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The Proscription of Darwinism.

ON March 23 the Governor of Tennessee signed a Bill which enacts that "it shall be unlawful for any teacher in any of the universities, normal schools, and all other public schools of the State which are supported in whole or in part by the school funds of the State to teach any theory that denies the story of the Divine Creation of man as taught in the Bible, and to teach instead that man is descended from a lower order of animals." This Act marks another important advance in the outlawry of Darwinism in American education. Tennessee is one of the most enlightened of the Southern States, but it has followed the example of five others. The last previous action, as stated in Prof. J. W. Gregory's "Menace of Colour," 1925, p. 74, was the unanimous decision last July of the State Education Committee of Georgia to refuse grants to any school or university which teaches the doctrine of evolution. The Legislature of Florida had earlier decreed, also unanimously, that it is "contrary to the public welfare for teachers paid by taxation to teach as a fact any hypothesis that links man in blood relationship with any lower form of life." A Bill with the same purpose was defeated in Kentucky by one vote only. Text-books of biology have been debarred from schools in North Carolina because they asserted a relationship between man and monkeys.

This proscription of Darwinism is the result of two main impulses—one religious, the other racial. The religious impulse is the more publicly expressed, and is doubtless the more influential. The Fundamentalists in the United States are as powerful as the Evangelicals were in England seventy years ago. The conclusions of "The Origin of Species" were denounced by Bishop Samuel Wilberforce to the British Association at Oxford in 1860; and his argument that they are inconsistent with Genesis had to be taken seriously. The support to that position had become negligible in England fifty years ago; but its survival in the United States is shown by the writings of Mr. W. J. Bryan, who has been thrice candidate for the Presidency, and was State Secretary in Wilson's cabinet. His theological books, including his "The Menace of Darwinism, and the Bible and its Enemies" (1921), "In His Image" (1922), and "Shall Christianity remain Christian?" (1924), are written in the frame of mind of Wilberforce; and as the Bishop repudiated an ape as his ancestor, Bryan represents Darwinism as adding insult to injury by insistence that man has descended, not from an American, but

from an African monkey. Bryan regards the Modernists as descending from Christianity to Atheism by successive adoption of seven grievous errors—"The Bible not infallible; Man not made in God's image; no miracles; no Virgin Birth; no Deity; no Atonement; no Resurrection." The multitude of those who make this descent is attributed to Darwinism. "The principal objection to Evolution," says Bryan, "is that it is highly harmful to those who accept it, and attempt to conform their thought to it. Evolution does not ruin all who accept it, neither does smallpox kill all who take it. In fact only five per cent. of those who take smallpox die of it. The spiritual mortality among evolutionists is greater than that." Bryan is probably right in his view that Darwinism has been the most effective factor in undermining belief in the literal inspiration of the Bible. Hence it is charged with being the main cause of the asserted decline in American morals and ethics. "Darwinism," says Bryan, "chills the spiritual nature and quenches the fires of religious enthusiasm." Fairhurst, in his "Atheism in our Universities," complains that their influence is ruinous; he declares that most of the students drink, half of them gamble, and only a tithe of them are interested in religion. A census is claimed to show that eighty-five per cent. of the students enter the Universities as Christians; the number of sceptics is doubled in the first year and trebled by graduation. Some Fundamentalists describe American society as "brought to the verge of ruin by a godless philosophy," which is based on evolution. Hence Bryan declares "Evolution is the Menace of Civilisation. It is the greatest menace to civilisation as well as to religion. Belief in God is the fundamental fact in society; upon it rests all the controlling influences of life. Anything that weakens man's faith in God imperils the future of the race."

Bryan's attempt to refute Darwinism is futile. It is, he says, "not science at all; it is guesses strung together." In support of its unscientific character he quotes "Dr. Etheridge, Fossiologist of the British Museum," and misrepresents modern authorities such as Bateson. The main charge against it is that it is "not only groundless but absurd and harmful to society," as it rests on the brute doctrine of survival of the fittest, which is said to encourage selfishness, to be fatal to the spirit of brotherhood, and to render certain the destruction of modern culture by international and industrial war. Men with such convictions naturally feel bound to prevent national funds being used in the spread of such pernicious doctrine. No teacher in a public school in the States would be permitted to teach that monarchy is superior to republicanism, and Bryan objects to public funds being used to sap national faith by "teaching daily what cannot be true if the Bible be true." He claims that men of science are a small minority and should not be allowed to use the public schools for the dissemination of their subversive dogmas.

The campaign against Darwinism also gains support from the objection to its evidence of a common ancestor for the Negro and Caucasian. The extent of this impulse is uncertain, but it is significant that the six States which have taken action against evolution are all in the south. On this question the Bible would appear to agree with Darwin; for did not Paul on Mars Hill declare that God "hath made of one blood all nations of men"? Some Americans avoid this difficulty by denying that negroes are descendants of Adam and claim that accordingly they are not men. The negro is a soulless animal at the head of the ape family! Believers in Noah's Deluge may fairly claim that the negro cannot have varied from the white stock as quickly as would be necessary to explain his appearance on earlier Egyptian records. If the negro be not a descendant of Noah, the Bible statements regarding "all men" are held not to apply to him.

The inter-racial difficulties in the southern states have certainly helped the anti-Darwinism agitation indirectly; for their educational backwardness and the poverty of one section of their people is due to the presence of the negro and to cheap negro labour. Recent statistics show that in two counties in North Carolina the white crofters and "renters" have a cash income per person of fourpence and sevenpence per day respectively; the corresponding classes of negroes earn a penny a day more. Families with such income cannot afford education, books, newspapers, doctors, or enjoy a reasonable standard of life. It is not surprising that they retain beliefs which, according to British notions, are decades out of date.

Bryan's eloquence and sincerity have made him perhaps the most powerful recent individual influence in American politics. But he has often failed to persuade his countrymen to adopt his policy. His present appeal for trust in the Rock of Ages rather than in "Ages of Rocks" may carry still further the educational outlawry of Darwinism; but it will probably fail in the end as completely as his famous appeal to the United States to adopt bimetallism "to save a world crucified on a Cross of gold."

Isostasy.

Isostasie und Schweremessung: ihre Bedeutung für geologische Vorgänge. Von Prof. Dr. A. Born. Pp. iii+160. (Berlin: Julius Springer, 1923.) 2·20 dollars.

THE variation from place to place of the intensity and direction of the force of gravitation is one of the comparatively few phenomena from which we can obtain some knowledge of the nature of the earth's interior. We owe to Pratt and Airy the demonstration in 1855 that, broadly speaking, different regions of the earth's crust balance one another, or, as it is now expressed, are in a state of isostasy; that the weight of mountain masses above the sea-level is compensated by a defect of density below them, and that ocean deeps are underlain by material of high density. But, whereas Pratt believed that the high places of the earth were the result of expansion of the material beneath them, Airy compared a mountain range to a log of wood floating in water, which it displaced and by which it was buoyed up. After nearly seventy years the same difference of opinion as to the real meaning of isostasy continues to persist.

In his treatise on isostasy and gravitation, Prof. Born has furnished us with a comprehensive exposition of the different methods of interpreting the results of gravity determinations and of the evidence that, in conjunction with geological data, they afford of the internal structure of the earth.

The intensity of gravitation at any point is accurately determined by observing the number of swings of a pendulum of known length during a period recorded by a chronometer, checked by astronomical observations or wireless time-signals. At sea other less exact means have hitherto been employed, but Dutch observers have now shown us that pendulum observations can be carried out in a submarine sunk to a sufficient depth to be practically free from wave action.

In the United States, numerous observations have been made by J. F. Hayford and William Bowie, of the U.S. Coast and Geodetic Survey, and the values obtained have been made the basis of calculations to show how far the principle of isostasy corresponds with the facts (U.S.C. and G.S. Special Publications, Nos. 10, 12, 40, 69, and 99).[1] In these the value experimentally determined, g, is compared with a calculated value, γ_c, based on the assumed value, γ_o, at sea-level[2] at a point directly below. To obtain g_c from γ_o the following corrections are made: (1) for difference of altitude; (2) for the attraction of the local rocks above sea-level, assumed to have a density of 2·67; (3) for the defect of density below sea-level necessary to compensate for the weight of the rocks above it. The difference $g-g_c$ is the isostatic anomaly of Hayford and Bowie. It is quite small, usually less than 0·05 of a dyne, but occasionally approaching a tenth of a dyne.

In calculating the effect of the compensating defect of density, they assumed that it was distributed uniformly below the point of observation from sea-level down to a depth known as the level of compensation, where the density and pressure were supposed to be everywhere uniform. Various depths were taken as the basis of calculation, and that which gave the lowest isostatic anomalies was supposed to be the nearest approximation to the level of compensation. On this basis Bowie obtained for mountainous areas a depth of 95 km. Calculations by Hayford based on deflexions in the direction of gravitation gave a depth of 97 km. Accordingly, Bowie assumed a depth of 96 km. in place of 113·7 km. previously adopted by the Survey. The depth of compensation derived from gravity data at low stations would be indeterminate, but there can, in my opinion, be little doubt that in plains and even plateaux a level of practically uniform density and pressure would be found at a much smaller depth, say 20 or 30 km.

The truth is that the idea of a level of compensation does not correspond to any important reality in Nature. It has no more significance than the level of the base of the largest and deepest of a number of icebergs. It seems obvious to a geologist that the amounts of compensation corresponding to different elevations are not to be represented by columns of equal depth and different densities, but by columns of approximately equal densities but varying depths. In other words, the loftier the mountain range the deeper its foundations extend into the earth. Both mountains and their foundations appear to be mainly composed of similar comparatively light material, the "sial" (sedimentary and acid crystalline rocks), which in general rests upon and in mountain areas displaces more or less the heavier "sima" (basic material) below.

Isostatic anomalies are in some cases to be attributed to the support afforded to local elevations by the intrinsic strength of the earth's crust. This support is, however, given only for a limited time, except by rocks in the closest proximity and at a comparatively low temperature. Isostasy is a condition to which there is a constant approximation but which is never reached; for new developments, such as sedimentation or erosion, the formation or melting of ice-caps, and lateral compression or tension, are continually arising, which tend to destroy it, and then the process of

[1] Reference should also be made to the suggestive address to the Geological Society of America by the president, David White, on "Gravity Observations from the Standpoint of Local Geology" (Bull. Geol. Soc. Am., vol. 35, pp. 207-278, 1924). See, in addition, Andrew C. Lawson on the Geological Implications of the Doctrine of Isostasy, Bull. Nat. Research Council, vol. 8, part 4, pp. 22, 1924.

[2] By sea-level is meant the surface of the rotation ellipsoid adopted in 1912 by the U.S. Survey for the figure of the earth. As a matter of fact the computation is first made on the basis of the Helmert triaxial ellipsoid of 1901, with a subsequent correction (for U.S.A.) to the value of $g-g_o$ of − 0·008 dyne.

adjustment has to recommence once more. Other anomalies, perhaps the majority, can be best explained by the local occurrence near the surfaces, of rocks or deposits of a density differing in a marked manner from that assumed.

There is another method of reduction of gravity determinations, that of Bouguer, which throws more direct light upon the geological structure of the crust. The observed value, g, is reduced to what it would be at sea-level [3] if the whole of the rocks above (near enough to exercise any appreciable attraction on the point of observation) were removed. This value is indicated by the symbol g''_o, and the difference $g''_o - \gamma_o$, where γ_o is the theoretical value at sea-level, affords information of the depth to which the sial extends below it.[4] This is illustrated by an interesting map, by Kossmat and Lissner, of Middle Europe from Denmark to Sicily, showing the relation of $g''_o - \gamma_o$ to the great folds of sial, which form both the mountains above and their foundations below.

The whole subject of the relation of isostasy to mountain building, erosion, sedimentation, glaciation, and different types of earth structure is discussed in detail by Prof. Born. He makes the freest use both of the American determinations and of those of the Indian Topographical Survey, which will always remain a monument of the enterprise of Sir Sidney Burrard and his colleagues. Prof. Born gives a detailed account of the work of Hecker and others in marine areas, and of the light thrown by the results obtained by Hecker Borras, Kohlschütter, and Krenkel on the nature of the rift valleys of Africa and South-western Asia.

Other subjects dealt with by Prof. Born are pseudo-anisostasy, the apparent departure from isostatic adjustment resulting from the attraction of rocks which do not form part of the column immediately below the point where gravity is determined, so that their weight is not included in that of the column; observations in oceanic volcanic islands—which usually show an excess of gravitational force due to a lag of isostatic adjustment; the relation of earthquakes to the want of isostatic adjustment; and generally the assistance afforded by observations of variations in gravitational force in the interpretation of the meaning of the present configuration of the world, and of the changes which have taken place in its past history.

Prof. Born's work is usefully supplemented by two memoirs from the Finnish Geodetic Institute.[5] Dr. Heiskanen has calculated the isostatic anomaly in a number of localities in Europe and the Caucasus. These calculations have been made, first on the same lines as those employed by Hayford and Bowie, and secondly on the Airy hypothesis that it is the *depth* of the lighter material that varies. From the isostatic anomalies obtained in this way it would appear that the latter hypothesis is more in accordance with gravity determinations than the former. This is the case even with the determinations in the United States with which Hayford and Bowie have worked. At the same time, the results obtained indicate that the thickness of the "earth's crust" (presumably that of the sial) below sea-level varies in different localities. Another important conclusion is that the idea that mountain ranges are not compensated separately but only in conjunction with their marginal depressions (Randsenken), and that the former are therefore under-compensated and the latter over-compensated, must now be abandoned. It has been supposed that the Harz and Riesengebirge are uncompensated. Dr. Heiskanen denies that this is the case. The detailed account of the results of the triangulation of South Finland is also of great interest. It contains (*inter alia*) a comparison of the deviations of the direction of gravity actually observed at the triangulation stations with those calculated from the orographical features and the compensation determined by the methods of Hayford and Bowie. The knowledge of the details of the topographical features is, however, at present too imperfect to allow any conclusions to be drawn.

Comparatively few contributions to gravitational data have come in recent years from the British Empire—with the conspicuous exception of India—though so much requires to be done within its limits. It is greatly to be desired that we shall in the future take a due share in this important work.

The recent meeting of the Geodetic Union in Madrid included a section devoted to isostasy. Unfortunately, the German and Austrian men of science, who have done so much to advance knowledge in this direction, were not permitted to attend. Their co-operation would have been all the more valuable because they have worked on lines somewhat different from those pursued in India and the United States. They have taken the fullest advantage of the information afforded by a century of geological research on the structure and past history of the earth's crust. It is absolutely necessary that geodesists and geologists should work in the closest association with one another if trustworthy conclusions are to be reached. JOHN W. EVANS.

[3] Here it is the surface of the "geoid," the level at which the sea would stand if admitted by canals to a point immediately below the point of observation. It differs but little from the triaxial ellipsoid of Helmert or the rotation ellipsoid of Hayford and Bowie.

[4] It would be better if the expression $\gamma_s - g''_o$ could be employed, where γ_s represented what would be the force of gravity at sea-level if the earth's crust below it were composed entirely of sima, for this difference would roughly correspond to the depth of the sial below sea-level.

[5] "Untersuchungen über Schwerkraft und Isostasie," von W. Heiskanen; "Die Beobachtungsergebnisse der südfinnischen Triangulation in den Jahren 1920–23" (Veröffentlichungen des Finnischen Geodätischen Institutes, No. 4 and No. 3). Helsinki, 1924.

Early Chemistry.

The Story of Early Chemistry. By Prof. John Maxson Stillman. Pp. xiii + 566. (New York and London: D. Appleton and Co., 1924.) 18*s.* net.

THE "noticeable gaps" which so many books are "intended to fill" are often discernible only to the authors. However, the absence of any book in the English language which deals adequately with the early history of chemistry will have been brought home very forcibly to all those whose business or inclination has led them to inquire into the available literature on this subject. It is therefore with genuine pleasure that we welcome the late Prof. Stillman's thoughtful and scholarly treatise—a pleasure that is, alas, tinged with regret at the author's death just before the book was published.

As Prof. Stillman remarks in his preface, modern historians of chemistry have laid the emphasis upon the more recent development, so that it was very desirable to write a history of early chemistry which should incorporate the results of the investigations of Berthelot, Duhem, von Lippmann, Ferguson, Sudhoff, and other scholars. It may be said at once that the author has admirably accomplished the task—no light one—which he set himself. His book is brightly written, well balanced, and extremely accurate both in the main ideas and in the illustrative detail. No scientific library can afford to be without it, and this by reason of its intrinsic merits, quite apart from the fact that it has at present no competitors. A very valuable feature of the book is that, while avoiding a show of erudition, it gives full references to authorities for all important statements, and will thus prove useful to those who are engaged in research upon the history of chemistry.

In a field which extends from the beginnings of civilisation to the Chemical Revolution, no one man can hope to be infallible throughout. Prof. Stillman was especially interested in the fifteenth century, and in his account of this period he is seen at his best. He evidently has here a close acquaintance with the original sources, and his description is penetrating, sympathetic, and sound. For the other periods, he has relied chiefly upon the work of other scholars, but his judgment in the use of authorities is seldom at fault and is generally very shrewd. Particularly good is the first chapter, which deals with the practical chemistry of the ancients. On the question of the origin of chemistry he is not so trustworthy, and seems to be quite unaware of the theory of the growth of civilisation now so warmly advocated by Prof. Elliot Smith and Mr. W. J. Perry—a theory which has a very direct bearing upon the problem of the birth of chemistry.

The theories of the ancients upon matter and its changes (Chapter iii.) are described adequately but by no means comprehensively. Justice is scarcely done to the Greek thinkers, although we are pleased to see the stress which Prof. Stillman lays on the *Timæus*, the influence of which upon medieval chemical thought was very considerable.

That the description of chemistry in Islam is thoroughly unsatisfactory is no reflection upon Prof. Stillman. From the published work on this subject which he had at his disposal, he could not possibly have produced a better account than he has done. He might, however, have got an Orientalist to look through his transcriptions of proper names, and thus have avoided such needless errors as *Moaonia* for *Mu'āwiya*, *Oneeyade* for *'Omayyad* (p. 175), and *Eç-Confy* for *Al-Sūfī* (p. 176). These are details which should receive attention in the second edition.

In dealing with the seventeenth century, again, Prof. Stillman has almost entirely neglected the brilliant series of chemists at the Jardin des Plantes—Béguin, Davidson, Glaser, and others—who did much to prepare the way for the great Lemery. Taken as a whole, however, the book is a worthy example of modern American historical scholarship, and may justly claim to rank with Cajori's "History of Physics," Smith's "History of Mathematics," and Lynn Thorndike's "History of Magic and Experimental Science."

E. J. HOLMYARD.

On Being Born and Well Born.

Genetics and Eugenics: a Text-Book for Students of Biology and a Reference Book for Animal and Plant Breeders. By Prof. W. E. Castle. Third edition. Pp. viii + 434 + 60 plates. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1924.) 12*s.* 6*d.* net.

THE fact that this third edition is subdivided into forty-two chapters, six of them new, may provide an indication of the variety of the topics which interest the geneticist. In American literature this book, not the least remarkable feature of which is its cheapness, occupies the position which Punnett's "Mendelism" and Thomson's "Heredity" together hold on the eastern side of the Atlantic: it offers to a very wide public an introduction to genetical fact and theory and some notion of the applications of the science in agricultural and sociological endeavour. Associated with this edition there is a laboratory manual which outlines a very useful half-year's elementary experimental course in genetics. Most of the experiments demand the employment of *Drosophila melanogaster*, but this does not make the manual unsuitable, for there is an adequate supply of this

unrivalled experimental material now available in Great Britain as well as in the United States.

The book is not meant to be a text-book for a class in genetics: the intention of its writer is that it should be a text-book for students of biology and a reference book for animal and plant breeders. The characteristic stamp of the personality of the author is too deeply impressed upon its pages, in our opinion, for the book to be the ideal introduction to the subject for the student of general biology, and the value of those chapters which deal with the phenomena of inheritance in the different species, great as it is to-day, must quickly become depreciated in view of the recent appearance of such monographs as are included in "Bibliographia Genetica." To the geneticist, however, the book is most attractive, for in no other form could the views of the author, who, both as teacher and as experimenter, has contributed so notably to our knowledge of genetics, be so attractively placed on record.

There is abundant evidence in this book that Prof. Castle knows his rodents: that he knows his fowl as well is not so certain. On p. 77, for example, he submits that "one condition on which the crowing instinct of cocks rests is the production in its body of substances produced by the testis." While it is certainly true that the gonadless fowl does not crow, it is equally true that a cock castrated and with an ovarian implantation will do so, and that a hen, perfectly normal in structure and functioning in every way as a hen, will, in the protracted absence of the male, crow most vigorously, though her voice may not be so full of challenge. On p. 300 it is stated that "fowls of both sexes will develop the same plumage characters, viz. the full plumage of normal males, if no secretions interfere." It is true that the plumage of the capon and the poularde is as that of the normal male in colour and structure, but that of the gonadless bird is far more luxuriant in its growth and far looser in its texture than that of the functional cock. We think also that Prof. Castle accepts with too little reserve the suggestion that the "luteal" cells in the ovary of the hen and in the testes of the henny-feathered cocks are the source of an internal secretion which inhibits cocky-feathering. The weight of modern opinion is quite opposed to this contention.

In discussing the relation of Mendelism to mutation and evolution, the author submits that the Mendelising characters of the domesticated mammals consist very largely of such economically unimportant qualities as coat-colour, hair-length, or hair slope, and that the really valuable characters, such as those of size, proportion, early maturity, milk-yield, butter-fat content, wool, and fecundity, are not typically Mendelian in their inheritance, but are examples of blending. We were about to debate the question as to what exactly the author regards as typically Mendelian when a few lines further on we found that Prof. Castle acknowledges that very likely the inheritance of these complex characters of economic importance is also Mendelian. He provisionally accepts the conception of multiple factors, but is mistaken in assuming that such a theory demands that there shall be no dominance.

Forty-seven pages are devoted to eugenics. In a book such as this, written for such a public, it is indeed desirable, we think, that an outline of the facts of human inheritance should be included, for the determination of the extent to which mankind is subject to the general principles of genetics is most certainly a biological problem and one that should be brought to the notice of the student of biology. To determine how far these principles are socially controllable, on the other hand, is a problem for the sociologist, and Prof. Castle, a geneticist, makes no serious attempt to deal with it. However, he closes the book with a somewhat pessimistic chapter on "The Possibility and Prospects of breeding a better Human Race," in which he calls largely upon the conclusions of Prof. Cattell, drawn from the latter's study of the families of the one thousand leading men of science of the United States.

We commend this book especially to those who enjoyed and so ceaselessly quote "Eugenics and other Evils." They will find therein such conclusions as the following reached by one who is qualified to speak with some authority. The normal unperverted instincts of the average man have a distinctly eugenic trend. Cupid is a safer guide in matrimony than a licensing board. Racial crossing among men, as among domesticated animals, is biologically beneficial within limits. This mixture of elements not too dissimilar, provided the social heritage is not unduly disturbed, is on the whole beneficial. Biologically the human race can be improved only by improvement of the germplasm. If, as seems probable, acquired characters are not to any considerable extent inherited, then environmental agencies affect man chiefly culturally, not biologically. Practically we are limited to such eugenic measures as the individual will voluntarily undertake in the light of present knowledge of heredity. It will do no good, but only harm, to magnify such knowledge unduly, or to conceal its present limitations. We should extend such knowledge as rapidly as possible but not legislate until we are very sure of our ground.

With such conclusions all geneticists will agree. This being so, it is as unjust to blame the geneticist for the mishandling by the lawmaker or enthusiastic sociologist of the facts that he discloses, as to hold the chemist responsible for the adaptation by others of the results of his research to the purposes of war. F. A. E. C.

Our Bookshelf.

Meteorological Office: Air Ministry. British Rainfall, 1923. The Sixty-third Annual Volume of the British Rainfall Organisation. Report on the Distribution of Rain in Space and Time over the British Isles during the Year 1923, as recorded by about 5000 Observers in Great Britain and Ireland. (M.O. 269.) Pp. xxii+256. (London: H.M. Stationery Office, 1924.) 15*s.* net.

