who are studying zoology. Each states briefly a number of elementary facts and theories. Each at least avoids giving the impression that biology consists in a knowledge of the comparative anatomy of a series of organisms and some speculations as to the course of their evolution, but neither, we think, has avoided the opposite danger of superficiality. Prof. Newman's is the better book.

Our Bookshelf.

The Foundations of Colloid Chemistry: a Selection of Early Papers bearing on the Subject. Edited, on behalf of the Colloids Committee of the British Association, by Emil Hatschek. Pp. 173. (London: Ernest Benn, Ltd., 1925.) 18*s*. net.

MR. EMIL HATSCHEK has rendered a real service to all students of colloid chemistry by collecting early fundamental papers on the subject, six by foreign investigators being translated into English. The book makes no pretence to develop a historical account of the growth of colloid chemistry, but rather indicates certain outstanding conclusions which subsequent research has substantiated.

The first paper is by Ascherson (1840), who dealt with protein absorption at the interface: oil-aqueous solution. His results have been almost entirely overlooked by the many investigators who have since

published work on similar lines. With remarkable insight he speaks of "capillary condensation" at the interface between heterogeneous liquids, the modern notion of adsorption.

Three papers by Selmi (1845, 1847, 1850) disclose experiments and deductions little known to the majority of students. He recognised many colloidal solutions, naming them "pseudo-solutions," and anticipated the importance of the organic colloids. The pseudo-solutions could be coagulated by electrolytes, a fairly wide selection being tried out. The paper by Selmi and Sobrero, dealing with sulphur sols, is very important historically. A paper by Graham, "On the Properties of Silicic Acid and other Analogous Colloidal Substances," introduces nomenclature now firmly established.

The colloidal chemistry of metals has attracted numerous workers, and the subject lends itself admirably to quantitative treatment. It is satisfactory, therefore, to find the classic papers of Faraday (on gold sols), Muthmann (on silver sols), and Carey Lea (on silver sols). Faraday believed that his ruby sols contained solid gold in extremely fine division, and he mentions the use of a light cone to show up the particles; the Tyndall cone should really be termed the Faraday-Tyndall cone. Muthmann (1887) published his experiments on the dialysis of metal sols, an outstanding achievement in colloid chemistry. Carey Lea's work is somewhat better known, a complete edition of his papers having been translated and edited by Lüppo-Cramer. The remarkable publication of van Bemmelen (1888), "On the Nature of Colloids and their Water Content," is essential to the study of gels, and pointed to a new field in colloid chemistry.

Mr. Hatschek has provided most useful notes to all these papers, and he is to be congratulated on his work as editor and translator. The publishers have also done their work well. WILLIAM CLAYTON.

Introductory Geology: for Use in Universities, Colleges, Schools of Science, etc., and for the General Reader. Part 1: Physical Geology, by Prof. Louis V. Pirsson; Part 2: Outlines of Historical Geology, by Prof. Charles Schuchert. Pp. x+693. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1924.) 20*s.* net.

THE text of Part 1, "Physical Geology," first appeared in 1915 in Pirsson and Schuchert's "Text-Book of Geology," a revised second edition of which was published in 1920. With the exception of the chapter on ore deposits, which has been rewritten by Prof. A. M. Bateman, Part 1 in the present volume is reprinted from the second edition of the "Text-Book." The subject is treated under two main heads, dynamical geology and structural geology. In the first section the various geological agents and their work are dealt with fully but concisely, the geological work of organic life not being neglected. The second section is a well-arranged and comprehensive account of the composition, character, relations, and structures of the rocks forming the earth's crust. In scope and treatment the whole is an excellent introduction to the subject for students, and it must also be of interest to the general reader. The illustrations are good and include both reproductions of photographs and diagrams. There is an appendix on important minerals.

Part 2, "Outlines of Historical Geology," is a greatly reduced version of the author's "Historical Geology" in the "Text-Book of Geology" of Pirsson and Schuchert. In thus cutting down the original manuscript, the author has succeeded in producing a book more suitable as an introduction to the subject. The contents are well arranged, the first chapters dealing briefly with the changing aspect of the earth's surface, evolution, fossils, and the geological record, and thus prepare the way for an account of the history of the earth during the successive geological periods. This account is related with special reference to North America, and these chapters are therefore mainly a geological history of that country. Other chapters are devoted to the coming of land life, the evolution of mammals, and man. There are abundant illustrations of fossils and restorations together with numerous palæogeographical maps. A folding geological map of North America is appended. The volume includes a very full index.

The Natural History of Wicken Fen. Edited by Prof. J. Stanley Gardiner. Part 2. Pp. 65-171. (Cambridge: Bowes and Bowes, 1925.) 6*s.* net.

THE second part of this valuable work on the natural history of Wicken Fen includes an account of the dragon flies, the bugs, the Ichneumonidæ and some of the other less popular families of insects, the spiders, the wood lice, the leeches and the mollusca. It also contains an account of some observations on the hydrogen ion concentration of the waters of the Fen, and on its Phytoplankton, and an interesting essay by Dr. A. H. Evans on the history of Wicken and Burwell Fens.

We may congratulate the editor on the style in which his contributors have written their parts, for they write not only with authority on their several subjects, but also in a manner that interests the naturalist who has no special knowledge of the groups that are described. In the literature of the British fauna there are found many records which are simply unintelligible to any but the highly specialised systematists. There are no suggestions to excite the interest of the more general reader on the habits, associations, rarity, and other points of interest of the animals included in the long lists of specific names. There is no article in this volume to which this criticism could be fairly applied, for in every one of them we seem to catch the spirit of the true naturalist instead of that of the mere collector. With this little volume in his hand a visitor would have at least some idea as to what to look for and how to find it.

Mr. Saunder's essay on the hydrogen ion concentration of the water is a novelty in works of this description, but we hope it will be followed by others of a similar kind. It has often been a puzzle to naturalists why some ponds are so rich in their microfauna and others so poor. Is the solution of this puzzle to be found in the *p*H?

Reference cannot be made in detail to the individual essays in this part of the series, but as a whole it affords additional commendation for the wisdom and public spirit of those whose efforts have led to the preservation of Wicken Fen from the destructive forces of modern civilisation. The series should be in the library of every naturalist.

Scientific Paradoxes and Problems and their Solutions; Simultaneously Broadcast from 2LO. By A. S. E. Ackermann. Pp. viii+131. (London: The Old Westminster Press, 1925.) 5*s*. net.

MR. ACKERMANN is the author of a successful book on popular fallacies, now in its third edition. Early in 1925 he was engaged by the British Broadcasting Company to give a series of talks on popular fallacies connected with engineering and science. Listeners were invited to send such paradoxes to the speaker, and the pick of the matter received by him has been collected into the volume now noticed. Some of the problems, which seem trivial to a mind versed in science, are yet a source of constant perplexity to the general public.

A great number of people are attracted by arithmetical, geometrical, and mechanical puzzles, and the author found that a surprising variety of posers, many being of a very high quality, were sent to him by interested listeners. The solutions of some of the problems included will be obvious to many schoolboys. A few of them are mere verbal conundrums. From the more elusive questions discussed we select two, which are sufficient to indicate the scope of Mr. Ackermann's book. 1. (p. 70). Given two straight bars of steel identical in every respect with the exception that one of them is magnetised, in what way can it be determined which bar is magnetised? No third article of *any kind* is to be used. You may not even balance one or both bars on a finger or finger-nail, but you may hold the bars in your hands. 2. (p. 75). In going up a wide, steep road on a bicycle or other vehicle, does it make it any easier for the bicycle rider, horse, or engine of a car if a zigzag course be taken?

The solutions throughout are given in non-technical language and should appeal to any intelligent person without specialised training in science. We foresee a wide circulation for Mr. Ackermann's book: few readers will go through its pages without finding much to instruct them—and all of it presented in an entertaining way. W. E. H. B.

Electrical Engineering. By Prof. L. A. Hazeltine. (Engineering Science Series.) Pp. xvi+625. (New York: The Macmillan Co., 1924.) 30*s*. net.

THE author of this volume is the professor of electrical engineering in the Stevens Institute of Technology. It is primarily intended for the students in his classes, but it will be of interest to many teachers of physics and engineering in Great Britain. The author writes clearly, his object being to explain the essential elements of electrical science and its applications. It will prove useful as a class-book, and we also think that it will be useful to the private student who has a sound knowledge of elementary physics. The rational system of units is employed, the permittivity of a vacuum being taken as $1/(4\pi)$. Some formulæ are simplified, but others are made slightly more complex. The "true" units and the "international" electric units are both given. Seeing that now testing laboratories can measure resistances, and so on, in true units with an accuracy far exceeding that required in industry, we think that the time has come when the "international" units can be regarded as obsolete. No instrument reads absolutely correctly, and the "tolerance" permissible, with a given type of instrument, is many times greater than the possible error in calibrating the standard in true units. Mathematical proofs are always given when they can be understood by the average student, but advanced mathematical proofs are excluded. Many collections of problems are given throughout the book, and we were glad to see that the answers are given to them.

Practical Radio: including the Testing of Radio Receiving Sets. By James A. Moyer and John F. Wostrel. Pp. vii+249. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1924.) 8*s*. 9*d*. net.

RADIO broadcasting has greatly interested the public in radio science. There are many amateurs who have an excellent working knowledge of the art but lack that specialised knowledge of the science which alone can give them the confidence necessary for success. This book is clearly written and can be recommended to any one who wants to know standard modern practice and desires a simple introduction to elementary theory. A chapter is devoted to the future of radio, but the author rather confines himself to the history of past triumphs. A good description is given of the apparatus used for transmitting photographs over long telephone wires on a commercial scale; vacuum tube amplifiers, photo-electric cells and synchronising arrangements form an essential part of the method. It is therefore an adaptation of devices developed in connexion with radio communication, telegraphy and telephony. Future improvements in radio reception will probably consist of replacing storage batteries and dry cells by devices which can be connected with the electric supply; for example, a suitable thermocouple. As amplifiers become more sensitive a large antenna becomes unnecessary. Many sets operate with a loop at present, but in the future this loop will probably be very small. The elimination of static disturbances by directive reception is also mentioned.

Faune de France. 9: *Amphipodes.* Par Ed. Chevreux et Louis Fage. (Fédération Française des Sociétés de Sciences Naturelles: Office Central de Faunistique.) Pp. 488. (Paris: Paul Lechevalier, 1925.) 60 francs.

THE volume opens with a short statement of the characters of the order Amphipoda and of its three suborders, followed by an account of the habitats in which Amphipoda occur, the methods by which specimens may be obtained, studied, and preserved, and by a useful description of the external morphology and internal structure. Tabular keys are provided to the families, genera, and species—some 320 of the latter being considered. Under each species is given a concise statement of its characters—illustrated by clear line drawings, for the most part original—and of the distribution of the species in France, with a note of the neighbouring countries from which it has been recorded. Appended is a list of works on Amphipoda and there is an adequate index.

The present volume, like its predecessors in the same series, will receive a warm welcome in Great Britain, and will be of great service to those interested in the order of which it treats.

ERRATUM.—Page 461 of issue of September 26, col. 1, line 26, for "Microscopic Reactions" read "Macroscopic Reactions."

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.*]

Carnot's Cycle and Efficiency of Heat Engines.

ON p. 326 of NATURE for August 29 appears an abstract of a paper by Dr. J. S. Haldane, which he read before the Institution of Mining Engineers on June 16. In this paper he has "thrown to the winds" the usual academic teaching in regard to the efficiency of a Carnot cycle, and has put forward a claim that another cycle has a greater efficiency. This, which for brevity we will call the Haldane cycle, consists of an adiabatic expansion BC (Fig. 1) followed by an isothermal compression CA and a constant volume heating AB. In the discussion on the paper, I proved that this cycle has only about half the efficiency of a Carnot cycle working between the same limits of temperature. This proof did not make use of Carnot's principle, but required only a knowledge of the thermal properties of air, which was treated as a perfect gas. In such a case it is perfectly easy to calculate the work done and the heat changes and therefore the efficiency.

Dr. Haldane has challenged these conclusions; their truth, however, can be seen in other ways. In the Haldane cycle heat (say H_1) is taken in along AB and heat H_2 is given out in the condensation along CA (see Fig. 1). The balance of work done is the difference between the work of expansion along BC and the work of compression along CA; this balance is represented by the area ABC. Now to increase the efficiency we require to increase the work for a given quantity of heat rejected along CA. This can be done by replacing AB by an adiabatic compression AD which raises the temperature to that at B followed by an isothermal expansion DB. By making this change we have obviously practically doubled the area representing the balance of work available *without altering the amount of heat* H_2 *rejected*. But the new cycle so obtained is a Carnot cycle; this has therefore a greater efficiency than a Haldane cycle. When the difference of temperature is small the double area implies double efficiency, because H_1 and H_2 are nearly equal. But detailed calculation shows that it is practically so for differences as large as 200 degrees.

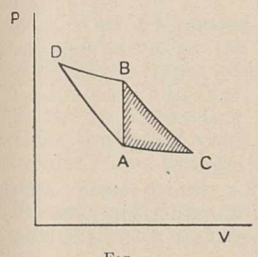

FIG. 1.

Of course more heat is now taken from the boiler (along DB), because the principle of conservation of energy must be satisfied—unless this principle is another which may be "thrown to the winds."

These conclusions can be verified by detailed calculation for the case where the working substance is a perfect gas. Air at moderate pressure is so nearly a perfect gas that they cannot be far wrong for air. What Carnot did was to give reasons for declaring that the efficiency for a given range of temperatures must be independent of the substance used in the cylinder in the case of reversible cycles. Whatever the efficiency may be for a perfect gas must be precisely the value for air also or for steam or even for ice. His reasoning was imperfect because it was based upon the caloric theory of heat. But it had such a form that when the energy nature of heat came to be recognised, the reasoning was easily transformed by Clausius (1850) and Kelvin (1851) so as to suit the general law of conservation of energy. The reasoning was transformed although the conclusion remained the same and is still known under Carnot's name.

The proof of the law of efficiency does not rest on the performance of actual steam-engines. These are always *less* perfect because they are not reversible. To those who cannot rise to the necessary heights of abstract reasoning the Carnot-Clausius-Kelvin proofs can be replaced by the more tangible facts that the thermal properties of any substance are connected together by relations which require the exact truth of the Carnot law. For example, the latent heat of a substance can be calculated from observations of pressures, volumes, and temperatures. The latent heats of substances would not be what they are if the law were untrue. It will take more than the unsupported assertions of Dr. Haldane to disturb convictions based upon the immense amount of evidence in the realm of physics which requires the truth of Carnot's theorems.

ALFRED W. PORTER.
University College, London.

Mutant Groups in Nature.

WHILE staying at Val d'Isère (Savoie) this summer, I noticed some facts which seem worthy of record as bearing on the evolutionary importance of mutations. *Gentiana campestris* L. was an abundant plant in many localities round the village. Not infrequently variants were noted in which the corolla was white and the leaves paler green than normal ("albinos"). It is not to be doubted that such forms have arisen from the type by a recessive mutation. Sometimes these mutants were found singly. This is in my experience the usual state of affairs with white-flowered mutants of other wild species (*e.g.* wild hyacinth), and was also the case with pink-tinged *Saxifraga oppositifolia* noted by me in Spitsbergen in 1921.

The fact which struck me as interesting, however, was the discovery, on five occasions, in quite separate localities, of *groups* of albinos. In two cases the groups were small, comprising only a score or so of individuals. In two further cases the number of individuals in the group was several hundreds, and in the last and most remarkable group it was certainly well over a thousand, and very possibly several thousands. This largest group was found on the left bank of the Charvet torrent, almost exactly at the waterfall which forms a conspicuous object in the view from Val d'Isère, about 2 miles up the Calabourdane valley. It would be interesting if botanists who were in this area would visit it from time to time to see whether it maintained itself. Over an area of ground about 70 paces long and 15 to 20 paces broad, albinos were very abundant; only one or two scattered type plants (purple-flowered) were discovered, after some searching. Round this patch was a zone apparently unsuited to the growth of this plant, extending away from the stream for 40 or 50 yards, upstream for nearly as much, and downstream for almost 100 yards; the stream itself formed a barrier on the fourth side.

The other two large groups, one of which was about 10 × 15 yards in extent, also showed a very few normal plants. In one at least of the small groups, no normals were found within the albino group. The isolation of the group by a zone unsuited to the species was clear also in one of the moderate groups, but definitely did not exist in one of the small ones. I have no notes on the point for the remaining two groups.

These groups, all belonging to a distinct and obviously mutant type, strongly recall the findings of R. E. Lloyd in rats in India ("The Growth of Groups in the Animal Kingdom," London, 1912). Here, however, the fate of the group might be followed year by year, which was difficult or impossible for the rats.

The most probable explanation of the existence of such groups is that they are all descended from a few or probably a single mutant ancestor. The ecological isolation of the areas occupied by some of the groups is interesting. When such isolated areas occur, then, should especially adverse circumstances kill off a species over part of its range, if a mutant chance to be the first to recolonise an isolated patch, it has a good chance of populating the whole patch; whereas (if recessive and non-advantageous) if not isolated it will tend to be swamped. Once the patch is colonised with the mutant, it will not be easily invaded by the type unless the mutant is markedly less hardy. For a detailed discussion of these points, see C. S. Elton, 1924 ("Periodic Fluctuations in the Number of Animals," etc., *Brit. Jour. Exp. Biol.*, 2, p. 119), and A. L. and A. C. Hagedoorn, 1921 ("The Relative Value of the Processes causing Evolution": The Hague). It is to be noted that the patches tenanted by the white plants were not newly exposed ground, but similar in every way, so far as could be seen, to the neighbouring areas where the type plant was abundant.

It is in any case interesting to find a mutation which by analogy is almost certainly recessive, and most probably less vigorous than the type, capable of colonising and holding in force areas as large as that described. It shows how easily mutations may become established in nature. If the mutation were of smaller extent and less unfavourable it would have still more chance of surviving, though less of detection; if it possessed a biological advantage over the type, *a fortiori* it would survive still more readily. In any case, the importance of tiny semi-isolated areas within the habitat of a species may be expected to provide, as in this case, occasional "reservoirs" of mutants. Such "reservoirs" would also be expected in normally self-fertilised species, though the isolation here would be physiological.

I have no doubt that similar cases must be known to botanists, and that many more are awaiting discovery. Meanwhile, I venture to record these observations for what they are worth.

JULIAN S. HUXLEY.

Department of Zoology,
King's College, London, W.C.2,
September 12.

Coastal Refraction of Wireless Waves.

DR. SMITH ROSE, in his letter on this subject in NATURE of September 19, has directed attention to the striking discrepancy between theory and experience in the matter of coastal refraction of wireless waves. It may be of interest to point out that the conclusion, to which he is led from Zenneck's analysis, that waves travel with a greater effective velocity the lower the conductivity of the surface, though contrary, I believe, to what is now generally accepted, is supported by quite simple reasoning.

If we make Zenneck's assumption that at a considerable distance from the transmitter we have to deal with a single wave, sensibly plane, it follows that (neglecting the conductivity of the air and assuming its S.I.C. is unity) the wave must be travelling with the speed of light.

Further, since there is only one wave, the conditions at the surface must be those for an incident and *refracted ray* but without *reflected ray*;[1] that is, the wave must be incident at the critical, or Brewsterian, angle of incidence (i) given by

$$i = \tan^{-1} \mu, \quad . \quad . \quad . \quad . \quad (1)$$

where $\mu = \sqrt{K - \frac{2j\sigma}{n}}$ is the refractive index of the ground and

K is the S.I.C. of the ground,
σ is the conductivity (E.S.U.) of the ground,
n is the frequency of the waves.

The forward tilt of the waves ($90° - i$) implied by equation (1) is identical with that obtained by Zenneck.

The velocity (V) of such a wave *along the surface* can only be defined as the product of frequency into wave-length (*i.e.* distance apart of two crests) measured *along the surface*, so that we see from Fig. 1

$$V = n \frac{\lambda}{\sin i} = c/\sin i = c\sqrt{\frac{\mu^2 + 1}{\mu^2}} \quad . \quad . \quad (2)$$

(where c = velocity of light), and this is identical with the expression for superficial velocity obtained by

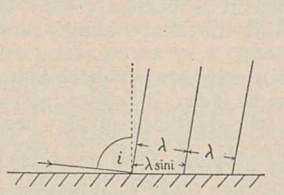

FIG. 1.

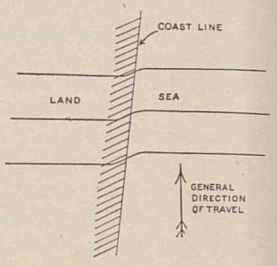

FIG. 2.

Zenneck and referred to by Dr. Smith Rose. Now μ decreases with decreasing conductivity, so the velocity will increase and be greater over land than sea.

If V_1 is the velocity over sea,
V_2 ,, ,, land.

The ratio V_1/V_2, which may be called the coastal refractive index (μ_c), is obtained by

$$\mu_c = V_1/V_2 = \frac{\sin i_2}{\sin i_1} = \sqrt{\frac{\mu_2^2(\mu_1^2 + 1)}{\mu_1^2(\mu_2^2 + 1)}} \quad . \quad (3)$$

(where μ_1, μ_2 are the refractive indices for land and sea). But, in the case of sea, $\mu_1^2 >> 1$ for commercial frequencies, so that

$$\mu_c = \sqrt{\frac{\mu_2^2}{\mu_2^2 + 1}}. \quad . \quad . \quad . \quad (4)$$

The coastal refractive index is thus less than one.

In the face of the experimental evidence, which seems to me very decisive, we are left with the conclusion that coastal refraction must be the result of other causes than a difference in superficial velocity.

I think that there is a possible explanation in the fact that there is greater absorption of the waves on land than on sea. The part of the wave-front on land must, for this reason, be weaker than that on sea, with the result that a continual transference of energy must take place across the boundary *at right angles to the general direction of travel of the waves*. This will give rise to a kink in the wave-front in the

[1] I now find Bouthillon has used much the same argument in a criticism of Zenneck's work (see *Onde électrique*, May 1923), but not in connexion with this particular problem.

neighbourhood of the boundary in some sort of manner as shown in Fig. 2.

This would account qualitatively for the facts. A mathematical development on these lines would be necessary in order to show whether it also gave quantitative agreement. R. H. BARFIELD.

Radio Research Board Station,
Slough.

Spermatogenesis of Spiders.

I HAVE been much interested in Prof. Ernest Warren's letter in NATURE of September 12 on the spermatogenesis of spiders, in which he claims amitotic division of spermatogonia, an abnormal type of maturation, and finally the formation of many spermatozoa from chromatin bodies, bereft of cytoplasm.

I recognise that it is naturally difficult for any one, in the limited space afforded by a letter to NATURE, to give an adequate account of the phenomena described by Prof. Warren; nevertheless, I feel that there is need for caution in accepting his results. The spermatogonial nucleus is polymorphic and lobulated, in itself no evidence of amitosis: the great Meves himself mistook the polymorphism of amphibian germ cells for amitosis—a mistake finally cleared up by Champy.

The formation of more than four spermatids from one spermatocyte is known in moths, where this effect is brought about by an extra, but normal, mitotic division.

Prof. Warren's figures 9-12 seem to recall apyrene sperm formation, or the degenerative changes found in many effete insect germ cells.

I feel that while Prof. Warren has described what may be an interesting cytologic phenomenon, he has not convinced your readers that fertilisation in his spider is not brought about by a normally formed sperm.

Nevertheless, I would be glad to see some of Prof. Ernest Warren's material upon which his results are based. J. BRONTË GATENBY.

Trinity College, Dublin,
September 14.

PROF. WARREN'S most interesting letter in NATURE of September 12 on the subject of spiders concludes with the challenging remark that "It would be obviously absurd to suppose that the mechanism of heredity differs fundamentally in certain spiders from that in other organisms. . . ." Why absurd? Spiders belong to a line of evolution remote from the mammals, for example, and a line which obviously "stuck"; and may this not be because its mechanism of heredity was not entirely satisfactory? Other lines carried on to the higher groups, and may it not be just because mammals possess a somewhat different and more useful mechanism for their heredity?

MARIE C. STOPES.

Givons Grove, Leatherhead,
Surrey.

Antimonial Analogues of the Cacodyl Series.

IN view of the interest now manifested in organic derivatives of antimony, we desire to place on record our discovery of the antimonial analogues of the cacodyl series on which we have been engaged during the last three years.

Although aromatic antimonials are known containing the metal combined with one or two aryl groups, so far the only well-authenticated aliphatic antimonials belong exclusively to the tertiary stibine series in which antimony is associated with three alkyl radicals as in trimethylstibine, $(CH_3)_3Sb$.

The following thermal decomposition,

$$(CH_3)_3SbX_2 = (CH_3)_2SbX + CH_3 . X,$$

has been generalised for the dihalides of trimethylstibine and leads to dimethylstibine chloride, bromide and iodide corresponding with cacodyl chloride, bromide and iodide in the arsenical series.

Dimethylstibine oxide has also been obtained, and the antimonial series has been completed in this laboratory by Mr. V. E. Yarsley's collaboration in the preparation of dimethylstibine cyanide, the analogue of Bunsen's cacodyl cyanide.

Antimony cacodyl itself has not been isolated in a state of purity, although its existence among the reduction products of dimethylstibine bromide has been demonstrated.

By carrying demethylation a stage further,

$$(CH_3)_2SbX_3 = CH_3 . SbX_2 + CH_3 . X,$$

we have obtained another new series of alkyl antimonials in which the metal is associated with only one methyl radical.

The following historical coincidence may also be of interest. Cacodyl and cacodyl oxide were originally prepared by L.C. Cadet de Gassicourt in 1760 when engaged on service work for the French army of that day, whereas the investigations referred to in this note have arisen out of war work for the British Military Authorities. G. T. MORGAN.
G. R. DAVIES.

University of Birmingham, Edgbaston,
September 15.

Thunderstorms and the Sound of Lightning.

I WAS interested in reading the recent correspondence in NATURE about the sound of lightning, for I also have once heard it. It was in East Griqualand one evening when, in the midst of a storm, I saw a blinding flash, followed almost instantaneously by an explosion like a shell. But between the flash and the crash there was a distinct small pistol-shot-like sound, immediately after the flash.

The Transvaal is a noted place for thunderstorms. On Christmas Day 1923 I witnessed what I should imagine must almost be a world record in the way of storms. It occurred in the late afternoon and evening over the Pretoria district. From my balcony I had a fine view of it about twenty miles away on the horizon. There were really two storms, one about 6 and the other between 7 and 8.30. I saw the latter. The flashes for about twenty or thirty minutes during the time I looked on must have been at the average rate of well over one per second. Mr. Stewart, the Government meteorologist at Pretoria, kindly gave me some statistics of the storm. He said that in three minutes there were the astonishing number of 360 flashes, an average of two per second. I should imagine that for something like an hour perhaps there were an average of 100 flashes per minute. It was a wonderful sight: the sky in the north towards Pretoria was simply one blaze of light. The damage done by the hail was tremendous, and one woman died from shock. It would be interesting to hear if any of the widely spread readers of NATURE in other parts of the world have ever seen a worse thunderstorm.

T. B. BLATHWAYT.

Box 7532, Johannesburg,
August 19.

The Mineral Elements in Animal Nutrition.[1]

By Dr. J. B. ORR.

SINCE the time of Lavoisier, research in nutrition has been directed chiefly to the chemistry and metabolism of organic compounds, *i.e.* proteins, fats, carbohydrates and allied substances, and in tables of rations the food requirements of animals have been expressed in terms of these or their equivalents. During the past half-century, however, an increasing number of workers have become interested in the rôle played by inorganic salts in nutrition. The information being yielded by the researches of these workers is throwing new light on many fundamental problems of biology, and some of it appears to be of potential economic value in animal husbandry.

From 10 to 25 per cent. of living matter consists of organic compounds of which the colloidal material of the protoplasm is formed. The remaining 75 to 90 per cent. consists of water and inorganic salts. In the recent literature of animal husbandry, the elements of these salts have been somewhat loosely termed "the mineral elements," to distinguish them from the carbon, hydrogen, oxygen and nitrogen of the organic compounds. In living matter these mineral elements are present, partly in chemical combination with, and forming an integral part of, organic compounds, and partly free or potentially free, either in solution as salts or ions in the water of the protoplasm, or in a temporary loose union with the colloids.

The fundamental nature of the functions of the so-called mineral or inorganic salts in life processes is at once apparent when we consider the part played by them in the origin of the cycle of energy exchanges which occur in the "organic world." All forms of life depend ultimately upon the transformation of the energy of sunlight into chemical energy. The power of carrying out this fundamental process, which can be regarded as the real origin of life, is possessed by inorganic salts in colloidal solution. Photosynthesis with the production of formaldehyde, which contains the trapped energy of the sunlight, arises from the action of sunlight and inorganic salts on water and carbon dioxide. According to Moore, chlorophyll itself is a product of photosynthesis, and its chief function is probably not the primary one of deoxidising the carbon dioxide and thus charging the carbon with energy, but of changing the formaldehyde into higher carbon compounds. Hence the beginning of life-processes lies in the action of radiant energy on inorganic salts. The carbon atom is harnessed as the most suitable vehicle for conveying the chemical energy formed. The giant molecules and colloidal aggregates with their complex carbon-containing compounds, which have been regarded as the fundamental organic substances, are really secondary developments to secure that degree of stability and complexity required for the evolution of higher forms of life. Thus the true basis of protoplasm is the saline solution which forms from 75 to 90 per cent. of its bulk and still resembles the sea water from which it originated.

It is impossible here to do more than refer briefly to the nature of the functions of the inorganic salts and ions. As has been already indicated, these functions are intimately connected with colloidal activities. The visible phenomena of life are the resultants of an enormous number of chemical and physical changes in the colloids of protoplasm and of exchanges between masses of protoplasm separated by membranes or interfaces. But these changes in the physical state of colloids are determined by the association and dissociation of colloids and inorganic ions. These ions also affect the permeability of membranes and the tensions at interfaces. Hence, in a real sense, protoplasmic activity is regulated by the action of the mineral elements in solution in the protoplasm or attached to its colloids. Thus, in the contraction of muscle, though the ultimate source of energy is the oxidation of organic compounds, the initiation of the process, the mechanism by which it is carried through and the factors by which it is controlled, depend on the action of the ions and salts present, which involve changes in osmotic pressure and other physical forces.

The foregoing considerations suggest that definite degrees of concentration of the various inorganic ions in the cell fluids are necessary for the maintenance of normal protoplasmic activity. This has been fully demonstrated by work done to determine the effect of changes in the normal concentration of the different ions. The results of experiments with unicellular organisms and with isolated organs such as the perfused heart have shown that slight alterations either in the absolute or relative concentrations of any of the inorganic ions may accelerate, retard, or even reverse processes being carried out by means of the colloidal mechanism.

In the animal body these changes in the concentration of the inorganic ions can be correlated with changes in the functions of the organs. Thus, all the organs regulated by the central nervous system depend for the integrity of their functions upon the maintenance of definite ratios of calcium, potassium, and sodium in the fluids within the nerve tissues. Changes in the relative proportions of these are accompanied by alteration in the excitability of nerve and in the irritability of muscle. The classical experiments of Ringer on the perfused heart show that minute changes in the concentrations of calcium or potassium in the perfusing fluids have a profound effect on the activity of the heart. These examples are merely illustrations of the general law that any disturbance of the normal physiological balance of the salt solution of the body is accompanied by a correlated impairment of function.

The body is remarkably efficient in maintaining this balance, in spite of the fact that there is a continuous loss in the excreta, and the mineral matter of the food is liable to be very different in composition from that found in the blood. Within limits, the elements present in excess tend to be excreted and those deficient to be conserved. The bones act as a reservoir, especially for calcium and phosphorus, the two required in largest amounts. Reserves can be deposited in the bones when the supply is ample, and mobilised in

[1] From the presidential address delivered at Southampton on August 31 before Section M (Agriculture) of the British Association.

times of need. It is probable that this function of the bones, namely, regulating the supply of mineral elements to the body fluids, is as important as the more obvious one of providing a rigid framework. It is probably more fundamental, for, when the available mineral matter is insufficient to maintain both the physiological balance in the blood and the rigidity of the skeleton, it is rigidity which is sacrificed. There is little doubt that in most diseases affecting the bones the skeletal symptoms are only secondary manifestations of the influence of some factor, often a dietary one, which upsets the balance of mineral elements in the blood.

Under experimental conditions it is possible by feeding diets with marked deficiencies or excesses of some of the mineral elements to produce conditions of malnutrition which are so definite and marked that they are as easily recognised as definite diseases; indeed similar conditions occurring in practice are regarded as definite diseases. Thus, primary anæmia, simple goitre and rickets are produced by deficiency of iron, iodine and either calcium or phosphorus respectively. An interesting case of a disease due to an excess of a mineral element is reported by McCollum, who regards an inflammatory condition of the eyes, resembling xerophthalmia, which he calls "salt ophthalmia," as due to excess of chlorine in the food.

In addition to these diseases due to excesses or deficiencies of mineral elements in the diet, in which the symptoms form a definite and easily recognised picture, and the cause is admitted, there are conditions of malnutrition due to the lack of balance of the mineral elements in the diet, where the signs are much less obvious. In young animals there may be retarded growth without any definite pathological symptoms. The only reason for supposing that such animals are not in a perfect state of health is that their rate of growth is not optimal, as is shown by the fact that improvement follows the adjustment of the mineral balance in the food. Thus, Kellner obtained an increased rate of growth in calves by the addition of a calcium salt to a diet on which the animals grew at an average rate and showed no signs of obvious ill-health. In some work, not yet reported, we have found that the addition of traces of iodine to the diet of stall-fed calves in winter increased the rate of growth as compared with that of control animals whose condition would be regarded as normal. Further, it has been shown recently that the supply of minerals in the food of the mother may have a profound influence on the vitality of the young at birth and for some time after, even where there may be no obvious effect on the mother. Thus Hart, Steenbock and Humphrey have noted that deficiency of calcium in the diet of cows may lead to the birth of dead or weakly calves, and Ennis Smith has shown that deficiency of iodine in the food of pigs may lead to the birth of dead young, although there is not, in either case, any obvious pathological condition apparent in the mothers.

Some attention has recently been devoted to the question of an increased susceptibility to certain infectious diseases in cases of malnutrition due to deficiencies of minerals. We have noted in feeding experiments that the mortality from intercurrent infections is much higher in the groups fed on diets which, for experimental reasons, are ill-balanced or deficient in mineral matter. Meigs has noted a similar increased incidence of diseases in cows on diets deficient in calcium.

It may be of interest to consider some reasons which can be adduced for believing that the danger of deficiencies of minerals in the food of farm animals has been increasing in recent years. During the past half-century, the types of animals after which breeders have been striving are those whose young have a very rapid rate of growth, or whose females have a great capacity for producing the constructive materials required for growth. A remarkable degree of success has attended these efforts of the breeders. Some breeds of pigs will increase in weight from 2 lb. to 2 cwt. in six months. There are dairy cows which can secrete in their milk as much as 10-12 lb. of solid matter per day. There are hens that lay 200 to 300 eggs in a year. Now, the faster the rate of growth, the greater must be both the absolute amount of mineral matter required in a given time and the proportion of mineral matter per unit of energy in the food. The following table shows that the percentage of mineral matter in the milk of different species, and also the amounts relative to the energy values, are in proportion to the rates of growth.

TABLE I.

	Number of Days in which Weight of New-born Animal is doubled.	Milk of Species contains	
		Ash per cent.	Ash per 1000 Calories.
	Days.		Grams.
Man . .	180	0·25	3·7
Cow . .	47	0·72	10·5
Pig . .	14	1·03	10·9
Rabbit .	6	2·50	15

Hence, in modern types of animals the mineral requirements have increased *pari passu* with increased capacity for growth, and the danger of malnutrition through an absolute deficiency of any of the mineral elements, or a lack of balance of these constituents of the food, is correspondingly increased. As a matter of fact, it is found that malnutrition due to disordered mineral metabolism occurs most readily in those animals that are growing fastest. In experiments with both dogs and pigs it has been found that symptoms of rickets tend to appear earliest in those that are growing most rapidly.

Concurrently with the evolution of these faster growing types, with their greater need for each of the essential mineral elements in their food, and for a more perfect balance of these elements, there has been an increasing use of concentrates to support rapid growth. These concentrates, which consist chiefly of commercial by-products of cereal grains and tropical seeds and nuts, are markedly deficient in some of those mineral elements which are required for growth, or for the production of growth material. The following table compares the mineral matter of some of these artificial feeding stuffs with that of milk and good mixed pasture, the only two foodstuffs of which the

mineral content corresponds approximately with the requirements of herbivora.

TABLE II.

	1000 Caloric Portions contain					
	Protein.	Calcium.	Phosphorus.	Sodium.	Potassium.	Chlorine.
	Gm.	Gm.	Gm.	Gm.	Gm.	Gm.
Cultivated pasture .	65·3	2·65	1·18	0·69	9·58	3·52
Cow's milk . .	51·6	1·73	1·52	0·58	2·66	1·39
Potatoes . . .	21·4	0·19	0·65	0·29	4·61	0·32
Maize . . .	28·6	0·02	0·76	0·08	1·13	0·0003
Wheat . . .	35·0	0·13	1·18	0·11	1·32	0·15

It is seen from the table that foodstuffs such as tubers and cereals are deficient especially in calcium, chlorine and sodium. Most concentrates resemble cereals in their mineral composition.

A third factor with an adverse effect on mineral metabolism is the increasing tendency to feed large numbers of animals together. This necessitates for practical purposes the adoption of fixed standard rations, which may be fed with little or no change for months on end, or even through the whole life-cycle of the animal. Unless such rations are almost perfectly constituted with regard to their mineral content, there must be a cumulative effect of any deficiency or lack of balance which would not occur in the case of either single animals or small groups, fed in a more haphazard fashion. As a matter of fact, in practice, the cottager's pig, with a varying diet consisting largely of scraps, differing in kind from day to day, seems less liable to disease and more successful in bearing and rearing large litters than pigs fed in large numbers under what might almost be termed factory conditions.

The reasons adduced above seem valid enough to justify the fear that, under modern conditions of intensive production in animal husbandry, there is a danger of malnutrition and disease arising on account of defects in the inorganic portion of the ration. Acting on this belief, attempts have recently been made to increase the rate of growth and improve the condition of animals by the addition of various mineral salts thought to be present in their rations in insufficient amounts. In many cases marked beneficial effects have been noted. Thus in pig-feeding, the cereal grains and most other foodstuffs commonly used in making up rations are deficient in calcium, sodium, chlorine and, in some cases, iron and iodine, and it has been found that growth, health and reproductive capacity all tend to be improved by the addition to the food of salt mixtures or foodstuffs such as fish meal or meat meal which are rich in these elements.

In poultry it has been found, in experiments carried out at Ohio and at stations in Scotland and Northern Ireland, that even though the birds have access to green food and lime or oyster-shell, egg-production can be increased by the addition to the cereal rations usually fed to poultry of a mixture of those salts which are present in the ration in smaller proportions than in egg.

Of all farm animals, the stall-fed heavy-milking cow is the one most likely to suffer from depletion of minerals from the tissues and consequent malnutrition, on account of the fact that it loses from its body such relatively large quantities of mineral matter in the milk. In short tests, running for a few days or weeks, the adjustment of the mineral matter of the ration is not usually followed by increased milk production, because the cow will continue to give milk even though the body is being depleted of minerals. But the influence of adjusting the ration is seen towards the end of a long lactation or in a subsequent lactation. In recent tests at Beltsville and Ohio and at Aberdeen, which have been carried over one or more complete lactation periods, it has been found that the adjustment of the ration by the addition of salts present in too small amounts has resulted in a rather greater yield of milk and in an increase in breeding capacity and decrease in disease.

Some interesting cases of deficiencies of one or more minerals in natural pastures have been discovered. In an investigation being carried on partly at the Rowett Institute and partly at the Nutrition Institute at Cambridge, it has been found that there are marked differences in the mineral content of uncultivated pastures grown in different localities, and that there appears to be a correlation between the mineral content of the pasture and its feeding value, as determined by the number of stock it can carry, and the health and breeding capacity of the stock. An interesting fact brought out is that, where the sheep have a choice of pastures, they actually eat the herbage the mineral composition of which most closely approximates to that of good cultivated pasture. As we saw above, good pasture contains the various elements in proportions somewhat similar to those which are found in milk, and might therefore be presumed to be suitable for growth and the maintenance of health, as indeed is found to be the case in practice.

In various countries where the modern type of rapidly growing animal has been put to graze on uncultivated pastures, malnutrition, as shown by stunted growth, low milk yield, or increased liability to disease, has appeared. Thus, in South Africa, Sir Arnold Theiler and his associates have shown that deficiency of phosphorus in the pastures is the cause of pica (depraved appetite), which is prevalent in cattle in certain districts there and leads to the ingestion of the organism which causes lamziekte, and that the condition can be prevented by feeding bone-meal, or any foodstuff rich in phosphorus. Not only does this adjustment of the mineral intake prevent the disease, but the general condition of the animals is also improved.

The two elements most frequently deficient in pasture are probably calcium and phosphorus. Malnutrition due to deficiency of these has been noted in various districts in Australia, New Zealand and India, and in the Falkland Islands. Other minerals may, however, also be deficient. Thus, in the North Island, New Zealand, Aston has found that deficiency of iron is the cause of malnutrition in animals which are grazed continuously on certain areas. The condition is avoided if the animals are transferred for a time to an area where the pasture is richer in iron. The symptoms of the disease can be relieved by feeding iron salts. It is probable that a similar condition

occurs in parts of the Cheviots where soil conditions are similar and the sheep show symptoms which resemble those described by Aston.

These examples of malnutrition in stock, associated with deficiency of one or more mineral elements in the food, are sufficient to show that the dietary conditions which produce such forms of malnutrition are fairly widespread. They also show that there is a possibility of remedying the defects if the nature of the deficiencies be known.

In order to be able to make the necessary adjustments, it is necessary to know the amounts of each of the minerals which should be present in the ration to meet the requirements of the animal. But this depends on the extent to which they are absorbed from the alimentary canal. There might be an abundance in the food, but owing to factors which affect absorption adversely, only a small proportion of what is present in the food may pass through the wall of the intestine into the metabolic field. For example, in the case of calcium, which is probably the element which involves most difficulty in this respect, the amount absorbed, as calculated from the intake in the food minus the output in the fæces, may vary from nil to over 80 per cent. of the amount ingested.