AN analysis of the rainfall for the year is given covering the whole of the British Isles. The year was decidedly wet, being the wettest year since 1916 except in Ireland. The largest excesses occurred in the west. There were more days with rain than in any other year since comparable statistics began in 1903. The average monthly rainfall during the year over the British Isles as a whole varied from 6·5 in. in February to 1·4 in. in June; only two months, March and June, showed considerable deficiencies. February 1923 is said to be probably the wettest February on record. Rainfall maps for the British Isles are given for each month, as well as for the summer and winter seasons and for the year.

Examples of dramatic weather during the year are given, these occasioning floods in different parts during July and November. Serious floods occurred at Carrbridge in Inverness-shire on July 8, and on the night of July 9-10 a memorable thunderstorm was experienced, and about 7000 flashes of lightning occurred during 6 hours in London and the suburbs, while 4·55 in. of rain fell in Sussex.

A special article is given on the fluctuations of annual rainfall; a comparison is made of different groups of 35 years in the period 1868 to 1921, and also with the standard period 1881 to 1915, the 35 years' average in general use in the Meteorological Office. The averages for the different periods of 35 years show a good general agreement. C. H.

Bearbeitung einheimischer Tiere. Herausgegeben von Prof. Dr. E. Korschelt. Erste Monographie: Der Gelbrand *Dytiscus marginalis* L. Erster Band. Pp. v+863. Zweiter Band. Pp. vii+964. (Leipzig: Wilhelm Engelmann, 1923–24.) n.p.

THESE two bulky volumes constitute the first of a series of monographs dealing with the fauna of Germany, the subjects selected forming a series of "types" of the animal kingdom for study in the university courses. Probably no better subject for the study of insect structure and metamorphosis than the "Gelbrand" could have been selected. Not only is the Great Water-Beetle hardy and easily kept in captivity, with a comparatively rapid metamorphosis, but it illustrates remarkably well the specialisation of a primitive type in response to the special circumstances of its environment.

Vol. 1 deals with the skeletal system, its appendages and sense organs, and the nervous, muscular, respiratory and circulatory systems of both adult and larva. Vol. 2 completes the structural treatment with the consideration of the fat-bodies, and the alimentary and reproductive systems, passing on to development and metamorphosis and various aspects of its bionomics. Finally, there are two very interesting chapters on its early literature and systematics. After each chapter is given a very full bibliography for that particular part of the subject. Both volumes are abundantly supplied with excellent illustrations.

Owing to unavoidable delay in the appearance of the work as a whole, it was felt that the results of certain pieces of research should be separately published in anticipation, so that some of the chapters in the complete work are practically reprints of papers previously published by Dr. Korschelt or his collaborators.

In view of the great attention to detail evidenced throughout the work, it is a little surprising to find no mention of the "pigment-spot" on the wings, an organ that has recently been claimed to serve a stridulatory function; neither, indeed, do we find any reference to the well-known stridulatory powers of the insect, and but the briefest mention of Finkler's experiments on the transplantation of the head from one individual to another.

An index would have facilitated reference, though its lack is to some extent compensated for by a very full list of chapter headings and subheads for each volume.

A History of Bleaching. By S. H. Higgins. Pp. viii+176+9 plates. (London: Longmans, Green and Co., 1924.) 10*s.* 6*d.* net.

AN investigation into the early history of any industry is of much interest, and may be of considerable value in throwing light on modern practice. Sometimes, as in the case of the bleaching of textiles, fairly detailed records of ancient processes are found, but it is not possible to compare the results obtained then and now, because a fabric bleached even one hundred years ago inevitably will have become more or less discoloured. On the other hand, there are many cases in which we can examine the results of ancient craftsmanship, but have no knowledge of the methods by which they were produced.

The demand for a "perfect" white on cotton, linen, and other textiles is comparatively modern. From an æsthetic view-point, the slightly brownish or greyish tint of white, which must have been the ultimate product of the bleacher before the introduction of chloride of lime, is more pleasing than the more luminous bleached white of to-day; which is probably the outcome partly of trade competition and partly of the requirements of some modern methods of textile printing.

The development of bleaching processes has taken place along two main lines, chemical and mechanical, and Mr. Higgins in his book traces the improvements due, in the first place, to the increase of chemical knowledge, and secondly, to the necessity of dealing with larger quantities of material. Chemical engineering received its early stimulus through the exigencies of the alkali industry and its offshoots, and thus early turned its attention to bleaching and the allied industry of calico printing; the mechanical developments in dyeing processes coming much later.

With the single exception of the introduction of bleaching powder about the beginning of the nineteenth century, there has been no fundamental change in bleaching processes since a very early period. The magnitude of the industry at the present time is indicated by the statement in the last paragraph of the book that about 2,000,000 *miles* of cloth are bleached

annually in Great Britain, a statement which may be approximately accurate if the amount of cloth which is partially bleached as a preliminary to dyeing or printing, is included. W. M. G.

Liverpool Marine Biology Committee. L.M.B.C. Memoirs on Typical British Marine Plants and Animals. 26: *Botryllus.* By E. Catherine Herdman. Pp. xi+40+6 plates. (Liverpool: University Press of Liverpool, Ltd.; London: Hodder and Stoughton, Ltd., 1924.) 4*s.* 6*d.*

THE author of the present volume, on the compound Ascidian Botryllus, is a daughter and pupil of the late Sir William Herdman, who himself, twenty-five years ago, wrote a description of a simple ascidian as the first volume of the series to which this is the latest addition.

The editors of the series explain in a preface the interest attaching to Botryllus, and its advantages as a representative of the group to which it belongs. Miss Herdman's account, which follows, is carefully done, well arranged, clearly written, and excellently and fully illustrated by means of six plates, one of which is in colours. Besides the description of the anatomy, the author gives sections on embryology and development, and on the formation of the colony, as well as paragraphs on such subjects as coloration and the systematic position of the family. There are interesting references to the germ-layer theory in relation to the formation of the organs in the asexually produced blastozooids; to the mode of capture of the food particles; to the functions of the neural gland and dorsal tubercle; to the cause of the curious recurring alternations in the direction of the blood-flow; and to the special functions of the colonial vascular system. It is, however, to be regretted that in a book which the editors hope "will be found of value by students of biology in laboratories and in marine stations, and will be welcomed by many others working privately at marine natural history," the author has not included some account of the most suitable methods of examination.

The Place of Partial Differential Equations in Mathematical Physics: Being a Course of Readership Lectures delivered at Patna University in 1921. By Prof. Ganesh Prasad. Pp. iv+49. (Patna: Patna University, 1924.) n.p.

IN the six lectures before us, Prof. Prasad gives an interesting account of the part played by partial differential equations in dealing with vibratory phenomena, conduction of heat, gravitational attractions, electrostatics, magnetostatics, hydrodynamics, electrodynamics and the theory of electrons. Since D'Alembert's discovery in 1747 of the equation $\ddot{y}=c^2y''$ arising from the motion of a vibrating string, the study of natural phenomena by mathematical physicists has led them to certain standard types of differential equations. The essential difficulty in finding the solution of such a differential equation lies in fitting it to specified boundary conditions. If we have an initial stage of heat given by

$$f(x)=x \text{ for } x>0, f(x)=-x \text{ for } x<0,$$

the first and second differential coefficients are non-existent at the origin and the equation of linear conduction, $\partial v/\partial t=\partial^2 v/\partial x^2$, is meaningless there. An unlimited number of similar cases can be constructed. Though partial differential equations are quite serviceable for most ordinary purposes, in a rigorous treatment they have to be relegated to a secondary place. It is quite possible that at some future time differential equations will appear as but crude instruments and be discarded in favour of the more powerful and more refined integral equations.

Linear Integral Equations. By Prof. W. V. Lovitt. Pp. xiii+253. (New York: McGraw-Hill Book Co., Inc.; London: McGraw Hill Publishing Co., Ltd., 1924.) 15*s.* net.

THE subject of integral equations has been much neglected in university teaching in Great Britain, partly because of the scarcity of text-books suited to the needs of the normal student of mathematics. In addition to a clear exposition of the theory, to carry conviction what the student requires above all is a number of particular examples and applications. The works of Bôcher (1909) in English, Volterra (1913) in French, and Kneser (1922) in German are available but are scarcely in general use.

Prof. Lovitt has produced a very readable book on this very important branch of mathematical study. The discussion, confined to those equations which are linear and in which a single integration occurs, does not deal with equations involving several independent variables, systems of integral equations or integro-differential equations. The author covers, however, in systematic manner the general theory of linear equations, exemplifying the points as they arise by a large number of particular cases and applying the methods to problems in differential equations, the calculus of variations, Neumann's and Dirichlet's problems, and to a series of cases of vibration. There is nothing very new in substance in the book, but it is eminently readable and very well produced.

In the High Himalayas: Sport and Travel in the Rhotang and Baralacha; with some Notes on the Natural History of that Area. By Hugh Whistler. Pp. 223+16 plates. (London: H. F. and G. Witherby, 1924.) 15*s.* net.

MR. WHISTLER'S book treats of sport and travel in a remote part of the Himalayan districts of the Punjab, Kulu, Lahul, and Spiti, of which the last is geographically part of Tibet though politically a district of India. The chapters dealing with it are of most interest since the country is almost unknown, but the whole book contains a great deal of valuable geographical and natural history material, including a chapter on birds. There are some fair illustrations and an adequate map.

Ross and Cromarty. By Prof. W. J. Watson. (Cambridge County Geographies.) Pp. xi+140. (Cambridge: At the University Press, 1924.) 3*s.* 6*d.*

PROF. WATSON has added a useful volume to the series of county geographies. The book is especially interesting on the human side, though with commendable restraint his section on the people, race, and dialect occupies only two and a half pages. We notice that he describes the Celts as members of the Nordic race, without actually using that term, and to this stock he attributes some of the fair-haired people of this highland area.

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.*]

Disintegration of Atomic Nuclei.

SINCE the discovery that high speed protons are emitted from the nuclei of a number of light elements by a close collision with an α particle, it has been a matter of great interest to understand the mechanism of these collisions and particularly the fate of the bombarding α particle. Dr. Chadwick and I have shown that the protons are emitted in all directions relative to the bombarding particles, but with greater velocity in the forward direction. This difference of velocity was ascribed to the effect of recoil of the nucleus, and assuming that the law of conservation of momentum, but not of energy, holds in such collisions, we were able to calculate from the experimental data the distribution of momentum between the particle, proton, and nucleus after the collision. These calculations showed that the velocity of the escaping α particle was small for nitrogen, sodium, aluminium, and phosphorus, but considerable for boron and fluorine. Unfortunately, on account of the small number of particles, it is difficult to determine accurately the velocity of the proton in different directions, but, with accurate data, this method should prove useful in throwing light on the distribution of momentum amongst the particles concerned in the collision.

The number of collisions leading to the escape of the proton increases rapidly with the velocity of the impinging α particle, and in the case of aluminium we could observe few, if any, protons when the bombarding α particle had a range less than about 5 cm. The most direct method of studying the results of these collisions is to obtain actual photographs of the tracks of the particles by the well-known cloud method. From the data obtained from our investigations with nitrogen, it seemed probable that about one α particle in 40,000 would liberate a proton when using a source of the swiftest α rays available, namely, thorium-C, which emits particles of range 8·6 cm. in air.

The laborious task of photographing in two perpendicular directions the tracks of about 400,000 α particles was undertaken by Mr. Blackett in the Cavendish Laboratory, using a modification of Shimizu's method. The results of this investigation have been recently published in the Proc. Roy. Soc., 107, p. 349, 1925. In addition to a number of collisions of the α particle with a nitrogen nucleus which obeyed the ordinary laws of an elastic collision, Blackett observed eight forks in all where these laws were not obeyed, and these he ascribed to collisions involving the liberation of a proton. The fine track of the proton was clearly visible, also that of the recoiling nucleus, but there was no sign of a third track to be expected if the α particle escaped after the collision. He concluded that the α particle is captured by the nitrogen nucleus under these conditions, and that in consequence the mass of the recoiling nucleus should be 17 and its charge 8—namely, an isotope of oxygen. He observed that the tracks were coplanar, indicating the conservation of momentum, and found the velocities of the proton and recoiling nucleus to be in fair accord with this assumption. Mr. Blackett hopes to examine in a similar way a number of other active elements to see if a similar process takes place.

It is not my intention here to discuss the bearing of these results on the mechanism of disintegration, but rather to direct attention to other results and suggestions in connexion with this important problem. In 1923, Prof. W. D. Harkins and R. W. Ryan (Journ. Amer. Chem. Soc., 45, p. 2095) photographed about 21,000 α ray tracks in air, using the Shimizu method, and amongst other observations recorded a photograph of a collision in which the α ray track broke into three distinct branches—indicating a disintegration in which two high speed particles appear in addition to the recoiling nucleus. My attention has recently been directed to another interesting photograph in air by a similar method, recorded by M. Akiyama (*Jap. Journ. Phys.*, 2, p. 272, 1923), which also shows three branches. The proton in this case is expelled nearly in the backward direction, and two other tracks ascribed to the escaping α particle and recoiling nucleus are clearly visible. It is, of course, difficult to reconcile these photographs with the eight obtained by Blackett in which no third branch has been noted; but it may prove significant that the collisions photographed by Harkins and Akiyama appear to have occurred when the α particle has lost a good deal of its range. It is obvious that there is still much work to be done to clear up these difficulties.

In view of the evidence obtained by Blackett of the capture of an α particle, I have thought it of interest to bring to the attention of readers of NATURE two clear statements of the likelihood of such a capture in a collision which leads to the expulsion of a proton. In a discussion of a paper on the structure of the atom, read by me before the Solvay International Institute of Physics in 1921 (Rapports et Discussions du Conseil de Physique de Bruxelles, p. 68, published 1923), a reference to this question was made by Prof. J. Perrin. A selection of the remarks made by him will be given in full, as the above publication may not be generally accessible to readers of NATURE:

M. Perrin:— . . . "Les expériences mêmes de M. Rutherford semblent prouver qu'il faut renoncer à cette idée d'un simple choc. Le projectile α, en raison de sa grande vitesse, et malgré une très forte répulsion électrique, peut arriver, très ralenti, au voisinage immédiat du noyau. A ce moment, une 'transmutation' se produit, consistant probablement en un réarrangement intranucléaire, avec capture possible du noyau α incident (car nous ne savons pas ce qu'il devient), émission du noyeau d'hydrogen formant le rayon H observé, et peut-être encore avec d'autres projections moins importantes. Il n'y a aucune raison, dans cette façon de voir, pour que le projectile H émis 'se souvienne' de la direction du choc initial ni pour que son énergie (empruntée pour une part à l'énergie électrique intranucléaire) soit inférieure à celle du projectile incident.

"Si, par exemple, le noyau d'aluminium heurté capture le projectile α et n'émet pas d'électrons, il reste, après l'émission du projectile H, un atome dont la masse est (27 + 4 − 1), soit 30, et dont le numéro d'ordre est (13 + 2 − 1), soit 14, donc un atome isotope du silicium. D'autres hypothèses seraient d'ailleurs faciles."

A suggestion of a similar kind has also been made by Pettersson and Kirsch. They forwarded to me, in June 1924, a short paper intended for publication in which they gave a brief statement of preliminary experiments on the number and nature of the particles liberated from carbon and aluminium at an angle of about 135° with the bombarding α particles. From these data they suggested that the α particle might be captured in collisions in which the proton is liberated. A paper including a statement of their

views on this question was given at the Versammlung Deutscher Naturforscher und Ärzte at Innsbruck in August and published in the *Physikalische Zeitschrift* (25, No. 22, p. 588, 1924).

We must await the results of further detailed experiments to see how far such observations of scattering throw definite light on the problem of the mechanism of a disintegrating collision. It seems clear, however, that a large amount of careful quantitative work as well as a great number of photographs of α ray tracks will be required before we can hope to obtain detailed evidence of the mechanism of such collisions and of the fate of the bombarding α particle for all the "active" elements.

E. RUTHERFORD.

Cavendish Laboratory, Cambridge.

The Source of Stellar Energy.

I AM glad to have drawn so interesting a letter from Prof. Eddington as appears in NATURE of March 21. I cannot, however, agree with him that the present position is one of "an almost hopeless deadlock," and neither do I agree with his criticisms of my scheme (NATURE, Feb. 28), by which a star consists of a mixture of different types of destructible matter which spontaneously dissolve into radiation at different rates, the rate in each case being unaffected by physical conditions of temperature and pressure. The process imagined by me was in fact analogous to radioactive decay except that the end product is radiation instead of other forms of matter.

Prof. Eddington considers that under this scheme the stars would be unstable. A star which in some way increased its rate of generation of energy would expand and this expansion would, he says, lessen the rate at which it was able to radiate its energy away. But why? The expanded configuration is not one of equilibrium and I cannot see that we have any knowledge as to the corresponding rate of radiation. *A priori* we would certainly expect that the star's first move, when it found too much radiant energy accumulating in its interior, would be in the direction of getting rid of more radiation, not less, as Prof. Eddington asserts. If so, Prof. Eddington's argument collapses entirely. It may be remarked that if the argument were sound and instability were proved, we could only restore stability by supposing that a decrease in a star's density and temperature *decreased* its spontaneous generation of energy, whereas in actual fact it is the stars of lowest density and of lowest internal temperature which radiate the most energetically.

My suggestion that when a star breaks up its ingredients are not fairly distributed between its constituent parts is criticised in the light of some conclusions Prof. Eddington has drawn from a certain recently published mathematical theorem. May I here merely state that in my opinion this theorem is entirely fallacious? I hope to justify this statement in print very shortly.

My scheme certainly requires "that the rate of emission of radiation by the star shall be very largely dependent on its previous history." In actual fact considerable ranges of luminosity are shown by stars of identical mass. These I should attribute to differences of birth and previous history, and it may be possible to infer something as to the past histories of the stars from these ranges. Prof. Eddington considers that the observed range is too small, but does he know enough of the past history of different stars to say how large a range ought to be expected? He discusses two hypothetical stars born originally with masses 12 and 3, but is there any reason for thinking that stars can be born with so great a disparity of mass? I have, of course, to admit that in time a real difficulty may appear here, but at present its existence is not proven. To my mind the present difficulty lies in precisely the opposite direction; it is to account for the tendency towards equality of mass which appears in the two components of a binary as its evolution proceeds.

I find it difficult to understand the advantages of the hypothesis which Prof. Eddington offers as an alternative to mine. He supposes certain destructible types of matter to be formed at a rate which depends on temperature and density. Their rate of spontaneous dissolution does not depend on the temperature and density at the instant, so that the rate of generation of radiation depends only on the total amount of destructible matter present in the star, which in turn depends on all the temperatures and densities of the past. The radiation, in fact, represents a sort of integral of the past temperatures and densities. As regards stability his stars are in the same position as those of my scheme, while as regards dependence on past history they seem to be worse off.

Any variation, either of creation or destruction of matter, with temperature and density ought almost certainly to be in the direction of higher activity accompanying an *increase* of density and temperature, whereas in actual fact the (internally) hot dense stars radiate little and vice versa. If Prof. Eddington insists on any sort of dependence on density and temperature, he must not only, as he says, "admit exhaustion-effects also," but must actually admit more exhaustion-effects than are required by my own hypothesis—unless indeed he can prove that high temperature and density inhibit radiation.

J. H. JEANS.

March 23.

Relation of Light to Bird Migration and Developmental Changes.

THAT light is a factor of prime importance in the inauguration or stimulation of bird migration, has been suggested by many authors from the days of Seebohm onwards. While many of the suggestions will not bear close investigation, at least one very attractive view has been put forward by Sir E. Sharpey-Schafer. In an address delivered some years ago to the Scottish Natural History Society [1] he makes the following comments, ". . . the regularity with which migration occurs, indicates that the exciting cause must be regular. There is no yearly change, outside the equatorial zone, that occurs so regularly in point of time as the change in the duration of daylight. On this ground this may well be considered a determining factor in migration, and it has the advantage over other suggested factors that it applies to the northerly as well as to the southerly movement." He says further "That it [migration] is a result of developmental changes in the sexual organs is improbable."

Evidently inspired by the work of the botanists Garner and Allard on what they have termed "photoperiodism," an American author [2] has lately revived this theory and has, apparently independently, come to the same conclusion as Sir Edward with regard to the absence of relation between developmental changes in the reproductive organs and migration.

On purely theoretical grounds it has always seemed to me that if the waxing and the waning of the days really in any way affect the migratory impulse, they must produce their effect through the gonads. This

[1] "On the Incidence of Daylight as a determining Factor in Bird Migration," E. A. Schäfer, NATURE, vol. 77, pp. 159-163 (December 19, 1907).

[2] "Is Photoperiodism a Factor in the Migration of Birds?" G. Eifrig, *Auk*, vol. 41, pp. 439-444.

is not the place for theoretical discussion, and I merely wish to record an experiment that has just reached completion. Other corroborative work is still in progress and a critical histological examination of the experimental and normal material yet remains to be undertaken.

In September of last year I trapped a number of Juncos (*Junco hyemalis*) on their southward migration to the Middle States. These were turned into two large open-air aviaries removed from shelter of any kind. One, into which about a dozen birds were put for the experimental work, was fitted with two 50-watt electric lights. The other housed controls. Commencing on October 2, the lights were turned on at sunset (that is, while the birds were still fully active) and kept on until five minutes after dark. Each day afterwards the time was lengthened by five minutes. Taking into consideration the differences in time of sunrise, the birds thus got about three minutes longer illumination daily. On account of the fact that they went to roost at their usual time on the first day in spite of the glaring lights, and that attempts at educating them to keep awake were never wholly successful, and less so with some individuals than with others, it has proved impossible to estimate the effective light increases. For the same reason there is lack of uniformity in the results obtained.

Elimination of the warmth factor was unexpectedly successful—thanks to a severe winter—the lowest temperature to which the birds were exposed being 50° below zero (Fahrenheit).

Birds were killed at intervals of approximately two weeks, with the following results :

Dates of Killing.	Number Examined.	Size of Testes.[3]
Oct. 15	1	0·50 × 0·48
(A wild bird killed same date		·60 × ·60) [4]
Oct. 29	1	·44 × ·41
Nov. 13	1	·45 × ·53
Nov. 26	1	·60 × ·44
Dec. 11	1	·80 × ·79
Dec. 27 [5]	2	(*A*) ·90 × ? (Part of ribbon destroyed)
		(*B*) 1·80 × 1·54

Catastrophe overtook my control birds and I had to find substitutes. Through the kindness of the Museum of Vertebrate Zoology, University of California, I have been receiving fixed gonads of Juncos (a closely related species of approximately the same size) wintering in the Berkeley district. These are not strictly comparable with mine, therefore, but the samples include birds taken at intervals from November to early January. In spite of the California climate, the January testes are minute. My solitary female, killed also on December 27, as compared with the early January females from Berkeley, has an ovary two to two and a half times as large and with conspicuous follicles.

The two males and the female killed on December 27 were kept indoors for their last week at an average temperature of about 40°. (Their drinking water froze one night.) The marked difference in the size of the testes of the two males may probably be accounted for by their habits. *A* went to roost, in spite of the lights (the birds were together in the same cage) about an hour to an hour and a half each night before *B*. The female kept the latter company. *A* sang a good deal ; *B* incessantly. All the birds were in excellent condition when killed.

It would, therefore, appear that whatever effect daily increases of illumination may or may not have on migration, they *are* conducive to developmental changes in the sexual organs. Comparison of the normal material from Riviera-like California with the experimental product from Alberta further suggests that favourable light conditions are more potent in this respect than favourable temperatures.

WILLIAM ROWAN.

11142 86th Ave., Edmonton, Alta.,
Canada, January 28.

[3] The whole series of testes was sectioned at 6μ. The first column indicates the greatest diameter of the largest section in each series in millimetres. The second is arrived at by adding the total number of sections for each series and multiplying by 0·006.

[4] The testes of this bird, still on migration, had not yet reached the winter minimum and this accounts for their large size. Diminution in size during the initial stages of the experiment is very marked.

[5] *A* was an adult bird : *B* a bird of the year.

The Mortality of Plaice.

IT is most valuable to have Dr. Wallace's authoritative opinion (NATURE, March 7) that the scarcity in the North Sea of male plaice more than 8 years old is due to their own physiology and not merely to selective fishing. I suggest, however, to Dr. Wallace that this is no evidence of senile death, but of what we may conveniently call *parental* death. "The *rapid* decline in the relative number of males just after maturity" (the italics are Dr. Wallace's) indicates that death is a consequence of their last and most productive spawning, and Atkinson's Barents Sea Statistics (Table II.) seem explicable only if ⅘ of the males there die after first spawning. We know that fresh-water eels spawn once and die, the conger also (Cunningham, Journ. M.B.A., vol. 2, p. 31) spawns once and dies, and Child ("Senescence and Rejuvenescence," p. 302) states the same of the American salmon, adding, "the organism is undoubtedly in an advanced stage of senescence when sexual maturity is attained." Minot and Child, by the great importance of their work, have permanently changed the meaning of the word "senescence" to signify progressive diminution in rate of metabolism, and they have shown that "senescence" starts at a maximum in the dividing ovum and falls rapidly with advancing age. I would plead that "senility" be still left in its original meaning to designate the negative growth in man which begins after full sexual maturity, and the like phenomenon where it is found to occur in other organisms ; so that we have terms in which it is possible to discuss whether "senility" be really merely the latter stage of "senescence." The death of a fish after spawning in the fulness of its power bears little resemblance to senile death, but is comparable to death of the spore-case when the spores are discharged, or of the wheat-stem when the grain is fallen ; sexual reproduction primitively destroys the parent. The whole dividing protozoon disappears and the whole is utilised, but in metazoa a continually larger and more important somatic residue is wasted in death : in the conger, figures cited by Cunningham indicate that the heaviest roes approach to half the total weight, the residual body unutilised being therefore, at the lowest, equal in weight to the matricidal ovaries. So in many groups this loss of capital to the species is gradually avoided ; the spent British salmon succeeds in returning to the sea and building up again in a year or two strength sufficient for a second spawning ; the descendant of annual flowering plants takes on the biennial habit.

The hypothesis of potential immortality applies only to those plants and animals (of which, I still suggest, the female plaice may be one) which have completely lost the originally universal liability to parental death and have become perennial; and botanical

friends tell me that they know no evidence of senility in perennial root-stocks or 5000-year-old trees. My suggestion is that we have no evidence of senility in the female plaice, and that senility is not an inherent quality of protoplasm, but the consequence of a mechanism for the preservation of specific size. The plaice has no specific size, and therefore, when in the female growth is not ended by parental death, no mechanism for the limitation of growth is evolved and there is no senility.

Among animals which produce numerous young there is more reason for the female to attain the perennial habit than for the male, since a female plaice must grow for many years before she is large enough to produce as many ova as one eight-year-old male can fertilise. Even human curves of growth and senility indicate that in these aspects the male and the female are different animals. Looking at other groups, it becomes clear that no conclusion as to the gradient of life in one sex can be formed from observation of the incidence of death in the other: the queen-bee's life-history bears little relation to that of a drone; the longevity of the female spider is not measured by that of the consort she devours; and the female barnacle, *Scalpellum ornatum*, is associated with a succession of short-lived epizoic males.

I suggest to Dr. Wallace that we have as yet no evidence of senility in plaice, but of parental death for the North Sea male on perhaps the third spawning, at a body-weight of some 700 grams. There is an unproved possibility of parental death for the female on reaching some very much larger size at which her ovaries would bear a lethal ratio to her body-weight; this we may guess, on the analogy of the conger, might be when the ovaries form about one-half the total weight. If the ratio of ovary-weight to body-weight continue to increase according to the formula $y = x^k/400$ (NATURE, January 31, p. 155), the ovaries would be one-half the weight when the plaice attains 6000 grams if $k = 1{\cdot}61$, and when it weighs 16,000 grams if $k = 1{\cdot}55$. (The largest plaice recorded, *fide* Cole and Johnstone, weighed 6800 grams.) If, on the other hand, as the fish grows larger k diminishes, and reaches 1·0 at a constant ratio of ovary-weight to body-weight which allows the residual body to recover after spawning, then the female plaice has lost liability to parental death, while it has assumed neither specific size nor the senile death which is its consequence.

GEO. P. BIDDER.

Cambridge, March 12.

The Propagation of Radio Waves over the Earth.

IN NATURE of March 7 there are two letters dealing with the subject of the transmission of electric waves over the earth's surface. Prof. Appleton has given some results which indicate that very marked interference effects occur at night. So far as I understand, he has suggested an interpretation of the experimental results in terms of the simple theory in which the maxima and minima of received intensity are supposed due to the interference of a direct ray over the surface of the earth, and a single reflected ray, passing from the earth to the Heaviside layer and back to the receiver. But the problem is scarcely so simple as this, for the multiple reflection may occur, the ray passing many times between the earth and upper layer before reaching the receiver. Such an effect would obscure the main results if the intensity of these rays were of the same order as those of the direct ray.

About a year ago I made a mathematical investigation of the case, where the bounding surfaces are assumed to be plane; the results obtained are of interest in connexion with the present problem.

Very briefly, the electric force at the receiver due to a current I in a transmitter of effective height (h) situated on the lower of the two surfaces consists of the direct wave:

$$i.e. \qquad \frac{120\pi hI}{\lambda x}\cos\left(\frac{2\pi}{\lambda}x - pt\right),$$

together with a finite number s of terms of the form

$$\frac{120\pi hI\sqrt{1-\beta_m^2}}{2H\sqrt{\lambda x}}\cdot\cos\left(\frac{2\pi x}{\lambda}\sqrt{1-\beta_m^2} - pt + \frac{\pi}{4}\right),$$

where s is the nearest integer less than $2H/\lambda$, and H is the height of the layer, λ the wave-length of the transmitted wave, x the distance, and

$$\beta_m = \frac{(s-m)\lambda}{2H},$$

m being an integer which varies from zero up to s. These terms represent a series of progressive waves which travel to and fro between the upper and lower surfaces along rays which are inclined at angles θ_m to the earth's surface where $\sin\theta_m = \beta_m$.

Together with these there are a series of stationary wave terms which are unimportant compared with the progressive waves at distances large compared with the height of the Heaviside layer.

The effect of resistance in the bounding layers is to introduce an attenuation factor in each of these terms of the form $E^{-\alpha x/\sqrt{\lambda}}$ and to modify the intensity only to a second order amount.

The state of affairs in the space between the two layers is very complex, especially when a wave-length is used which is very small compared with the height. The object of this letter is to point out the conditions under which the simple theory is applicable, and also to show how these mathematical results may be used to determine the height of the Heaviside layer in the daytime, a determination which is beyond the scope of Prof. Appleton's experiment, since the interference effects with which he deals do not occur in the daytime.

With regard to the first question, I agree with Prof. Appleton that there is evidence that the bounding surface of the upper conducting layer is not sharply defined, and that there must be a more or less gradual transition. This would favour the reflection at glancing incidence compared with that at normal or nearly normal incidence.

If, then, the receiver were fairly close to the transmitter so that the distance between them were of the same order as H, multiple reflections might not occur, and the results might be explained by the simple theory; but the fact that fading effects as well as directional variations have been observed so close as twenty miles from the transmitter, shows that high angle reflections must not be entirely neglected. Experiments must decide whether they are or are not of importance in Prof. Appleton's case.

With regard to daytime transmission, I think that in spite of the fact that there are no signs of interference phenomena, transmission on long wave-lengths, and as recently shown, on very short wave-lengths, must be effected by the help of an upper layer, which for long waves acts as a pure conductor and for very short waves as a refracting medium with ionic dispersion.

This view is upheld by the results of a large number of measurements made during the past three years, the results of which will be published shortly in a paper before the Institution of Electrical Engineers. These indicate that for transmission on waves longer than

about 5000 metres, diffraction alone is wholly inadequate to account for the signals obtained.

If now we assume the presence of some reflecting or refracting layer, the foregoing mathematical theory can be applied at a distance large compared with H, but small relatively to the earth's radius, so that the curvature can be neglected.

In actual practice the interference between the large number of terms postulated by the theory is not present, and this may be accounted for by assuming that the layer is a good reflector only for glancing incidence; in this case it can be shown that only the zero order term remains (with $m = s$, $\beta_s = 0$),

$$i.e. \qquad \frac{120\pi hI}{2H\sqrt{\lambda x}} E^{-\alpha x/\sqrt{\lambda}}$$

apart from the direct wave, which, varying inversely as the distance, is negligible at greater distances than a few hundred kilometres.

Now the experimental results show that the observed signal strength E can be expressed very well by a formula of this type in which the value of H is approximately 40 km. This must be regarded as only an equivalent value since the lower surface of the layer is probably very ill-defined. T. L. ECKERSLEY.

Marconi's Wireless Telegraph Co., Ltd.,
Chelmsford, March 20.

The Absorption of Cathode Rays in Aluminium.

IN a recent paper in the *Physical Review* (December 1924), H. M. Terrill gives some measurements of the variation in the fraction of a beam of cathode rays transmitted by an aluminium foil when the velocity of the rays is varied. These results are not in agreement with those published by me (Proc. Roy. Soc. A, vol. 104, 1923); and the author states that "Whiddington, and later Schonland, worked with rays of uniform velocity produced by magnetic sorting, but the results obtained by them are not in agreement with each other nor with those of the earlier writers. It is believed that the lack of agreement in these results may be traced to the difficulties of velocity determination."

This is scarcely correct. A variety of causes rendered the work of the earlier writers unsatisfactory from a quantitative point of view, while the experiments of Whiddington suffered from an important defect, for no precautions were taken against the disturbing effect of the emission of secondary rays from the foil. My apparatus was designed to remove this source of error, and when allowance is made for the secondary emission, Whiddington's results are in satisfactory agreement with my own.

Dr. Terrill's explanation of the difference between his results and mine would require a correction to my values of $H\rho$ amounting to about 20 per cent., while I am certain that they are not at fault by more than 2 per cent., the measurements having been repeated with a new and differently wound solenoid.

That the difference is, however, not due to this cause at all but to the experimental arrangement for measuring the fraction transmitted, is shown by the fact that our results for the velocity of those rays which are just unable to penetrate the foil (the "Range" velocity) are in close agreement. Thus, for a foil 0·00031 cm. thick he finds 19,000 volts, and I, 19,500 volts for the P.D. corresponding to this velocity. This indicates that my velocity measurements are substantially correct and that the differences between our results arise from errors in the measurement of the fraction transmitted.

I believe that Dr. Terrill's arrangement for this purpose is open to criticism, principally owing to the method adopted to prevent the emission of secondary rays from the foil, but also to the fact that so small a fraction (< 1/1000) of the cathode ray beam was employed in the actual measurements. I have had experience of both these causes of error and found them to be very serious.

B. F. J. SCHONLAND.

University of Cape Town,
February 18.

Adsorption of Acids by Purified Silica.

IN the issue of NATURE for January 31, p. 157, it has been stated that hydrated silica free from all impurities adsorbs acids. The amounts adsorbed by these samples are, however, small. We have since found that if thoroughly washed hydrated silica prepared from pure silicon tetrachloride be allowed to be partially dehydrated in air at room temperature, it shows a marked increase in its capacity to adsorb acids, as the following data will show:

Electrolyte.	Concentration.	Amount of Adsorption per 10 grams of Hydrated Silica.
Oxalic acid	N/2	46·0 c.c. of N/10 solution
	N/10	7·5 ,, ,, ,,
	N/50	1·0 ,, ,, ,,
Potassium oxalate.	N/2	45·0 ,, ,, ,,
	N/10	7·5 ,, ,, ,,
	N/50	1·0 ,, ,, ,,
Sodium oxalate	N/10	7·5 ,, ,, ,,
	N/50	1·0 ,, ,, ,,
Hydrochloric acid	N/2 (F:1·08)	42·0 ,, ,, ,,

The samples are free from all impurities. At equivalent concentrations, neutral oxalates and oxalic acid show equal adsorption of the oxalate ion, which, together with the increase in the negative charge of the silica in contact with solutions of neutral salts of low concentrations, proves that we are dealing with anion adsorption as suggested by the writer to account for the latent acidity of sour soils. The large amounts of acids adsorbed leave no doubt that Joseph and Hancock were mistaken in stating that purified silica cannot adsorb acids. That they could not observe any adsorption of acids by silica was due to their using ignited silica, as we have found that on ignition the power of silica to adsorb acids greatly diminishes.

In my previous letter referred to above, a mistake occurs (page 158) in the P_H value for the acidity developed on interaction between barium chloride and potassium sulphate. The value given was 2, whereas it should have been 5.

J. N. MUKHERJEE.

University College of Science,
Calcutta.

Method of Measuring Deep Sea Tides.

IN the course of a conversation with William Beebe regarding plans for work to be done on his oceanic expedition, my attention was directed to the fact that no method had been devised up to the present time for recording the rise and fall of the tides except in comparatively shallow waters. It appeared that the Hydrographic Office was very anxious to have data regarding the tides at localities where the depth of the ocean was measured in miles.

The problem looked rather hopeless at first sight, but on thinking about it, the idea occurred to me that if we could make an artificial island, reaching up from the sea floor to within a few feet of the surface, the rest would be easy. Such an island could be made by means of a submerged buoy

anchored to the sea bottom by a wire. If the ocean were calm, and there were no currents, this buoy would remain in a fixed vertical position above its cement anchor at a constant distance from the ocean floor. If the buoy contained a self-recording barograph of special design operated by the pressure of the water above the buoy, the periodic rise and fall of the tide would be recorded.

Other factors might, and probably would, be present which would cause a variation in the height of the water above the buoy. Ocean currents, by causing the buoy to swing out from the vertical, would depress it, and there would of course be a rapid periodic change due to waves. It seems probable, however, that if the curve drawn on the revolving drum of the barograph was subjected to analysis by passing it through such a machine as Prof. Michelson's harmonic analyser, the tide curve would come out uncontaminated by the variations contributed in other ways.

The scheme could be tried at very small cost. The first experiments should be made in comparatively shallow water (say three or four hundred feet), and the depth gradually increased. For deep sea work the position of the submerged buoy would have to be marked by a smaller surface buoy. The action of the wind on this would introduce another disturbing factor, which would disappear, however, in the analysis of the curve. R. W. WOOD.

Johns Hopkins University, Baltimore.

Electricity in Curved Space-time.

IT is often thought that the theory of curved space-time (general relativity theory) accounts for gravitation but *does not account for the electromagnetic phenomena*. This is not so.

In the general four-dimensional space, the Riemann tensor which characterises the curvature at each point can be shown to be the sum of two parts. We may characterise these two parts geometrically, using Hamilton's device of telling what a thing is by telling what it does. What a Riemann tensor does is to assign to every two-dimensional direction, or orientation, a certain number—its curvature; the first of the two parts mentioned above is characterised by the property that it assigns to two (absolutely) perpendicular orientations *equal* curvatures, while the second part assigns to such orientations *opposite* curvatures. We may mention that of the twenty constants which are needed to give the complete Riemann tensor, the first part involves 11 and the second 9.

In the case of the physical space-time, the first part accounts for gravitational phenomena and the second for electromagnetism; we do not know much about the first part outside the fact that it satisfies the so-called cosmological equations (in fact, to say that a Riemann tensor satisfies the cosmological equations is equivalent to the statement that it only consists of the first part). Our information with respect to the second part is much more complete: if f_{ij} is the electromagnetic tensor and r_{ij} the tensor associated with its reciprocal or dual, the second part can be written as $\frac{1}{2}(f_{ij}f_{kp} - r_{ij}r_{kp})$; conversely, if the second part is given in a region of space-time, this determines the electromagnetic tensor in this region. This result follows easily from an earlier work of the writer (Proc. Nat. Acad. of Sciences, April and July 1924; Trans. Amer. Math. Soc., January 1925).

G. Y. RAINICH.

The Johns Hopkins University,
Baltimore, Md., U.S.A.,
February 20.

Artificial Incubation.

IN the account of Mr. Llewelyn B. Atkinson's article on "The Scientific Principles of Artificial Incubation" (NATURE, February 21, p. 282), the author is quoted as saying that practically every type of incubator has the air too dry. If this is so, the number of eggs hatched should be dependent to some extent on the humidity of the outside air. That this is the case is we think borne out by the following. We took the percentages of fertile eggs hatched out at Fishponds Poultry Farm, Netley Abbey, and correlated the figures with the relative humidity deduced from the dry and wet bulb readings at Calshot, four and a half miles distant. The hatchings considered were from December 17, 1923, to March 12, 1924; there were hatchings on 26 days; the largest number of eggs hatched out on any one day was 95, the smallest two 37 and 60; the highest percentage of fertile eggs hatched on any one day was 93·2, the lowest 63·5. The readings at Calshot are those taken four times in the twenty-four hours, and we have taken them from the Daily Weather Report. The following values were found for the correlation coefficient between the percentages of hatchings and the mean relative humidity for various periods:

	Day of Hatching.	7 Previous Days.	14 Previous Days.	21 Previous Days.
Correlation coefficient .	0·31	0·55	0·69	0·68
Standard error .	0·18	0·14	0·10	0·11

It seems, therefore, that the hatchings were dependent to some extent on the mean relative humidity of the outside air during the greater part of the period of incubation. C. J. P. CAVE.
T. VERNON JONES.

Stoner Hill, Petersfield,
March 12.

Solutrean Art.

PROF. SOLLAS, in his letter to NATURE, March 21, p. 420, refers to M. Peyrony's interesting discovery of a carving in high relief in a Solutrean level in the Dordogne. In this connexion it is worth noting that, some months before M. Peyrony's discovery, Dr. Henri Martin had found fragments of limestone bearing engravings of animals in an Upper Solutrean site (still unpublished) in the Charente.

These two finds, so nearly simultaneous, are very important, as Prof. Sollas points out, but it is only fair to recall the fact, apparently overlooked both by M. Peyrony and Dr. Martin, that the credit of being the first to find a work of art in an undoubted Solutrean milieu belongs, not to either of them, but to the Abbés A. and J. Bouyssonie and L. Bardon, who in 1908 found in the Upper Solutrean level of the rock-shelter Pré-Aubert near Brive a slab of sandstone engraved with the rough but unmistakable figure of a horse (*Revue anthropologique*, 1920, p. 188.)

At a moment when discoveries of Solutrean art are exciting great interest both in Great Britain and in France, it is merely just that full credit should be given to the three indefatigable scientists whose work, so little advertised, has been of such fundamental importance to prehistoric archæology.

D. A. E. GARROD.

85 Banbury Rd.,
Oxford.

Mutation.[1]

By Prof. R. Ruggles Gates.

THE term mutation in the modern sense means a discontinuous germinal change. Conceptions of continuity or discontinuity have played an important rôle in the history of thought not only in biology, but also in other sciences, notably physics and geology. In the latter science the earlier and cruder theories of catastrophism, in which the sudden extinction of floras and faunas was followed by the creation of new ones, were superseded by the uniformitarianism of Lyell. This, coupled with the slow and gradual modification of species as upheld by Darwin, led to a complete triumph of "continuity." But with the followers of Darwin it frequently reached an extreme expression which was not in accordance with the facts of biological variation. It was thought that variations which were often spoken of as infinitesimal, could be accumulated in any direction to produce new species. But to produce a new species by this method, such accumulation of infinitesimals must take place simultaneously in several diverse directions, for species differ from each other in a number of independent characters.

Neither Darwin himself nor Wallace ever contemplated infinitesimal variations as a source of new species. Darwin was at pains to show that the gaps between species or varieties could frequently be bridged by intermediate steps, but he was too widely observant of actual variations in plants and animals to make the mistake of assuming complete continuity in all variation. The innumerable cases of variation which he cites in the "Origin" and the "Animals and Plants" usually concern differences which are relatively large compared with many which we now cite and study as discontinuities. The mutations of Drosophila, for example, such as the eye colour series, represent differences which are smaller than anything upon which Darwin relied for the origin of new forms. When all these eye colours are placed together they represent so close a series that to the average naturalist they appear to show complete continuity even under the microscope; and even the expert can scarcely sort all the individuals belonging to the different types in this series with certainty. Yet we know that they arise as marked discontinuities and not as steps in a consecutive series. They are moreover independently inherited, belonging often to quite independent groups of characters.

Biological controversy on this subject has oscillated somewhat like a pendulum gradually coming to rest. Each time the upholders of continuity have pointed out an apparently continuous series, their opponents have replied by showing progressively smaller discontinuities within the series. Waagen, Korschinsky, Bateson, W. B. Scott, de Vries, Morgan and others have taken part in this controversy.

Continuity or discontinuity is then a purely relative matter. Series of variations which Darwin and his contemporaries would have regarded as showing complete continuity biologists of this generation have shown by breeding experiments to be inherited as independent units. The essential point is not whether the series appears continuous or not, but whether the differences depend on fixed inherited units. Two series of variations may overlap so as to appear like a single continuous series and yet may depend upon two independent units of inheritance.

When we touch modern physics discontinuity appears everywhere. To the senses matter is continuous, but no scientific man doubts the atomic and molecular, that is, the discontinuous, structure of matter. The atom itself, once regarded as an ultimate unit, is now decomposed into electrons with definite orbits revolving about a nucleus, the analysis of which into protons and electrons has only just begun. Planck's theory of quanta of energy or action extends discontinuity from matter into the field of energetics, and even radiation is now considered as a discontinuous process. Sir Oliver Lodge, in his presidential address to the British Association at Birmingham in 1913, said, "So far from nature not making jumps, it becomes doubtful if she does anything else." Even the ether of space is not retained as a continuum to serve as a background for these physical events. It cannot be adequately used in physical theory except by giving it a granular, that is, a discontinuous structure.

I refer to these similarities in the history of physics and biology, to show that discontinuity is a philosophical necessity in scientific analysis. The mere process of analysis of any structure, however large or small, whether it be a star, a chromosome or an atom, endows it with parts which have relations with each other and are more or less disconnected.

The real problem for the biologist is, then, to determine whether his units in the study of variation are rightly chosen, so that the laws of their inheritance can be followed. In the modern point of view, variations are of two sorts: (1) mutations, which form a new point of departure and are inherited, and (2) fluctuations, which are merely deviations grouped on either side of the mean, produced by environmental or nutritional disturbances and not inherited. This distinction we owe to de Vries, whose "Mutation Theory," first published in 1901, marked, together with the rediscovery of Mendelism, the beginning of a new era in the study of evolution.

Before outlining the theory of mutation, in the later development of which my own work has played some part, I wish to refer briefly to a few of the earlier observations and theories of discontinuity in variation. The earliest actual mutation recorded is that of *Chelidonium laciniatum* Miller, a subspecies derived from *C. majus* Linn. the common celandine, a monotypic genus of the poppy family. This laciniate variety was found by an apothecary named Sprenger growing in his herb garden at Heidelberg, about 1590, among typical plants. It was new and unknown to the botanists of his time; it bred true from seeds and has continued to do so ever since. It differs from the type in having laciniate petals and leaves. Such variations are by no means uncommon, the cut-leaved varieties of many trees such as the birch, etc., being of this character.

We need not pause here to consider whether the laciniation first arose at the time when it became

[1] From a lecture delivered at King's College, University of London, for the Board of Studies on the History, Principles and Methods of Science.

externally visible or whether it had been carried germinally as a recessive condition for some previous time. Nor need we probe here the question whether the germinal change involved arose in a pure line or in a line the ancestors of which had been derived from the intercrossing of distinct types within the species. Something distinct and new has declared itself, and we call it a mutation, recognising that further analysis will throw much light on the precise manner of its origin, that is, the nature of the germinal change involved.