Excess or deficiency of one mineral element may interfere not only with the absorption but also with the utilisation of another. Thus, for example, excess of magnesium interferes with the assimilation of calcium, the ratio of sodium to potassium affects the assimilation of both calcium and phosphorus, either too much or too little oil in the diet decreases the amount of calcium absorbed from the intestine. So the ratios of the different minerals to each other and to the organic constituents of the food are almost as important as their absolute amounts.

Recent work on the ultra-violet irradiation of animals is of great importance in this connexion. The beneficial effects of sunlight have been recognised for many generations. Within the past few years it has been shown that the beneficial effect of sunlight in nutritional diseases such as rickets can be obtained from artificially produced ultra-violet rays.

At the Rowett Institute we have found that when animals are subjected to the influence of these rays the amounts of calcium and phosphorus absorbed from the intestine tend to be increased, or at least the amount excreted in the fæces is decreased, even though at the same time the amount excreted in the urine may be increased. This result, which has an important bearing on mineral metabolism, has also been obtained by other workers. It is of interest to note that the influence of irradiation on the absorption of minerals from the intestine appears to be greatest when the diet is badly balanced.

Ultra-violet irradiation is probably of very great practical importance in milk production. It has been shown by balance experiments that there is difficulty in preventing a loss of calcium from the body of the cow at the height of lactation, when the cow is fed indoors, and there is reason to believe that this loss of calcium is a predisposing cause of some of the diseases prevalent among high-milking cows. It has been found that irradiation at the height of lactation can decrease the loss of calcium in goats, or even convert a negative balance into a positive. The practical value of irradiation will, however, not be demonstrated until experiments have been carried out with large groups of stall-fed cows in winter, to determine whether the irradiation will favourably affect milk yield, breeding capacity and health.

From what has been said regarding factors which affect the assimilation of minerals, it will be readily understood that, before the mineral content of a ration can be adjusted, it is necessary to consider all the existing dietary factors. Even when all this has been done, it is impossible, in the present state of our knowledge, to do more than make an empirical adjustment by adding inorganic salts containing elements thought to be deficient in the ration. In a few cases we can predict, with some degree of certainty, that beneficial results will follow such adjustments, but in most cases the attempt must be regarded as an experiment, the results of which may or may not justify the continued use of the salt mixture tried.

It is obvious that the use of a stereotyped salt mixture with different rations, and for animals of different ages, and even of different species, is not warranted. In feeding experiments errors arise from the assumption that the addition of such mixtures obviates any necessity for further consideration of the mineral requirements of the animal, or of the influence which may be exercised by inorganic salts present in foodstuffs, the value of which is being tested. Under practical conditions, the use of such fixed mineral mixtures proves beneficial in many cases because they are rich in those inorganic constituents which are most frequently deficient in concentrates, but in cases where the ration is already rich in some of the minerals present in the mixture, the resulting excess may be harmful. No mineral mixture is a panacea.

Our knowledge of this subject is, therefore, still so scanty that it forms a very uncertain guide to the stock-farmer. It is sufficient, however, to warrant his testing, under practical conditions, some of the results which have been obtained under experimental conditions. The results of such tests, if positive, would secure the early application in practice of information which we already possess, and, whether positive or negative, would be a valuable guide to further efforts to increase that part of our knowledge which is of immediate practical value.

Though this practical experimental work is important because it may yield results of immediate economic value, yet with regard to the future it is not more important than academic research. Valuable results are likely to be yielded by further investigations being carried out on the interactions of colloids and inorganic ions, on the influence of the electrical charge and chemical characteristics of the ion on these reactions, on the effects of radiant energy on the processes associated with mineral metabolism, and on the relationship of these to both normal and pathological processes in the body. In this region, which we have only begun to explore, there seems to lie the key to the solution of many obscure problems, both of the normal metabolism of health and the abnormal metabolism of disease.

The Discipline of Chemistry.[1]

By Prof. CECIL H. DESCH, F.R.S.

TWO tendencies are clearly visible in the chemistry of to-day, and are profoundly affecting our methods of study and instruction, and also the direction of research. On one hand, chemistry, like every other science, is being split up into a number of distinct specialisms, and workers are tempted or even compelled to confine themselves to a narrow field; on the other, the boundaries between the several sciences are becoming less definite, through the development of border sciences, which themselves become new specialisms. In so far as it is possible to arrange the abstract sciences in a linear series, chemistry may be said to depend upon physics, as the biological sciences in their turn depend upon chemistry, the theoretical part of each being built up on the established laws of the preceding science as a basis. Physics has gone far to provide the required basis for chemistry, and each new advance in physics suggests new ideas in chemistry. Chemistry in its turn is providing a basis for biology, although more slowly than had been hoped. Great as have been the triumphs of organic synthesis and of investigations of the colloidal state, the chemical study of living organisms is still looking to chemistry for more help than it has yet received.

Whether we look at the serious publications dealing expressly with the progress of science or at the mass of popular articles in newspapers and periodicals, we see that the centre of interest at the present day lies in the new discoveries and hypotheses of physics. There is no question but that the structure of the atom, the theories of relativity and of quanta, the existence of the ether, and the results of the examination of crystals by means of X-rays, interest the educated public more deeply than any questions in chemical or, probably, in biological science. On the other hand, there is little public curiosity in regard to the advance of chemical science. A few of its applications, and those mainly concerned with warfare, attract attention from time to time, although the progress of agricultural chemistry, the most important of all from a national point of view, is shamefully neglected, in spite of the admirable work which is being done at Rothamsted and elsewhere. The public interest in chemistry does not extend far beyond poison gases and dyes. The progress of pure chemistry and the development of chemical theory are followed only by a small body of specialists, engaged in teaching or research, and of students whom our present system of scholarships and degrees forces more and more to become specialists, even at a very early stage of their studies. Perhaps this state of things is responsible for a certain attitude concerning the future of chemistry which may be traced, in implication rather than expression, in the work of some chemists at the present day. It appears to be thought that chemistry is fated to become a branch of physics, and thus to lose its own peculiar discipline, leaving its long-established methods to chemists engaged in operations of a routine character, whilst new knowledge is being acquired by the application of physical methods of experiment, and interpreted by the methods of mathematical physics.

The knowledge of the internal structure of the atom, and consequently of the manner in which atoms may unite chemically with one another, has advanced with such extraordinary rapidity that it has seemed that chemical facts must henceforth be regarded in an entirely new light. If we accept the view that protons and electrons are the units of which all atoms are composed, the forces between them being purely electrical, and that the whole system of the chemical elements may be built up in a perfectly regular and systematic fashion from these units, whilst the structure of each atom enables us to predict how it will enter into combination with other atoms, then it would seem that chemistry should in course of time become a purely deductive science. If such a state of things were to come about, experiment in chemistry would be unnecessary, since all facts could be deduced from certain general principles and from fundamental physical constants which would by then have been determined with great accuracy. Chemists, however, know that this is not how their science has advanced or is likely to advance. Chemistry is an experimental science, which progresses by the application of a definite discipline, obtaining conclusions by induction from the observed facts, and making use of deduction from a small number of well-tried hypotheses where required.

Granting the theoretical possibility that atomic theory might become so perfect that the facts of the chemical structure of molecules might be deduced from a comparatively limited mass of data, it would nevertheless remain true that the labour of such deduction would be beyond human powers, except in relatively simple cases. We can scarcely imagine the properties and synthesis of indigo being deduced from the internal structure of the atoms of carbon, nitrogen, oxygen, and hydrogen, although it is possibly true that the one is implicit in the other. Human intelligence is not equal to the task, nor does it seem likely to be so in the future.

Chemical science has been responsible for the introduction of a number of hypotheses which have survived to the present day, and it may be worth while to look at them for a moment. The doctrine of atoms was not a chemical invention, but there is a vast difference between its use among Greek philosophers as a means of satisfying their desire to find a consistent explanation of the universe and its scientific application in the hands of Dalton as a means of explanation of the quantitative facts of chemical combination. There has been some discussion as to Dalton's personal attitude on this question, but there can be no doubt that those who did most to establish the doctrine attached no metaphysical importance to it, but used it frankly as an hypothesis to explain known facts and, above all, to predict new facts.

It is probable that throughout the nineteenth century it was a matter of comparative indifference to most scientific chemists whether atoms had a real existence. All that was important was that matter behaved as though it had an atomic structure, and that no fallacies

[1] From the presidential address, entitled "The Chemistry of Solids," delivered on August 31 at Southampton before Section B (Chemistry) of the British Association.

or errors were introduced by making such an assumption. The value of the atom to them was quite independent of any possible demonstration of its real existence. Gradually, as the conception of atoms and molecules was found to fit a larger and larger field of facts, confidence grew, and atoms came to be regarded as real, in the only sense in which the scientific experimenter can understand reality. Molecules, built up of atoms according to well-established laws, shared in this confidence, which was thoroughly justified by the remarkable concordance of the determinations of Avogadro's number, the number of molecules in the gram molecule of a substance, as arrived at by a number of totally independent methods.

The discovery of radio-activity, whilst enlarging the conception of the atom, has made it possible to isolate the effects of single atoms travelling at a high velocity, so that the impact of a single α-ray on a fluorescent screen produces a visible effect, and the counting of these rays, which are known to be charged helium atoms, corresponds perfectly with the original hypothesis. When the minuteness of the atom was realised, chemists cannot have dreamed that a day would come when the effect of so extraordinarily minute a particle could be perceived by the eye and even exhibited on a screen to an audience. No more extraordinary confirmation of the soundness of the theoretical views of the chemists of the early nineteenth century could have been received.

Next came the development of structural theory, with reference to organic compounds, associated with the names of Kekulé, Couper, Crum Brown, and Butlerow. Again the assumed arrangements of atoms in compounds were adopted in order to express the reactions of the substances, without reference to the real existence of the chains of atoms represented in the new formulæ. Within the last few years the study of the films of fatty acids and similar substances on the surface of water by Langmuir, Hardy, and Adam has shown that the properties of such films can only be accounted for by assuming the reality of those chains of atoms which served so well the purposes of the chemist, but seemed physically improbable. The examination of solid fatty acids by means of X-rays leads to exactly the same conclusion. The greatest triumph of structural theory, the hexagon formula for benzene, need only be mentioned in passing, since it is only a month or two since the celebration of the discovery of benzene by Faraday, when the wonderful chemistry of the aromatic compounds was eloquently described by Sir William Pope and Prof. Armstrong. Next came the generalisation known as the periodic system of the elements, due mainly to Mendeléeff and to Lothar Meyer, and finally the hypothesis of the tetrahedral arrangement of the atoms around a carbon atom, devised by van 't Hoff and Le Bel to account for optical isomerism. Modern X-ray methods show that the structure of crystals of the corresponding substances is fully accounted for by assuming that the benzene hexagon and the tetrahedral linking of carbon are actually present, and the interpretation of crystals has been made possible and unambiguous by the existence of so great a mass of fully established chemical data.

The point which I wish to make is that these hypotheses, of the chemical atom, of the molecule, of the chains and linkings represented in the graphic formulæ of organic compounds, of the hexagonal ring in aromatic substances, and of the tetrahedral carbon atom, were introduced without reference to any metaphysical conception of the nature of matter, and were independent of any dogma concerning reality. They were intended as working hypotheses, connecting and co-ordinating facts which had been discovered by the classical methods of chemical experimentation. That they have been confirmed by entirely independent physical means shows how sound was their foundation, and encourages us to suppose that the same methods which have served so well in the past may again be trusted to lead to new discoveries in the future.

The remaining example which I have mentioned, the periodic law, was regarded by many chemists as a convenient means of arranging the facts of inorganic chemistry, but was expressly stated to be only empirical, since a theoretical basis was inconceivable. The work of Moseley, the discovery of the radioactive elements, and the conception of isotopes, have shown the periodic classification to be the most fundamental thing in the chemistry of the elements, and the atomic number has been found to have greater theoretical significance than the atomic weight. Reference to isotopes reminds us that this discovery also was made by chemical means, although its investigation appears almost to have passed out of the hands of the chemist into those of the physicist, since the introduction of the positive ray method of analysis. It was the chemical work of Soddy, Russell, Fleck and Fajans, establishing the fact that two or more elements, differing in atomic weight but identical in chemical properties, could occupy the same position in the periodic classification, which opened up this new and extraordinarily important and interesting field of research.

The development of the theory of atomic structure, due mainly to Bohr, has necessarily affected modern views of chemistry. The theory was devised to explain the phenomena of radiation, and later proved to accommodate itself in a wonderful manner to those of chemical union, making use for the purpose of Werner's doctrine of co-ordination. In its new form it promises to do much to reduce to order the facts of inorganic chemistry, still so far behind the organic part of the science in the perfection of its logic. The static atom of Langmuir, now abandoned, played an important part in bridging over the gap between the planetary arrangement, chiefly suited to the explanation of spectra, and the present highly developed system.

Whilst recognising the immense value of the new ideas, may I once more venture to utter a word of warning? The modern student tends to specialise in his scientific studies at a very early stage, and, if introduced in detail to the new conceptions while still engaged in learning the elementary facts of chemistry, is likely to suppose that the facts depend on the theory, instead of the opposite being true. The danger may seem to be exaggerated, but it is nevertheless real. I would submit that the facts should be known to the student before he applies to them this interpretation, which may prove so fascinating as to distract his attention from the experimental basis of the science.

The Discharge of Electricity through Vacuum Tubes.[1]

By Prof. R. WHIDDINGTON, F.R.S.

DISCHARGE tubes with cold electrodes and low gas pressure present a great variety of complex phenomena which, at the time of their discovery, were most difficult to explain. Many of these old difficulties remain, but some have been cleared away or are in process of being cleared away in the light of recent work. In any event, within the last few years sufficient new points of view have been put forward and fresh phenomena discovered to warrant recollection of the past and special notice of the present.

With the gas pressure in the neighbourhood of 1 mm. of mercury and the discharge passing along a straight cylindrical glass tube furnished with plane electrodes, the appearance shown diagrammatically in Fig. 1 is presented. For convenience we may consider the discharge under three headings.

1. *The cathode region,* comprising the softly luminous cathode glow, the Crookes' dark space and the negative glow.

2. *The anode region,* consisting of a very thin layer of light over the anode surface.

3. *The central region of the tube including the positive column* continuously glowing, sometimes striated, separated from the cathode region by the Faraday dark space and extending right up to the anode.

These are the usual, easily recognisable divisions of the discharge with cold electrodes and a steady applied potential of a few hundred volts.

Speaking generally, the current passing through the tube will be carried almost entirely by electrons and positive ions, negative ions being comparatively unimportant. Owing to the difference in nature of these two types of carrier, however, and their interdependence, important space charge effects within the tube and area charge effects on the walls are set up, which play an important part in determining the electric forces and thus the nature of the discharge. We shall outline these and other matters in what follows.

1. *The Region of the Cathode.*

The cathode is the seat of origin of the very speedy electrons—the cathode rays—which often possess a velocity little short of that given by the usual relation

$$eV = \tfrac{1}{2}mv^2,$$

where V is the potential difference between the cathode and the edge of the dark space—the so-called cathode fall.

The dark space edge is inexplicably sharply defined and is imagined to represent the region where there is not only ionisation by the cathode rays but also recombination resulting in light emission. This is probably bound up in the fact that the electric field in the dark space has a high value whereas in the glow the field is very much smaller.

This matter of the value of the electric field is of great importance in the theory of the discharge. Measurements, whether made by the much criticised probe method or by Aston's transverse cathode ray method, show that the axial field X increases linearly with distance from the dark space boundary to the cathode. Brose, by a most ingenious method based on observations on the Stark effect in the weak light emitted from the dark space region, has recently shown that *very close to* the cathode there is a sharp drop in the electric field. This is shown in an exaggerated manner in Fig. 1. This state of affairs in the dark space is regarded as due to the space charge effects.

It was shown long ago by Schuster, Wehnelt and others by placing obstacles in the dark space that there was a "shadow" thrown both ways, so to speak, the supply of electrons from the cathode and the positive rays approaching thereto being simultaneously cut off. It was inferred that the main supply of electrons from the cathode arose somehow from the arrival there of positive ions originating in the edge of the negative glow. We conclude therefore that, since the speed of the ions is so much smaller than the electrons, there will be, on the whole, a concentration of positive

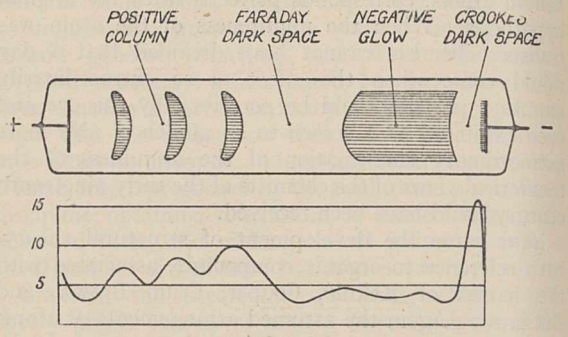

FIG. 1.—Diagrammatic representation of the regions in an exhausted tube, with, below, a curve showing the changes in the electric field in passing along the tube.

electricity in the dark space. We should thus be able to obtain an expression for the variation of X by applying Poisson's law,

$$\frac{dV}{dx} = -4\pi\rho,$$

in much the same manner as in Langmuir's well-known application to the thermionic valve.

The form of the expression obtained, however, will clearly depend on the assumption made as to the distribution of positive electricity in the dark space. Assuming an impartial distribution of the positives in the dark space—an assumption incidentally not in accord with the generally accepted view of ion production outlined above—Sir J. J. Thomson deduces an expression for the electric field in accordance with the experimental results of Aston.

Very close to the cathode, on the other hand, the expression would scarcely be expected to hold, since here, production of electrons by ion bombardment is taking place, resulting in a negative space charge and a consequent lowering of the field. This brings Brose's experimental result into line.

It is interesting to note in passing that it is not an entirely straightforward matter to explain how electrons are produced at the surface of the cathode by positive ion impact. For although the whole energy of the approaching ion is adequate, this energy can only be handed over in part—and a very small part, a consideration which, when taken into account quanti-

[1] Substance of three Tyndall Lectures delivered at the Royal Institution on May 19, 26, and June 2.

tatively, leads to the result that insufficient energy to effect ionisation is actually available.

The most likely explanation appears to be that the ion on reaching the cathode captures an electron, radiates at the appropriate frequency, and it is this radiation which ejects from the cathode low speed electrons destined to form the cathode rays. We should expect on this view that the heating effect at the cathode would represent nearly the whole energy of the incident positive rays, an expectation in accordance with the facts.

2. *The Anode Region.*

Just as there is a jump of potential near the cathode in passing across the dark space, so there is an anode fall of potential.

The anode fall, however, appears to be capable of easy explanation. It is not at all dependent on the nature of the electrodes but only on the gas and on the current flowing. Moreover, as the current is diminished the anode fall rises to a constant value which approximates very closely to the ionisation potential of the gas.

We conclude, therefore, that the cloud of negative electrons near the anode produces this anode fall, and that at small currents its nature is such that single impact ionisation occurs at the anode surface, this ionisation taking place perhaps in a film of gas on the electrode. At high current densities the anode fall diminishes, probably because cumulative ionisation then takes place.

3. *The Central Region of the Tube.*

The positive column which occupies the central portion of the tube is in many respects the most puzzling part of the discharge. Separated from the negative glow by the Faraday dark space and extending right up to the anode, its character is usually independent of the length or shape of the tube; it is sometimes a uniform column of light, sometimes—particularly when the gas is impure—striated. The conductivity of this region is high and the electric force small.

It has usually been supposed that for the continuous positive column there is a copious supply of electrons moving with ionising speed under an electric field partly determined by the space charges and partly by the charges on the wall of the tube. It is clear that the electrodes themselves cannot contribute, directly, at all to this field.

The emitted light has been supposed to be due to ionisation and subsequent recombination, which latter process is encouraged by the small electric field—in contradistinction to the state of affairs in, for example, the Crookes' dark space. The striations have been supposed to be a repetition of the state of affairs near the cathode, the non-luminous spaces between the striations being the equivalent of the Faraday dark space.

It is an interesting fact, however, that even with the perfectly steady potential from a battery of storage cells applied to the tube, it is very usual to find that the current itself is regularly intermittent, a phenomenon which has been known for many years but has never been explained.

I pointed out recently (Proc. Camb. Phil. Soc., 1924) that this effect is particularly marked in the case of the discharge through argon, and that if the tube be made of quartz and a current of several amperes passed to produce a brilliant luminosity, then most beautiful effects are observed if the tube be viewed in a mirror rotating rapidly about an axis parallel to that of the tube. Fig. 2 is an untouched reproduction taken from an instantaneous photograph obtained in this way. It will be seen that the appearance presented is that of a number of straight, parallel equidistant lines inclined at an easily measurable angle with the horizontal. The heavy horizontal line is a superimposed photograph of the glowing tube viewed in the mirror at rest. The narrow vertical line on the extreme right of the equally spaced markings is a photograph, in the same spinning mirror, of a little mercury vapour lamp fed with alternating current of about 40,000 frequency from an oscillating thermionic valve.

Interpreted broadly, this photograph shows that, so far as the luminous character of the discharge is concerned, flashes of uniform speed follow each other at equal intervals of time down the tube moving from anode to cathode. Their velocity and frequency past any point in the tube may be calculated from their inclination and distance apart.