The conception of discontinuity in evolution did not originate with de Vries, although he was the first to investigate it by experimental methods. Without tracing its sources in biology, its modern emphasis began with Bateson, whose "Materials for the Study of Variation," in 1894, marked a reaction from the morphological problems then current in zoology and from the post-Darwinian attempts to explain evolution entirely through the accumulation of infinitesimal variations by natural selection. Bateson's subsequent development of Mendelian theory has been a continuation of views there set forth.

Another work which had an important effect, especially on botanical thought, was the "Intracellular Pangenesis" of de Vries, first published in 1889. The views there expressed were themselves derived from the development and modification of Darwin's provisional hypothesis of pangenesis, set forth in the last chapter but one of the "Variation of Animals and Plants under Domestication." This hypothesis of representative particles or gemmules assumed that every cell of the body is represented by particles which multiply by division as the organism develops. These particles (1) not only grow and multiply and are thrown off from the cells, but (2) they "aggregate themselves into buds and the sexual elements," by this means transmitting their qualities to the next generation. The hypothesis of de Vries discarded the second part of Darwin's hypothesis (which Darwin had introduced to account for the assumed inheritance of acquired characters) while limiting the first part, so that pangens were not extruded from the cells but controlled the development of a cell by passing from its nucleus into the surrounding cytoplasm.

Both Strasburger in cytology and Pfeffer in plant physiology adopted the term and the conception. The necessity for some such conception to account for the phenomena of development and heredity has been felt by many other physiologists, such as Verworn with his biogens. Physiologists who deny the necessity for such a conception have not occupied themselves seriously with the study of heredity. Chromosome division in mitosis must itself be looked upon as an hereditary process—an essential act of reproduction—and the chromosome as a body composed of autogenetic substances which show alternately the phenomena of growth or multiplication and division. The chromosome, as the most conservative body in the cell, thus makes possible the phenomena of heredity. The autogenetic particles which it is assumed to contain tend with increasing knowledge to lose their "representative" character and to become more purely chemical aggregations.

The whole history of the many conceptions of biological units furnishes but another example of the necessity for discontinuity in scientific analysis. The modern gene or factor, which is essential to the explanation of Mendelian heredity and mutation, is the same particle under another guise, the properties and modes of action of which are gradually becoming more precisely defined. Each such gene may have come into existence through the alteration of a previous element, and not necessarily through the loss or gain of a "particle." The philosophical necessity which Darwin himself felt, and which was the *raison d'être* of his hypothesis of pangenesis, has been followed by a long historical chain of representative particles, such as the ids and biophores of Weismann, down to the modern gene, which has been stripped of some of its mystery but is still essential for an explanation of the phenomena of heredity and variation.

In the original work of de Vries with *Oenothera Lamarckiana*, a number of new forms or mutations were described as arising, which usually differed from the parent in a number of features. Later cytological investigations, beginning in 1906, made it clear that the origin of many of these new types was concerned with changes in the number of chromosomes. This finally led to the formulation of the cell theory of mutation,[2] in which it was indicated that Mendelian mutants, such as *Oe. brevistylis* and *Oe. rubricalyx*, had arisen as the result of a change in one element or gene of a chromosome, while such mutants as *lata* and *incurvata*, which possessed an extra chromosome, had appeared in connexion with an irregular reduction division of the chromosomes in the parent. Since the extra chromosome was found in every cell nucleus, the conclusion was clear that a mutation represented a germinal change which was transmitted by mitosis to every cell. This point of view has been strengthened by many subsequent discoveries. A whole series of Oenothera mutations with 15 chromosomes is now known.[3]

The origin of the mutant *Oe. gigas* involved still a different type of germinal change, for in this case the chromosome number was doubled (28). This was the first instance in which tetraploidy was shown to occur under experimental conditions. *Oe. gigas* is so distinct from *Oe. Lamarckiana* in all its characters that if found wild it would undoubtedly be described by systematists as a new species. There is even a conspicuous change in the shape of the pollen grains. Polyploidy, or the multiplication of the chromosome series, is now known to have played a part in the evolution of many plant genera.[4]

Another conception based upon the discoveries with Oenothera is that of parallel mutations. It was shown originally in 1912 that *Oe. biennis* can produce a *lata* mutation having the foliage peculiarities, sterile pollen and 15 chromosomes of the *lata* derived from *Oe. Lamarckiana*, but having the small flowers of its parent *Oe. biennis*. Innumerable cases of such parallel mutations are now known,[5] and the principle is bound to play an important part in the future interpretation of phylogenies.

Many other developments in the theory of mutation have occurred since 1901. The experimental work with Mendelism and mutations has shown that these two fields of research are fundamentally in harmony and can be further developed under a common point of view.

[2] Gates, "The Mutation Factor in Evolution," 1915.
[3] Gates, "The Trisomic Mutations of Oenothera," *Ann. of Bot.*, vol. 37, p. 543, 1924.
[4] "Polyploidy." *Brit. Journ. Exptl. Biol.*, 1, 153-182, 1924.
[5] See for example Gates, "Mutations and Evolution," 1921.

The Manufacture of Blue Water Gas.

THE manufacture of water gas first became an industrial proposition in 1873 with the introduction of the intermittent system by Strong and by Lowe in the United States. Strong, who aimed at manufacturing blue water gas mainly for heating purposes, utilised the heat value of the "blow" gases to superheat the steam admitted to the generator. Lowe, on the other hand, aimed at producing a gas of high illuminating value, and utilised the large quantities of combustible gas produced during the "blow" periods for heating chambers in which enriching oil was decomposed. No real progress in the manufacture of water gas in Great Britain was made until 1888, when a plant was installed at the Leeds Forge. Since that time the utilisation of water gas has advanced rapidly, and the manufacture of water gas, both blue and carburetted, is now an important auxiliary in the production of gas for town supply.

The blue water gas process, according to general British practice, may conveniently be divided into two distinct operations. The hot fuel, usually coke, is first raised to a high temperature by the admission of air at such velocity that the pressure below the generator grate is 12 to 18 inches water-gauge. This operation, known as the "blow," occupies from one to three minutes. The gases produced are blown away to the atmosphere through the stack, either directly or after combination with air and passage through a waste heat boiler. When the temperature of the coke has been raised to the required degree, the air supply is closed, and the bed of fuel is submitted to the action of steam supplied at a measured rate. The steaming operation, which is known as the "run," occupies from four to ten minutes according to the cycle of operations adopted. The blow and run operations are carried out alternately during a period of several hours, at the end of which the operations are suspended for the removal of ash unless mechanical grates are provided.

BLOW PERIOD.—The addition of heat to the bed of fuel during the blow period results mainly from that developed by the oxidation of carbon to carbon monoxide and carbon dioxide, and provided other conditions remained unchanged, the degree of heat addition would be dependent on the proportion in which these two gases are produced. The principal reactions which take place may be represented by the equations:

$$(1)\quad C + O_2 = CO_2 + 97{\cdot}3 \text{ Cal.}$$
$$(2)\quad C + \tfrac{1}{2}O_2 = CO + 29{\cdot}0 \text{ Cal.}$$

The aim during the air-blow should therefore be to obtain the maximum amount of carbon dioxide and the minimum of carbon monoxide. The first reaction predominates at lower temperatures and the second at higher temperatures. The efficiency of heat generation therefore decreases with rise of temperature.

RUN PERIOD.—When steam is passed over incandescent coke, of the reactions which occur, consideration should be given to the following:

$$(3)\quad C + H_2O = CO + H_2 \textit{ minus } 29 \text{ Cal.}$$
$$(4)\quad C + 2H_2O = CO_2 + 2H_2 \textit{ minus } 19 \text{ Cal.}$$

At temperatures above 1000° C., the products of reaction of steam and carbon are almost entirely carbon monoxide and hydrogen. At lower temperatures the importance of reaction (4) increases, and the proportion of steam decomposed decreases.

From consideration of the reactions which take place in the intermittent process of manufacture of water gas, it is clear that in order to obtain high efficiency of heat addition during the air-blow, the fuel must be kept at a comparatively low temperature, and the time of contact of the gases with the hot fuel must be small. On the other hand, to obtain a high efficiency during the steaming operation, the fuel should be kept at a high temperature, and a longer time of contact must be allowed. It is evident, therefore, that these opposing factors must be taken into account in determining the conditions of best efficiency for the whole process.

During recent years, the large scale production of water gas has been the subject of investigations by a Research Committee of the University of Leeds and the Institution of Gas Engineers, and by the Fuel Research Board. From the data procured, thermal balances were constructed. As an example of a thermal balance under conditions typical of British practice, the following is taken from the tenth report of the Research Committee of the Institution of Gas Engineers:

HEAT BALANCES IN THERMS PER 1000 CUB. FT. WATER GAS MADE.

Heat supplied—		
(*a*) Coke to generator		4·900
(*b*) Fuel to raise steam to generator		0·551
(*c*) ,, ,, ,, turbine		0·643
(*d*) Sensible heat of air to blower	Minus	0·001
		6·093
Accounted for as follows—		
1. Water gas, potential heat		2·960
2. ,, ,, sensible heat		0·171
3. Steam not decomposed (total heat)		0·163
4. Blow gas, potential heat		1·042
5. ,, ,, sensible heat		0·462
6. Heat lost in raising steam to generator		0·165
7. ,, ,, ,, ,, turbine		0·193
8. Heat of steam used and lost in turbine and blower		0·446
9. Ashes, potential heat		0·207
10. Clinker ,, ,,		0·017
11. Dust ,, ,,		0·070
12. Ashes, clinker, and dust, sensible heat		0·020
13. Losses, not separately determined, leakages, radiation, convection, etc. (difference)		0·177
		6·093

In a paper presented a short time ago to the Institution of Chemical Engineers, Dr. M. W. Travers has studied the results of the investigations previously mentioned. Dr. Travers is of the opinion that in addition to thermal balances of the type illustrated, thermal accounts should be constructed to show the amounts of heat added to the fuel during the blow periods and abstracted during the steaming operations. These two amounts of heat should be identical provided that the whole of the necessary data is available with a high

degree of accuracy. The problem, however, is complex, and many other factors in addition to the main carbon-oxygen and carbon-steam reactions must be considered. The coke supplied to the generator invariably contains moisture, hydrogen, sulphur, nitrogen, and ash, and these constituents take part in a number of reactions which cannot be neglected. The amount of water vapour in the air supplied to the generator also has an important effect on the heat account. Separate thermal accounts for the "blow" and "run" periods would undoubtedly be of value, but further study of the subject is required before these can be constructed with sufficient accuracy to enable trustworthy conclusions to be drawn. A. PARKER.

Obituary.

PROF. AXEL WIRÉN.

THE death of Prof. Axel Wirén of Upsala has deprived zoology of an able original worker and a distinguished teacher in the University of Upsala. Born on July 12, 1860, in Eskilstuna on the western or landward side of the province of Sodernau Land, about 50 miles west of Stockholm, and the eastern border of which (province) reached the sea, Wirén received his early education at the school of Norrköping, in which his matriculation examination also took place, and he afterwards entered the University of Upsala, where he graduated as Ph.D. in 1885, his thesis being on the circulatory and digestive organs of certain families of polychæts.

From the first the young graduate was attracted to marine zoology and at a time when several departments were sorely in need of scientific advancement. He set himself to work up the zoology of Upsala, especially the chætopods, and by and by he published a series of important researches in the Kongl. Svensk. Vetersk.-Akad. Handl., all finely illustrated by his artistic pencil, the plates varying in number from 5 to 10 (4to) in each communication. The accuracy and beauty of these plates and the value of the accompanying researches would alone have given him a solid reputation. They dealt chiefly with the circulatory and digestive organs of the polychæts, though the minute anatomy of the solenogastres was also worked out with conspicuous ability. Amongst his interesting novelties was the discovery of *Hæmatocleptis terebellidis*, a parasitic eunicid living in the wall of the chitinous stomach of *Terebellides Strœmi*—just as Spengel had found another polychæt, *Oligognathus Bonelliæ*, in the cœlom of Bonellia. Besides other papers he published one on *Nereilepas fucata* in its atokous and its epitokous forms, and the changes in its body-wall, as well as a work on the elements of zoology, a useful treatise for his students. He also gave an account of a visit he made to the museums and zoological institutes of Germany in 1891.

Besides his own strenuous labours in upholding zoology at Upsala—mindful of his responsibilities—Wirén encouraged the young graduates and others to carry on original work in his department, and exerted himself in founding the zoological institute of the University from which many important memoirs were issued. These were published in the series of the "Zoologiska Bidrag från Uppsala" (large 8vo), edited by Prof. Wirén. The perusal of these fine memoirs (the expense of which was partly defrayed by the generosity of the late consul, R. Bünsow) raises a feeling of regret that, in a great country like Britain, zoological institutes on the sea beach should be closed for lack of men, interest, and money, instead of continuing the fascinating researches in marine zoology and botany—not to allude to the importance of these in connexion with the fisheries.

Prof. Wirén was elected to the chair of comparative anatomy at Upsala in 1893, after holding various minor posts. He became professor of zoology and Director of the Zoological Institute in 1908, and held these offices until his death on January 22 last. He worthily served his country and science.

W. C. MCINTOSH.

MR. W. H. FINLAY.

A CORRESPONDENT at Cape Town sends us some particulars of the life and work of Mr. William Henry Finlay, formerly chief assistant in the Royal Observatory, Cape Town, who died there on December 7, 1924. Mr. Finlay was born at Liverpool on June 17, 1849, and educated at Liverpool College School. He proceeded to Trinity College, Cambridge, graduating 33rd Wrangler in 1873. In the same year he was appointed first assistant at the Cape Observatory, when Mr. Stone, who succeeded Sir Thomas Maclear, was H.M. Astronomer. Mr. Stone's directorate is chiefly remarkable for the enormous amount of arrear reductions of transit observations which he accomplished, and for his well-known 1880 Cape Catalogue of Stars. In all this work Mr. Finlay took his full share.

As an observer, Mr. Finlay was very zealous in the observation of comets and occultations of stars. He independently discovered the great comet of 1882, and also one, which bears his name, in 1886, and undertook the difficult task of computing its elements as well as of many another. Perhaps in astronomical circles he will be best remembered by his excellent Star Correction Tables, which exemplify the clear grasp he had of his subject, and the orderly practical habit of his mathematical mind.

In addition to his purely astronomical work, Mr. Finlay took an active part in the geodetic work which Sir David Gill, who succeeded Mr. Stone, undertook during his famous directorate. He took the principal share in the longitude operations for connecting Aden with Cape Town, and on his voyages to and from Aden he took advantage of the short stoppages of the steamer at Delagoa Bay, Quilimane, Mozambique, and Zanzibar to determine local time at these places with portable instruments, and to exchange time signals with Cape Town. These observations and the resulting longitudes were published in the Monthly Notices of the Royal Astronomical Society.

In 1887 Mr. Finlay undertook the discussion of the tidal records of Table Bay and Algoa Bay, and the result of his analysis, which is published in the Journal of the South African Philosophical Society, is still the

basis for all tidal predictions at those ports. In addition to these activities, he became the general secretary of the Society from 1881 to 1887, in which year he was elected president. He was also a member of the Cape Meteorological Commission.

When the staff of the Royal Observatory was reorganised in 1897, Mr. Finlay was appointed the chief assistant, but owing to ill-health he was obliged to retire on pension the following year. He spent several years in England, where he completely regained his health, and upon his return to South Africa he took up the work of teaching, a task for which he was eminently suited. When Prof. Williams, of the Rhodes University, Grahamstown, left South Africa to take part in the War, Mr. Finlay took his place as professor of mathematics and surveying, and he remained there at work after Prof. Williams had returned, to within a few days of his death.

LÉON MAQUENNE.

LÉON MAQUENNE, whose death is announced, was born in 1853, and will be remembered as one of those able experimenters and clear-sighted research workers who made notable discoveries in the domain of organic chemistry when the science was still in its infancy and before any really definite views as to the structure of carbon compounds, especially those of natural origin, had been developed. His most noteworthy contributions deal with the structure of the sugar alcohols, important naturally occurring substances which, for many years, resisted the attack of the chemists of his time, and his first achievement in this field was the determination of the constitution of inositol, a compound which occurs widely in both the animal and vegetable kingdoms. He was able to show that this sugar alcohol was hexahydroxycyclohexane, and thus not only established the structure of the first member of an important new series, but also indicated the close relationship which exists between substances produced in the organism and benzene.

Maquenne was also successful in determining the constitution of perseitol, a seven carbon sugar alcohol which occurs in the leaves of *Laurus Persea*, but his most outstanding work in this connexion was probably the isolation of the dextro form of erythritol by the reduction of *l*-threose, a discovery which was shortly afterwards supplemented by the preparation of *d*-erythritol by his pupil Gabriel Bertrand, who isolated it by the action of the "sorbose bacterium" (bacterium xylinum) on natural erythritol. The two enantiomorphs were then united to form the *racemic* modification which was found to be identical with the compound which Griner had synthesised in 1893 from divinyl. The natural form of erythritol is the *meso* modification, but both the *meso* and *racemic* stereoisomers were prepared by Griner in his synthesis.

Of special importance also is the work carried out by Maquenne on starch, which is embodied in a series of papers published during 1904 and 1905. One outcome of this investigation was the discovery, made with Eugene Roux, that crude starch is a mixture of amylose and amylopectine.

During recent years Maquenne turned his attention more particularly to biochemical problems, and he was able to elaborate many important and delicate methods of analysis. His great range of knowledge led him, however, to carry out researches over a wide field, and to him, amongst other things, is due the preparation of pure acetylene from barium carbide, as well as the method of eliminating nitrogen from the air by means of metallic magnesium, which was ultimately used by Rayleigh and Ramsay in the preparation of argon.

ALL who are concerned in the world of shipping and in the electrical industry will learn with regret of the death on March 17, a few hours before his forty-sixth birthday, of Mr. W. W. Bradfield, general manager of the Marconi International Marine Communication Co., Ltd. Practical radio telegraphy, particularly in connexion with shipping, owes much to Mr. Bradfield, whose connexion with the Marconi Company dates from September 3, 1897, when he entered what was then known as the Wireless Telegraph and Signal Company, Ltd. As electrical assistant to Senatore Marconi, in the earliest days of commercial wireless, Mr. Bradfield took part in experimental work on Salisbury Plain, and assisted in the erection of the wireless station at the Needles, Isle of Wight. In the year 1899 he installed the first wireless apparatus on British battleships, and a little later took charge of the demonstrations to the United States Government on board the U.S. battleship *Massachusetts*, while in 1901 he undertook similar demonstrations before the French Government, when communication was established between the French Riviera and Corsica. In the same year he supervised the erection of the famous stations at Siasconset (Nantucket Island) and the Nantucket Lightship. From 1902 until 1908 Mr. Bradfield was chief engineer to the Marconi Wireless Telegraph Company of America, and during this time he took part in the first International Radio-Telegraphic Conference, held in Berlin in 1906.

SIR WILLIAM PECK had occupied the post of City Astronomer of Edinburgh, in charge of the Calton Hill Observatory, since 1889, when the erection of the new Royal Observatory on Blackford Hill set the older building, with most of its instruments, at liberty. He was of an active and inventive mind, and interested in all mechanical pursuits, besides astronomy. He constructed many of his own instruments. He was, in addition, a popular lecturer of considerable power and attraction, and was the author of a popular "Handbook and Atlas of Astronomy" and other works. The City Observatory was devoted chiefly to showing the heavens to visitors — a service much appreciated by the citizens. For this purpose a six-inch photovisual telescope, presented to the observatory, was of good service. In pursuance of the science, Sir William Peck visited Spain for the eclipse of 1905, and Egypt in 1908. He received the honour of knighthood in 1917. He died on March 7, after a long illness, aged sixty-three years.

WE regret to announce the following deaths:

Prof. A. Dendy, F.R.S., professor of zoology in the University of London (King's College), on March 24, aged fifty-nine.

Mr. H. E. Jones, president in 1917 of the Institution of Civil Engineers, on March 24, aged eighty-two.

Current Topics and Events.

IT has been common knowledge for some time in the scientific world that the Royal Society intended to dispose of part of the collection of early printed books in its library, especial attention having been directed to the fact in the report of Council issued to fellows in November last, and published in the Year Book of the Society. While it is true that during the last few years the Society has received large gifts of money, it has to be borne in mind that without exception the application of such moneys has been limited to certain definite objects, and none is available for the general purposes of the Society, however badly it may be needed; that, no doubt, explains the last sentence of the president's letter to the *Times* of March 27, "As circumstances stand, sentiment must be tempered by practical expediency." The larger portion of the books are relics of the collection presented to the Society in 1666 by Henry Howard, afterwards Duke of Norfolk, and only those volumes which have no scientific interest or are duplicates are being offered for sale; but two of the books which are likely to fetch very high prices—a Bible, and Richard Baxter's "A Call to the Unconverted," both translated into the Massachusetts Indian language—were presented to the Society in 1669 by John Winthrop, Governor of Connecticut. One of the features of the collection is a series of several hundred Reformation Tracts printed in Germany, more than one hundred of these being by Martin Luther. Among other books of interest are Caxton's second edition of "The Canterbury Tales," 1484, Fust's "Liber Sextus Decretalium" (1465), and Cicero's "De Officiis" (1466). A first edition of Euclid, included in the sale, is a duplicate. It is the intention of the president and Council that the proceeds shall be kept as a separate fund, known as "The Arundel Library Fund," to be used for the purchase of scientific books. A nucleus has already been formed by the sale to the British Museum, at its own valuation, of some seventy items.

THE Council of the Institution of Electrical Engineers has addressed a letter to the Postmaster-General stating that some of the provisions of the Wireless Signalling Bill are of such far-reaching importance that unless they are modified they will prove a serious hindrance to electrical and physical research. In particular the Council desires that it should be made perfectly clear that the words "any apparatus for wireless telegraphy" apply only to such apparatus when used for signalling purposes. Crystal detectors and radio valves, for example, are used in many physical laboratories for testing apparatus and materials which have no connexion with radio signalling. It should be clearly stated in the Bill that licences are not required in these cases. It is also recommended that all regulations made by the Postmaster-General under Clause 3 (Regulations and Fines) of the Bill should be submitted to a statutory advisory committee for consideration, and it is suggested that the committee should be representative of the Royal Society, the Institution of Electrical Engineers, the Radio and other interested societies. We think that this suggestion is a good one and would form an effective barrier against legislation which might injuriously affect research. It is also pointed out that Clause 7 of the Bill, which applies its provisions to the use of etheric waves for the transmission of energy, may greatly interfere with research and industrial development. A new clause might be substituted for it rendering liable to penalties any one using electromagnetic radiations of the frequencies commonly employed in radio telegraphy in such a way as to affect injuriously the working of authorised radio telegraphic stations. It is conceivable that in the future important industries may be founded on the transmission of energy by etheric radiations. Several suggestions for utilising these radiations have already been made, and it would not be in the national interest to hamper unnecessarily research in these directions.

THERE has been a considerable addition to our knowledge of scarlet fever during the last year through the researches of G. F. Dick and his wife, Gladys H. Dick, of the John McCormick Institute for Infectious Diseases in Chicago. Hitherto the causation of scarlet fever, like the other exanthemata, has been completely obscure. It was not regarded as likely that any of these fevers were due to ordinary bacteria, for although bacteria have been constantly found in one and all of them, no single bacterium isolated has been able to reproduce the disease in man or animals. The Dicks have, however, obtained (1923) a streptococcus from a case of purulent infection of the hand of a nurse suffering from scarlatina, and have directed attention to certain of its peculiarities. The application of pure cultures of this streptococcus has been alleged to produce scarlet fever in man, and it is concluded that, after all, scarlet fever is probably a bacterial disease analogous to diphtheria in its general pathogenesis. The organism is supposed to produce a local lesion in the throat, and a soluble poison produced in this site is absorbed into the system and is the cause of the rash and some other manifestations of the fever. By applying the toxin of the streptococcus scarlatinæ to the skin, a very definite red area appears in some persons but not in others. Where this "Dick reaction" is positive the individual is presumed to be susceptible to scarlet fever. Where the reaction is negative the individual is immune. These reactions are strictly analogous to the Schick reactions in diphtheria. It is possible to pick out the immunes from the non-immunes, and by inoculating the latter it is hoped that scarlet fever can be completely controlled as diphtheria has been. These results of the Dicks have been confirmed in all important respects by trustworthy workers in the United States, and the subject is now receiving close attention in Great Britain.