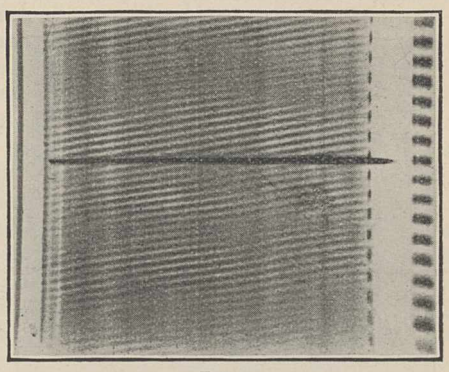

FIG. 2.

When it is remembered that these discontinuities in the discharge occur with a steady applied potential and are practically independent of any capacity, inductance or resistance, included in the circuit, it will be seen that the phenomenon is well worth remark and further investigation. It is intended at the moment to give only a very general account and explanation so far as the available experimental evidence will allow.

In the first place—as might be expected on almost any reasonable theory—the velocity of the flashes increases as the gas pressure is reduced, being nearly proportional to $1/p$. For a given strength of electric field this is what is to be expected if the moving flash consists of or is associated with moving electrons or ions. The speed is, however, also determined in part by the strength—or rather average strength—of the current, increasing somewhat with greater currents. At the same time the frequency—indicated by the distance apart of the flashes—also increases as the velocity increases, in many cases, in nearly the same proportion.

A highly important fact which came out quite early in the experiments is that the emitted light, when examined with a spectroscope of high resolving power (a spectroscope fitted with a Fabry and Perot étalon), shows no signs of the Doppler effect. That is, when

the spectrum is viewed at right angles to and along the axis of the tube, there is no detectable change of wavelength in any of the lines suitable for examination. Had the sources of emission been moving with the speed of the flashes an effect should certainly be observable.

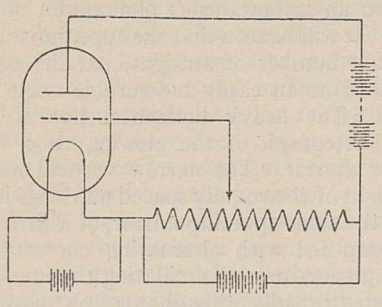

FIG. 3.

I think that an explanation (although another is possible) of this flash phenomenon may be based on a rather similar effect I chronicled in 1919 in the late *Radio Review*. If an ordinary thermionic valve con-

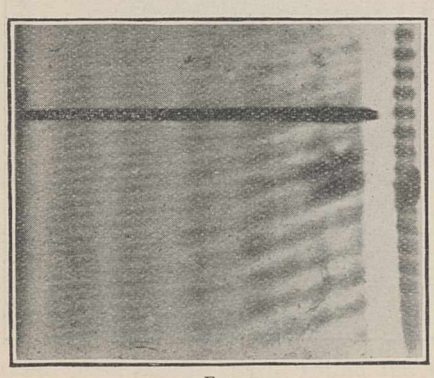

FIG. 4.

taining a trace of mercury be linked to a non-inductive circuit as in Fig. 3, then if the potential (V) applied to the grid be varied between certain limits, the current in the valve circuit oscillates at a frequency (n) such that n^2/V is constant. It was shown that the effect can be satisfactorily explained on the reasonable supposition that there is some particularly active electron-emitting point on the valve filament which, when bombarded by positively charged mercury ions, emits still more vigorously (whether by space charge neutralisation or by local heating is immaterial to the general idea); the result is that there are set up regular sequences of electrons flowing to the grid in a negligibly small time and positive ions produced in the region of the grid and falling back to the filament. The time taken by these positives in travelling from grid to filament determines the oscillation frequency. In the note referred to, it was shown that a quantitative explanation along these lines is possible.

It would seem that a similar explanation might be made in the case of the flashes in the long discharge tube. The anode, on this view, would be the seat or origin of the flashes. We suppose a cloud of electrons round the anode; only those starting from a certain minimum distance will ionise at the anode surface. As soon as this occurs a sheet of positive ions will move away from the anode at a speed determined by the electric field, but the presence of this positive sheet constitutes a space charge which will so reduce the field in its train as to prevent further ion production; it therefore moves away as an isolated sheet of ionisation—to be followed in due course by a similar one produced in a similar manner. Why is not the Doppler effect observed? The suggestion is that the visible light emitted is not due to these moving ions but is a state of affairs produced by them. We must imagine that invisible radiation is given out which excites (possibly without ionising) the relatively immobile atoms of gas past which the radiating ions move.

There is some evidence, however, which it is not proposed to discuss here, in favour of a modified view of the ordinary discharge recently propounded by Günther Schulze. This investigator suggests that where a stream of electrons moving with high speed encounter and ionise (or excite) gaseous atoms, the spent electrons may produce a space charge. I merely wish to mention here that it is possible to give an alternative explanation along these lines but at the same time to point out that it is by no means impossible that both mechanisms operate, according to the conditions obtaining within the tube.

When the gas in the tube is pure it is usual to observe the appearance shown in Fig. 2, but after the discharge has passed for some time, there appear in the rotating mirror two sets of flashes; those at the anode end being much steeper, *i.e.* more slowly moving, than those at the cathode end. A reproduction of a photograph of this kind is shown in Fig. 4.

I believe this to be due to the presence of a little hydrogen. If the spectrum of the light emitted be examined, it is found that near the anode the spectrum of hydrogen is strongly developed, while near the cathode it is absent or very weak. Now the slopes of the two sets of flashes are such as to suggest that the slow ones are due to argon ions and the fast ones to

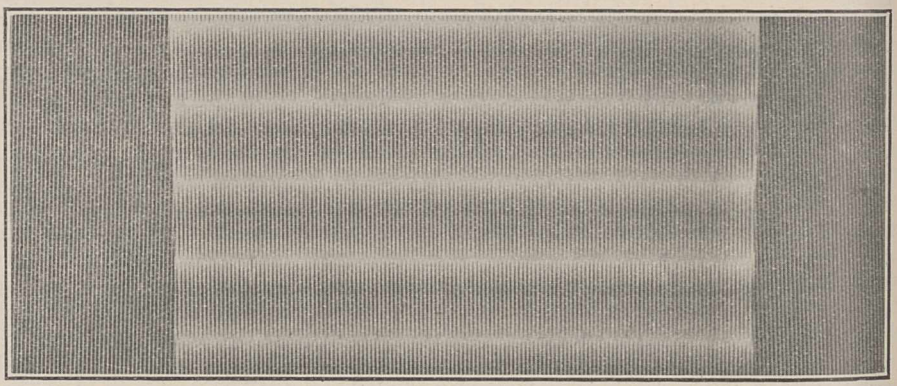

FIG. 5.—Two coarse-ruled gratings superimposed with lines slightly inclined to each other.

hydrogen ions. This at once suggests a reason for the spectrum distribution just mentioned, for where the fast flashes occupy the tube, all or most available hydrogen will be taken up in the form of non-luminous ions and the radiation they emit will only have argon atoms on which to work. The hydrogen spectrum will therefore be weak or invisible.

So far we have been walking on fairly solid ground, but it is interesting to observe in conclusion that the definite experimental proof of the existence of these two sets of flashes through an impure gas may be made the basis of a somewhat speculative suggestion as to the origin of the familiar vacuum tube striations. We have only to suppose that in the impure gas there are two sets of flashes moving with different speeds and in simultaneous existence along the tube and we get at once that if the velocities are related in a certain manner, continuous steady striations occur where the two sets cross. An example of this combination effect is shown in Fig. 5, which is a photograph of two coarse-ruled gratings with their lines slightly inclined to each other. The edges of this photograph clearly show the lines of the two gratings separately and the central part where they are superimposed. The horizontal equidistant bands in this superimposed area are parallel to the shorter diagonals of the parallelograms produced by the intersections of the two sets of mutually inclined lines, and, according to our speculation, would represent the striations as seen in the rotating mirror. Further experiments, however, must be performed before anything more definite can be put forward.

A Cotton Research Station for the British Empire.[1]

IT has long been a weak point in the scientific investigation of the agriculture of the British tropical dominions that we have had no stations where problems that are fundamental and underlying, affecting all tropical countries alike, could be attended to. Local departments of agriculture are necessarily and rightly occupied with local questions, and authorities might look askance at such a department if it were to devote itself, for example, to the fundamental problem of the connexion between lint characters in cotton and spinning qualities.

This defect in our organisation is now to be removed, so far as cotton is concerned, a forward step of great importance having been taken by the Empire Cotton Growing Corporation, which, with the express aim in view of the solution of problems of this nature, has decided to open in Trinidad a cotton research station, near the Imperial College of Tropical Agriculture. The station is to be provided with a first-rate staff, and well endowed with funds, so that great results may be expected from this far-seeing enterprise.

"It is intended to investigate there the cotton plant in all phases of its growth and under rigorously controlled conditions, so that it may be possible to ascertain and to estimate the importance of the several factors which contribute to the final result." In other words, it is in no sense intended as a local station for the investigation of problems which are of local origin and can only be solved under corresponding local conditions, nor is it intended as a place for the breeding of pure-line seed upon a large scale. Such seed, with various special characteristics, will indeed be produced, but when it is introduced into other places, the effects of acclimatisation (at present not understood) will come in, and it is for each individual country to produce from the seed the cotton that is best adapted to its local conditions. Much labour in breeding will thus be saved to the local workers, for they will start from seed of known genetic qualities. The new station will not relieve the local agricultural departments from the necessity of scientific work upon their local problems, but will provide them with better fundamental knowledge upon which to base their investigations.

Since it was decided to establish the station, a strong committee has been at work considering the claims of various places in the warmer parts of the British Empire, and at last, by a process of gradual elimination, decided that Trinidad was the most promising. Prof. J. B. Farmer and Mr. L. G. Killby (secretary of the Corporation) were then sent out to report in more detail, and as a result Trinidad has been finally selected.

In his preface Dr. W. L. Balls directs attention to the fact that it was the late Mr. J. W. McConnell (first chairman of the Council of the Corporation) who was chiefly responsible for the achievement of this result—a result which even ten years ago would have been considered Utopian.

Trinidad is suited, in the neighbourhood of Port-of-Spain, to the cultivation of cottons of many different kinds, but has not proved commercially successful in their growth, so that the cottons upon the station will not be liable to hybridisation with others growing near by—an important advantage. It is easily accessible from England, and from the other countries of the American continent where cotton is cultivated on the large scale. It has a good and healthy climate, and the site chosen is near to the capital town, while it is also near to the Imperial College of Tropical Agriculture, thus placing its staff in close contact with the workers in the latter, and with the facilities there provided. This is another advantage of great importance to both parties, especially as a good many of the future employés of the Corporation are trained at the College, and will thus have the station near at hand, and be in a position to get upon friendly terms with the staff, from whom they will be able to get useful hints in their work.

The site is an area of sixty acres, about one-third of which will be planted in cotton every year, with cane as a rotation. It is proposed that work be begun by the appointment of a geneticist and a plant physiologist, each with a competent understudy and the needful assistance, including frequent study-leave and travel. The management and general direction it is proposed to entrust to a local advisory committee of two—Dr. H. Martin Leake, Principal of the Imperial College, who has done much research work upon cotton, and Mr. W. Nowell, Assistant Director of Agriculture in Trinidad, well known for his work in mycology, etc. These gentlemen will act in their private and not in their official capacity. It is also hoped to arrange for exchanges of staff with the Shirley Institute of the British Cotton Industry Research Association.

[1] Summary of a Report to the Empire Cotton Growing Corporation, by Prof. J. B. Farmer and Mr. L. G. Killby, with a foreword by Dr. W. L. Balls (London, 1925).

Obituary.

PROF. F. R. JAPP, F.R.S.

FRANCIS ROBERT JAPP was born in Dundee on February 8, 1848, his father being the minister of the Catholic Apostolic Church in that city. His early academic training gave little indication of his ultimate career, for after graduating in arts at the University of St. Andrews he entered the University of Edinburgh as a student of law in 1868. Ill-health, unfortunately, soon led to an interruption of these studies and to a fairly long period of foreign travel and residence, mostly in Germany, and it was not until the autumn of 1873 that Japp definitely settled down to the study of chemistry in Bunsen's laboratory at Heidelberg. He completed his curriculum at that university by graduating as doctor of philosophy in 1876, and afterwards proceeded to Bonn, whither the fame of Kekulé attracted chemical pilgrims from all parts of Europe. In his Kekulé Memorial Lecture, delivered before the Chemical Society in 1898, Japp paid eloquent tribute to the inspiring genius of this great chemist. While in the Bonn laboratory, Japp worked more especially under Schultz and Anschütz, and papers were published jointly with each of these investigators.

In 1878 Japp returned to Great Britain, and after working for a short time in Crum Brown's laboratory in Edinburgh he became research assistant at the Normal School of Science, South Kensington, under the late Sir Edward Frankland. At the reorganisation of the Science Schools in 1881 he was made assistant professor in the department of chemistry, and this post he continued to hold until his appointment in 1890 to the chair of chemistry in the University of Aberdeen, as the successor of Thomas Carnelley. During his tenure of the London post, Japp devoted himself with great industry and enthusiasm to the prosecution of research in organic chemistry, and in the decade 1880–1890 he published, either in his own name or conjointly with his pupils, about forty papers dealing largely with phenanthraquinone and other diketones and their derivatives. This activity in research was recognised by election into the Royal Society in 1885, and by the award of the Longstaff medal of the Chemical Society in 1891. For six years, moreover, he acted as foreign secretary of the Chemical Society, of which body he was later a vice-president for two periods.

At the time of Japp's arrival in Aberdeen the reconstruction and extension of the chemistry department were overdue, but for several years the work had to be carried on in the old, ill-ventilated, badly lighted laboratories. In spite of this, Japp, who was pre-eminently an investigator, contrived to prosecute and encourage research work, and it was perhaps his chief service to the northern university that he fostered the spirit of original investigation and inquiry in a none too favourable environment. During his tenure of the Aberdeen chair, covering the period 1890–1914, about forty memoirs emanated from the chemical laboratories there.

The character of this, as well as the earlier research, was such as to attract the notice mainly of specialists; but Japp's address on "Stereochemistry and Vitalism," delivered in 1898 in the capacity of president of the Chemistry Section of the British Association, made a much wider appeal, and gave rise to an animated discussion in the columns of NATURE. The thesis put forward in the address, and defended with much suggestiveness and resource, embodied a development of Pasteur's view that "the production of single asymmetric compounds or their isolation from the mixture of their enantiomorphs is the prerogative of life. Only asymmetry can beget asymmetry."

This sketch would be incomplete without some reference to the very wide scope of Japp's interests. Primarily a chemist, he possessed marked literary, artistic, and linguistic talent, and the British Association address already mentioned furnishes ample evidence of his broad philosophic outlook and of his well-stored mind. An accomplished linguist, he was familiar with much of the best in the literatures of Germany, France, and Italy, as well as of his own country, while on the artistic side he was a musician of knowledge and taste.

After relinquishing the Aberdeen post, Japp lived quietly in retirement in London until his death on August 1 last. Latterly a semi-invalid, he was dependent on the unremitting care and attention of the widow and two daughters who remain to mourn his loss. J. C. P.

PROF. OTAKAR KUKULA.

THE Charles' (Bohemian) University of Prague lost on August 11, at the relatively early age of fifty-eight years, one of its most eminent professors, namely, Prof. O. Kukula, professor of surgery, director of the first surgical clinic, and at the same time Rector Magnificus of the University. Prof. Kukula's clinic was equipped in the most modern way, and he was in close touch with internal chemical as well as biological methods of investigation, so that his chair was a model of its kind. As a surgeon he was unsurpassed, being able to carry out surgical operations of the most difficult and delicate kind with the greatest ease and calm. He not only studied all known good methods of operation, but also introduced many new and the most difficult ones, and he was well known for this in scientific circles abroad as well as at home.

Prof. Kukula published in Bohemian, French and German more than forty scientific papers, of which only those on stones in the bladder and on the surgery of the kidneys need be mentioned. His great work, "Pathology and Therapy of the Inflammation of the Appendix," is a remarkable monograph, finding its equal only in the work of Kelly.

Prof. Kukula was a member of the Bohemian Academy and of many foreign scientific societies, and he was also the founder and president of the Czechoslovak Automobile Club. He rendered great services to the Serbs in the war with Turkey and was decorated with the highest Serbian orders. BOHUSLAV BRAUNER.

WE regret to announce the following deaths:

Prof. E. H. Barton, professor of physics, University College, Nottingham, on September 23, at sixty-six years of age.

Don Luis Cubillo y Muro, director of the Geographic Institute of Spain and president of the Spanish National Committees of Geophysics and of Astronomy, on July 10.

Current Topics and Events.

PARTICULARS of the fifth Congress of Industrial Chemistry, organised by the Société de Chimie Industrielle, are now available. On October 4 there will be an official reception, followed by a musical soiree, in the Hôtel Majestic, Paris. The following day, the Minister of Public Instruction will open the congress in the Conservatoire National des Arts et Métiers, where the international exhibition of the decorative arts is being held, and where all the subsequent meetings will be held. At the opening ceremony, M. L. Guillet will give an address on the rôle of French science in metallurgy. Sir Robert Hadfield is contributing a valuable paper on French scientific investigators and institutions and on some unsolved problems relating to manganese steel. October 6 will be devoted to conferences on fuels and on metallurgy; October 7 to meetings of the sections, and a banquet in the evening; and on the final day, October 8, the presidents and recorders will meet, and an address on the refining of mineral oils will be given by Prof. H. T. Waterman, of the University of Delft. The remainder of the week will be spent visiting the exhibition, the Renault automobile works at Billancourt, the dyeworks and vanneries at Saint-Denis, or, alternately, to an excursion to Grenoble, where the international water-power exhibition will be in full swing.

ON Sunday, October 11, the centenary of Chevreul's researches on the animal fats will be celebrated in the amphitheatre of the Natural History Museum, Paris, and the proceedings will be honoured by the attendance of the President of the Republic and of the President of the Council of Ministers. In the evening there will be a reception of the foreign delegates. It was in the same place that the anniversary of Chevreul's hundredth birthday was celebrated on August 31, 1886, by the unveiling of a statue to him. On that memorable occasion, Frémy, who followed Chevreul as director of the museum, delivered the principal oration, in the course of which he aptly quoted the saying of Malebranche: "Il faut tendre à l'infaillibilité sans jamais y prétendre"; and no less happily, the Minister of Public Instruction quoted the remark which Dumas, the chemist, had made to Chevreul some fourteen years before: "Your work has been the only occupation which has never fatigued you." Chevreul's achievements as an investigator, and as an eclectic philosopher, are inscribed for all time on the pages of history, and on October 11, not only chemists but all followers of science in Great Britain will do silent homage to his memory.

FULLER details of the wreck of the airship *Shenandoah* are now available. The explanation, attributed to a German expert, that relief valves had been removed from nearly half the gas bags, and that their absence would cause disruption, has been dismissed by the U.S.A. official investigator. He attributes the accident to structural failure under the exceptional stresses imposed by a severe local atmospheric disturbance. Controversy is now directed to the question of effective meteorological service for aeronautics. The reports of the U.S.A. stations are edited by the Weather Bureau of the Department of Agriculture. Information is received daily by telegraph and embodied in the British chart of weather in the northern hemisphere, which shows a shallow depression moving across the great lakes along the line Winnipeg-Chicago-Washington on September 2, 3 and 4. The U.S.A. daily chart, since received in England, amplifies the information and indicates local thunderstorms along the fronts of the disturbance, without suggesting the extreme severity of the conditions developed along the front of the disturbance. The *Shenandoah*, travelling westward from New Jersey on September 2, met the front of the disturbance on the morning of September 3, near Cambridge, Ohio, roughly half-way between Washington and Chicago, and was destroyed. Meteorologists will be of the opinion that ample material for serious warning was available but that the liaison service was inadequate. More precise information, such as an hourly local report from the nearest meteorological stations, would have been required to warn the airship fully of the rapid increase in the severity of the conditions locally. The fact remains that a continental area exposed to numerous severe and sudden storms is not specially suitable for airship services, and the wider question is inevitably raised as to whether the airship is not altogether too fragile a structure on which to place hopes of regular commercial transport services over thousands of miles of land and sea.

THE Imperial Social Hygiene Congress will meet at Wembley on Monday, Tuesday, and Wednesday of next week. The Congress is being organised, as last year, by the British Social Hygiene Council, which at that time was known as the National Council for combating Venereal Diseases. The president is Sir Auckland Geddes, and the patrons include Mr. L. S. Amery, Mr. Neville Chamberlain, Viscount Willingdon and the High Commissioners of the Dominions. In an opening address Mr. Amery will discuss the Imperial aspect of social hygiene. He will be supported by the High Commissioners, and reports will then be received on the administrative, military, and naval position with regard to venereal diseases within the Empire. The afternoon programme includes a statement by Sir Claude Hill, director-general of the League of Red Cross Societies, on methods of health propaganda in Europe and the Far East, and a paper by Dr. H. M. Hanschell on the problem of venereal disease in relation to race and climate. The chief debates on Tuesday will be on the position with regard to venereal disease in Great Britain and self-governing dominions, to be opened by Mr. Neville Chamberlain, and on social hygiene in relation to the mercantile marine, while there will also be a discussion on venereal disease and emigration. The concluding day on Wednesday will be devoted to the consideration of the problem of venereal disease in India and in the Colonies and Protectorates and mandated territories. During the course of the

meeting a number of films dealing with the work of the Council will be exhibited.

WE see by a letter in the *Veterinary Record* that Prof. Hobday is this week taking over to Holland a party of veterinary surgeons and others with the object of showing them that, contrary to general opinion, England in its treatment of such animal products as milk and meat very greatly lags behind many of the continental countries. He has secured the co-operation of a considerable number of veterinary public health officials, and the party, which leaves on Saturday, will include amongst its representatives a number of delegates from those who for years past have been attacking what is generally known as the "decrepit horse traffic." His interest is primarily, according to the statement issued, in the fact that Holland possesses laws (and enforces them) which make it practically impossible for unsound food to be placed on the market. The programme is an interesting one. The party will have every opportunity of seeing the horses as they embark and as they disembark. The members will see the application of the Mallein test, which is compulsory by law, for glanders. Dr. Laurens is enabling them to visit the Serum Institute at Amsterdam, and this visit will be followed by one to a large hygienic dairy at Hillegom, where the cattle are all milked by machinery. On the following day there will be an inspection of the well-known dairy herd of the Netherlands Herd Book Association. The Veterinary School at Utrecht and the Amsterdam abattoir (one of the most up-to-date and modern buildings in existence), with its splendidly organised system of veterinary supervision and its humane methods of killing, will be inspected. On Tuesday, through the courtesy of Dr. Bonner, the director, there will be an inspection of the Cancer Institute and of the Amsterdam zoo and aquarium, each of which are amongst the most celebrated in the world. The visitors to Amsterdam will be accompanied by Dr. J. A. Klauwers, the District Veterinary Inspector, who is responsible for the carrying out of the law concerning the contagious diseases of animals in Amsterdam and the surrounding district.

THE British Institute of Philosophical Studies, which was formed in the early spring of this year, has recently issued a syllabus of the initial courses of lectures to be given under the auspices of the Institute. The lectures, which are ultimately intended to cover every branch of philosophy, are open to all persons interested in the subject who have registered and paid the necessary fees, 1*l.* 5*s.* for a term's lectures, and 2*l.* 2*s.* for the whole course of two terms. The courses of lectures announced for the forthcoming term are on "Problems of Philosophy," by the Hon. Bertrand Russell, on Wednesdays at 5.30, at the London School of Economics, beginning October 7; on "Present Tendencies in Political Theory," by Mr. H. J. Laski, on Thursdays at 5.30, at the Royal Anthropological Institute, 52 Upper Bedford Place, beginning October 8; and on "Psychology," especially tendencies and controversies in modern psychology, by Prof. T. H. Pear, on Fridays at 5.30, also at the Royal Anthropological Institute. Copies of the syllabus, which contains further announcements for the Lent term, can be obtained from the director of the Institute at 88 Kingsway, W.C.2, to whom all inquiries relating to the work of the Institute should be addressed.

THE centenary of the opening of the Stockton and Darlington Railway occurred on September 27, and to commemorate this important event a special exhibition has been formed in the Science Museum, South Kensington, as a supplement to the general railway groups of the land transport collection. This supplementary collection comprises many objects from this collection relating to the Stockton and Darlington Railway, together with a number of new objects, documents and pictures, bearing on the history of railways, which have been lent for the occasion by the railway companies and by private contributors. A catalogue of the collection has been prepared, the contents being classified under the headings—history, construction, locomotives, rolling-stock and working. The earliest books and other documents relating to the Stockton and Darlington Railway are shown, including George Stephenson's original report of 1822, and many original letters, portraits, prints and medals are exhibited in the historical section, besides early railway plans and specifications, drawings of works of construction and buildings, and examples of permanent way. A few models and numerous drawings of locomotives are also included, with various items connected with rolling-stock. Railway working is illustrated by signals and signalling apparatus, time-tables, tickets and ticket printing machines. The exhibition, which will be found on the ground floor of the new Science Museum building, will remain for several weeks.

IN consequence of the rearrangement of the collections in the different museums at Hull, as a result of the opening of the New Commercial Museum, one of the galleries in the Natural History Museum, Albion Street, has been entirely rearranged and devoted to the exhibition of osteological preparations, including a representative series of skeletons and skulls of various mammals and birds, the larger mammalia (whales, etc.) and fishes being exhibited in the Museum of Fisheries and Shipping in another part of the town. One side of the new gallery is devoted to human skeletons of various ages, and include bronze age, iron age, Roman, Anglo-Saxon and medieval skulls, the Museum possessing a remarkably fine series in this respect. There are also human crania from various parts of the world and plaster casts of all the really important prehistoric skulls at present available. In addition, there are copies of the well-known series of restorations of different types of prehistoric man, the originals of which are in the Museum of Natural History, New York.

A MESSAGE from the Dublin correspondent of the *Times*, which appeared in the issue of September 23, announced the appointment of Dr. Walther Bremer as Keeper of Irish Antiquities in the National Museum at Dublin. This appointment has been vacant since the resignation of the late Mr. E. C. R. Armstrong at the end of 1922 under the arrangements for the retirement

of Civil Servants made by the Irish Government. Dr. Bremer is honorary professor of prehistoric archæology in the University of Marburg, Germany, and has a high reputation on the continent as a prehistoric archæologist, especially in connexion with the neolithic period and with the antiquities of Great Britain and Ireland. He has contributed a number of articles to the "Reallexicon der Vorgeschichte," published by Messrs. Gruyter, of Berlin. During the War he was a prisoner in England, but was released on parole and devoted himself to archæological research.

DR. G. C. CLAYTON, M.P., and Prof. H. C. H. Carpenter, F.R.S., have been appointed, by Order of Council dated September 16, to be members of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research.

IN honour of the founder of the British Science Guild, Sir Norman Lockyer, the Council has established an annual Norman Lockyer Lecture, one of the objects of which is to direct the attention of the public to the influence of science upon human progress. The first lecture will be given by Sir Oliver Lodge, on Monday, November 16, 1925, at 4 P.M., upon the subject of "The Link between Matter and Matter." Lord Askwith, president of the Guild, will be in the chair, and the lecture will be delivered in the hall of the Goldsmiths' Company (by kind permission of the Master and Court of Assistants of the Company). Tickets of admission may be obtained on application to the secretary, British Science Guild, 6 John Street, Adelphi, London, W.C.2.

DURING the forthcoming winter, Mr. H. V. Garner, the guide demonstrator of the Rothamsted Experimental Station, Harpenden, will be able to give a few lectures to Chambers of Agriculture and Horticulture, Farmers' Clubs, Farm Workers' Associations, Agricultural Societies, etc., on the Rothamsted experiments in regard to artificial manures and their use on the farm, practical lessons from recent field experiments, profitable improvement of grass land, chalking and liming, and similar subjects. For students' societies and similar bodies, lectures can be arranged dealing with the planning and carrying out of field experiments, factors in soil fertility, etc. No fee will be charged for Mr. Garner's services, but any association engaging him would be expected to defray his travelling expenses and to make such arrangements for the lecture as may be necessary. All communications regarding lectures should be addressed to the Secretary, Rothamsted Experimental Station, Harpenden.

SIR CHARLES SHERRINGTON, president of the Royal Society, will give the introductory address at the opening of the London (Royal Free Hospital) School of Medicine for Women (University of London), on Thursday, October 1, at 3 P.M.

THE new price list of fine organic chemicals issued in August by the British Dyestuffs Corporation, Ltd., includes indicators, microscopic stains, medicinal and photographic chemicals. Of special interest is the wide range of microscopic stains, produced by standardised methods and tested for purity both in the laboratories of the Corporation and independently. Information on a number of the substances can be obtained from separate booklets issued by the Corporation.

THE Oxford University Press announces the early publication of "The Surface History of the Earth," by Prof. J. Joly. The work is intended for the general reader with scientific interests and for students of geography and geology, and deals with the forces which have moulded the earth's crust.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: In the Royal Aircraft Establishment, South Farnborough, Hants—A scientific assistant primarily for work in the aerodynamic section; two junior scientific assistants, one primarily for mathematical and experimental work on the stability and control of aeroplanes, and one for wind tunnel experiments; and three junior scientific assistants, respectively primarily for elasticity research, for problems arising in connexion with high altitude flying, and for work in connexion with indicating and recording instruments and similar apparatus—The Superintendent (October 13). A scientific assistant primarily for research in connexion with electrical ignition appliances—The Superintendent (October 20). A lecturer in chemistry at Armstrong College, Newcastle-upon-Tyne—The Registrar (October 17). A director and curator of the Harris Art Gallery and Museum, Preston—The Town Clerk, Town Hall, Preston (October 31). A research chemist at the new central research laboratory of the Colonial Sugar Refining Company, Sydney—Parbury, Henty and Co., 20 Eastcheap, E.C.3.

Our Astronomical Column.

BROOKS' PERIODIC COMET.—As other observers failed to find any comet close to the place announced by Prof. Tcherny, fears were expressed that the news of the detection of Brooks' comet might be erroneous. A further telegram from Russia, transmitted by the I.A.U. Bureau, Copenhagen, makes it clear that the discovery is correct, but that Tcherny's first telegram gave incorrect position and magnitude. The following two positions are communicated:

	Univ. T.	R.A.	S. Decl.	Mag.
1925 Sept.	$9^d\ 19^h\ 33{\cdot}1^m$	$23^h\ 23^m\ 12{\cdot}6^s$	$1^\circ\ 49'\ 31''$	13·1
	$24\ 18\ 57{\cdot}9$	$23\ 18\ 6{\cdot}7$	$4\ 2\ 54$	12·5

The observers are MM. Albitsky and Shain. These observations indicate that Dubiago's predicted date of perihelion needs a correction very close to −6 days, his other elements being near the truth.

The following ephemeris for 0^h has been deduced on this assumption:

	R.A.	S. Decl.	log r.	log Δ.
Oct. 2.	$23^h\ 16^m\ 19^s$	$4^\circ\ 57'$	0·278	9·965
10.	$23\ 15\ 39$	$5\ 48$	0·276	9·977
18.	$23\ 16\ 35$	$6\ 25$	0·274	9·993
26.	$23\ 19\ 22$	$6\ 46$	0·273	0·013

The comet should be observable for some months. It is the fourth periodic comet observed this year, the others being Tempel (2), Wolf, and Borrelly. Faye's and Schorr's comets have also been looked for, but unsuccessfully as yet.

Research Items.

A SURVIVAL OF THE "THAMES PICK."—*Man* for September contains a note by Mrs. M. E. Cunnington on a "Thames Pick" found on a ledge or shelf in the chalk side of a pit-dwelling in Casterley Camp, Wilts. The flint is of a pale bluish-grey, the unground sharp nose shows no sign of use, and the whole surface is sharp and rough to the touch as if newly made, as it must have been when buried in the pit. The "Thames Pick" type of implement is usually held to be of late palæolithic or early neolithic date. In the present instance, however, it is recorded that it was found with three skeletons, two adult and one of a child, and under one of these were the remains of an iron brooch with a spiral spring of La Tène type, and under the child's skeleton was a second fragment of iron which was possibly the bow of another brooch. Pottery of a poor quality was also found which, taken in conjunction with the flint implement, might have led to an attribution to the Neolithic Age had it not been for the presence of iron. It is, however, clear from this find that implements of this type continued to be manufactured in Britain until well into the Iron Age.

PHYSICAL ANTHROPOLOGY OF THE HOS OF KOLHAN.—Mr. D. N. Majumdar has recently published several studies of the Hos or Kols and their culture. Of four in the current issue of the Journal and Proceedings of the Asiatic Society of Bengal (Vol. xx., N.S., Pt. 5) one deals with their physical characters, as shown in 10 measurements of 200 individuals which are given in a series of tables. They are short of stature, of dark complexion, with short, broad, and flat noses, small dark eyes, wavy to curly hair, beard or moustache being absent. The complexion varies from sooty black to dark brown. Fair Hos are occasionally encountered, but this is to be attributed to admixture with Rajput traders. The lips are medium, and slight prognathism is noticeable. The average cephalic index is 75·5, but 63 per cent. were dolichocephalic, 47 per cent. mesocephalic, and 12 per cent. brachycephalic. Cases of artificial deformation were noted. The highest nasal index was 91·1, the lowest 74·6. The average stature is about 161 cm., the lowest individual measurement being 158·2 cm., and the highest 170 cm. The arm's reach is proportionate to the stature, ranging from 166·6 cm. to 173·5 cm. Tattooing, formerly practised, has fallen out of favour, but where in use it is only on the fore-limbs, and especially the right hand. If a woman does not tattoo she commits a sin, as she takes nothing to the next world but these marks on her limbs.

THE BOSKOP SKULL.—Mr. W. P. Pycraft, who undertook to examine and report on the calvaria found at Boskop, Transvaal, in 1913, has contributed to the Journal of the Royal Anthropological Institute, Vol. LV., Part 1, a discussion of the conclusions at which he himself and Dr. H. S. Haughton, assistant director of the South African Museum, have arrived. Mr. Pycraft's reconstruction gives length 205 mm., breadth 150 mm., auricular height 125 mm., basi-bregmatic height 137 mm., cranial capacity probably 1717 c.c. In all its salient features the skull shows a likeness to the Bushman skull, but it is also comparable with the "Strandlooper" and the Cromagnon. The contours of the Strandlooper and Boskop skulls are almost identical except in the greater height of the latter. The Strandlooper stands midway between the Boskop and the Bushman skulls. Boskop Man is also genetically related to Cromagnon Man, the conclusion being that he would appear to be a derivative of Cromagnon Man and the progenitor of the Bushman. It is therefore suggested that the proto-Bushman, *i.e.* the Boskop Man, arose out of the Neanthropic flux which gave rise to the Grimaldi people and the Cromagnards, the Australo-Dravidians and Rhodesian Man, the common stock from which all were derived being the smooth and "beetle-browed" Palæanthropic peoples. The apparently somewhat sudden appearance of the Neanthropic peoples is probably fictitious.

THE FLOODS OF THE NEVA.—The tendency of the lower Neva to inundate part of Leningrad has been a serious problem since the foundation of the town. It has been explained by river flooding due to precipitation, banking of the river flow by winds, and changes in the level of Lake Ladoga. In an article entitled "Les Crues de l'embouchure de la Neva" in *Matériaux pour l'étude des calamités* for April-June 1925, Dr. E. P. Pouichet shows that the main cause is a southerly and south-westerly gale in the southern part of the Baltic. This forces the water into the Gulf of Finland, especially since the free passage into the Gulf of Bothnia is obstructed by the Abo and Aland archipelagoes. In the narrow and shallow Gulf of Finland the waters are heaped up, if the westerly winds persist, and overflow the tidal reaches of the Neva. If the westerly winds give way to northerly or north-westerly winds, the floods rapidly subside, and indeed may not reach dangerous proportions. Dr. Pouichet gives synoptic charts showing the meteorological conditions on the occasion of several serious floods, and describes the system of warning instituted some years ago and improved by the existing government in Russia. He discusses the possibility of protective works, but concludes that their cost would be prohibitive.

RAIN AS A CAUSE OF SPOTTING OF FOLIAGE.—Field observations having led to the conclusion that spotting of the foliage in apple trees in the wet season of 1924 was associated with the abnormal rainfall, Messrs. C. E. T. Mann and T. Wallace, of the Horticultural Research Station at Long Ashton, proceeded to examine the effect upon the foliage of these trees of temporary immersion in distilled water. As somewhat similar blotches appeared on these leaves, and as analysis showed that the distilled water was leaching considerable quantities of potash out of the leaves, the experiments were continued and showed that a variety susceptible to this spotting in the field, Cox's Orange, lost no less than 64 per cent. of the total potassium in the leaves after 24 hours' immersion in the water, whilst a variety resistant to spotting in the field in a similar experiment lost only 12 per cent. in the 24 hours. In view of their experimental results with varieties of different susceptibility, as recorded in the *Journal of Pomology*, vol. iv. pp. 146-161, there seems little doubt that the conclusion drawn from the field observations was justified, that rain was responsible for the spotting of the leaves noted in this particular season. It would also seem that the action of the rain water is associated with this little suspected capacity it has for leaching considerable quantities of soluble substances, including potassium compounds, out of the foliage of the plant.

CREAMING OF SPRAY FLUIDS.—Rowland Marcus Woodman continues his investigation of the fundamental physics and chemistry of spray fluids in the *Journal of Pomology and Horticultural Science*, vol. iv. pp. 184-195, with an interesting discussion of the difference between the "cracking" of an emulsion,

i.e. a mass separation of the two liquid phases, and the "creaming," in which a stable emulsion, containing practically the theoretical amount of the disperse phase when present in spherical droplets packed as closely as possible, separates itself by creaming from the excess of the continuous, and in this case denser, solvent phase. He points out that cracking and creaming are very different and that they are not necessarily favoured by the same conditions; furthermore, in practice with spray fluids, the danger is creaming. As a result of creaming a paraffin wash may be pumped on to foliage, the bulk of which is too dilute to be effective, whilst the remainder, the cream, may be so concentrated as to do damage. Mr. Woodman discusses the factors that facilitate creaming; he shows that the farmer is justified in his traditional view that a wide pan favours rapid creaming, a fact which is to the disadvantage of the sprayer, whose concoction is usually mixed in wide tubs on the farm. The author analyses the methods available to retard creaming, and gives his reasons for selecting as the most practical that of bringing both liquid phases nearer to the same density. He describes some very successful results obtained by means of cresols added to paraffin oil emulsions with this end in view. Altogether this paper seems a very satisfactory example of pure science in the service of horticulture. Mr. Woodman is working at the Horticultural Research Station, University of Cambridge.

PLIOCENE CLIMATE OF NORTHERN EUROPE.—Some deductions regarding the climatic conditions of Pliocene times in Iceland have been drawn by Gudmunder G. Bárdarson from his study of the mollusca in the deposits of that age, estimated at about 700 metres in depth, at Tjörnes (*Det Kgl. Danske Videnskab. Selskab., Biolog. Medd.*, 4, 5, 1925). He finds that the remains of mollusca associated with warm-temperate seas occur chiefly in the older shell-bearing zones. These suggest climatic conditions similar to those of south and west Norway, or possibly of the British Isles. But during the period of the accumulation of the Pliocene deposits there was a gradual deterioration in temperature, for the southern forms of mollusca give place in the upper beds to an immigrant northern or arctic fauna, closely related to the molluscan fauna now existing on the shores of the North Atlantic. The Icelandic forms show, as geographical proximity would suggest, a closer relationship to the present-day fauna of America than do the fossils of the English Crag series, which the author considers to have been formed about the same time. There is no indication in the Tjörnes beds of a sea-temperature on the coasts of Iceland colder than that of the present day.

PHYSIOGRAPHY OF THE SHIRÉ VALLEY.—A paper on the physiography of the Shiré valley by Dr. F. Dixey has been published by the geological survey department of Nyasaland. Dr. Dixey shows that an examination of the uplands bordering the Shiré Rift exhibit several additional branches of the main rift of considerable importance. Parallel with the Upper Shiré Rift, which runs N.N.E., is the long depression that includes the Upper Lujenda, Lake Chilwa, and the plains to the south. Parallel with the Lower Shiré Rift, which runs N.N.W., is a depression that extends from the southern end of Lake Nyasa, and includes Lake Malombe, part of the Upper Shiré Rift, Lake Chilwa, and the eastern foot of the Mlanje mountains. These intersecting rifts thus account for the position of Lakes Chilwa and Malombe and the upland area of the Shiré highlands. Dr. Dixey discusses the succession of the faulting that caused these features, which be believes took place at several distinct periods separated by appreciable intervals.

CLIMATE OF GLASGOW.—The Meteorological Office, Air Ministry, has published in Geophysical Memoirs, No. 23, a memoir on "The Climatology of Glasgow," by Prof. L. Becker, professor of astronomy in the University of Glasgow (M.O. 254 C., H.M. Stationery Office, 1925, 10*s.* net). Weather observations recorded at the Glasgow University Observatory since 1843 are dealt with; since 1868 the observations have been taken in association with the Meteorological Office. In the course of time much building has sprung up round the Observatory, and it seems quite possible that some of the weather changes may be due to artificial causes rather than to natural change of climate. The author attributes the lines followed in the discussion as "suggested by inquiries from engineers and lawyers." The charm of the work is the diversity of inquiry to which the several elements are subjected. The statistics are said to have been ready for publication since 1908, when forty years were available, but funds for publication were lacking. Barometric pressure, temperature, humidity, sunshine, cloud, visibility, and wind are analysed, and to take temperature as an illustration, the examination consists of more than twenty tables. In addition to the normals for the several months and years, the diurnal changes and 5-day means, there are tables of excesses and deficiencies in mean temperature relative to the average, number of warm days and warm nights in summer, number of cold days and cold nights in winter (these are given for each year), number of periods of warm weather in summer and cold in winter. An examination of the discussion has suggested the wish that it might be possible to submit the Greenwich Observatory records to similar diversities of inquiry. There the system and uniformity of observation, together with the relatively open position, would probably allow a change if ascertained to be attributed to cosmical effects.

MAGNETIC DECLINATION AND THE MAGNETISATION OF ANCIENT LAVA.—The lava flows of Mount Etna have been studied by M. R. Chevallier, who shows that it is possible to determine the magnetic declination at the time the lava solidified by observing the direction in which it is now magnetised (*Annales de Physique*, July-August). Although the actual field in which solidification took place was, in general, disturbed by the presence of other masses of magnetised lava, it appeared possible, by taking the mean between the directions obtained from a number of specimens chosen from points in a given lava flow where there has evidently been no displacement of the lava after solidification, to obtain a satisfactory value for the declination at the time of solidification. The values deduced in this way from the lava streams of 1669 and 1911 agree with the known declination curve; and when the declination values determined from observations on earlier lava flows of known date were plotted, it was found that a curve was obtained which continued the known curve symmetrically backward, passing through zero about 1630, through 18° E. about 1440, and again through zero towards westerly declinations about 1240. The time intervals from zero to zero are nearly equal, and the amplitudes of the easterly and westerly declination are the same. The curve of dip shows irregularities which are attributed to the influence of adjacent lava masses.