A STEP towards the improvement of loan facilities between libraries of university rank in Great Britain has been taken by the Association of University

Teachers, which recently convened a Conference to consider the matter. As a result, regulations for inter-library loans have been approved, and inquiries are now being dealt with by Mr. Oldaker, the University, Edmund Street, Birmingham, to whom all correspondence should be addressed. The movement is a healthy one, for it represents a reaction against the policy of library inflation which was characteristic of library administration in the latter half of last century. It is now seen that the future needs of the research student can only be met by a pooling of the resources of our research institutions. We have, however, some doubt as to the wisdom of instituting at this stage the inquiry office in Birmingham. To provide prompt and accurate answers to inquiries as to the place of deposit of a given work presupposes the existence of an extensive collection of bibliographical serials and library catalogues which are to be found in few municipal or university centres. Moreover, the inquiry officer should have access to the work for the loan of which application is made. Further, the institution to which he is attached should be equipped with modern photographic copying apparatus. Few institutions comply with these requirements. The A.U.T. appears to have overlooked the fact that the bibliographical aspects of the problem should in the first instance have been left to the decision of bibliographers. We think it would be wise even at this stage for the A.U.T. to refer its proposals to a small committee of experts to consider whether the institution of a separate inquiry office is best calculated to secure the professed objects, and in case of an unfavourable answer, to authorise the committee to submit alternative proposals.

SIR OLIVER LODGE'S seventh and last "talk" of the series on "Ether and Reality," which is being broadcasted from the London station 2LO of the British Broadcasting Company, was given on March 31, and dealt with the probable utilisation of the ether. The ether or continuum has perfect properties, while matter is liable to deterioration and dissipates energy. No law of dissipation applies to the ether; matter exists not only inorganically but also as the complex molecules of protoplasm, which can be animated and made a vehicle for "life." But the coherence of all bodies is effected by the etheric connecting medium, and the question arises: Can that ether body be animated too? We usually ignore the ether body because it is outside the ken of our senses, but knowing what we know of matter and its fields of force, it is reasonable to suppose that we act more directly on ether than on the discontinuous particles of matter. All force is exerted through the ether, and it is thus that matter has become indirectly and apparently amenable to life and mind and memory and affection. These psychic attributes belong to the unseen universe; and if they require a physical medium, the ether is permanently available. Our material bodies have thus been built up, and are worked for temporary purposes of demonstration here and now, but they are imperfect and wear out. Mind may always need a vehicle, a body, a habitation, an instrument, but it need not be made of matter. It is doubtful if matter is ever really animated directly. Our present connexion with matter is probably indirect as well as temporary. Sir Oliver stated that, in his opinion, permanent reality lies in a region which does not appeal to the senses,—a region of inference; and to that region we really belong.

SIR ERNEST RUTHERFORD, in his discourse at the Royal Institution on Friday, March 27, on atomic nuclei, stated that the most direct method for determining the nature and magnitude of the forces that hold the atom in equilibrium, and the size and constitution of the nucleus, is to examine the scattering of swift α particles when they traverse matter. Such experiments have shown that the inverse square law appears to hold over the greater part of the space occupied by the atomic structure. It breaks down, however, when the α particle approaches very close to a light nucleus like that of hydrogen or aluminium. By studying the variation of the number of α particles of different initial velocity scattered nearly backwards from the bombarded material, it has been found that there is a sudden change in the law of scattering for aluminium for a definite velocity. Experiments made with thin films of gold and uranium show that the law of the inverse square holds to the closest distance of approach of the α particle to the nucleus, namely, about 3×10^{-12} cm. This is remarkable, for from radioactive information it is believed that the nuclear structure of uranium extends to more than twice this distance. A distribution of charged electric doublets in the form of satellites extending some distance from the central nucleus may account for these effects. Previous work has shown that a change in nuclear structure can be brought about by intense collisions between α particles and light nuclei, but the fate of the α particle after liberating a proton has been a matter of great uncertainty. Some recent experiments by Blackett show that in the case of nitrogen the α particle may be captured by the nucleus. Thus in the case of nitrogen there is on the whole a building up rather than a disintegration. This result is of great importance and interest, but we are still far from understanding the mechanism of such disintegrating collisions.

A SERIES of interesting demonstrations has been given at Messrs. Selfridge and Co., Ltd., London, W.1., by Mr. J. L. Baird, of an experimental apparatus of his own design for wireless "television" (*i.e.* the simultaneous reproduction at a distance of an image of a fixed or moving object). The inventor does not claim any great perfection for his results, but we have seen the production in the receiver of a recognisable, if rather blurred, image of simple forms, such as letters painted in white on a black card, held up before the transmitter. Mr. Baird has overcome many practical difficulties, but we are afraid that there are many more to be surmounted before ideal television is accomplished. In the transmitting apparatus, the object, strongly illuminated, is placed opposite a revolving disc provided with a series of lenses, each a little nearer to the centre than the last, which project a

series of moving images upon a selenium or other photo-electric cell, each a little displaced laterally from the last. This is the equivalent of passing the cell over the whole surface of the object in a succession of close parallel lines. The light thus reaching the photo-electric cell is rhythmically interrupted by a rapidly revolving slotted disc, and the result is that owing to the variations of resistance of the cell, undulations at an audio-frequency are produced in the current through it, whenever a bright part of the object is being dealt with. These are amplified and supplied to a simple wireless transmitter which is caused to emit corresponding signals..

IN the receiving section of Mr. Baird's television apparatus, the signals sent out from the transmitter are detected and amplified by very powerful valves until they are strong enough to light up a neon tube when a signal is received, *i.e.* when a bright part of the object is being dealt with by the transmitting apparatus. A disc with lenses or holes corresponding to the lenses of the transmitting disc is rotated synchronously with the transmitting disc, causing spots of light produced by the neon tube to appear upon a screen in positions corresponding to the part of the object being dealt with. With a sufficiently rapid rotation of the discs, a recognisable image of the object is produced. A duplicate of the receiving apparatus is provided at the sending end with its disc mounted on the same shaft as the transmitting disc, to enable the necessary adjustments to be made. Synchronism between the sending and receiving discs is obtained by a little alternator with a frequency of about 300 geared to the revolving system, which causes signals to be sent out by another wireless transmitter at this frequency. These are received and amplified at the receiving station to an extent enabling a similar little alternator connected to the receiving discs to be synchronised with them.

DR. A. W. CROSSLEY, presiding at the annual dinner of the Chemical Society on March 26, referred to the difficult position in which the Society finds itself on account of the increased cost of publication. Subscriptions of fellows have been raised, various limitations have been placed upon the distribution of the Society's publications, and papers are curtailed as much as possible, yet there is a financial deficit, and no practical means of avoiding it have yet been found. During the War, chemists saved the nation from disaster by supplying drugs, poison gases and protection from them, and other products demanded by the times, and it does not seem too much to ask that assistance should now be afforded in placing upon record the work they are doing for the advancement of knowledge. When one remembers the vast sums expended upon the verbatim reports of proceedings in Parliament published in the large volumes of Hansard, and considers how trivial most of the matters are in comparison with the original contributions made to a body like the Chemical Society, it is difficult to understand the national sense of value which leaves the Society in its present anxious position. Possibly the additional 1500*l.* received by the Royal Society in aid of scientific publication will enable a grant to be made to the Chemical Society, but in our opinion a very strong case can be made out by many other scientific societies for assistance towards costs of publication, either from the State or private benefactions, and we should like to see a concerted effort made with the view of securing adequate funds for this purpose.

MR. W. J. U. WOOLCOCK referred at the annual dinner of the Chemical Society on March 26 to a scheme for the establishment in London of a "Chemistry House" which would provide office accommodation for the chief chemical societies as well as one or more lecture theatres and other facilities. The scheme is being put on a business footing, and there is every reason to believe that it will take definite shape before long. It is possible that other scientific societies may like to be housed in the same building, and the plans may be enlarged to enable this to be done if there is a clear demand for such increased accommodation.

So far most of the clinical reports on "Bayer 205," now renamed "Germanin," have encouraged the belief that at last a specific for the treatment of trypanosomiasis has been found. A paper by Dr. Clement Chesterman in the Transactions of the Royal Society of Tropical Medicine and Hygiene (1924, vol. 18, p. 311) is somewhat disturbing from that point of view. Seventeen cases, all well advanced in the "second" or nervous stage of the disease, were treated with the new drug. Of these, nine had already received arsenical drugs without permanent improvement, and eight had not been given any previous treatment. Nine of these cases relapsed in from six weeks to fifteen months after a course of "Bayer 205." Two died of acute nephritis after their discharge from hospital and two from intercurrent bilharzial dysentery. Two more, who had suffered from amblyopia during arsenical treatment, became blind after administration of "Bayer 205," and a third developed amblyopia more quickly than usual when given arsenical treatment after a course of the new drug, due, it is suggested, to the possibility that damage to the kidneys by "Bayer 205" prevented the usual rapid elimination of the arsenic afterwards given. Two cases were definitely improved and have remained so for four and five months respectively. Unfortunately, none of the cases could be re-treated owing to the small supply of the drug available. It is pointed out that the two cases who died from acute nephritis might have been saved by careful nursing but were brought back to hospital too late. Dr. Chesterman has not lost faith completely in "Bayer 205," but thinks it important that "the limitations of yet one more of tropical medicine's 'conquering heroes' should be realised."

THE genesis of "Bayer 205" is described in a recent paper (*Zeitschrift für angewandte Chemie*, 1924, vol. 37, p. 585) by Dr. B. Heymann, one of the chemists who took part in the long and arduous researches which resulted in its discovery. There

is a good deal of special pleading for the Bayer Co.'s refusal to disclose the constitution of the new drug, and this is critically commented on by M. Fourneau (who, it will be remembered, re-discovered "Bayer 205," or at least made an effective substitute for it) in *Chimie et Industrie*, 1925, vol. 13, p. 284. Whatever the ultimate value of "Bayer 205" as a remedy for sleeping sickness may prove to be, there can be no doubt that its advent has provided chemists and pharmacologists with new ideas for chemotherapeutical work.

PROF. H. A. LORENTZ, of Leyden, Holland, will deliver the fifteenth annual May lecture of the Institute of Metals on May 6. The subject of the lecture will be "The Motion of Electricity in Metals."

THE seventy-fifth anniversary of the foundation of the Royal Meteorological Society will be celebrated on April 21 and 22. The celebrations include a visit to Kew Observatory and a lecture by Prof. E. van Everdingen, director of the Royal Netherlands Meteorological Institute, and president of the International Meteorological Committee.

THE Fondation George Montefiore, given every three years for the best original work of the preceding three years on the scientific advance and on the technical applications of electricity, is to be awarded this year. The 1923 award was deferred and the prize now amounts to 22,500 francs. The committee of award consists of ten electrical engineers, five of whom are Belgian, under the chairmanship of the Director of the Montefiore Electrical Institute of Liège. Competing works, addressed to M. le Secrétaire-archiviste de la Fondation George Montefiore, Association des Ingénieurs électriciens sortis de l'Institut électrotechnique Montefiore, rue Saint-Gilles, 31, Liège, must be received by April 30 next.

THE first annual report has been issued of the Ella Sachs Plotz Foundation for the Advancement of Scientific Investigation. Thirty-two applications for grants were received from various countries and eight awards were made, involving a sum of 8550 dollars. For the present, problems in or bearing on medicine are to be favoured and preference will be given to groups of researches on a single problem. Thus last year, four of the grants were for work bearing on chronic nephritis. Two only of last year's awards, to Dr. A. Bezredka, Pasteur Institute, Paris, and to Dr. J. Aberlin, Berne, went outside the United States. Applications for grants for 1925–26 must reach Dr. F. W. Peabody, Boston City Hospital, Boston, Mass., before May 15 next.

ARRANGEMENTS are in progress for a meeting of the Commission for the Exploration of the Upper Air to be held at the Meteorological Office, South Kensington, on April 16-22, under the presidency of Sir Napier Shaw. The Commission is in connexion with the International Meteorological Committee. The principal business of the coming meeting is to discuss the publication of the results obtained by balloons and kites in the various countries of the world during the years 1923 and 1924. A sum to meet the expenses of a specimen volume was allocated by the Union of Geodesy and Geophysics at Madrid in October last.

AMONG the financial items recently adopted by the French Chamber of Deputies is one of unusual interest to scientific workers. The clause in question is due, according to the *Revue générale des Sciences*, to Prof. Emile Borel, and provides for a tax of 5 centimes on each 100 francs paid in salaries by French commerce and industry, and the products of the tax, which it is estimated will bring in about fourteen million francs a year, is to be allocated to French scientific laboratories. In this way it would seem that industry might be made to contribute directly to the support of the fundamental scientific research on which it is based. The measure has still to be passed by the Senate before becoming law.

THE Norwich Castle Museum Committee of the City Corporation has under consideration the celebration of the centenary of the foundation of the Museum under the presidency of the famous Norwich botanist, Sir James Edward Smith, F.R.S., in 1825. The history of the Museum shows that its fortunes were of a varying character until 1894, when the Corporation took over the collections of the Museum Society and housed them in the spacious galleries adjacent to the Castle. The year 1925 is important for the City of Norwich, as in addition to the celebration of the centenary of the Museum, there will be an official opening of the Bridewell Museum of Local Industries in the 13th-century house of the first Mayor of Norwich, which will provide about 11,000 feet of floor space for the exhibition of material illustrative of the textile and other past and present industries of the City of Norwich.

IN publishing the first biological number of the Science Reports of the Tohoku Imperial University, Sendai, Japan, Prof. S. Hatai announces the formal opening of the Biological Institute of this University and of a Marine Biological Station, located at Asamushi. Among the special features of this station is an under-sea laboratory and a spacious open marine pool for observations on the growth of marine organisms. Several residences and a large dormitory have been erected where investigators may live with their families and where students may find suitable accommodation. Prof. Hatai hopes that his colleagues in Japan and in other countries may take advantage of the facilities offered for research.

YEAR-BOOK No. 23 of the Carnegie Institution of Washington, recently issued, contains a report by the Department of Genetics. The investigations reported upon range from chromosome studies in Datura and Drosophila, sex conditions in Cladocera, pigeons, and moulds, to the genetics of rabbits, mice, and horses, and eugenic studies of Indian-negro-white racial complexes in Virginia, inheritance of exceptional intelligence, the endocrines of mongoloid idiots, and a European study of the ancestry of American immigrants. No attempt can be made here even to outline the results obtained in these and other fields of research, but it is clear that substantial

progress is being made in such problems as the further analysis of the relations between chromosomes and heredity, and the compilation of data on which the improvement (germinally) of the human race could be based.

WE have received the annual report for 1924 of the Crichton Royal Institution, Dumfries—a hospital for mental diseases. Both private and rate-aided patients are admitted, numbering approximately 630 and 339 respectively during the year. Some 70 per cent. of the private admissions were voluntary, but all the rate-aided admissions were under certificate, and the medical superintendent, Dr. Easterbrook, comments forcibly on the obsolescent provisions and objectionable terminology under existing statutes which officially distinguish the latter class as "pauper lunatics," and he points out that the absence of definite statutory provision for the treatment of rate-aided patients as voluntaries has had unfortunate results. A well-equipped clinical and pathological laboratory conducts much useful work at the Institution, which has received commendation from the Commissioners of the General Board of Control after inspection.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: Grade IV. of the Civilian Educational Staff of the Royal Air Force, preferably with engineering qualifications and experience.—The Secretary, Air Ministry, Adastral House, Kingsway, W.C.2; Bio-chemist at Dove Marine Laboratory, Cullercoats.—The Registrar, Armstrong College, Newcastle-upon-Tyne; an assistant lecturer in the department of physiology of the Welsh National School of Medicine.—The Secretary, University College, Cardiff (April 11); a lecturer in morbid anatomy and histology in the University of Manchester.—The Internal Registrar (April 15); a research fellowship at Somerville College, Oxford, open to Oxford women graduates.—Miss Lorimer, at the College (April 16); woman as principal administrative officer of King's College for Women, Household and Social Science Department, Campden Hill Road, W.8.—The Chairman of the Executive Committee (April 16); two assistant lectureships in physics in the University of Manchester.—The Internal Registrar (April 18); the professorship of bio-chemistry at Middlesex Hospital Medical School.—The Academic Registrar, University of London, South Kensington, S.W.7 (April 23); the professorship of chemistry and directorship of the department of chemistry, the University of Birmingham.—The Secretary (May 1); four scientific assistants for the science exhibition of the Royal Society at the British Empire Exhibition.—The Secretary, British Empire Exhibition Committee, Royal Society, Burlington House, W.1.

Our Astronomical Column.

TWO NEW COMETS.—Comet 1925 *a* was discovered by Herr Schain at Simeis Observatory, Crimea, on March 23. It is of the tenth magnitude and visible in moderate telescopes. When discovered it was near β Virginis, and was moving slowly to the north-west. Being nearly opposite to the sun, it is observable for most of the night. The following positions have come to hand:

G.M.T. (new).	App. R.A.	App. N. Decl.	Observer.	Place.
d. h. m.	h. m. s.	° ′ ″		
Mar. 23. 22 43·6	11 47 48·9	1 43 49	Schorr	Bergedorf.
,, 25. 23 42·3	11 44 8·3	1 53 46	Vinterhausen	Copenhagen.
,, 27. 23 37·5	11 40 32·2	2 3 22	Steavenson	Norwood.
,, 29. 0 22·0	11 38 39·7	2 7 53	,,	,,

The last place depends on an approximate position of the star *BD* + 2° 2468, mag. 9·5; assumed place for 1925·0, $11^h\ 39^m\ 6{\cdot}3^s$, 2° 12′ 12″. Use should not be made of this position until a better star-place is available. The comet's R.A. is diminishing by about $1^m\ 53^s$ daily, its declination increasing by 5′ daily.

The orbit has not yet been calculated, but the ascending node is evidently near 0°, and the inclination not large; this fact would make an elliptical orbit not unexpected.

Comet 1925 *b* was found by Mr. William Reid at Cape Town on March 24. It should be stated, in correction of some paragraphs in the press, that Mr. Reid, whose diligence and success in comet-sweeping are well known, is not on the staff of the Cape Observatory, but is an amateur.

This comet is brighter than the other, being of magnitude 8, but its low altitude is a hindrance to easy observation in England. The following positions have come to hand:

G.M.T (new).	App. R.A.	App. S. Decl.	Observer.	Place.
d. h. m.	h. m. s.	° ′ ″		
Mar. 24. 21 33·0	13 29 47	20 16 0	Reid	Cape Town.
,, 28. 1 9·4	13 26 58·3	21 5 16	Steavenson	Norwood.
,, 28. 2 49·0	13 26 54·5	21 6 15		Algiers.
,, 29. 1 12·0	13 26 0·1	21 20 36	Steavenson	Norwood
,, 29. 1 29·0	13 25 59·8	21 20 54	,,	,,

The R.A. is diminishing by 54 sec. daily, the south declination increasing by nearly 16′ daily.

The orbit has not yet been calculated, but, as in the case of Comet 1925 *a*, the observations given should be sufficient to deduce preliminary orbits. Reid's comet is not far from γ Hydræ, and is due south about three-quarters of an hour after midnight. There will be more chance of observing the comets after the moon has set.

BROADENING STELLAR SPECTRA.—In Mon. Not. R.A.S., vol. 85, p. 47, Dr. W. J. S. Lockyer, Director of the Norman Lockyer Observatory at Sidmouth, describes a new method of broadening stellar spectra for purposes of reproduction. Since stellar images are merely points, the spectra have no breadth unless special methods are adopted to broaden them. For practical purposes it is customary to allow the image of the star to "trail" on the photographic plate by a suitable adjustment of the rate of the driving clock, but very little breadth is usually possible owing to the increased time of exposure entailed. Further, various unavoidable irregularities in brightness make the spectra broadened in this way unsuitable for picturesque reproduction. In the arrangement devised by Dr. Lockyer, the original negative, showing a narrow spectrum (after being specially prepared in a manner explained in the paper) is allowed to fall under gravity in a direction parallel to the spectrum lines, its speed being regulated by a flow of oil which, by an ingenious arrangement, is produced by the fall. During the fall the negative is illuminated by a constant source of light and photographed, the breadth of the spectrum thus obtained clearly being determined by the distance of descent. The paper contains an account of investigations made to determine the most satisfactory time of exposure, and also a beautiful photograph of the spectrum of α Cygni broadened by the new method.

Research Items.

THE STONE AGE IN THE EASTERN SAHARA.—In the course of an account of the oasis of Kawar (Kaouar), Eastern Sahara, in *La Nature* for March 14, Capt. Marius Prevost, who writes in collaboration with Dr. Lucien Mayet, describes stone implements found on a considerable number of sites in the oasis explored by him. The implements occur in such numbers as to suggest that the oasis supported a considerable population from an early date. In addition to flint, which was imported, quartz, quartzites, silicious limestone, hæmatite and volcanic rocks were used in the manufacture of the implements. In the absence of stratification, the only indication of date is the somewhat uncertain evidence of type. On this basis certain implements worked sometimes on one side, sometimes on both; flakes, points, carinated implements, etc., would, if found in Europe, be classified beyond question as palæolithic, while others, arrowheads, with or without tang, or triangular, spear-headed knives, polished axes, etc., would belong to the neolithic. Beads and pendants of stone and ostrich shell were also found. The neolithic industry shows strong affinities with that of Egypt which, if contemporary, would indicate an antiquity of 9000 to 12,000 years, and the palæolithic type might therefore be assumed to be older still. Up to the present, neolithic typology in the Sahara seems to point to a great uniformity of culture in the whole area.

ARCHÆOLOGICAL RESEARCH IN CENTRAL AMERICA IN 1924.—A report by Dr. Sylvanus G. Morley, in Year Book No. 23 of the Carnegie Institution of Washington, covers a number of investigations in Central America. A fourth Initial Series from the Maya New Empire region of Yucatan has been discovered. Excavations by Mr. E. H. Morris at Chichen Itza in the "Court of the Thousand Columns" have cleared the North-eastern Colonnade, an edifice 100 feet in length by 49 feet in width facing south. On three sides and part of the fourth it was bounded by solid walls, but the remainder of the support of the superstructure was a series of 5 rows of columns, rectangular in cross section. Their height was 8 feet. The season's excavations confirmed the type of the most prevalent form of column-supported structure at Chichen Itza, with a rectangular plan, arches paralleling the longer dimension, and an altar or throne at the centre in the rear. In the course of a survey of the archæological area by Mr. Kilmartin, a number of partly finished sculptures were discovered which throw light on the technical practices of the Maya in this art. Measurements of the great terrace show that it contained an area of 47 acres and, in some places, was built up to a height of 25 feet. At Uaxactun, Guatemala, a structure was discovered which appears to have been a sun observatory. Dates on three stelæ discovered nearby equate with A.D. 97 and A.D. 235, and the observatory, therefore, if it be one, cannot have been erected later than the latter year and was planned before the two earlier stelæ were set up. Excavations by Mr. O. G. Ricketson, jun., in mounds at Baking Pot, British Honduras, have brought to light a number of skeletal remains. In a sepulchral structure were found seven skeletons. In two the upper front teeth were filed, and in one the five upper teeth were inlaid with circular fillings of iron pyrites. All showed signs of fronto-occipital flattening.