ATMOSPHERIC IONISATION.—In 1910 and 1911, by observation of the ionisation of the atmosphere at different heights, Gockel came to the conclusion that the radiations due to the radioactive processes taking

place in the earth's crust and in the lower atmosphere were not capable of explaining the conductivity of the upper atmosphere, and suggested that penetrating γ-radiations entered the atmosphere from outside. Since then a large amount of work on the subject has been done, which is summarised and discussed by Dr. Walter Schulze in the *Naturwissenschaftliche Umschau* for July. He comes to the conclusion that the existence of such a hard γ-radiation has been established, and that it originates either in the upper atmosphere itself, or more likely in the neighbourhood of the Milky Way.

QUARTZ FILTERS.—The *Chemiker-Zeitung* for August 25, p. 716, gives an account of some experimental tests on quartz crucibles with filtering bottoms made by the Jena firm of Schott und Gen. The porous bottoms are made from the same material as the crucibles themselves, and in the case of those made from rock-crystal the analytical results were highly satisfactory, even when normal solutions of ammonia or caustic alkalis were used for washing the precipitates. The speed of filtration is rather slower than with the ordinary asbestos pads in Gooch crucibles. The analytical results obtained with the opaque crucibles were not quite so good, but the latter are suitable for filtering very hot liquids.

HIGH FREQUENCY VIBRATIONS IN PIEZOELECTRIC CRYSTALS.—A new method for showing the vibrations produced in piezoelectric crystals by an alternating electric field is described by Messrs. E. Giebe and A. Scheibe in the *Zeitschrift für Physik* of August 8. A suitably cut rod of quartz, the length of which was either 100 or 80 mm., the breadth 3 mm., and the thickness 1·5 mm., was in the simplest case placed between two electrodes connected to an oscillating valve which could be tuned to different frequencies. One of the electrodes, E_2, was separated from the quartz rod by about 0·5 mm., and it was found that, when the bulb containing the electrodes was evacuated, a discharge took place in the space between E_2 and the quartz rod when the frequency had a certain very definite value, which corresponded to a longitudinal vibration of the rod with a node at the centre. The luminosity was greatest at the centre. W. G. Cady showed in 1922 that a crystal rod was set into longitudinal vibration in a suitable alternating field in virtue of the reciprocal piezoelectric effect, and in the present experiments these vibrations produce in the crystal alternating positive and negative surface charges which depend on the alternating compressions and rarefactions, and are therefore greatest at the node; these charges alter the electric field and facilitate the electric discharge. It is possible by means of a suitable system of electrodes to obtain a similar effect for an upper harmonic of the fundamental vibration of the rod, and photographs are given showing the appearance of the discharges for a number of upper harmonics up to the fifteenth.

THE PRODUCTION OF HELIUM IN GERMANY.—Since there are no natural gas sources from which helium can be obtained in Germany, experiments are being carried out at the Physikalisch-Technische Reichsanstalt in Berlin on the production of helium by other methods. An account is given in *Die Naturwissenschaften* (1925, p. 695) of the isolation of the gas by Dr. Walther Meissner by liquefaction from the helium-neon mixture, which is a by-product of the Linde Oxygen works. The Linde process is applied, liquid air and liquid hydrogen being used as refrigerators. It is claimed that the method is simpler than those used by Prof. Kamerlingh Onnes in Leyden and by Prof. McLennan in Canada. A second method described by Kurt Peters (*ibid.* p. 746) is by heating monazite sand, containing 5 to 7 per cent. of thoria, to 1000° C. One litre of helium was obtained thus from 1 kilogram of the sand. It is pointed out that the German thoria factories, which produce 60 tons of thorium nitrate annually from 500 tons of monazite sand, could recover between 250 and 500 cubic metres of helium.

NITROGEN FIXATION.—An interesting illustrated account of the synthetic ammonia processes of Casale and of Fauser is printed in *La Nature* of August 22. Both these processes are now in use on the manufacturing scale. The Casale process is more or less identical in principle with the well-known Haber process, but the details of working are different. Hydrogen is generated in the pure state by electrolysis of water; the nitrogen is obtained by mixing air and hydrogen in such proportions that on ignition all the atmospheric oxygen is removed as water, leaving nitrogen and hydrogen in the correct proportions for combination. The dried gas mixture is pumped through a heat recuperator and thence into the catalyst furnace. This consists of four concentric tubes. The electric heating element is placed in the centre tube; the next annular space is packed with catalyst (an active form of iron). The two outer annular spaces act as a heat exchanger. The gas mixture passes through the outer annular space (which is heated by hot gases from the catalyst chamber passing through the next space) and thence over the heating element in the centre tube. They pass from this to the next tube, containing the catalyst, and then into the third annular space, from which they are drawn off. This furnace economises heat. The exit gases pass once more through the heat recuperator and then to a refrigerator where liquid ammonia is condensed out. This economical process is now being worked at Terni and Nera Montoro (Italy), at Toulouse, in Belgium, Japan, France, Spain, Switzerland, and United States. In the Fauser process hydrogen is prepared electrolytically, mixed with nitrogen (see below) and compressed to 300 atm. During the compression a small quantity of water is added, which serves both as lubricant and to absorb the ammonia. The mixture is passed over the catalyst and then proceeds to the absorber. The aqueous ammonia solution thus obtained is distilled, the vapours being collected in a gasometer. The ammonia is then oxidised to nitric acid by mixing with air and passing over heated platinum. The excess nitrogen from the air, which proceeds from this apparatus, is used to mix with the hydrogen in the synthetic plant. The process is in use at Novara, Marengo, and other Italian towns.

MODERN LOCOMOTIVES.—The August issue of *La Science Moderne* has a well-illustrated article of 14 pages on the modern locomotive by M. Leflot, of the testing department of the Orleans Railway. The modern locomotive is the same in type as the one of 1845, and has now reached a stage in its development when increases of power or efficiency are only likely to be brought about by radical changes in construction or working. The present weight of European locomotives is about 12 tons, the steam pressure between 200 and 300 lb. on the square inch, and the power 2000 H.P. Oil fuel has been tried, but the increase of the price of oil has retarded progress in this direction. Powdered coal produced immediately before use in the furnace has been used successfully in America. Compounding and superheating are customary on some lines. The author considers that the future lies with the steam turbine and the heavy oil motor, and gives some details of European locomotives constructed on these lines.

Experimental Zoology in Poland.

WE have recently received several volumes of the Bulletin International de l'Académie Polonaise des Sciences et des Lettres covering the period June 1922–May 1924. The following notes based on communications in the Bulletins will serve to indicate some of the activities of workers in Poland in the field of experimental zoology during this period.

In "L'hérédité dans les cellules végétatives au cours de la régénération chez l'axolotl" (Bulletin, June 1922) Godlewski records his endeavours to discover whether somatic cells as distinct from genital cells preserve their inborn characters when transported to a new environment, or whether in such circumstances they "acquire" new characters. He transplanted a small piece of the skin of a black axolotl to a previously prepared spot on the base of the tail of an albino axolotl from which he had removed the skin. The new graft effected a satisfactory union with the neighbouring tissues and the animal was kept alive for five years. After the graft had united with the neighbouring skin, the tail was removed by a cut passing through the graft, and in about six months a new tail had been completely regenerated.

It is obvious that the grafted skin would necessarily take part in forming the new skin covering the regenerated tail, and the question was whether the new cells produced from the black skin would remain black or not. It was found that as the tail grew a black band of skin extended from the graft towards the tip of the tail; but that as time went on this band became narrower, and finally, after about two years, completely disappeared; but the area covered by the original graft maintained its black colour. Hence Godlewski concludes that the new cells derived by division from the black cells of the graft retain for a time their "inborn" black character, but that as time goes on their descendants slowly "acquire" the albino character of their environment and transmit this new character to their later descendants.

The original graft alters its position somewhat and moves slowly towards the base of the tail, but does not achieve more than a moderate change of position. This puzzling fact Godlewski explains by the assumption that in regeneration the skin grows more quickly than the other tissues, and so glides over them towards the tip of the tail.

Godlewski obtained a different result when he grafted a piece of skin from an albino axolotl on a wound in the base of the tail of a black axolotl. In this case the grafted piece of white skin soon assumed the colour of its black surroundings. This is explained by assuming that the skin chromatophores from the surrounding black skin migrate into the graft and change its colour.

Z. Kolodziejski has a paper on "Studies on the Metabolism of the Budding Hydra" in the Bulletin for October 16, 1923. In some cases of budding, as for example in Annelida, it has been shown that physiological differentiation is subsequent to morphological differentiation. Thus the reaction of the front part of the gut of an Annelid is acid whilst that of the remainder is basic, but the whole alimentary canal of the bud is basic in its reaction until its development is complete, and then alone physiological differentiation sets in. The primary object of the author was to discover whether similar differences in capacity existed between the mother Hydra and its immature buds.

The bud of Hydra is not formed as a simple eversion of the body-layers of the mother. It originates as a local thickening of the interstitial cells of the ectoderm, which penetrate between the neighbouring ectoderm cells and, after having pierced the supporting lamella, between the endoderm cells also. These young cells gradually become transformed into ordinary ectoderm and endoderm cells, and the mass becomes hollowed out and forms a young bud.

When Hydra is fed on food coloured with Sudan red or on naturally coloured food such as green infusoria, the fate of the food can be followed. The author in this way confirms previous accounts to the effect that the food is first partially dissolved and converted into an emulsion with solid particles by the action of ferments secreted by special gland cells. Thus the contents of insect larvæ provided with hard chitinous coverings such as those of Chironomus or Corethra are dissolved out. The particles are afterwards ingested by amœboid action on the part of the large endoderm cells. The use of colour indicators proves that the endoderm cells have a basic reaction. All the endoderm cells both of mother and bud are equally active, and the particles of the food emulsion penetrate even into the tentacles, especially into those of the bud, which have wider internal openings than those of the mother.

When a brown Hydra is fed on the green infusorian Euglena, the chlorophyll is ingested by the endoderm cells and the animal appears like a green Hydra; but the chlorophyll is finally completely digested and disappears. Hydra can be induced to ingest fat by mixing it with protein; the fat globules afterwards appear in the endoderm cells but are very slowly dissolved. Starch is at once rejected as indigestible material. The brown granules of the ordinary Hydra, which give to it its characteristic colour, are of an excretory nature. They have a crystalline character which is revealed when they are examined by polarised light. They are not influenced by alcohol, ether, or chloroform, but yield slowly to the action of 10 per cent. solutions of caustic potash and soda, and of hydrochloric, nitric, and sulphuric acids. The author considers that they are probably allied to guanin. After solution the colour remains as an amorphous mass, and is to be looked upon as another substance which is being excreted along with the supposed guanin.

S. Skouron in "Le Rapport plasmo-nucléaire pendant la Spermatogenèse chez *Helix pomatia*" (Bulletin, May 1924) examines the question whether there might be an emission of nuclear substance into the spermatogonia of Helix. He preserved the ovo-testes in corrosive sublimate and acetic, and determined by comparison with living material that this preservation produced no change in the nucleo-plasmic relation.

The youngest spermatogonia had large vesicular nuclei with a very fine spireme of chromatin. As the cell grows this spireme thickens and becomes contracted into a closely woven tangle of chromatin at one side of the nucleus. This stage is of course that of "synapsis." Afterwards the tangle loosens, distinct chromosomes appear, and the nucleus and cell divide into two. The later generations of spermatogonia are distinguished by their larger size, and by the fact that even in the resting nucleus the chromatin can be seen as thickenings of the nuclear network. There is always a "yolk-nucleus" or "Nebenkern" in the protoplasm at the side of the nucleus. The period of growth is terminated by the formation of the spermatocytes of the first order, distinguished by their comparatively large size and by the arrangement of the chromatin material in tetrads. The spermatocytes, by the reducing or meiotic division, become spermatocytes of the second order; by another division following immediately on this, each

spermatocyte forms two spermatids. These are much smaller cells with nuclei filled with large and small granulations of chromatin. The spermatids by a series of well-known changes are converted into the spermatozoa.

The proportion of plasma to nucleus in young spermatogonia is about 2·3 – 1; but in spermatogonia in which synapsis has set in, it varies from 1 – 1 (equality) to 0·7 – 1. These figures indicate an enormous growth of nuclear matter which can actually exceed in bulk the remaining plasma. But if we follow the proportion between protoplasm and nucleus in subsequent generations of spermatogonia, we find that this in the first succeeding generations rises to 2·5 – 1 and in the later generations increases to 5·3 – 1. As the latest generations of spermatogonia are changed into spermatocytes of the first order, this proportion rises to 6·8 – 1. After the formation of the spermatids, and during the growth of these, the proportion rises to 19 – 1.

In the spermatogenesis of Helix there often occur polynuclear cells each of which gives rise to several spermatozoa. These cells result simply from nuclear division unaccompanied by cell division. If we compare the relation of protoplasm to nucleus in these cells we find that it runs through a series of changes parallel to those undergone by the plasmo-nuclear relation in normal spermatogonia. During the whole period of development of the sperm cells there is never any evidence of the emission of chromatinic substances from the nucleus into the protoplasm such as occurs in the egg.

Jean Prüffer contributes an interesting paper on "Observations and Experiments on the Phenomena of the Sexual Life of *Lymantria dispar*" (Bulletin, January 8, 1923). The pairing impulse becomes active as soon as the imagos of the Gipsy-moth emerge from their cocoons, and since a large number of chrysalides are found on the trunk of the same tree and the males emerge first, the latest males to emerge fertilise the first females. But a great deal of pairing occurs during the subsequent lives of the insects; and to accomplish it the males fly long distances, their flights occurring only by day. The females, though inactive by day, fly about at night.

Experiments proved that the males were able to seek and find the females, when their eyes were covered with an opaque substance, when their wings were removed, when one entire antenna was removed, and when the distal portions of both antennæ were removed. When both antennæ, however, were entirely removed, the males were unable to find the females even when their eyes were uncovered. It is obvious, therefore, that the sense organs which serve to detect the female must be situated in the basal portion of the antenna, and we may remember that it was in this region that Mr. K. M. Smith, of the Imperial College of Science, now at the University of Manchester, discovered and described highly developed sensory pits in flies.

The attractiveness of the female for the male was not diminished by the removal of the "scales" from the female's wings, nor by the removal of its wings, nor by the amputation of the two antennæ; but it was diminished and rendered uncertain by the removal of the scales from the abdomen, and entirely destroyed by the amputation of the abdomen. On the other hand, the amputated but otherwise uninjured abdomens of females were as attractive as the uninjured insects. It is obvious, therefore, that the hedonic scent which emanates from females and attracts males is localised in the abdomen and especially in the scales covering the genital region.

It has been shown that in newly hatched pigeons the liver and pancreas increase rapidly in weight, and that their rate of increase is out of all proportion to the increase of weight in the animal. Nevertheless in sections, no signs of either mitotic or of amitotic division of cells is to be seen. In the full-grown animals the liver and pancreas decrease in weight. In order to investigate this matter further, young pigeons were killed on the first, third, and fifth days after hatching and thereafter on every second day until full size was attained. The liver and pancreas were weighed in each bird thus examined and portions of these organs fixed and sectioned. ("Cell Growth and Body Growth Investigations in Pigeons," by L. Kaufmann. Bulletin, April 1924.)

It transpires that the cell volume increases most rapidly between the first and third day (about 50 per cent.). Between the third and fifth day the rate of growth decreases, and on the ninth day the cells are actually smaller, a proof that cell division has taken place. The nucleus undergoes its greatest growth during the first two days, but in seven-day old pigeons it is only as large as nuclei in one-day old pigeons, and in still older pigeons it is even smaller, so that from the ninth day there may be said to be a permanent shift of the nucleo-plasmic relation in favour of the plasma. In one-day old pigeons the plasma exceeds the nucleus in volume 12·4 times, but in the full-grown bird the volume of the plasma is 66 times greater than the nucleus. After the seventh day, the number of karyokinetic figures diminishes and the increase in volume of cells is roughly proportionate to the increase in weight of the whole organ. As the liver is a storage organ, its weight increases with feeding and diminishes during fasting more than does the weight of the body as a whole. The decrease in weight of the liver in old birds is associated with a diminution in cell plasma.

In the growth of the pancreas, similar phenomena were observed, but the following differences are to be noted. The liver cell of the adult has five times the volume of the liver cell of the one-day old bird, but the pancreas cell of the adult is only twice the volume of the corresponding cell in the one-day old bird. The highest curve of increasing weight in the pancreas corresponds to the lowest curve of increase in cell-volume, whereas in the liver the lower curve of increase in liver weight corresponds to the higher curve of cell growth.

The author concludes that the nucleo-plasmic ratio has not, as had been previously supposed, a fixed point of equilibrium for each species, but that with each change in the general physical condition the nucleo-plasmic area may undergo alteration. Further, increase in volume and weight may be due to increase in amount of deutoplasmic substances and not of plasma.

Since Urodela are probably the most primitive land vertebrates now surviving, the mode of development of their blood-vessels, as indeed of their other organs, becomes a matter of interest and importance. This development had previously not been satisfactorily traced back to a sufficiently early stage of development; former authors relied mainly on sections, but Z. Grodinski ("*Über die Entwicklung der Gefässe des Dotterdarmes bei Urodelen*," Bulletin, February 11, 1924) has made successful injections of exceedingly young larvæ beginning with those only 4·5 mm. long.

These "larvæ" are really embryos with the tail and head merely indicated. In this youngest stage the main blood-vessels arise as metamerically arranged transverse branches from the aorta which unite with one another on either side to form a longitudinal vein at the level of the ventral edges of the myotomes,

which the author terms the *vena mesenterica*. From this vena mesenterica, further transverse vessels arise running half-way round the yolky gut and uniting on each side in its ventro-lateral region to form another longitudinal vessel, which are termed the *vena omphalo-mesenterica*. In older larvæ (5·5 mm. in length) these two omphalo-mesenteric veins unite to form a single median *sub-intestinal* vein, which loses itself in the liver in front, and behind is continuous with the caudal vein. The venæ mesentericæ open into this sub-intestinal vein in front.

When the larva has attained a length of 7 mm. the yolk begins to disappear rapidly and the gut consequently to shrink in diameter. The vena mesenterica of each side moves in a dorsal direction, and so approaches its fellow. The two become connected by transverse anastomoses and finally fuse into one. This single vein in the region of the duodenum describes a loop and fuses with the sub-intestinal vein. The transverse branches connecting it with the sub-intestinal vein become transformed into a network enwrapping the intestine. Those branches which connected it with the aorta disappear. The hinder end of the sub-intestinal vein now disappears, and finally only a small anterior portion of it remains where it receives the mesenteric vein. The posterior cardinal veins begin as vessels draining the developing pronephros on each side. These gradually extend backwards until they reach and unite with the caudal vein and drain off its blood, and it is this new connexion which leads to the disappearance of the sub-intestinal vein. E. W. M.

The Source of the Cold Air of the North "Polar Front."[1]

By Prof. W. H. HOBBS, University of Michigan.

DENUDED of its liquid envelope, the figure of the earth may be compared to that of a tomato having a flat lump affixed at one side of the depression from which the stem has been removed. Not a close parallel—even a caricature—but I trust a true one, and successful caricatures are full of meaning. It is necessary to place the tomato in such position that the depression represents the deep basin of the Arctic Ocean, the bulging portion which is opposite will then represent the flat ice-dome of the Antarctic continent, and the artificial lump beside the depression the entirely similar though somewhat smaller ice-covered continent of Greenland. Both of these domes rise to elevations of nearly two miles above sea.

No adequate treatment of the atmospheric circulation is possible unless account be taken of this unsymmetrical figure of the earth; though, curiously enough, it has been the rather general custom to discuss the circulation of the atmosphere as though the areas surrounding the two ends of the earth's axis were characterised by exactly similar conditions. The theory of Ferrel, and the newer conception of Bjerknes which seems to have taken its place, alike ignore the contrast which exists between the two polar regions.

Bjerknes, in reviving an older view of von Helmholtz, has assumed that because of exceptionally high irradiation about both poles of the earth there must be formed about them caps of cold air with corresponding areas of high pressure; and that this cold air must pour out in all directions and meet the warmer air from the equatorial regions upon a surface of discontinuity—the "polar front."

Of the existence of a source of cold air within high latitudes, and the families of cyclones associated with it which the Bjerknes, father and son, have made known in a series of brilliant monographs, it is impossible to doubt. The individual characteristics of the cyclones composing a family within which youthful characteristics and notably turbulence are found curiously reversed, the crescendo of vigour which they display in sequence, and the abruptness with which the series comes to an end—these discoveries must be accounted as very important contributions to meteorology.

It is the field to which Bjerknes's keen research has not been directly extended, but within which the chief foundation of his theory has been laid, toward which I now direct attention. Is the north polar region one of high atmospheric pressure from which cold air is poured outwards? Fortunately the data for a satisfactory answer are present, and the decision must be in the negative.

We may perhaps conveniently limit the north polar region by the parallel of 80° N., which will bring within it the entire Arctic Ocean for the sectors facing Europe and eastern North America, and will include upon its margins relatively small portions only of the land masses which in part bound that ocean. So far as explored, and with little doubt throughout, this entire area is deep sea covered with floating ice-cakes, which are continually drifting and which in no case rise more than a few tens of feet above the surface of the sea.

During the years 1894–96 the *Fram* drifted far into this region, and for the entire calendar year 1895, when the ship was nearest the Pole, it zigzagged along the 85th parallel of latitude. The mean daily atmospheric pressure for this year based upon complete data was 761 mm., with very slight seasonal or monthly range of pressure. Mohn, who discussed the meteorological data on the basis of the entire drift,[2] wrote: "The pressure at the North Pole seems to have its maximum—about 764 mm.—in April, and minimum—759 mm.—from June to September. This gives an annual range of only 5 mm." As I have divided the cruise, for the calendar year 1894 during which the *Fram* zigzagged between latitudes 79° and 84° N., the mean annual pressure was 758 mm.; and for the seven months of 1896, which were about equally divided between winter and summer, during which the vessel ranged in position from lat. 85° to 81° N., the corresponding figure was also 758 mm.

These essentially normal figures obtained for the mean annual atmospheric pressure of the north polar region are, moreover, confirmed by the observations made by other explorers within the region or very close to its border, as the following figures will show:

Place.	Latitude.	Explorer.	Mean Annual Pressure.
			mm.
Cape Flora . .	79° 77′	d'Abruzzi	760
,, . .	,,	Fiala	753
,, . .	,,	Jackson	756
Rudolph Island .	81° 13′	Nansen	757
Teplitz Bay . .	81° 47′	Fiala	754
Mosser Bay . .	79° 57′	A. E. Nordenskiöld	757
Advent Bay . .	79° 9′	Wegener and Robitzsch	756
Fort Conger . .	81° 40′	Nares (1875–76)	759
,, . .	,,	Greely (1881–82)	758
,, . .	,,	,, (1882–83)	759
,, . .	,,	Peary (1909–10)	761
Polaris Bay . .	,,	Hall (1871–72)	761
Cape Sheridan .	82° 25′	Peary	759

[1] Paper presented to Section E (Geography) of the British Association at Southampton on August 28.

[2] H. Mohn, The Norwegian North Polar Expedition, 1893–96, Scientific Results, edited by Fridtjof Nansen, vol. 6, London, 1905, Meteorology, p. 572.

There is here a quite monotonous uniformity, and the records for winter and summer months considered separately are similarly uniform, as the range in pressure is throughout very small and quite in harmony with the known characteristics of an expanse of frozen sea.

The one continuously high pressure area of large dimensions to be found within high—though not polar—latitudes of the northern hemisphere, is the continent of Greenland, with the geographical centre distant some nineteen degrees from the North Pole. Greenland is a flat dome of snow-covered ice rising nearly two miles above the sea and, thanks to Peary and a long line of distinguished Danish explorers, of which Lauge Koch is the latest, Greenland is far better known than is its sister ice-dome in the Antarctic. Summer and winter alike it is overlaid by a high pressure area, and the anticyclonic circulation is characterised by powerful pulsations, or *strophs*, which begin gradually, develop centrifugal surface winds in a mighty crescendo of vigour often culminating with hurricane intensity. This outward flow of cold air drops down off the ice-dome and comes to a sudden halt at the culmination of its intensity. With this abrupt termination are associated a sudden rise of temperature and all the other characteristics of falling winds—foehns. As a surface wind this air does not pass out beyond the coast of Greenland, and must in consequence rise in the passing cyclones of which the coast line is the common border with the anticyclone.[3]

The fixed anticyclone of Greenland and the corresponding one over the Antarctic must not be confused with migrating anticyclones, which they resemble only in the direction of rotation and vertical movement, and very little in their quantitative attributes. They are the great drainage shafts for the high level currents as well as reversing positions for the general atmospheric circulation—they are the wind poles of the earth.

Of the "polar front" Bjerknes says:[4] "On the north side of this line all signs indicate air of polar origin; it has a low temperature for the latitude, shows great dryness, distinguishes itself by great visibility. . . ." Now these are not the characteristics of the air over the polar sea, where rain and fog are common, but just those of winds which drop down from a height, and such conditions are nowhere observed in such perfection as on the borders of Greenland. Moreover, the winds of the European sector of the north polar region are not outward toward Europe. They are extremely variable in direction, but winds of southerly component are somewhat more common than those of northerly component.

To bring out clearly the relationships of the strophic outpourings of cold air from the high continent of Greenland to the cyclone families of which J. Bjerknes has furnished so intimate a portrait, it will be necessary to state the salient characteristics of these interesting cyclones.

Each cyclone family is made up of sometimes two but generally four to six cyclones in succession, designated in order A, B, C, and D, with sometimes E and even F; and these cyclones represent a crescendo of vigour. They usually pass eastward during a period of about six days and on paths which diverge from some point near to but west of the coast of north-western Europe. Cyclone A is weak and sluggish in its movement, travels slowly, and generally pursues a course over Norway to the Arctic. It seems to be in a dying condition, and this is interpreted to mean that it has travelled from some region far to the west of Europe. Cyclones B and C, starting from some point west of Europe but relatively near, swing to the right and pursue their way farther south so as to pass over Sweden and Finland. D cyclones either follow this route or steer still farther to the right over Denmark, southern Sweden, and the Baltic; whereas E cyclones, if they are formed, pass either along this latter route or still farther to the southward.[5]

Now with the exception of the first one or two members of a cyclone family, which Bjerknes and Solberg believe to have travelled a long distance, the remaining cyclones of the family are thought by them to have been generated relatively near to but west of north-western Europe.[6] There is, I believe, confirmation of this near origin for all later members of the cyclone family in the fact that such families have not been recognisable in the United States,[7] and there is much reason to believe that those cyclones which are passing Greenland at the times of outpouring of cold air (strophs) within the Greenland glacial anticyclone, are by it rejuvenated and have imparted to them a measure of vigour which is dependent upon the stage to which the stroph has evolved at the time. The crescendo of vigour, the sudden halt, and in a rough way the period covered, are all closely in correspondence between the stroph of the anticyclone and the cyclone family.

Enough has been said, it is believed, to bring out the intimate relationship which appears to exist between the cyclone families of western Europe and the glacial anticyclone of Greenland; also to show that the cyclones C to E of each family are probably rejuvenated as they pass the east coast of Greenland; and that the cold air supply of the "polar front," instead of coming from the north polar regions, is due to outpourings from the strophs of the Greenland anticyclone. If there is a surface of discontinuity between this cold air and the warmer air of equatorial origin, this so-called "polar front" should be known as the *Greenland front*.

The close correspondence in time of the arrival at the Greenland coast of foehn winds from the interior with the passage of strong cyclones along the coast, was long ago observed on the west coast by Rink[8] and on the east coast by Holm[9]; and confirmation has been found in the work of later observers, notably Stade.[10]

To give warning of the coming of dangerous cyclones to the coast of Europe, Bjerknes has recommended that a meteorological station equipped with wireless be established on the southern point of Greenland. A better locality for such a station would be opposite the widest portion of the continent, but this station should be located upon the slopes of the ice-dome at an elevation of at least 3000 feet, since the outstreaming currents

[3] W. H. Hobbs, *Zeitsch. f. Gletscherk.*, vol. 5, 1910, pp. 110-120; Proc. Am. Phil. Soc., vol. 49, 1910, pp. 99-104; "Characteristics of Existing Glaciers" (Macmillan, 1911), chaps. ix., xvi., and especially the Afterword; "The Rôle of the Glacial Anticyclone in the Air Circulation of the Globe," Proc. Am. Phil. Soc., vol. 54, 1915, pp. 185-225, figs. 11; "The Mechanics of the Glacial Anticyclone illustrated by Experiment," NATURE, July 22, 1920; "The Glacial Anticyclones, the Poles of the Atmospheric Circulation," monograph soon to be published in book form by the University of Michigan.

[4] V. Bjerknes, "The Meteorology of the Temperate Zone and the General Atmospheric Circulation," NATURE, vol. 105, June 20, 1920, pp. 522-524.

[5] V. Bjerknes, "The Importance of Wireless Weather Reports from Greenland," *Monthly Weather Review*, Washington, Jan. 1922, pp. 16-19.

[6] J. Bjerknes and H. Solberg, "Life Cycle of Cyclones and the Polar Front Theory of Atmospheric Circulation," *Geofysiker Publikationer*, vol. iii., No. 1, 1922, p. 14.

[7] See A. J. Henry, *Monthly Weather Review*, Sept. 1922, pp. 468-474.

[8] H. Rink, "Grönland," 1860, pp. 111-112.

[9] "Medelelser om Grönland," vol. 9, 1889, pp. 348-408.

[10] E. von Dryjalski, "Grönland-Expedition der Gesellschaft für Erdkunde," 1891–93, Berlin, 1897.

override in large measure the lower strata of air. The tumult of the tempest above is often heard in the fjord as a dull roar, though the surface of the water is not stirred by a ripple.[11] The projected Danish Greenland Expedition of 1926–27, which is to be commanded by Dr. Lauge Koch, will for the first time afford an opportunity to put this suggestion to a practical test, for his base is to be located on Scoresby Sound. On the border of the Antarctic ice-dome, Sir Douglas Mawson, equipped with wireless, was able in 1911–14 to show that the outrushes of cold air preceded by about forty-eight hours the arrival of strong cyclonic disturbances at the Australian south coast.[12] Some such prevision for north-western Europe should be possible from a station on the Greenland dome, or on high land outside reached by the strong slope winds.

[11] Cf Rink, *op. cit.*
[12] D. Mawson, *Geogr. Journ.*, vol. 44, 1914, pp. 257-286.

Transport Problems.

AT the Southampton meeting of the British Association, Section F (Economic Science and Statistics) joined with Section G (Engineering) for the discussion of transport problems. A two-days' joint meeting was held concurrently with the separate meetings of the respective sections.

On the first day the representatives of the engineers discussed the more technical aspects of the road problem. Col. H. T. Tudsbery, of the Ministry of Transport, read a paper on "The Economics of Highway Engineering," in which he dealt with traffic matters and the construction, maintenance and design of roads. Stressing the cost involved in traffic delays, he computed that one-third of a lorry's time in the London dock area is consumed by traffic delays.

Mr. Philip Johnson, speaking of the "Roadless Vehicle," indicated the great scope available to such vehicles in undeveloped countries where railways or roads would be too expensive to build. He suggested that in much less time than it has taken to develop road vehicles to the present stage, roadless vehicles will show a similar development. He believed that there can be little question about the demand for them, since that portion of the world which is well equipped with roads is an insignificant fraction of the areas where no efficient transport facilities exist at all.

The third paper, by Mr. W. Maughan, dealt with the classification of roads. He described some early road censuses of traffic that he had undertaken, and stressed the importance of accuracy in that work.

On the second day three papers were read by members of the Economic Section. Mr. Tetley Stephenson discussed the "Present Position of British Railways." Somewhat pessimistic in tone, he emphasised the effects of the competition of road transport. He alleged that in practice the road haulier had a subsidy, since part of the cost of road repair was borne by the local taxpayer. He advocated relief from such local taxation imposed on the railways. He referred also to the fact that the British trader demands a very high quality of service, expecting rapid delivery and no waiting for full loads—factors, of course, that tend to increase cost. The trader also demands and obtains a long period of free demurrage—an expensive form of warehousing to the railways. Emphasising the necessity of operating economies, Mr. Stephenson stated that, as the labour bill accounts for 65 per cent. of the expenses, economies must inevitably involve a material reduction in this item.

A paper on the "Economics of the Modern Port," by Mr. Alfred Schofield, outlined the development of the modern port. Two of the factors, he said, which determine the economic importance of a port are the hinterland which it serves and the nature of the shipping that is cleared at it. A large port cannot, however, live on passenger traffic alone. Trade in Great Britain tends to concentrate in five or six leading ports, and the future lies with the large port.

The third paper was read by Mr. K. G. Fenelon, who took as his subject "The Development and Economic Significance of Road Transport." In the first part of his paper, which was mainly statistical, he illustrated and analysed the growth in the number of motor vehicles in Britain, from some 854,000 in May 1921 to some 1,420,000 in May 1925. In about the same period the increase in the U.S.A. was from some 9,200,000 to some 17¾ million. The reasons for this great development are to be found in the economic advantages of road transport. Road transport is flexible, door-to-door services can be provided, and but a small capital outlay is required to purchase a vehicle. On the question of the economic significance of motor transport, Mr. Fenelon showed that it is opening up the country to an extent never before achieved, and that this has important bearings on social and industrial developments. Road transport is playing an important part in relation to agriculture and rural life, to housing and health, and to the further development of industrial technique.

University and Educational Intelligence.

NEWCASTLE.—Prof. H. V. A. Briscoe has been appointed director of the chemistry department of Armstrong College, Newcastle-upon-Tyne, in succession to Prof. W. N. Haworth, now professor of chemistry in the University of Birmingham. Prof. Briscoe has been for several years professor of inorganic and physical chemistry in Armstrong College. Dr. G. R. Clemo has been appointed professor of organic chemistry. He has recently been in charge of the research department of the British Dyestuffs Corporation at their laboratories at Manchester.

LAND-GRANT COLLEGE EDUCATION, 1910 to 1920, forms the subject of a series of studies which are being published by the United States Bureau of Education. The institutions known as Land-Grant Colleges were founded under the Morrill Act of 1862 and subsequent acts which provided for their endowment by grants of land by the Federal Government to the States, the primary object of the endowment being to ensure the teaching of "such branches of learning as are related to agriculture and the mechanic arts, in . . . order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life." They include 26 State universities, 17 institutions for coloured persons, and 26 other land-grant colleges. They are educating approximately one-third of all college or university students in the United States and three-fourths of all those trained at publicly controlled colleges and universities. Their total enrolments during the ten years 1910–1920 increased by 78 per cent.: the number of their women students doubled during the same period. It is obvious that they must have already exerted important influences on national development, and the importance of their functions ever tends to increase as the necessity for husbanding the natural resources of the country becomes more urgent. At the present rate of increase of the population, the United States will within about twenty years become a food-importing nation unless extraordinary efforts are made to increase production upon the present acreage.

Early Science at Oxford.

October 6, 1685. The Minutes of July 28th, 1685, being first read, the Secretary in ye name of Dr. Peirce of Bath presented ye Society with ye *shell* found by ye Doctor in ye kidney of a woman, and described in the *Philosophical Transactions*, No. 171, which very curious present was ordered to be reposited in the Musæum Ashmolianum.

A letter from Dr. Middleton dated August 8, 1685 was read, it brought us a letter from Dr. Garden to Dr. Middleton concerning two monstrous Children lately born at Aberdeen; concerning the Sucker or Proboscis of ye Bee, and the Instruments, by which they break ye globulets, (or little bags of liquors) taken from the flowers, and prepare their wax: and also concerning ye circulation of ye blood, easily seen in ye Lacerta Aquatica by reason of its transparentnesse.

A letter from Mr. Ja: Aston to Dr. Bathurst, dated Whitelackenden Oct: 1 1677, was communicated us from the Doctor. It gave an account of three Persons (one Man and two Women) in ye house of Mr. Speke of Whitelackenden taken with fitts, which came and went off in all and every one of them, though in distant places, at ye same time, and with the same symptomes; insomuch that if one laught, sung, curst, or ye like, the rest did so also.

Mr. President presented a booke, ye author Richard Norris, it treated of his manner of finding ye true sum of ye infinite of an arch, by an infinite series.

Proposals for printing Mr. Ray's History of Plants, together with a pattern of it, were presented.

October 7, 1684. Mr. Anderton, haveing formerly been admitted, acquainted ye Society, that a *spout* of rain fell between Farnborough, and Brittleton, in Barkshire, ye 3rd of May last; that ye fall of ye water was so violent, as to beat its way into a house on the top of a hill.

He says farther, that a woman near him in ye country, did, at 60 years of age, give suck to a little child; tho she herself had no child, nor given suck, for many years before.

Dr. Plot communicated an account of ye weather here at Oxon:, in September last; He presented us with some of ye East Indian Bange, which is ye leaf of a tree taken commonly by ye inhabitants at their feasts; it is said to intoxicate, and put every man in his particular humor.

He also communicated an abstract of a letter, sent him by Mr. Todd, dated September ye 7th, from Rose Castle in Cumberland, concerning a salt spring, and another (Minerall) spring near Durham; as also concerning some Roman Urns which he promises to send us. Mr. Todd says in this letter, that as he traveild over Stane-Moor in Yorkshire, he observ'd ye River Greatah (which is about half as big as the Charwell) run underground for about a mile, so that he, and his company, past over it drye foot. The passage under ground is but narrow; so that in winter, when the streams are high, it keeps ye channell above ground.

October 13, 1685. A discourse entituled *Logica rerum* composed by Mr. Foley, Member of ye Dublin Society, and by him dedicated to ye Royall Society, was presented and read, and ye thankes of this Society ordered for it.

The Figures of some antiquities cheifly Roman, communicated by a Member of ye Royal Society were communicated.

A farther account of ye Aqueduct about Versaille was read; as also was a letter of Dr. Lister's to Mr. Ray concerning some addenda to the *Ornithology*.

ERRATUM.—In this column of September 12, p. 415, line 12 from bottom, for *erythmiformis* read *crythmiformis*.

Societies and Academies.

PARIS.

Academy of Sciences, August 10.—The president announced the death of Hugo Hildebrand Hildebrandsson, correspondent for the section of geography and navigation.—André **Blondel**. The determination of the coefficient of hysteresis by means of apparatus with a rotating magnet.—Amé **Pictet**, Werner **Scherrer**, and Louis **Helfer**: The presence of argon in living cells. The presence of argon in yeast and in sheep's brain has been proved: further experiments are in progress to determine the origin of this gas.—C. **Gutton** and E. **Pierret**: The perturbations at the extremities of a line which is the seat of stationary electromagnetic waves. From a study of the harmonics the perturbation at the extremities of a line can be determined, and a curve or a table constructed giving the value of the perturbation for different wavelengths.—A. **Grumbach** and S. **Schlivitch**: The variation of the surface tension of liquids under the influence of radiation. The ordinary method based on the rise of a liquid in a capillary tube is not sufficiently sensitive to show the effect of radiation. A new method is based on the fact that if a drop of liquid is introduced into a horizontal capillary tube, and the surface tension of one meniscus is altered, the drop will move in the direction where the surface tension is greatest. In the experiments described one meniscus was exposed to the light of a mercury lamp; water, alcohol, and xylene were not displaced, but motion was observed with several liquids, including ordinary petroleum, aqueous or alcoholic solutions of fluorescein.—H. **André**: Conductibility by metallic colloids and its electro-technical applications.—W. **Kopaczewski**: Turgoelectricity.—J. **Bougault**: An example of ether-oxide ketone hydrate. The benzylphenylethylsuccinic acids.—Louis **Glangeaud**: The existence of the Aptian in the coast region of the province of Algiers and on its tectonic signification.—V. **Agafonoff** and Mlle. **Malichef**: The brick earth and ergeron of the plateau of Villejuif.—Mlle. Aimée **Camus**: Hitchcockella, a new genus of Madagascan bamboo.—Charles **Kayser**, Mlle. Eliane **Le Breton**, and Georges **Schaeffer**: Magnitude of the respiration of the tissues and active mass in the course of the development of organisms. The elementary respiration of homologous tissues of different individuals of the same species is greater the younger the organisms.—J. G. **Szuman**: The structure of the membrane separating the white and the yolk of the egg. P. **Petit**: The liquefaction of starch paste. G. **Guittonneau**: The transformation of sulphur into sulphate by microbial association. The conversion of sulphur into sulphates is the work of two distinct races of organisms: one converts the sulphur into thiosulphate, the other thiosulphate into sulphate.

August 17.—H. **Deslandres**: Complementary researches on the structure and distribution of band spectra.—Mlle. Sylvie **Creanga**: New properties of curves of constant normal curvature; their rôle in the representation of surfaces on parallel surfaces. Applications.—Ragnar **Frisch**: The semi-invariants of Thiele.—André **Bloch**: The non-uniformisability by meromorph functions of the most general algebraic varieties. N. **Lusin**: The problem of Emile Borel and the method of resolvants.—A. **Dauvillier**: Researches on the Crookes tube.—Y. **Rocard**: The diffusion of light and ratio of the absolute retardations in Kerr's phenomenon.—R. **Fosse** and A. **Hieulle**: The identification of glyoxylic acid by the action of hydrazine and xanthydrol, with

production of the dixanthylhydrazone of glyoxylic acid. The new substance is a definite crystallised compound, $[O(C_6H_4)_2.CH]_2=N-N=CH.CO_2H$, and serves to detect 1·0 mgr. to 0·1 mgr. of glyoxylic acid in dilutions of 1 in 100,000.—William Herbert **Hobbs**: The asymmetry of the atmospheric circulation.—E. **Rothé**, J. **Lacoste**, and Mme. A. **Hée**: Earthquakes in France in 1924. A description of 24 earthquakes, mostly in the neighbourhood of the Pyrenees.

SYDNEY.

Linnean Society of New South Wales, July 29.—H. J. **Carter**: Revision of the Australian species of Chrysobothris (Buprestidae), together with notes and descriptions of new species of Coleoptera. Nineteen species are described as new, including five Buprestidae, two Lucanidae, ten Tenebrionidae, and two Cistelidae. Keys are given for identification of species of Nyctozoilus and Seirotrana.—E. **Cheel**: Two new species of Callistemon, with notes on certain other species. One of the new species is nearest to *C. lanceolatus* and has been obtained from a number of localities in New South Wales and also in Gippsland; the type is from Nattai River. The other is from North Queensland and shows some resemblance to *C. linearifolius* and *C. rigidus*, but is distinguished by the less prominently veined leaves, paler filaments, and differently shaped fruits.—G. H. **Cunningham**: Gasteromycetes of Australasia. ii. A revision of the genus Tulostoma. The characters of generic and specific value are described; three species and one variety are described as new.