FISH TRAPS IN EASTERN ASIA.—The distribution of thorn-lined traps in Assam and farther east is discussed by Mr. Henry Balfour in *Man* for March. The principal feature of these traps is that the inside of a conical trap is lined with the thorns which beset the leaf-ribs of climbing palms (Calamus, Dæmonorops, etc.), the sharp points being set toward the apex of the cone, thus rendering exit impossible when the trap has once been entered. Such traps had not been recorded from the Naga Hills of Eastern Assam prior to 1922, although their existence seemed probable from the Indonesian affinities of Naga culture. Inquiry, at first unsuccessful, finally produced an example from the Lhota Nagas from Okotso Village which is practically identical with the forms which range through the Malayan and Indonesian areas and extend as far as Melanesia. Several varieties of similar traps have since been collected from other Naga tribes by Mr. J. P. Mills. Varieties of the trap are noted from Western Burma, Malaya, Sumatra, the Philippines, Borneo, New Guinea, where it is widely distributed, New Britain, and the Solomon Islands. Though the place of origin is uncertain, there is no doubt that these thorn traps are referable to a common prototype and form a connected series.

THE DISCOVERY OF THE ANTARCTIC CONTINENT.—It has long been the practice to credit Sir J. C. Ross with the discovery of the Antarctic continent when he sighted South Victoria Land in 1841. Some years ago the late Dr. W. S. Bruce showed that the real discovery was made in 1820, when E. Bransfield sighted Trinity Land, a part of that section of Antarctica now known as Graham Land. In the *Geographical Journal* for March, Lieut.-Commdr. R. T. Gould publishes the full evidence on which Dr. Bruce based his contention. Bransfield's own log-book has disappeared, but contemporary accounts of his voyage are available. One of these that had previously been overlooked, together with Bransfield's own charts, which are in the possession of the Admiralty, make it clear that in January 1820 he sighted the northern extremity of the mainland in the vicinity of the mountain which now bears his name. Lieut.-Commdr. Gould's article is accompanied by a chart on which Bransfield's discoveries are shown in relation to more modern surveys, and his track is marked as accurately as is possible in the absence of the log of the *Williams*.

USE OF STIBAMINE IN KALA AZAR.—In the *Indian Medical Gazette* for January 25, Dr. Napier, who is in charge of kala-azar investigations at the Calcutta School of Tropical Medicine, has an interesting note on the treatment of this disease by derivatives of stibamine (*p*-aminophenylstibinic acid). It is well known that sodium antimonyl tartrate is an effective remedy, but it is slow and the coolie victims prefer as a rule to put up with the disease rather than submit to injections of this drug for several months. Improved remedies are therefore urgently required, and chemotherapeutical and clinical experiments carried on in Germany, England, and India during the last ten years have shown that stibamine is almost certainly as specific in its action in kala-azar as any drug can be. Unfortunately it is unstable and too toxic for use, and the difficulty has been to find a stable form in which to administer it. The acetyl derivative, which at first seemed promising, had to be abandoned after several accidents with it, but three other promising compounds are now under trial; urea-stibamine, which appears to be a combination of carbamide and stibamine of unknown constitution, discovered by Dr. Brahmachari of Calcutta; *meta*chlorostibacetin, produced by von Heyden

of Dresden, and stibamine glucoside, first made a few months ago in the Wellcome Chemical Research Laboratories, which is the subject of the note by Dr. Napier referred to above. All three new drugs seem to be about equally valuable as curative agents, and the period of treatment by them is reduced to two or three weeks. It is too soon to say which of them will prove most effective, but their advent marks an important step in the treatment of another tropical disease.

THE ŒSTROUS CYCLE IN CATTLE.—H. S. Murphey has published a paper on the œstrous cycle in the cow, in the Journal of the American Veterinary Medical Association (vol. 65, August 1924), and G. W. McNutt in the same number has given an account of the corpus luteum in the cow in relation to the cycle. The cycle is divided by the former author into two main periods, diœstrum and œstrum, and the latter is subdivided into proœstrum, œstrum in the restricted sense (*i.e.* the actual time when coitus may occur), and postœstrum. Both the vagina and the uterus are shown to undergo marked cyclical changes, pronounced congestion and œdema beginning with the proœstrum and not subsiding until four or five days later. In the case of the vagina the congestion and œdema are followed by active secretion. McNutt describes ovulation as occurring shortly after "heat," an observation which agrees with what has been found by John Hammond, whose investigations at Cambridge have covered much the same ground, but have not so far been published. The corpus luteum is said to be formed both from the follicular epithelium and from the theca interna. It may commence involutionary changes after 14 to 16 days, but there is some individual variation. In young animals the involution is completed in a year or somewhat less, but as the cow grows older, involution takes place more slowly and is less complete. The colour of the corpus luteum is at first a light brown, about the 7th day an old gold, by the 14th day a bright golden yellow, and by the 20th an orange colour, eventually changing to a bright brick red. The colour change is associated with the quantity and character of the lipoid in the luteal cells.

FRUIT TEMPERATURES IN CALIFORNIA.—A discussion of considerable value to fruit-growers is given in the recently issued *Monthly Weather Review* for August 1924 in an article on "Substitution of fruit temperatures for air temperatures in regulating orchard-heating for oranges." The essential features of the discussion aim at improvement in eliciting a more precise estimate of the lowest temperature to which fruit can be subjected without damage. For thirty years or more, orchard-heating has been practised in the United States, mostly without exact data as to effective damage, and based on the reading of sheltered and unsheltered thermometers in varying degrees of proximity to the fruit. The frosts are found not only to render the fruit unmarketable, but also in many cases to prevent the crop being included in the "choice" or "extra choice" grades. Information is given to show how successfully under ordinary cold the fruit escapes damage. A special mercurial thermometer is used; the bulb of the instrument is inserted well into the fruit, and readings from this are used for determining when the heaters should be lighted; the thermometer is somewhat similar to a clinical thermometer. It is asserted that from 85 to 90 per cent. of the fruit is screened from the sky by foliage. The freezing-point of the juices of the fruit varied from 26° to 28·5° F., and examples are given of the temperature falling to about 24° F. before the juice began to freeze. The amount of damage to mature fruit depends largely on the thickness of the rind.

LEECHES FROM KASHMIR.—Dr. J. Percy Moore describes (Proc. Acad. Natural Sci., Philadelphia, vol. 76, pp. 343-388, 1924) the first collection of leeches from Kashmir, and it is interesting to note that the following species are included—*Glossiphonia complanata*, *G. weberi*, *Hemiclepsis marginata* (subsp. *asiatica* nov.), *Erpobdella octoculata*, and *Dina weberi*. The first, third, and fourth of these are widely distributed and abundant Eurasiatic species, the first being even holarctic. The remaining two are characteristic Indo-Malayan forms. Dr. Moore also gives an account of a collection of leeches from eastern China.

CRITICAL STUDY OF LEIDY'S ACANTHOCEPHALA.—Dr. H. J. Van Cleave has investigated the specimens of Acanthocephala in the Leidy collection deposited in the University of Pennsylvania and in the Academy of Natural Sciences, Philadelphia, and gives a critical review of this important material (Proc. Acad. Natural Sci., Philadelphia, vol. 76, pp. 279-334, 1924). He states that of the North American genera of Acanthocephala known at the present time fully half had come to the attention of Leidy. The author gives in tabular form a list of the specific names used by Leidy and the valid or corrected names, pointing out at the same time that Leidy's work was characterised by great care and that some of his difficulties in identification were due to the incomplete description of European species. Twenty-one species are represented in the collection and they are arranged under thirteen genera.

EXPERIMENTAL STUDIES ON *DIBOTHRIOCEPHALUS LATUS* IN MAN.—G. Z. L. le Bas (*Journ. Helminthology*, vol. 2, No. 4, 1924) publishes observations on three persons who infected themselves with this tapeworm by swallowing the plerocercoid stage obtained from pike taken from the Lake of Neuchâtel. Case A was infected with three worms which attained maturity (as evidenced by finding the eggs in the fæces) in 20 days; case B was also infected with three worms which reached maturity in 14 days, while the single worm in case C took 26 days to reach sexual maturity. The average length of the three worms from case B after 99 days was 22 feet, and the number of eggs present about this time per gram of dried fæces was about 7 millions in case A, and in case B 12¼ millions about the 90th day of infection and 17½ millions on the 99th day. Intestinal disturbance is associated with the period of maturation of the worm, but, apart from this diarrhœa in the early stages, infection with three Dibothriocephalus for so long as nine months does not necessarily give rise to any symptoms which would suggest the presence of the parasite. No appreciable anæmia was produced, nor was there a definite diminution of the red blood corpuscles. Leucocytosis and an increase of the polymorphonuclear cells was observable in a slight degree, especially early in the infection.

CLASSIFICATION OF IGNEOUS ROCKS.—E. T. Hodge proposes a new form of classification for igneous rocks in a Publication (vol. 2, No. 7, 1924) of the University of Oregon. The older classifications are ably summarised and criticised. Single plane arrangements have hitherto been far from satisfactory. Winchell employed three planes exhibiting relative degrees of "alkalinity"; Holmes used five planes, dividing rocks according to Shand's saturation principle; and Johannsen used a solid double tetrahedron, thus introducing obvious difficulties in presentation. It is claimed that the new method

avoids the defects of previous attempts. The first division is into four *classes* based on the percentage of felspars plus felspathoids. Each of these is divided into seven *ranges* according to the principle of saturation. Further subdivision is into nineteen *orders* depending on the ratio of orthoclase to the various types of plagioclase. The division thus makes provision for a large number of different types of rocks, all of which can be represented quantitatively in a plane circle on a single sheet. Four segments of the circle take the classes. Six smaller concentric circles give seven spaces for the ranges, and each segment is divided into nineteen smaller segments by radial lines to take the orders. So far only mineral composition has been considered, though the author makes the remarkable claim that, whether chemical or mineral composition be given, the rock will fall into the same division of the classification. Texture next requires attention, and to meet the formidable difficulties inherent in any cross classification of so variable a factor, it is suggested as a simple expedient that to each a symbol be given which could be added to the rock name as a subscript. As a mental prop a classification of this kind may have its use, but petrology has now passed the stage in which it would have been considered as a contribution to the development of the subject.

UNITED STATES COASTAL SURVEYS.—The Report of the United States Coast and Geodetic Survey for the year 1923–24, published by the Department of Commerce, Washington, contains a long record of useful work and a review of the present state of the various hydrographic, geodetic, and magnetic surveys now in hand. Among the surveys of the year the progress in Alaska was very notable. So far the work has been mainly in the waters of southern Alaska, but it is spreading northwards to the shores of Bering Strait. A new survey of the waters of the Philippines is nearly complete, and a survey of the Virgin Island waters is half finished. The provision of several new survey vessels has greatly facilitated the work of the department. The results of experiments with the sonic depth-finder on the *Guide* are promised in a separate report. The apparatus is to be used in extending the survey of Pacific coastal waters to the 1000-fathom line. The Report is furnished with numerous maps showing the present state of surveys.

FLOTATION METHOD OF CLEANING COAL.—In the Bulletin de la Société d'Encouragement pour l'Industrie Nationale of January recently received, Charles Berthelot describes fully the process of cleaning fine coal by the flotation method, and points out the advantages to be derived therefrom. He gives an account of the plant employed at the Fiscal Mines of the Netherlands, devised by the chief engineer, Mr. Kleinbentink, which differs from the well-known plant of the Minerals Separation Company in that the frothing chamber is circular in plan surrounded by a circular chamber for collecting the froth. In Holland it has given very satisfactory results, and the working costs are only half of those incurred by the Minerals Separation Company, namely 1·32 francs as against 2·66 francs per ton. The mines in question are dealing with 100,000 tons per annum of coal slimes, the ash content of which is reduced from 30 per cent. to 8 per cent., the floated coal being well adapted to the preparation of either metallurgical or foundry coke or briquettes. It is stated that the cost of a plant to treat 50,000 tons of coal slimes per annum amounts to 200,000 francs and can make a gross profit of 850,000 francs per annum. The article makes no reference to the means employed for removing the water from the froth in the Dutch plant described.

DIAMOND HARDNESS TESTING MACHINE.—In the Brinell hardness test, the steel balls hitherto used for making measurable impressions under load were themselves deformed when indenting very hard specimens. The results fell off in accuracy at an early stage. Messrs. Vickers, Ltd., have now produced a machine, employing a small diamond pyramid (included angle 136°) as indenter, which gives trustworthy readings upon the very hardest steels. The use of a pyramid is scientifically sound, and the "hardness numbers" are similar to, if not identical with, those of the universally adopted Brinell scale. The indentations are very small, and the machine meets almost all the demands of a modern metallurgical hardness tester, for (*a*) the load is applied at a constant rate and for a constant time; (*b*) the load may be varied from 10 to 100 kgm. to suit the sample being tested; (*c*) thin sections, *e.g.* hardened safety razor blades, may be tested; and (*d*) there is no damage to finished work. The machine is suitable for research and general use, as loading is automatic and the measuring operations are simplified. A microscope is swung into position directly over the specimen, and knife edges in the eyepiece are brought up to opposite corners of the indentation. The reading then appears externally in actual figures.

SOLUBILITY AT HIGH PRESSURES.—A method of determining solubility at high pressures, by means of measurements of electrical conductivity, is described by Messrs. E. Cohen and J. C. van der Bosch in the *Zeitschrift für physikalische Chemie*. of January 20. Thallous sulphate was employed, as the alteration of volume on solution is large, and a considerable alteration of solubility with pressure was to be expected. Measurements were made at various concentrations to find the relation between concentration and resistance at high pressures. To determine the maximum solubility, at 1500 atmos. for example, weighed quantities of thallous sulphate and water were taken, which would give a slightly oversaturated solution at 30° C.; this was placed in a suitable resistance vessel in a compression bomb, which could be constantly shaken by means of a mechanical arrangement driven by an electric motor. The pressure was raised to 1800 atmos., and the salt dissolved completely; when the pressure was reduced to 1500 atmos., without shaking, a supersaturated solution was obtained the resistance of which was determined. After long shaking the excess of salt gradually crystallised out, the resistance rising and finally becoming constant. From these measurements it was possible to find the amount of salt in the saturated solution. The method takes a long time, but the results obtained agree well with those arrived at by other observers, using the direct method.

ZINC OXIDE INDUSTRY.—An account of the zinc oxide industry by Dr. N. F. Budgen appears in the *Chemical Trade Journal* for February 20. Zinc oxide has been known from the times of antiquity; the ancients called it *tutia*, and the alchemists referred to it as *nix alba*, "philosophical wool," or flowers of zinc. Courtois recommended its use as a paint in 1770, and in 1781 he commenced the large-scale manufacture of the substance. The Wetherill process in the United States involves the reduction and distillation of zinc from oxidised ores mixed with a certain amount of anthracite to act as reducing agent. The vaporised zinc is quickly oxidised, and with the gases of combustion is drawn from the furnaces and cooled in a system of flues and chambers, finally passing into a series of muslin bags which act as filters, allowing the gases of combustion to escape, at the same time retaining the condensed zinc oxide. The difficulties and drawbacks in the Wetherill process are discussed.

The Molecular Mechanism of Capillary Phenomena.[1]

By N. K. ADAM.

AN important question for the theory of capillarity is this: Is it necessary, in order to explain the observed phenomena, to conclude that there is, in the surface of a liquid, any differentiation of the molecular arrangements and forces from those prevailing in the interior, of such a nature that there is a skin possessing a tension parallel to the surface? Many writers appear to assume that, because the free energy associated with each unit of area of the surface is most conveniently replaced in calculations by a tension parallel to the surface, there must be some special structure in the surface which produces this tension physically. Although any free energy resident at the surface may mathematically be considered as the product of a "surface tension" and the area, there is no justification in this fact for concluding that the molecular arrangements and forces at the surface resemble those in a stretched membrane. Indeed, probably all attempts made to explain the molecular structure of surfaces, which have assumed such a contractile mechanism, have been complete failures.

Recent work on films of fatty material, one molecule thick, on water surfaces, has been satisfactorily interpreted in terms of molecular structure by regarding the molecules of the film simply as small floating objects, which attract one another when close enough, and repel when quite closely packed; thus assuming only the ordinary properties of molecules. If a film of this nature is confined by barriers to a given region of the surface, the force on the barriers is regarded as a compression on the floating film. Very striking analogies between the structure of the films, and the structure of matter in three dimensions and in solid, liquid, and gaseous states, have been revealed on this assumption; while if the force on the barriers had been treated as the difference between two tensions, those of the clean and contaminated water surfaces, no progress could have been made in unravelling the molecular structure. The two ways of regarding the films are mutually exclusive, and the success of the "compression theory" casts much doubt on the reality of any structure in the surface which produces tension.

A liquid probably has a well-defined surface; a surface of water forms a satisfactory support for films one molecule thick, which are as closely packed as matter in solid or liquid form, and will withstand lateral compression of one or two hundred atmospheres, calculated on their thickness. Only a liquid of density practically the same at the surface as in the interior could form a stable support for such films. The rarefied transition layers between liquid and gas, discussed by Van der Waals, can scarcely be conceived as able to bear these condensed films.

The surface energy of all liquids, and the tendency to diminish the surface to a minimum, are due in the following way to the molecular cohesion. In the interior, a molecule is attracted equally in all directions by its neighbours; at the surface the attraction outwards is lacking, and every surface molecule is therefore attracted inwards. Simple cohesive forces will produce no other net force on the surface molecules. This is sufficient to cause molecules to leave the surface more frequently than they reach it, and consequently, since the molecules occupy a definite area in the surface, the surface diminishes. The free energy of the surface is the work which must be done to bring the number of molecules requisite to form unit area, to the surface, against this inward force.

There are two other arguments sometimes cited as evidence of the existence of a surface skin; the floating of a heavy solid object on the surface of a liquid, and the spreading of one liquid on another. But consideration of possible molecular structures for the skins which would cause a liquid surface to diminish, and would resist perforation by a solid body, show that opposite qualities would be required in the two cases. The skin tending to contract the surface would essentially expel molecules from itself; but the skin which would act as a support for a heavy body would need such cohesion that it would be most unlikely, left to itself, to diminish indefinitely.

An experiment of Osborne Reynolds[2] renders it very probable that spreading of oil on water is due to an outward thrust from the oil drop, instead of a pull from the water surface. Oil placed on a dusted surface of clean water pushes the dust back as it advances, only immediately at the edge of the advancing oil, there being obviously no contractile motion over the rest of the water surface. A force which can produce this expansion in the form of a thrust from the drop is not far to seek. The molecules of the water are in constant thermal agitation, and the horizontal components of this motion act in the required direction, and will carry out the molecules of oil along the surface, if they are sufficiently adherent to the water molecules to share in their motion, and are not more attracted by the oil than by the water. Evidence of the importance of these thermal motions parallel to the surface is also given by the behaviour of the monomolecular films, as the temperature rises. It is found that, when the temperature is high enough, the disruptive effect of the agitation overcomes the lateral attraction between the film molecules and causes expansion to take place, the expanded film being analogous to a two-dimensional gas.

These thermal agitations also account for the diminution of the free surface energy, or "surface tension," of all liquids with temperature. If the surface is warmer on one side of a floating object than on the other, the intensity of the horizontal bombardment on this object is greater on the warm side than on the cold. We need not regard the observed motion towards the cold side as due to the attraction of the surface skin being less on the warm than on the cold side. By reason of this difference in intensity of bombardment, work must be done to increase the area of the cold surface at the expense of that of the warm, and the "surface tension" of the cold surface is greater than that of the warm.

It is well known that the pressure is greater on the concave side of a curved liquid surface than on the convex, and that the amount of this excess pressure is $\eta\left(\frac{1}{R_1}+\frac{1}{R_2}\right)$ where η is the "surface tension" and R_1 and R_2 the principal radii of curvature of the surface. The amount of this excess pressure can be deduced simply from the fact of a free energy η per unit area of the surface, by considering a variation of the area of surface, keeping the volume constant. The fact that its magnitude is the same as if the surface were covered by a membrane of tension η is not evidence as to the molecular mechanism by which the pressure is produced.

At the free surface, the attractions perpendicularly

[1] Based on a lecture delivered to the Physical Society of Sheffield, on October 28, 1924.

[2] Works, vol. 1, p. 410. Brit. Ass. Rep., 1881.

inwards on the surface molecules produce a pressure on the underlying molecules, the "internal pressure." Fig. 1 will show that on a plane surface the forces producing this pressure are parallel; on the surface convex outwards they are convergent and therefore the pressure is greater; on the surface concave outwards they are divergent, giving a smaller pressure than under the plane surface. Thus the unbalanced perpendicular attraction on the surface accounts for

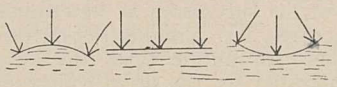

FIG. 1.

the pressure under a curved surface, without the assumption of an elastic skin.

Where the surface is the surface of separation between two liquids, or between a solid and a liquid, the attractions on the surface molecules of each phase towards the interior of that phase are modified and usually less than at a free surface; but the only net force on the surface molecules is an attraction away from the boundary. The equilibrium between the forces of attraction at the interfaces of solid, liquid, and gas, in contact, results in the angle of contact (Fig. 2). If W be the work per unit area required to

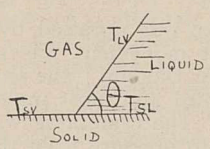

FIG. 2.

separate the solid from the liquid perpendicularly, then

$$W = T_{SV} + T_{LV} - T_{SL} \quad . \quad . \quad . \quad (1).^{3}$$

W may be called the adhesion of the liquid for the solid. Further, the equation

$$T_{SV} = T_{SL} + T_{LV} \cos\theta \quad . \quad . \quad . \quad (2)$$

may be obtained by taking account of the changes of area involved in a virtual displacement of the line of contact of solid, liquid, and gas. Hence

$$W = T_{LV}(1 + \cos\theta). \quad . \quad . \quad . \quad (3).$$

By (3), a zero angle of contact indicates that the adhesion of the liquid for the solid is equal to the cohesion ($2T_{LV}$) of the liquid for itself; 90° shows the adhesion to be half the liquid cohesion, and 180° would indicate no adhesion.

When there is motion of the liquid over the solid surface, the angle of contact is different. If the liquid is advancing, the angle is greater, if receding, it is less, than the equilibrium value. The amount of this difference, sometimes called the hysteresis of the angle of contact, probably depends more on the smoothness of the surface than on its chemical characteristics. For a rough surface of paraffin wax, for which the equilibrium angle is 104° 30′, the difference between advancing and receding angles may amount to nearly 60°; and on such a surface it is practically impossible to obtain the equilibrium angle, within several degrees. However, on a wax surface which had been turned in a lathe, Ablett[4] obtained consistent results, within a few minutes of arc, for the equilibrium angle. Mr. G. Jessop has pointed out that this "hysteresis" is probably due to the friction of the liquid on the solid surface, acting to oppose the motion. If the frictional force is F, then for advancing motion, equation (2) becomes

$$T_{SV} - T_{SL} = T_{LV} \cos\theta_A + F,$$

and for receding motion,

$$T_{SV} - T_{SL} = T_{LV} \cos\theta_R - F;$$

hence the angle must be greater for advancing than for receding motion. Also,

$$2(T_{SV} - T_{SL}) = 2T_{LV} \cos\theta = T_{LV}(\cos\theta_A + \cos\theta_R);$$

therefore

$$2\cos\theta = \cos\theta_A + \cos\theta_R,$$

an equation approximately verified by Ablett, for his surface of paraffin wax.

This surface friction probably explains the third of the phenomena sometimes attributed to the surface skin; the floating of a solid object on a liquid of less density. In Fig. 3, the line of contact between the liquid and solid surfaces will not move unless the part of the weight of the solid not supported by the

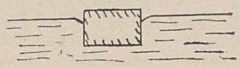

FIG. 3

buoyancy of the liquid exceeds the frictional force F. In this way a substance heavier than water can float on the surface, as any depression of the line of contact below the level of the surface requires an increase in area of the liquid surface, if the angle of contact is greater than 90°, and requires the performance of work.

The sequence of events in the rise of a liquid in a capillary tube suddenly brought into the liquid will be, first, the setting up of an angle of contact (acute for a rising liquid); second, a diminution of pressure under those regions of the surface where there is disturbance due to the angle of contact; third, motion of the liquid upwards, by reason of this diminution of pressure, first probably to complete the meniscus, and then as a whole up the tube. If the tube is dry, the liquid is advancing and the angle of contact will be greater than the equilibrium angle, the radius of curvature of the meniscus will be greater, the pressure deficiency under the curved surface will be less, than the equilibrium, and the liquid will not reach the equilibrium height in the tube; this is a well-known experimental fact. Washburn[5] has shown that the rate of movement of liquid in a capillary tube is in accordance with the value of the capillary pressure, and the viscous resistance to flow; but this does not serve to distinguish between this explanation and one based on the idea of "surface tension," since the capillary pressure is numerically equal to what would be caused by a membrane in tension. Rideal[6] obtains the same differential equation for the motion of the liquid, considering the force driving the liquid as a tension of magnitude $2\pi r\eta$, where r is the radius of the tube, and the liquid wets the walls perfectly.

In general, where the phenomena considered are merely consequences of the fact of potential energy in the surface, the term "surface tension" can legitimately be employed; but where the molecular mechanisms producing the phenomena are under consideration, the term is apt to be misleading, as it suggests some kind of contractile skin in the surface, the existence of which is very unlikely.

[3] Dupré's well-known equation. Equation 3 has been obtained by Edser, and a similar equation is obtainable from Laplace's theory, considering the attractions between *particles* of liquid and solid, and liquid and liquid.
[4] *Phil. Mag.* 46, p. 244 (1923).
[5] *Phys. Review*, 13, p. 273 (1921).
[6] *Phil. Mag.* 44, p. 1152 (1922).

The Syrian Arc.

THE Syrian Arc is the name proposed by Dr. E. Krenkel for a mountain chain which can be traced around the south and east of the Levant from Tunis to the Taurus. The name is given in a short but important paper ("Der Syrische Bogen," *Centralblatt für Mineralogie*, 1924, No. 9, pp. 274-281, and No. 10, pp. 301-313) which correlates the mountain movements which have determined the position of the south-eastern Mediterranean. According to Dr. Krenkel, this mountain chain begins to the west in Tunisia, where there are two sets of fold mountains. The predominant set belong to the Atlas System and its members trend to the north-east. The set in southern Tunis trends east and west and is obviously a distinct mountain group from the Atlas.

According to Dr. Krenkel, this southern set is the westernmost element of the Syrian Arc. It is cut off by the Great Syrtis from Cyrenaica. Dr. Krenkel, from the writer's work on the geology of Cyrenaica, interprets its plateau as one of the inner members of the Syrian Arc. In Egypt this arc is represented by three fold ranges, those of Abu Roasch, Wadi Araba and Quena. It continues with a trend to the east-north-east, across the deserts of northern Sinai, where it has been determined by Messrs. Moon and Sadek. The Egyptian and Sinaitic members of the Syrian Arc are separated by the Gulf of Suez.

According to one view, the Clysmian valley of Dr. Hume, which includes that gulf, is the direct continuation of the Rift Valley of the Red Sea. According to another view, it is a synclinal. According to Dr. Hume, it is due to a combination of faulting and a series of Erythrean folds. Dr. Krenkel supports the first of these interpretations as the Gulf of Suez lies in a rift valley which has broken across the Syrian Arc nearly at right angles; and the structures which have been interpreted as due to a series of Erythrean folds Dr. Krenkel explains as due "to the tossing and tilting of uniclinal sedimentary blocks which appear on the floor of the rift valley." He denies the existence of Erythrean folds due to pressure in a westerly or easterly direction.

From Sinai the Syrian Arc passes north; it is bounded westward by a series of steps down to the Mediterranean and eastward, according to some accounts, by flexures. Dr. Krenkel represents these flexures as fractures which have broken across pre-existing folds. He attributes the topography of this area to a combination of an older folding with the younger rift valley fractures. In Syria, however, where the structure has been represented by Diener and most of his successors as determined by simple block structures, Dr. Krenkel insists on the importance of folds. In middle Syria, the Lebanon on the west is separated by the great valley of the Bakaa from Mt. Hermon and the Anti-lebanon. This valley he attributes to a down-fold lasting from the end of the Cretaceous to the Upper Miocene; but the Bakaa in its present form he describes as a rift valley made by Pliocene fractures. The Damascus Arc is a branch from the Syrian Arc and is marked by the presence of the only overfolding recognised by Dr. Krenkel anywhere along the Syrian Arc; it happened there to a slight extent owing to the pressure of the Damascus Arc against the northern edge of the Arabian Foreland. Farther north the Syrian Arc ends against the cross folds of the Taurus. The line of separation is defined by Dr. Krenkel as the Afrin line which divides the African element from those of Asia Minor.

The Syrian Arc was upraised by folding in three stages: the first movement was in the uppermost Cretaceous (Upper Danian); the second in the Lower Miocene; the third and most important was in the Upper Miocene. The crumpling was due, according to Dr. Krenkel, to pressure from the south and east toward the Mediterranean. It was therefore in the opposite direction to that in the Dinaric-Taurus Arcs, which extend along the eastern side of the Adriatic, through Greece and the Archipelago to the southern chains of Asia Minor. The general course of the Syrian Arc conforms closely to that of the Dinaric and Taurus Mountains; and both of the mountain arcs moved toward the great depression of the Eastern Mediterranean which lies between them.

J. W. GREGORY.

Permanent Magnets.

MR. S. EVERSHED read an important and valuable paper on permanent magnets to the Institution of Electrical Engineers on March 19. The paper gives the results of many years' research, and ought to prove of immediate value in improving the quality and cheapening the cost of high-grade permanent magnets. In 1616 Barlowe wrote concerning the medieval art and mystery of magnet making—"The compass needle, being the most admirable and useful instrument in the whole world, is so bungerly and absurdly contrived as no other." Although the permanent magnet has become an indispensable adjunct of modern engineering, yet industries rooted in tradition are generally backward, and magnet making is no exception.

The hardening of iron and the making of steel were probably discovered accidentally. Metallurgists have found that ordinary pure iron exists in various allotropic forms depending on the temperature. At ordinary temperature it is called Alpha iron and is the commonest of all metals. Its specific heat at 0° C. is 0·1055 precisely, which is in excellent accord with theory. This specific heat gradually increases until about 750° C. The author calls this the precursor effect, as it indicates that the heat is not all expended in raising the temperature; some of it is doubtless expended in effecting a change of some kind in the structure of the iron. At about 770° C. Alpha iron begins to change into Beta iron, and the transformation is practically complete at 810° C.

Alpha iron is magnetic, Beta iron is entirely non-magnetic. As the molecule of Beta iron must be quite different from that of Alpha iron it is practically a new element. Throughout the narrow zone of temperature of 40° C. Alpha and Beta molecules can exist together, and this explains the loss and recovery of magnetism in iron as shown by experimental curves. At between 918° and 920° C. Beta iron is converted into Gamma iron, and at between 1404° and 1405° C. Gamma iron becomes Delta iron, its specific heat suddenly increasing by 50 per cent. At 1528° C. pure iron melts. Assuming that specific heat is inversely proportional to atomic weight, it would follow that these varieties of iron should have atomic weights of about 56, 37, 41, and 27, which are the atomic weights of iron, chlorine, calcium, and aluminium. The molecules have not changed successively into the molecules of these elements, but they must have done something equally revolutionary.

The carbides used in manufacturing magnet steels dissolve freely in Delta, Gamma, and Beta iron, but

these kinds of iron are all non-magnetic. To make a magnet the steel must be magnetic, and consequently in the Alpha state. It is necessary, therefore, to heat the iron until it is in the Beta or Gamma state, dissolve a quantity of carbide in it, and then by plunging it into cold water make it return quickly to the Alpha state.

Nowadays carbon steel is seldom used for permanent magnets. Tungsten magnet steel is made similarly to carbon magnet steel, but half the carbide of iron is replaced by carbide of tungsten, the total content of carbon remaining unchanged. The effect of replacing part of one solute substance by another is to increase the magnetic coercive force from rather less than 50 to slightly more than 70. When cobalt is used instead of tungsten the coercive force is increased to 180. From the point of view of the manufacturer, tungsten steel is generally the most attractive. Carbon steel is 60 per cent. more costly, and cobalt steel costs three or four times as much. Cobalt steel withstands demagnetising forces much more effectively than tungsten steel. If two permanent straight magnets, one of tungsten steel and the other of cobalt steel, were subjected to demagnetising forces equal to 20 per cent. of their coercive force, the tungsten magnet would lose 14 per cent. of its strength, but the cobalt magnet would only lose 3 per cent.

The author has made many experiments on the loss of the coercive force in all kinds of "permanent" magnets. In a cobalt magnet, for example, the initial coercive force was 180, but after 4·4 years it had fallen to 161·8. The continued falling off in the coercive force of hardened magnet steel is attributed to the passage of carbide molecules out of solution. Immediately after the hardening, the coercive force decreases by about 7 per cent. in the course of the first hundred hours, but after a year the rate of decay seems to settle down to a small steady value. The author calculates that the whole of the surplus carbide in cobalt steel might pass out of solution in about seventy years, the steel then being completely softened. He has noticed, however, a seasonal oscillation in the value of the coercive force, the reason of which is still unexplained.

When manufacturing steel containing tungsten or cobalt for use in making permanent magnets, the greatest attention has to be paid to the heat treatment. The experiments described prove conclusively that if tungsten steel be heated to any temperature between 750° C. and 1214° C., and kept at this temperature for an appreciable time before hardening, its magnetic properties are weakened, the weakening increasing with the length of time the steel has been kept at the high temperature. The deterioration of the steel goes on most rapidly when the temperature is 950° C. At 1200° C. the spoiling of the steel goes on very slowly, the coercive force falling only 0·4 units per hour. At 1240° C., however, which is only 26° above the danger zone, restoration of coercive force takes place at the rate of 15 units a minute. It is obvious, therefore, that great attention has to be paid to the temperature to which the steel is heated, before hardening.

This paper is a sequel to one the author read to the Institution in 1920, and together they give a very complete account of the modern theory and practice of magnet making. The results obtained by the British Scientific Instrument Research Association on the possibility of making magnets of complicated shapes by casting them with molten metal and then subjecting them to a suitable heat treatment are described. The method appears to be very promising and already cast magnets are on the market.

University and Educational Intelligence.

CAMBRIDGE.—Particulars are now available of the Pinsent-Darwin Studentship in mental pathology, founded in 1924 by Mrs. Pinsent and Sir Horace and Lady Darwin for promoting research into any problem which may have a bearing on mental defects, diseases or disorders. The Studentship is of the annual value of about 200*l.* and is tenable for three years in the first instance. Candidates may be of either sex, and need not be members of the University of Cambridge. Applications must be sent before May 1 to the Secretary, Pinsent-Darwin Studentship, Psychological Laboratory, Cambridge.

EDINBURGH.—The following are among the honorary degrees to be conferred in July:—LL.D.: Brigadier-General the Hon. Charles Granville Bruce, chief of the Mount Everest Expedition; Prof. A. S. Eddington, Plumian professor of astronomy and experimental philosophy in the University of Cambridge; Prof. Robert Muir, professor of pathology in the University of Glasgow; Principal C. G. Robertson, University of Birmingham; Sir Harold J. Stiles, emeritus professor (clinical surgery) in the University of Edinburgh.

LEEDS.—Mr. J. Gordon has been appointed lecturer in bacteriology in succession to Dr. Ross resigned. An honorary demonstratorship has been instituted in the Department of Zoology, and Mrs. H. W. Swift appointed thereto.

LONDON.—In commemoration of the donation of 105,000*l.* made in 1914 by Sir Hildred Carlile, Bart., to the Endowment Fund of Bedford College, it has been resolved that the University chairs of English literature, Latin, botany, and physics tenable at the College shall henceforth be entitled the "Hildred Carlile" chairs.

The following doctorates have been awarded: *Ph.D.* (*Science*), Mr. K. C. D. Hickman (Imperial College—Royal College of Science) for a thesis entitled "Studies in Adsorption, with special reference to the Washing of Photographic Products," and other papers, and Mr. D. F. Stedman (University College) for a thesis entitled "The Liquid-vapour Equilibrium of the System Glycerine-water"; *D.Sc.* (*Physics*), Mr. F. Simeon (University College) for a thesis entitled "1. The Carbon Arc Spectrum in the Extreme Ultra-violet: 2. Note on the Striking Potential necessary to produce a Persistent Arc in Vacuum," and other papers, and Mr. B. W. Clack (Birkbeck College) for a thesis entitled "On the Study of Diffusion in Liquids by an Optical Method."

ST. ANDREWS.—The Senatus Academicus has resolved to confer the honorary degree of LL.D. on the following, among others: Sir William Bragg, Fullerian professor of chemistry at the Royal Institution, and Director of the Davy-Faraday Research Laboratory; Prof. F. G. Donnan, professor of inorganic and physical chemistry in the University of London; Prof. Etienne Gilson, professor of philosophy of the Middle Ages, Sorbonne, University of Paris; Mr. R. W. T. Gunther, fellow of Magdalen College, Oxford.

A COMPETITIVE examination for two scholarships at the Household and Social Science department of King's College for Women, namely, the Carl Meyer, 80*l.* a year for three years, and the Minor College, 40*l.* a year for three years, will be held on May 21. The latest date for the receipt of entry applications is May 18. They should be sent to the Secretary of the department, Campden Hill Road, W.8.

THE next election to the research scholarships of the Grocers' Company for the prosecution of original research in sanitary science will take place in May, and applications for them are invited until April 14. The scholarships are each of the annual value of 300*l.*, plus an allowance for apparatus and other expenses. They are tenable for a year, with the possibility of renewal for a second or a third year. Applications, upon a form to be provided, should be sent to the Clerk of the Company, Grocers' Hall, E.C.2.

THE second session of the summer school for post-graduate mathematics, organised by the Extra Mural Department of the University of Manchester, will be held at University College, Bangor, on August 24-September 5. The object of the school, which is recognised by the Board of Education, is to afford facilities for advanced study in mathematics to teachers and others who have read mathematics for a university degree. The following three alternative courses are proposed: (*a*) Atomic structure and the quantum theory, by Prof. Sydney Chapman (Imperial College of Science, London); (*b*) theory of functions, by Prof. L. J. Mordell (University of Manchester); (*c*) higher geometry, by Mr. H. W. Richmond (King's College, Cambridge). Particulars may be obtained from Miss D. Withington, The University, Manchester. Application should be made at an early date, as the holding of the courses depends to some extent upon the number of applications received.

IN any college where a large staff is employed, the duties and interests cover a wide variety of subjects, and the results of research work are often scattered over technical journals and the proceedings of many societies, a procedure which fails to provide an adequate view of the work of the college as a whole. The authorities of the Royal Technical College, Glasgow, have been considering this matter, and have resolved to publish an official journal, which will contain records of the research work done in the college, and thus prove an incentive to junior workers in particular. A copy of the first number of the Journal of the college is now before us, and contains records of eleven researches conducted in the college, representing chemistry, metallurgy and engineering. The name of the editor does not appear, but he is to be congratulated upon the production, and especially upon the useful feature of printing a short abstract of each paper immediately under its title. The research activities of the college may be judged by the articles which appear in this issue. These include papers on some acyl derivatives of hydrazine; the formation and constitution of certain double salts with a review and criticism of van 't Hoff's theory; radio-active substances as indicators with a study of the adsorption of lead and bismuth by ferric hydroxide and the adsorption of thorium by basic ferric acetate and by barium sulphate by this method; the hydro-ferro- and hydroferri-cyanides of the organic bases and some applications; the separation of the components of petroleum with the view of utilising this commodity as a raw material for chemical industries; the iron-carbon diagram; the copper-zinc system; the petrological and chemical examination of slag and metal samples from a basic open-hearth furnace. These papers are followed by two on engineering subjects which occupy nearly one half of the issue; the subjects are the pipe loss in steam nozzles, and turbine wheel friction, on both of which the Royal Technical College has already given authoritative papers. The last paper deals with the structure and mode of life of the sulphur-bacteria and their value as indicators of pollution. The appearance of this Journal will be welcomed alike by science and engineering workers, and cannot fail to be beneficial to research workers in the college itself.

Early Science at Oxford.

April 6, 1686. Mr. Aston communicated amendments of ye Treatise *De Moventibus in Fluido*, and Mr. Ash sent a Demonstration of the 2d and 5th books of Euclide, and ye whole doctrine of proportion done more briefly than heretofore; for both which ye Secretary was ordered to returne ye thankes of ye Society.

April 7, 1685. A very rationall Discourse concerning Weather, written some time since by Dr. Garden (by way of Letter to his Friend Mr. Scougall) was read. The Society ordered their thankes to be returned, both to Dr. Middleton and to Dr. Garden, for the communication of so considerable a piece of Philosophy. One passage in Dr. Garden's discourse deducing the Rise and Fall of Vapours from their weight in respect to that of the Air, (intimating, that ye Vapours arise, when specifically lighter, and fall when specifically heavier, than the Air). Mr. President, not denying this to be true, added hereunto, that Subterraneal heats, or other ferments, may bear some part in producing this effect; as impelling upwards those Vapours, which, being specifically heavier than the Air, fall again in a little time: An instance of which he gave in ye boyling of Water, where the vapours are forced upwards by the fire placed under the Vessell, and, having lost that impetus, which raised them, and being intensively heavier than the Air, sink down again.

A Letter from Mr. Aston mentioned a Catalogue of Rarities, brought from Ceylon, by Dr. Heerman of Leyden, and preserved according to a peculiar way known to him. A Transcript of this Catalogue is desired. The remaining half of Mr. Leewenhoeck's Letter concerns the Salts of Wine, Vinegar &c, was read.

April 8, 1684. Mr. Ballard discoursed concerning ye Magnetism of Drills, being by way of answer to a letter of Mr. Aston's on that subject, dated March ye 15th. Six or seven severall Drills were caused to be made before my face; and ye bit, or point, of every one became a North Pole, onely by ye hardning, before they ever came to be workd either in Iron, or any other Matter. That peices of plain Iron in shape like Drills (that is something long, and small,) do always change their Poles, as they are inverted (ye end downward being over ye North Pole) he finds not allways true. Mr. Hunt's experiments on drilling were repeated, but his conclusions were found not to be always confirmed. Mr. Bernard read a letter of his to Dr. Huntingdon, concerning ye place of ye fixed starrs, as treated of in severall Arabic authors, given to Merton College Library by ye Doctor.—There being some discourse concerning ye insipid tast of ye Ice of Seawater, it was queried, whether sea-water might not be sweetned, and rendred serviceable.

April 10, 1688. The Standards of the wine, corn, and Ale Gallons, kept at St. Marys, were examined by Dr. Bernard, Mr. Walker and Mr. Caswell. They were filled with Pump-water, and then weighed. The weights compared with a former experiment by this Society of the weight of a cubic foot of water, give the quantitys of these Gallons in cubic Inches, &c.

Wine—Gallon - -	232 : 00	cubic Inches.
Corn—Gallon - -	270 : 43	
Ale—Gallon - -	280 : 15	

The variation of the Needle at Oxford July 22nd 1687 was found to be 5°20′ West.

Dr. Bernard presented the Society with his book *De Ponderibus et Mensuris Antiquis*; for which the Society returned their thanks.

Societies and Academies.

LONDON.

Royal Society, March 26.—O. W. **Richardson** and T. **Tanaka**: Regularities in the secondary spectrum of hydrogen. It has been possible to arrange 123 additional lines provisionally in 22 series. Three of these form a PQR combination. The present indications are that the moments of inertia of the emitters are spread fairly well over a range extending from the high value deduced from the PQR combination found previously to a value somewhat below the lowest value which has been deduced from Fulcher's second band. This involves an extreme variation by a factor of almost six in the moments of inertia.—S. **Chapman**: The lunar diurnal magnetic variation at Greenwich and other observatories. The systematic changes of magnetic declination at Greenwich, during the course of the lunar day, have been determined from hourly records extending over 63 years. This and other magnetic elements have been similarly studied, using shorter series of data, for the observatories of Batavia, Zikawei, and Pavlovsk. The character and magnitude of the lunar daily changes depend on the following factors: the position of the sun relative to the moon, the position of the sun relative to the equator, the distance of the moon, the sunspot epoch, and the general state of magnetic activity upon the earth—the latter being connected with particular disturbed regions on the sun's surface. The lunar daily magnetic variation varies much less with sunspot epoch, and much more with the magnetic activity, than does the solar diurnal variation. It is concluded that the lunar influence on the earth's magnetic field, exerted through the agency of the lunar tide in the earth's atmosphere, is most efficient in the polar regions.—H. T. **Flint**: A general vector analysis with applications to electrodynamical theory. The vector analyses in use, as a rule, are concerned with quantities represented by straight lines, and the space to which they are applicable is Euclidean. An account is given of an analysis in which a vector is represented by

$$\delta a' = \sum_n i^n \delta x^n.$$

The vector is of infinitesimal length and δx^n represents a component measured in any system of co-ordinates. In any kind of space, Euclidean or not, in which a point B has co-ordinates $(\delta x^1, \delta x^2, \ldots, \delta x^n)$ with respect to A we shall regard $\delta a'$ as denoting a definite quantity, whatever the system of co-ordinates. In this space we shall suppose the geodetics unique and shall regard the geodetic arc joining A and B as the geometric representatives of the vector $\delta a'$. So far as possible the notation will be similar to that of Gibbs' vector analysis. The notation may be applied to space of any dimensions, but four-dimensional space is taken as fundamental. In many cases it is possible to employ a notation that leaves the formulæ of ordinary vector analysis almost unchanged, and formulæ of the restricted principle can be carried over to the general principle by merely applying rules of generalised vectors.—Miss M. O. **Saltmarsh**: The spectra of doubly and trebly ionised phosphorus (P III and P IV). The series system in the spectrum of doubly ionised phosphorus is a doublet system in accordance with the spectroscopic displacement law. Three members of the triplet series of the spectrum of trebly ionised phosphorus have been identified. For three groups of elements, each having its own characteristic electron structure, the sharp terms are greater than the diffuse terms with the same Rydberg number for the neutral and singly ionised element, but for higher stages of ionisation the diffuse terms are greater than the sharp.—D. M. **Wrinch** and J. W. **Nicholson**: Laplace's equation and the inversion of surfaces of revolution.—T. R. **Merton** and J. G. **Pilley**: On experiments relating to the spectrum of nitrogen. When helium at about 30 mm. pressure containing a very small quantity of nitrogen is excited by feebly condensed discharges, the arc spectrum of nitrogen is developed, and under these conditions is completely isolated from the spark spectra. The arc spectrum of nitrogen is not developed in the presence of an excess of argon under the same conditions in which it appears in the presence of helium. Special precautions have to be taken to ensure the purity of the gases. When nitrogen is excited by electron impacts there appears to be a direct transition as the energy of the impacts is increased from the negative band spectrum to the spark spectrum, which would imply that the rupture of nitrogen molecules is generally into ions rather than neutral atoms.—T. H. **Havelock**: Studies in wave resistance; the effect of parallel middle body. The ship is altered by inserting varying lengths of parallel middle body between the same bow and stern. The main problem is the study of the equivalent wave-making length of the ship, and its variation with velocity and with the length of parallel middle body.—T. **Tanaka**: Wave-lengths of additional lines in the many-lined spectrum of hydrogen. Some 560 new lines in the secondary hydrogen spectrum have been measured. Incidentally it was necessary to make measurements of a considerable number of lines in the oxy-hydrogen band spectrum.—H. S. **Taylor**: A theory of the catalytic surface. A catalytic surface seems to be composite, of atoms in varying degrees of saturation in a crystal lattice. The saturation varies from that in a plane surface to those which are only held to the surface by a single constraint. It is by this constraint that these outermost atoms differ from gaseous atoms. Thus several molecular species, for example, hydrogen and an unsaturated molecule, may be attached to the same atom of catalyst.—E. F. **Armstrong** and T. P. **Hilditch**: A study of catalytic actions at solid surfaces. Pt. XII. Some observations relative to those particles of a catalyst which participate in chemical change. The rate of decline of activity of several nickel catalysts in the presence of varying concentrations of impurities characteristic of natural fatty oils has furnished evidence supporting Taylor's hypothesis (*v.* above). The active nickel atoms seem to be actually detached from their neighbouring metallic atoms during the moment in which catalytic change is effected. Pt. XIII. Some factors controlling selective hydrogenation with particular reference to certain terpene derivatives. Whilst adjacent (conjugated) ethylenic linkages are converted completely to a saturated system, two separate ethylenic linkages are hydrogenated consecutively, one double bond disappearing completely before the other is attacked: acetylenic linkages are transformed to the saturated compounds with little or no production of the corresponding ethylenic compound. Similarly, the hydrogenation of esters or glycerides of polyethylenic higher fatty acids (but not the free acids themselves) is markedly selective, and the same applies to diethylenic derivatives of the terpene series. Selective hydrogenation, observed by ourselves and by Vavon, in compounds such as carvone, limonene, citral, geraniol, and linalool, is determined mainly by (i) degree of substitution of ethylenic carbon atoms, and (ii) proximity to one or other double bond of a carbonylic or hydroxylic group. It is also deduced from these results that citral, geraniol, and linalool all contain the grouping $(CH_3)_2C=CH—$. Selective hydrogenation is of considerable importance in relation to the general theory of catalysis at a solid surface.