VIENNA.

Academy of Sciences, July 9.—J. **Pollak** and E. **Gebauer-Fülnegg**: On the action of chlorosulphonic acid on phenols.—E. **Riess**: On derivatives of the three cresols and of phenol. Disulpho-chlorides, sulphonylides, and neutral sulphuric ester are formed.—O. **Tomaschek**: On Exner's polarimeter and a way of applying this instrument.—F. E. **Suess**: Report on a geological excursion to Hauzenberg in the Bavarian forest: a contribution to the tectonic of granite.—E. **Müller**: Mid-point surfaces and a relative theory of surfaces.—K. **Fritsch**: Contributions to our knowledge of Gesneriaceae, the species of the genus Napeanthus.—O. **Dischendorfer**: Researches in the domain of vegetable chemistry. On the amyrin of elemi resin.—E. A. W. **Schmidt**: Communication of the Radium Institute, No. 178. Action of α-rays on aluminium. Radium C and polonium were used as sources of α-rays and the effect on H-particles explored.—M. **Blau**: Radium Institute, No. 179. On the photographic action of H-rays from paraffin.—G. **Kirsch** and H. **Pettersson**: Radium Institute, No. 180. On the reflection of α-particles at atomic nuclei. Reporting on experimental results of the retrograde method, it seems that for internal collisions between α-particles and atomic nuclei the energy and impulse law is not valid if only the α-particle and the nucleus are considered. Atom shattering with surrender of protons seems an attainable process for all elements by bombardment with α-rays. Various money grants are reported, including those to A. **Ginzberger** for publications on the change of species on islands, to F. **Lieben** for researches on the relations between the kreotin-kreotinin transformation and the sugar transformation, and to R. E. **Mark** for researches on the action of insulin on the linkage of sugar and phosphoric acid in the animal organism.

Official Publications Received.

University of Manchester: Faculty of Technology. Prospectus of University Courses in the Municipal College of Technology, Manchester, Session 1925-26. Pp. 283. (Manchester.)

Agricultural Research Institute, Pusa. Bulletin No. 156: Bud and Boll-Shedding in Cotton; a Preliminary Enquiry. By G. R. Hilson, V. Ramanatha Ayyar and R. Chokkalingam Pillai. Pp. 34+8 plates. 14 annas; 1s. 6d. Bulletin No. 157: The Experimental Sullage Farm, Lyallpur. By Dr. P. E. Lander. Pp. 25. 12 annas; 1s. 3d. Bulletin No. 158: A new Fodder (Siloed *Shisham* Leaves) for Dairy Cows. By Dr. P. E. Lander and Pandit Lal Chand Dharmani. Pp. 11. 6 annas; 8d. Bulletin No. 159: Preliminary Investigations in the Bacteriology of Milk. By J. H. Walton. Pp. 14+2 plates. 6 annas; 8d. (Calcutta: Government of India Central Publication Branch.)

Colony of the Gambia. The Annual Report of the Department of Agriculture for the Year 1924. Pp. 44+2 charts. (London: The Crown Agents for the Colonies.) 5s.

Anales del Museo Nacional de Historia Natural Bernardino Rivadavia, Buenos Aires. Tomo 32. Pp. xxiv+526+8 láminas. (Buenos Aires.)

Fifteenth Report on the Sarawak Museum, 1924. By E. Banks. Pp. ii+33. (Kuching, Sarawak.)

Zoologica: Scientific Contributions of the New York Zoological Society. Vol. 4, No. 3: The Galapagos Tortoises in their Relation to the Whaling Industry. By Charles Haskins Townsend. Pp. 55-135. (New York.)

Department of the Interior: Bureau of Education. Bulletin, 1925, No. 12: Statistics of State Universities and State Colleges for Year ending June 30, 1924. Pp. ii+23. (Washington: Government Printing Office.) 5 cents.

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 508: Spark Photography and its Application to some Problems in Ballistics. By Philip P. Quayle. Pp. 237-276. (Washington: Government Printing Office.) 20 cents.

U.S. Department of Agriculture. Farmers' Bulletin No. 1456: Homes for Birds. By E. R. Kalmbach and W. L. McAtee. Pp. ii+22. (Washington: Government Printing Office.) 5 cents.

East Anglian Institute of Agriculture, Chelmsford (Essex Agricultural Committee). Calendar, 1925-26. Pp. 120. (Chelmsford.)

The Journal of the Royal Anthropological Institute of Great Britain and Ireland. Vol. 55, January to June, 1925. Pp. 198+22 plates. (London: Royal Anthropological Institute.) 15s. net.

County Borough of West Bromwich. Technical School Prospectus, Session 1925-6. Pp. 50. (West Bromwich.) 2d.

Transactions of the Leicester Literary and Philosophical Society, together with the Council's Report and the Reports of the Sections, 1924-25. Vol. 26. Pp. 97. (Leicester.)

Bergens Museums Aarbok, 1923-1924. 2 Hefte. Naturvidenskabelig Række. Pp. 39+57+8+33+4+32. (Bergen.)

Bergens Museums Skrifter: Ny Række. Bind 3, No. 2: Beitrag zur Kenntnis einiger hermaphroditischen dekapoden Crustaceen. Von Sven Runnström. (Mitteilung Nr. 61 der biologischen Station des Museums zu Bergen.) Pp. 115+5 Tafeln. (Bergen.)

Transactions of the Institution of Chemical Engineers. Vol. 2, 1924. Pp. 110. (London: Abbey House, Westminster.)

The National University of Ireland. Calendar for the Year 1925. Pp. viii+324+396+136. (Dublin.)

Hull Museum Publications. No. 140: Numismatic Notes. Edited by Thomas Sheppard. Pp. 29. (Hull.)

Transactions of the Yorkshire Numismatic Society. Vol. 2, Part 5. Edited by Thomas Sheppard. Pp. 169-224. (Manchester: Sherratt and Hughes.) 5s.

Transactions of the Hull Geological Society. Vol. 6, Part 5, 1922-1925. Edited by T. Sheppard. Pp. 259-296+xii. (Manchester: Sherratt and Hughes.) 5s.

Memoirs of the Department of Agriculture in India. Chemical Series, Vol. 7, No. 7: The Phosphatic Nodules of Trichinopoly and the Availability of Flour Phosphate as a Manure for Paddy. By Rao Sahib M.R. Ramaswami Sivan. Pp. vi+145-200+3 plates. 1.4 rupees; 2s. Bacteriological Series, Vol. 2, No. 1: Nitrogen Fixation in the Punjab. By Dr. P. E. Lander and Barkat Ali. Pp. 28. 8 annas; 10d. Entomological Series, Vol. 8, Nos. 10 and 11. No. 10: Papers on Indian Tabanidæ. iv: The Head and Mouth-Parts of the Larva of *Tabanus rubidus*, Wied. (=*Albimedius*, Wlk.). v: The Mechanism of Suction in the Larva of *Tabanus tetens*, Wlk. vi: The Male and Female Genitalia of *Tabanus tetens*, Wlk. vii: Notes on the Life-History of *Tabanus striatus*, Fabr. (=*Hilaris*, Wlk.). By P. V. Isaac. No. 11: Some Indian Species of the Dipterous genus *Atherigona*, Rondani. By J. R. Malloch. Pp. 93-126+plates 11-18. 1.8 rupees; 2s. Entomological Series, Vol. 8, No. 12: The *Nim* Mealy Scale (*Pulvinaria maxima*, Green). By T. V. Ramakrishna Ayyar. Pp. 127-155+plates 19-23. 1.4 rupees; 2s. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co.)

Ceylon Journal of Science. Section B: Zoology and Geology. Spolia Zeylanica. Edited by Dr. Joseph Pearson. Vol. 13, Part 2, July 31st. Pp. 143-260. (Colombo: Colombo Museum; London: Dulau and Co. Ltd.) 3 rupees.

Catalogue of Indian Insects. Part 6: Staphylinidæ. By Malcolm Cameron. Pp. iii+126. 1.14 rupees; 3s. 3d. Part 9: Zygænidæ. By T. Bainbridge Fletcher. Pp. ii+92. 1.5 rupees; 2s. 3d. (Calcutta: Government of India Central Publication Branch.)

Aeronautical Research Committee. Reports and Memoranda, No. 947 (Ae. 167): The Interference of Wind Channel Walls on the Downwash Angle and the Tailsetting to Trim. By H. Glauert and A. S. Hartshorn. (A.3.k. Misc. Model Experiments, 48—T. 1991.) Pp. 9+4 plates. (London: H.M. Stationery Office.) 6d. net.

The Royal Society of Medicine. Calendar 1925-1926. Pp. 74. (London: 1 Wimpole Street.)

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 49 (Botanical Section): Mycological Work in Egypt during the Period 1920-1922. By H. R. Briton-Jones. Pp. viii+129+10 plates. (Cairo: Government Publications Office.) 5 P.T.

Apia Observatory, Apia, Samoa. Upper Air Observations, 1923–1924. By Andrew Thomson. Pp. 31. (Apia.)

Cawthron Lectures, Vol. 2. No. 1: The Geology of Nelson, by Dr. P. Marshall; No. 2: The Coming of the Maori, by Te Rangi Hiroa. Pp. 56+19 plates. (Nelson, N.Z.: Cawthron Institute.)

Smithsonian Institution: United States National Museum. Bulletin 129: The Spider Crabs of America. By Mary J. Rathbun. Pp. xx+613 +283 plates. (Washington: Government Printing Office.) 2 dollars.

Smithsonian Miscellaneous Collections. Vol. 77, No. 4: An Introduction to the Morphology and Classification of the Foraminifera. By Joseph A. Cushman. (Publication 2824.) Pp. 77+16 plates. (Washington: Smithsonian Institution.)

Catalogue of the Ceramic Library, Central School of Science and Technology, Stoke-on-Trent; including the Solon Library, the Ceramic Society's Library, and the Library of the Pottery Department of the School. Pp. iv+228. (Stoke-on-Trent.)

Annual Report of the Meteorological Observatory of the Government-General of Chosen for the Year 1921. Pp. iv+4+143. (Zinsen.)

The Calendar of the London School of Economics and Political Science (University of London) for the Thirty-first Session, 1925–26. Pp. 293+ xxv. (London: Houghton Street, Aldwych.) 3s. 6d.

Aeronautical Research Committee. Reports and Memoranda, No. 932 (Ae. 153): Experiments on a Model of a Bristol Fighter Aeroplane (1/10th scale). Section 1: Force and Moment Measurements at various Angles of Yaw. By H. B. Irving and A. S. Batson. Section 2: Lateral Derivatives by the Forced Oscillation Method. By R. A. Fraser, A. S. Batson and A. C. Gadd. (A.3.g. Complete Models, 53—T. 1930.) Pp. 40+14 plates. 2s. net. Reports and Memoranda, No. 959 (M. 28): A Method of Improving the Properties of Aluminium Alloy Castings. By S. L. Archbutt. Pp. 10+4 plates. 1s. net. (London: H.M. Stationery Office.)

Cornell University: Agricultural Experiment Station. Bulletin 427: Farm Motor Trucks in New York. By V. B. Hart. Pp. 56. Bulletin 428: The Clover-Seed Caterpillar. By Lawrence Paul Wehrle. Pp. 34. Bulletin 430: An Economic Study of Rural Store Credit in New York. By Leland Spencer. Pp. 47. Bulletin 431: The Cost of Living in a small Factory Town. By Clarence Vernon Noble. Pp. 70. Bulletin 432: An Economic Study of Dairying on 163 Farms in Herkimer County, New York. By E. G. Misner. Pp. 59. Bulletin 433: Economic Studies of Dairy Farming in New York. 2: Grade A Milk with and without Cash Crops. By E. G. Misner. Pp. 147. Bulletin 434: Experiments in Crop Rotation and Fertilization. By R. G. Wiggans. Pp. 56. Bulletin 435: The Organization and Development of Co-operative Fire Insurance Companies in New York. By R. W. Bartlett. Pp. 36. Bulletin 436: Results of Experiments with Oats in New York. By H. H. Love and W. T. Craig. Pp. 24. Bulletin 437: Feeding Work Horses. By M. W. Harper. Pp. 59. Bulletin 438: Economic Studies of Dairy Farming. 3: Grade B Milk with Alfalfa Roughage. By E. G. Misner. Pp. 104. (Ithaca, N.Y.)

Cornell University: Agricultural Experiment Station. Memoir 76: Effect of the Process of Manufacture on the Germ Content of Bulk Condensed Milk. By Harrison A. Ruehe. Pp. 18. Memoir 77: A Systematic Study of the Anthomyiinae of New York, with Special Reference to the Male and Female Genitalia. By H. C. Huckett. Pp. 91. Memoir 78: A Study of the Leaf-Mining Diptera of North America. By S. W. Frost. Pp. 228. Memoir 79: A Biological Study of *Aphelinus mali* Hald., a Parasite of the Woolly Apple Aphid, *Eriosoma lanigera* Hausm. By Arnold E. Lundie. Pp. 27. Memoir 80: The Ciccadellidae of the Vicinity of Ithaca, New York, with Special Reference to the Structure of the Gonapophyses. By John L. Buys. Pp. 115. Memoir 81: Some Effects of Freezing on Mature Fruits of the Apple. By D. B. Carrick. Pp. 54. Memoir 82: Inheritance of Xantha Seedlings in Maize. By Helen Trajkovich. Pp. 13. Memoir 83: The Inheritance of Brown Aleurone in Maize. By Paul Kvakan. Pp. 22. Memoir 84: Genetic Relations of Five Factor Pairs for Virescent Seedlings in Maize. By M. Demerec. Pp. 38. Memoir 85: Wire Stem of Cabbage. By Levi Otto Gratz. Pp. 60+7 plates. Memoir 86: A Study of the Dietary Relationships and the Pathology of "Stiffness" in Swine. By L. A. Maynard, S. A. Goldberg and R. C. Miller. Pp. 34. Memoir 87: Studies in the Transplanting of Vegetable Plants. By W. E. Loomis. Pp. 63. Memoir 88: The Take-All Disease of Cereals and Grasses caused by *Ophiobolus cariceti* (Berkeley and Broome) Saccarado. By Robert S. Kirby. Pp. 45. Memoir 89: The Gray Bulb-rot of Tulips caused by *Rhizoctonia tuliparum* (Klebh.) N. Comb. By H. H. Whetzel and John M. Arthur. Pp. 18. Memoir 90: The Production of Volatile Fatty Acids in the Intestinal Tract of Calves fed Whole Milk or Cereal Gruel. By Leo Chandler Norris. Pp. 32. (Ithaca, N.Y.)

Bulletin of the Experiment Station of the Hawaiian Sugar Planters' Association. Agricultural and Chemical Series, Bulletin No. 49: The Influence of Aluminium, Manganese and Iron Salts upon the Growth of Sugar Cane, and their Relation to the Infertility of Acid Island Soils. By W. T. McGeorge. Pp. v+95. (Honolulu, Hawaii.)

Birkbeck College (University of London) The Calendar for the Year 1925–26 (103rd Session). Pp. 16+204. (London.)

Department of Scientific and Industrial Research. Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for the Year 1924; with Report of the Geological Survey Board and Report of the Director. Pp. iv+154. (London: H.M. Stationery Office.) 2s. 6d. net.

Forest Bulletin No. 62 (Silviculture Series): Preliminary Yield Table for *Dalbergia Sissoo*. By S. H. Howard. Pp. 6. (Calcutta: Government of India Central Publication Branch.) 2 annas; 3d.

Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia. Verhandelingen No. 15: Uitbreiding van regenbuien te Batavia (Extension of Rainshowers at Batavia). Door Dr. J. Boerema. Pp. ii+54. (Weltevreden: Albrecht and Co.)

Conseil Permanent International pour l'Exploration de la Mer. Bulletin Hydrographique pour l'année 1924. Pp. 54. (Copenhague: Andr. Fred. Høst et fils.)

Memoirs of the Indian Museum. Vol. 8, No. 3: Anatomy of the common Indian Apple-Snail, *Pila globosa*. By Dr. B. Prashad. Pp. 91-154+plates 16-18. (Calcutta: Zoological Survey of India.) 3.8 rupees.

Lunacy and Mental Deficiency. The Eleventh Annual Report of the Board of Control for the Year 1924. Pp. iv+454. (London: H.M. Stationery Office.) 12s. 6d. net.

Diary of Societies.

SATURDAY, OCTOBER 3.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Joint Meeting of the North-Western and Yorkshire Districts) (at Todmorden), at 2.30.—R. H. Mattocks, R. Bruce, and others: Discussion on Regional Town Planning.

SMOKE ABATEMENT LEAGUE OF GREAT BRITAIN (at Buxton).—Conference on Smoke Abatement.

SUNDAY, OCTOBER 4.

SMOKE ABATEMENT LEAGUE OF GREAT BRITAIN (at Buxton).—Conference on Smoke Abatement.

MONDAY, OCTOBER 5.

SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—Major V. A. M. Robertson: Bridges: their Renewal in England and France during the Great War.

JUNIOR INSTITUTION OF ENGINEERS (North-Western Section) (at 16 St. Mary's Parsonage, Manchester), at 7.30.—J. D. Porteous: Responsibility.

SMOKE ABATEMENT LEAGUE OF GREAT BRITAIN (at Buxton).—Conference on Smoke Abatement.

TUESDAY, OCTOBER 6.

ROYAL SOCIETY OF MEDICINE (Orthopædics Section), at 5.30.—A. S. Blundell Bankart: The Physiology of Muscular Action (Presidential Address).

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at Caxton Hall, Westminster), at 7.—E. Ower: Practical Measurement of Air Flow.

INSTITUTE OF METALS (Birmingham Local Section) (at Chamber of Commerce), at 7.—Dr. F. Johnson: Some Phases of Life in India.

ROYAL PHOTOGRAPHIC SOCIETY, at 7.—J. D. Johnston: In Search of the Picturesque (Lecture).

INSTITUTE OF METALS (North-East Coast Local Section) (at Armstrong College, Newcastle-on-Tyne), at 7.30.—H. J. Young: Chairman's Address.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Automobile Club), at 8.—K. Thomas: The Automobile Engineer (Presidential Address).

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Dr. G. Róheim: Hungarian Calendar Customs.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (Glasgow).

LIVERPOOL PSYCHOLOGICAL SOCIETY (at Liverpool University).—G. C. Field: Inaugural Presidential Address.

WEDNESDAY, OCTOBER 7.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—Investigations into the Analytical Chemistry of Tantalum, Niobium, and their Mineral Associates.—A. R. Powell and Dr. W. R. Schoeller: III.—A New Method for the Separation of Tantalum from Niobium; IV.—The Detection and Determination of Tantalum in Niobium Compounds.—Dr. H. B. Dunnicliff: The Determination of Sulphates in Guncotton.—C. O. Harvey: The Reduction of Chloric Acid and Chlorates by Ferrous Sulphate.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

THURSDAY, OCTOBER 8.

INSTITUTE OF METALS (London Local Section) (at Institute of Marine Engineers, 85-88 The Minories), at 7.30.—Dr. J. L. Haughton: Chairman's Address.

OIL AND COLOUR CHEMISTS' ASSOCIATION (at 8 St. Martin's Place, W.C.2), at 8.—Dr. H. H. Morgan: The Need for Research in the Oil and Colour Industry.

FRIDAY, OCTOBER 9.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—Technical Questions and Discussions.

INSTITUTE OF METALS (Sheffield Local Section) (at Sheffield University), at 7.30.—F. Mason: Some Notes upon the Value of the Institute of Metals to the Local Industries (Chairman's Address).

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (at Royal Society of Arts), at 8.—Dr. W. E. Gibbs: Aerosols in Industry.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—G. Glegg, G. H. Pooley, H. Lee, and — Goulden: Discussion on Penetrating Injuries of the Eye.

DIESEL ENGINE USERS' ASSOCIATION (at Caxton Hall, Westminster).—E. M. Bailey: The Scottish Shale Oil Industry.

PUBLIC LECTURES.

WEDNESDAY, OCTOBER 7.

UNIVERSITY COLLEGE, at 5.30.—Prof. F. Weigert: The Photochemistry of Vision.—At 7.—A. H. Barker: The Heating Equipment of a Large Hospital.

THURSDAY, OCTOBER 8.

UNIVERSITY COLLEGE, at 2.30.—Sir Flinders Petrie: The Making of Egypt.—At 5.15.—Dr. T. G. Pinches: Recent Discoveries in Babylonia. (Succeeding Lectures on October 15 and 22.)

KING'S COLLEGE, at 5.—Dr. C. Da Fano: The Histology of Nerve Tissues and Paths of Conduction in the Central Nervous System. (Succeeding Lectures on October 15, 22, 29; November 5, 12, 19, 26; and December 3 and 10.)—At 5.30.—S. Smith: The Seals of Western Asia.

FRIDAY, OCTOBER 9.

BEDFORD COLLEGE FOR WOMEN, at 5.15.—Miss Hosgood: Caribbean Countries: some special Geographical Problems.

SATURDAY, OCTOBER 10.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: The Earliest Egyptians and their Remains.