Royal Anthropological Institute, February 10.—J. Reid **Moir**: Further discoveries of Early Chellean flint implements from the Cromer Forest Bed of Norfolk. The principal site investigated exists at East Runton, where, upon the foreshore exposed at low water, is a bed, averaging 18 inches in thickness, resting upon the chalk and very strongly impregnated with salts of iron. The deposit is being slowly broken up by modern sea action, and this results in the formation of a flint bed of a precisely similar character to that present upon the foreshore at Cromer. The accumulation represents in all probability the basal layer of the Cromer Forest Bed strata. From East Runton, Mr. Sairn of Cromer has found a number of Forest Bed mammalian remains, including *E. meridionalis, E. antiquus, Rhinoceros etruscus, Bison bonasus, Equus stenonis, Hyæna crocuta, Trogontherium cuvieri*, and numerous remains of the Cervidæ. The hand-axes recorded at East Runton and Cromer show that the pieces of flint from which they were made were struck off larger masses of flint, some of which were "prepared" by flaking beforehand. The evidence at East Runton establishes the fact of the occurrence of Early Chellean hand-axes in a bed at the base of the Cromer Forest Bed series of deposits, and beneath the glacial boulder clay of the Scandinavian ice-sheet, representing the second glacial period of East Anglia. It is highly probable that the specimens found upon the foreshore at Cromer were derived from a similar deposit to that still existing at East Runton.

February 20.—L. H. Dudley **Buxton**: The Stoney Indians of the Bow River, Alberta. The Stoney Indians are a branch of the Dakota Sioux, from whom they separated shortly before 1640. After leaving the parent stock they joined the Crees and gradually moved in a north-westerly direction. The reserve on which they now live lies on both sides of the Bow River, in southern Alberta, at an altitude of over 4000 feet above sea-level, in the foothills of the Rockies. The country is hilly and much of it is covered with grass and, in places, low scrub. The area of the reserve is just under 140 square miles, of which fifty acres only are cultivated. The total Indian population is just over six hundred. The Stoneys are divided into three bands, which are not endogamous, but the tribe, apart from a certain admixture of Cree blood, have kept themselves very much from outside contact. They are typical Plains Indians. They are very averse from agriculture, but hunt and trap at the right season and do a certain amount of trading. Although they are mostly nominal Christians, a number of the old customs, notably the Sun Dance, are still retained. The Stoneys seem in their physique to resemble closely the Siouan peoples to whom they are linguistically allied, but the most close resemblance is with the Blackfoot.

Linnean Society, February 19.—Miss A. Lorrain **Smith**: Templeton's drawings of lichens and fungi. John Templeton (1766–1825) was well known to the botanists of his day, more especially in Ireland. Taylor states in a note to the section *Lichenes* in the "Flora Hibernica" (1836): "The foregoing account of the lichens of Ireland would have been still more incomplete, but for the extensive collections of our lamented friend, the late Mr. John Templeton of Cranmore, near Belfast." Templeton entered on the scientific study of botany in 1790. His last paper seems to have been on peat-bogs, and was contributed to the Geological Society in 1821. Several manuscript volumes of his Hibernian flora with coloured drawings are preserved in the Belfast Museum.—J. **Burtt-Davy**: The tropical element in the arborescent flora of the Transvaal. The geographical distribution of 647 kinds of trees and allied shrubby plants was discussed. About 30 per cent. of these are endemic to the Transvaal and 70 per cent. are "wides." The percentage of endemics is only about two-thirds that of the endemics of all Transvaal phanerogams, suggesting that they represent types of vegetation older than many of the herbaceous types. Fully 90 per cent. of the wides are tropical or subtropical; the temperate element is very small. There is evidence in a limited area of the evolution of a recent warm-temperate flora (through recent elevation of the land-surface) replacing an older tropical and subtropical flora. Islands and reefs of older floras are left stranded where climatic conditions permit them to persist; these are not homogeneous, but represent different migration periods. Several cases are cited of strictly Northern Hemisphere genera migrating into South Africa, *e.g.* Salix, Dianthus, and Juniperus, none of which can have migrated from south to north. The highway of migration southward has been the great eastern mountain-range, owing to its favourable climatic conditions (relative absence of drought periods, etc.). The great central plateau has acted as a (recent) barrier to migration, probably owing to relatively low rainfall and periodic drought.—R. R. **Gates**: A virescent Delphinium. The numerous flowers showed little variation, the sepals were large and baggy, the spur of the posterior sepal being very short, forked at the tip, and very late in developing. The petals were very much reduced and without spurs or nectaries. The androecium was unaltered and the pollen normal. The carpels were long, curved, and without stigmatic surfaces. Virescence is frequently inherited as a Mendelian recessive, but often with complications, and the whole phenomenon deserves further genetic study.

Geological Society, February 25.—A. H. **Cox**: (1) The geology of Cader Idris (Merionethshire). Cader Idris is an escarpment of Ordovician igneous rocks south of the Harlech Dome. The strata have a general southward or south-eastward dip of about 40°, and the succession is given. The volcanic rocks have a much greater time-range than had been proved hitherto. The four volcanic groups are separated one from the other by sediments of thicknesses so considerable that each represents a distinct episode. The main structures have a north-east to south-west trend; but there is also a regular system of north-and-south minor folds that often cause a marked deflexion of outcrops. This minor folding was operative in pre-Ordovician, Ordovician, and post-Silurian times. (2) The dissection of pitching folds. By altering the inclination of the plane of dissection across a pitching fold, outcrops can be made to take any desired curve, either concave or convex. In a pitching anticline the curves will have a downward convexity when the inclination of the dissecting plane is less than the angle of pitch, but an upward one when the direction of inclination of the dissecting plane is opposed to that of the pitch. There must, therefore, be some intermediate position in which the outcrop "curve" is such that its projection on the map appears as a straight line, and the outcrop crosses the fold without apparent deflexion. Such deceptive projections are liable to occur in districts of high relief.

PARIS.

Academy of Sciences, February 16.—A. **Lacroix**: A new type of eruptive alkaline rock.—G. **Kowalewski**: Plane groups with two fundamental infinitesimal transformations.— — **Angelesco**: Polynomials con-

nected with those of M. Appell.—André **Roussel**: Semi-continuity.—A. **Alayrac**: Study of the *vol plané* in a wind of oscillating direction and in an oscillatory wind of short period.—André **Metz**: The entanglement of the ether and the aberration of the stars. The conclusion is drawn that the aberration of the stars, as shown by experiment, is incompatible with the hypothesis of the entanglement of the ether by the earth.—Louis **de Broglie**: The natural frequency of the electron.—A. **Marsat**: The verification of reflectors for the projectors of motor-cars. A description of a rapid method for determining the dimensions of the caustic curves of reflectors.—A. **Leduc**: Molecular association and the equation of state of gases.—H. **Buisson** and C. **Jausseran**: The spontaneous reversal of the lines in the spectrum of neon. In a neon spectrum, lines which are simple when viewed through a short length of gas show reversal when viewed through a longer length. As a consequence of this spontaneous reversal, neon lines are not so useful in determining standards of length as has been supposed.—André **Broca**: The rational mounting of stringed instruments. Modifications in mounting are described which have been proved practically to lead to improved tone and quality.—Robert **Castagné**: The radioactivity of some springs of Alpine stations (Aix-les-Bains, Challes-les-Eaux) in the Pyrenees (Bagnères-de-Bigorre) and the Cévennes (Lamalou-les-Bains, Balaruc-les-Bains, Les Fumades) and of the natural gases of Vergèze (Gard), of Hérépian and Gabian (Hérault). The results of the measurements given show the high radioactive power of the large springs at Aix-les-Bains, the important radioactivity of the waters in the Pyrenees, and the feeble radioactivity of the springs in the Cévennes and on the Mediterranean coast.—René **Audubert** and Mlle. Marguerite **Quintin**: The mechanism of adsorption of ions.—F. **Wandenbulcke**: The rapid estimation of sulphuric acid in waters.—A. **Kling** and Mme. A. **Lassieur**: The separation of zinc and nickel by sulphuretted hydrogen. Since the presence of sulphuretted hydrogen interferes with the working of the hydrogen electrode, the quinhydrone electrode and with coloured indicators, it is necessary to remove this gas completely from solutions, either by boiling or by passing air, before determining the acidity. For the quantitative precipitation of zinc as sulphide without separation of nickel the P_H must be between 1·35 and 2.—Georges **Denigès**: The alloxantin reagent, of very general application, for ferric iron.—J. F. **Durand** and R. **Naves**: The action of hydrogen peroxide on the magnesium arylamines. By using an anhydrous ethereal solution of hydrogen peroxide, phenylhydroxylamine can be prepared from C_6H_5. NH. MgBr with a yield of about 80 per cent.—Paul **Jodot**: Contribution to the petrographic study of *chailles*.—Jean **Piveteau**: The age of the lowest layers of the sedimentary strata of the south-west of Madagascar, between Onilahy and Mangoky.—J. **Savornin**: The cretaceous basin of the Haute-Moulouya.—R. **Bureau**: Atmospherics: their classification and their thermodynamical properties.—L. **Lutz**: The culture of Hymenomycetes fungi in artificial media.—V. **Vincent**: The action of the carbonates of the alkalis and alkaline earths on the acidity of soils. The best substance for neutralising acidity in soil, in spite of its insolubility, is calcium carbonate, because it can be employed at any period without endangering the seed, and is also safer for light soils than quicklime.—Mlles. J. **Lelièvre** and Y. **Ménager**: The application to *L. flexicaulis* of the method of analysis by combustion.—L. **Herrera**: The presence of silica in incinerated histological sections. Remarks on a note by M. A. Policard. Claim to priority.—A. **Maubert**, L. **Jaloustre**, P. **Lemay**, and G. **Andreoly**: The catalytic properties of bismoxyl. The tartrobismuthate of potassium and sodium precipitates the catalase of hepatic extracts: the precipitate formed shows great activity towards hydrogen peroxide.—A. **Rochon-Duvigneaud**, E. **Bourdelle**, and J. **Dubar**: Apparatus for the determination of the visual anatomical field by the method of the trans-scleral image.—E. **Hédon**: Life without the pancreas. The effects of the suppression of the treatment by insulin in the dog completely deprived of the pancreas: diabetic coma, its cure by sodium bicarbonate and insulin.—Raoul M. **May**: Relation of the nerves to degeneration and the regeneration of the gustative papillæ.—Jacques **Pellegrin**: African fishes of the family of the Phractolœmideæ.—R. **Argaud**: The nerve terminations in human cancer.—H. **Bordier**: Experiments in medullary radiotherapy. This treatment has produced marked improvement, and in some cases has cured infantile paralysis. The technique is given in detail.

ROME.

Royal Academy of the Lincei, January 4.—V. Volterra in the chair.—B. **Grassi**: Androphylic and androphobic gnats of Legendre.—Alfonso **Herrera**: Photosynthetic theory of the origin of life and production of organic forms with metaformaldehyde. Under certain conditions formaldehyde undergoes polymerisation into metaformaldehyde, which separates in a pseudo-crystalline mass composed of microscopic cell-like and amœboid forms; the silica present as impurity in commercial formalin apparently plays a part in this phenomenon.—Ferruccio **Zambonina** and Guido **Carobbi**: Isomorphism between tervalent thallium and rare-earth metals. As would be expected from the atomic structure proposed by Bohr, the isomorphism existing between compounds of tervalent thallium and those of the rare-earth metals is of limited range.—G. **Bisconcini**: Imperfect flexibility of ropes.—Mario **Crenna**: Observations on the variations in the latitude of Campidoglio.—R. **Magini**: Behaviour of empty [so-called "sandwich"] cathodes in the electric discharge at low pressure.—Paolo **Straneo**: Expression of hereditary phenomena. Deformation of materials is discussed in relation to previous stresses.—Emanuale **Quercigh**: Bismuthinite. Crystallographic measurements of artificial crystals of bismuthinite lead to the axial ratios, $a : b : c = 0{\cdot}985 : 1 : 1{\cdot}004$.—Francesco **Ranfaldi**: Ethyl ester of phenyl-*p*-nitrocinnamic acid. This substance forms crystals belonging to the prismatic class of the monoclinic system, the crystallographic constants being $a : b : c = 1{\cdot}65679 : 1 : 1{\cdot}83480$, $\beta = 69° 29'$; Scacchi's results for the corresponding methyl ester are modified to: $a : b : c = 1{\cdot}82871 : 1 : 0{\cdot}91775$, $\beta = 69° 29'$.—Umberto **D'Ancona**: Investigations on the growth and sexual maturity of *Alosa finta* (Cuv.).—Primo **Dorello**: Function of the digitated glands in the genus Helix.—L. La **Face**: Observations on the nutrition of *Culex pipiens*.—Luisa **Volterra**: Further notes on the variability of the pelagic daphnias of Lake Nemi.—N. **Passerini**: Influence of the quality of the food on the growth of the larvæ, and on the metabolism, of *Tenebrio molitor L.*

VIENNA.

Academy of Sciences, January 15.—L. **Siegl**: Communication from the Radium Institute, No. 174. The quantitative measurement of radium emanation in the guard ring plate condenser. In an attempt to make the radium standard and normal solutions superfluous, a measurement was made of the ionisation

stream which maintains the radium emanation and its successive products in equilibrium. An accurately made air-tight guard ring plate condenser was used as measuring chamber, since it alone is open to complete theoretical treatment. With regard to the three α-radiators (emanation, radium A, and radium C) only, observation and calculation gave a more than one per cent. agreement beyond 4 cm. plate distance, but at small plate distances a greater disagreement. An absolute measure of radium emanation and hence of radium itself can be obtained from the saturation current.—G. **Halledauer**: Communication from the Radium Institute, No. 175. A method of measuring the smallest quantities of emanation and its application to the determination of the radium content of some meteorites. The charge method can be freed from certain errors if the ionisation chamber is completely separated from the electrometer whilst charging, and only at the end and for measurement brought into brief contact with it. Emanation quantities of 10^{-14} Curie may be determined with certainty. For five iron meteorites an average of $0{\cdot}55 \times 10^{-13}$, and for five stone meteorites $6{\cdot}6 \times 10^{-13}$ gm. radium per gram, was found, in practical agreement with other authors.—H. H. **Handel-Mazzetti**: New Chinese plants, descriptions continued.—A. **Limberger**: Symbiosis of Anabæna with Azolla.

January 22.—H. **Handel-Mazzetti**: Map of a journey in the Chinese province of Hunan. H. Witt's surveys including the latitude of Wukang and of Dsingschou were utilised. Dr. H. Mazzetti as a botanist had no astronomical survey instruments, but in his survey emphasised the nature of the country within a wide range of his route, producing a general route map of scale 1 : 300,000 and maps of 1 : 100,000 near Hsikwangshan and Yunschan.

Official Publications Received.

United States Department of Agriculture: Bureau of Agricultural Economics. Atlas of American Agriculture. Prepared under the Supervision of O. E. Baker. Part 1: The Physical Basis of Agriculture. Section E: Natural Vegetation. Grassland and Desert Shrub, by H. L. Shantz; Forests, by Raphael Zon. Pp. 29. (Washington: Government Printing Office.) 50 cents.

Department of the Interior: Bureau of Education. Bulletin, 1924, No. 18: Introduction of Algebra into American Schools in the Eighteenth Century. By Lao Genevra Simons. Pp. vi+80. (Washington: Government Printing Office.) 15 cents.

The National Benzole Association. Second Report of the Joint Benzole Research Committee of the National Benzole Association and the University of Leeds. (Presented March 18th, 1925.) Pp. 246. (London: National Benzole Association.)

The Indian Forest Records, Vol. 11, Part 1: The Constituents of some Indian Essential Oils. By John Lionel Simonsen. Parts 14-15. Pp. 9. 3 annas; 4*d*. Vol. 11, Part 3: Regeneration with the Assistance of *Taungya* in Burma. By H. R. Blanford. Pp. 41+10 plates. 1.4 rupees; 2*s*. (Calcutta: Government of India Central Publication Branch.)

Transactions of the Geological Society of South Africa. Vol. 27, January to December, 1924. Pp. iv+77+6 plates. (Johannesburg.) 42*s*.

Proceedings of the Geological Society of South Africa. Containing the Minutes of Meetings and the Discussion on Papers read during 1924. To accompany Vol. 27 of the Transactions, January to December, 1924. Edited by the Hon. Secretary. Pp. iii+xlii. (Johannesburg.)

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 497: Thermal Expansion of Aluminium and various important Aluminium Alloys. By Peter Hidnert. Pp. 697-731. (Washington: Government Printing Office.) 15 cents.

Unemployment and the Calcutta University Propaganda for a Solution by Educational Colonies, Homecrofting and Homecrafting. Two Series of Articles by Capt. J. W. Petavel. Pp. xvi+vii+90+12. (Calcutta: "Capital," Ltd.) 8 annas; 9*d*.

New South Wales. Department of Mines: Geological Survey. Bulletin No. 10: Silica. By L. F. Harper. Pp. 19+10 plates. 1*s*. Bulletin No. 12: Coke. By L. F. Harper. Notes on By-Products by H. P. White. Pp. 45+9 plates. 1*s*. 9*d*. Bulletin No. 14: Asbestos, Emery, Fluorspar, Fuller's Earth, Graphite, Phosphates, Talc, and Soapstone. By H. G. Raggatt. Pp. 31. 1*s*. Bulletin No. 15: Diatomite. Siliceous Earths and Sands. By E. J. Kenny. Pp. 18+2 plates. 1*s*. (Sydney: Alfred James Kent.)

Proceedings of the Cambridge Philosophical Society. Vol. 22, Part 4, March 12. Pp. 481-600. (Cambridge: At the University Press.) 7*s*. 6*d*. net.

Transactions of the Royal Society of Edinburgh. Vol. 53, Part 3, No. 30: Geology of the Outer Hebrides. Part 2: South Uist and Eriskay. By Prof. T. J. Jehu and R. M. Craig. Pp. 615-641+5 plates. (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.) 5*s*. 6*d*.

Proceedings of the London Mathematical Society. Second Series. Vol. 23. Pp. lxxi+524. (London: Francis Hodgson.)

Ministry of Public Works, Egypt. Physical Department Paper No. 16: Metallic Spirit-Levels. By E. B. H. Wade. Pp. 9+4 plates. (Cairo: Government Publications Office.) 5 P.T.

The Annual Report of the Gresham's School Natural History Society, 1924. Pp. 14. (Holt, Norfolk.)

Diary of Societies.

SATURDAY, APRIL 4.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. J. H. Ashworth: The Nervous System and some Reactions (II.): Of Marine Annelids and Earthworms.

BRITISH ASSOCIATION OF MANAGERS OF TEXTILE WORKS (at Textile Institute, 16 St. Mary's Parsonage, Manchester), at 6.—F. A. Tomlinson: The Outside Growths of Cotton.

IPSWICH AND DISTRICT NATURAL HISTORY SOCIETY (at Ipswich).—J. Reid Moir: The Antiquity of Man in Ipswich (Presidential Address).

MONDAY, APRIL 6.

ROYAL SOCIETY OF MEDICINE (War Section), at 4.30.—Annual General Meeting.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Dr. E. Ash: Psychotherapy: Mind in Curative Action.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—E. R. Matthews: Problems in Designing and Constructing Sea Defence Works.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 6.—Dr. Jessie White: Scientific Pedagogy.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—A. Collins and others: Discussion on Insulation Problems in High-voltage Engineering.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—P. Leon: Æsthetic Knowledge.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Royal Society of Arts), at 8.—Prof. W. A. Bone: The Constitution of Coal.

SURVEYORS' INSTITUTION, at 8.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Major-Gen. Sir Percy Cox: A Journey behind Muscat to the Jebel Akdhar.

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre).—S. T. Allen: Radiators and Heating, with special reference to Material.

TUESDAY, APRIL 7.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—F. G. S. Whitfield: The Relation between the Feeding-habits and the Structure of the Mouth-parts in the Asilidæ (Diptera).—O. Thomas: The Mammals obtained by Mr. Herbert Stevens on the Sladen-Godman Expedition to Tonkin.—W. M. Le Gros Clark: The Skull of *Tupaia minor*.—Dr. R. H. Hunter: The Extensor Muscles in the Hind-foot in Mammals.

INSTITUTE OF MARINE ENGINEERS, at 6.30.

INSTITUTE OF METALS (Birmingham Section) (at Chamber of Commerce, Birmingham), at 7.—Annual Meeting.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—F. E. Lamplough: The Manufacture of Optical Glass (Traill-Taylor Memorial Lecture).

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Centre) (at Broadgate Café, Coventry), at 7.15.

SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (Jointly with the Chemical Engineering Group) (at Birmingham University), at 7.15.

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at 207 Bath Street, Glasgow), at 7.30.—E. A. Watson: The Economic Aspect of the Utilisation of Permanent Magnets in Electrical Apparatus.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.—W. I. Hay and D. McArthur: Canadian Bulk Cargo Vessels on the Great Lakes.

HULL CHEMICAL AND ENGINEERING SOCIETY (at Grey Street, Hull), at 7.45.—Annual Meeting.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Dr. H. S. Stannus: Some Types of Natives from Nyassaland, Normal and Abnormal.

RÖNTGEN SOCIETY (at British Institute of Radiology), at 8.15.—R. Craig Rodgers: The Organisation and Equipment of X-ray Rooms arranged for Private Radiologists.—G. T. Loughborough: Acute X-ray Burns.

WEDNESDAY, APRIL 8.

ROYAL ASTRONOMICAL SOCIETY, at 5.—A. N. Kriloff: Sir Isaac Newton's Formula for the Attraction of a Spheroid on a Point of its Axis.—Dr. J. H. Jeans: A Theorem of von Zeipel on Radiative Equilibrium.—Prof. H. H. Turner: Note on the 284-year Cycle in Chinese Earthquakes.—Royal Observatory, Greenwich: Characteristic Movements of Sunspots.

RADIO SOCIETY OF GREAT BRITAIN (Informal Meeting) (at Institution of Electrical Engineers), at 6.—E. C. Atkinson: Home-made Wireless Components and Sets.

INSTITUTION OF AUTOMOBILE ENGINEERS (Wolverhampton Centre) (at Wolverhampton).

THURSDAY, APRIL 9.

INSTITUTION OF ELECTRICAL ENGINEERS (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.15.

INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre, Dublin) (at Trinity College, Dublin), at 7.45.—P. J. Hayes: Automatic Telephony.

OIL AND COLOUR CHEMISTS' ASSOCIATION (at 8 St. Martin's Place, W.C.2.) at 8.—B. D. Porritt: Some Problems of the Paint and Rubber Industries.

INSTITUTE OF CHEMISTRY (Liverpool Section) (at St. George's Restaurant, Liverpool).