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Freedom of the Mind

OUR civilization is clearly separated from all that have gone before by its reliance upon science. Science makes certain demands on social environment, and among the chief of these is surely freedom of the mind. Without such freedom, our scientific system could not exist or progress : without it, representative institutions cannot be maintained. Milton saw these things very clearly, and it was in the early days of the Royal Society that he wrote :

". . . True Liberty
. . . always with right Reason dwells
Twinn'd, and from her hath no dividual being.
Reason in Man obscured or not obeyed
Immediately inordinate desires
And upstart passions catch the Government
From Reason, and to servitude reduce
Men, till then free."
"Paradise Lost", Book XII, 83–90.

We are witnesses of the simultaneous destruction in several parts of the world of the twins—liberty and reason—and the consequent deterioration of science. We see reason not only obscured and disobeyed but even ousted by unreal creatures of the imagination—'racial consciousness', 'national self-sufficiency', 'the leadership principle'—or one or other of the chimæras of the totalitarian States. Some peoples have been caught thereby from reason, so that the desires and passions of their Governments have already reduced men to servitude, and are on their way to reduce science to nothingness. We have seen a great country, until of late rightly proud of its universities and its scientific achievements, abandoning its belief in reason, destroying the careers of a fifth of its scholars and, by rendering the position of all insecure, humiliating the profession of learning itself and lowering the whole standard of its civilization.

For, let it be remembered, civilization must depend upon a small minority. Our present civilization is upheld by the critical and creative efforts of a few, whose judgment and knowledge ultimately determine the values of the rest. Only in an atmosphere of freedom can such men make their contribution to their own communities and to the world. The need for the Society for the Protection of Science and Learning to save for the freer parts of the world the learning rejected by these slave States, is the measure of the destruction of freedom.

It is an experience, gathered from history, that the great periods of intellectual activity follow the coincidence of the discovery of important new facts with the wide extension of a sense of personal liberty. Of this relation a fortunate illustration is provided by the seventeenth century, which saw both the foundation of English ideas of liberty and the establishment in England of the scientific disciplines. On these two foundations have been built most of the good things that make up our national life. The other democracies—and it is among democracies only that science seems now to flourish—have had a comparable experience.

The rise in the social valuation of freedom of the mind has, therefore, been of incalculable importance for science. Unfortunately, this great movement has had its own vicissitudes and has brought with it its own dangers. In the eighteenth century, science was still confined to a very small class, within which free opinions passed as common intellectual currency. With the emergence of the liberating influences of the French Revolution, such opinions came to be greatly feared. Active

measures were taken to stifle them when expressed freely, though if buried in expensively printed works the Governments of their day could afford to treat them with contempt. When the 'atheist' William Godwin brought out his "Enquiry concerning Political Justice and its Influence on Morals and Happiness" in 1793, it escaped prosecution only because the authorities supposed that little harm could be done by a three-guinea publication! Soon, however, the technical and industrial triumphs of science won it new prestige, so that during the later Victorian age, freedom of the mind came to be less feared. Gradually there came another change. With compulsory State education, the proportion of literates increased enormously. Moreover, new channels were found for the passage of ideas. Cheap printing, a new technique of daily journalism, and then the cinema and the wireless, have increased again the danger of ideas to those who fear them. Inordinate desires and upstart passions have now again caught Governments from reason, and man has again been reduced to servitude. The very products of science have been used to suppress the spirit of science.

Of all forms of checks on reason, that on the universities is the most dangerous and destructive, for it strikes many of those best equipped to determine social values. The totalitarian States have not failed to perceive this. National Socialism is the form of totalitarianism that has been most destructive of science, and National Socialism is, as its exponents never tire of explaining, an attempt to exalt instinct at the expense of reason. Last year, at the celebration of the so-called 'jubilee' of the University of Heidelberg, which was timed to coincide with June 30, the day of the great political massacre of 1934 in Germany, the Minister of Education, Herr Rust, delivered a speech in which he exalted the so-called 'racial instinct' over the disinterested pursuit of scientific truth. The day of the supremacy of the intellect, he assured us, is over. Under National Socialism, through its agent, Herr Rust, who has no sympathy with the great tradition of free thought, the universities have been regimented and those who do not share national socialist views have been eliminated. Science has thereby been degraded and German men of science have been made subservient to the engineers of a ruthless political machine.

In Germany, science has always been essentially a product of university officials, and the amateur has played a minor part in its intellectual life. But now, not only are its university officials spied upon and kept under a strict rule, but even private workers dare no longer express their opinions. The printing press is as much under control as are universities. What may and what may not be published is determined by men who have repeatedly and publicly expressed their opposition to freedom of the mind. The result has been a general deterioration in the quality of scientific publications in every department from mathematics to anthropology.

Apart from this, what can be said of the scientific literature that has been discouraged or suppressed? What of all that great output of the German intellect that we might have expected during the last four years? Some of it has appeared in foreign countries as the work of men whose continued activity has been rendered possible by foreign hospitality, and what Germany has lost other countries have gained, but much of the potential output of German men of science has been altogether lost. Nor must we forget the great episode of the 'Burning of the Books' which swept as an epidemic over the university towns of Germany. That event will be long held in memory as a sign of what may happen to men by whom reason is disobeyed and the desire for liberty is lost. It is three centuries since Milton wrote words that are as vivid now as then:

"Books are not dead things but do contain a potency of life in them to be as active as that soul was whose progeny they are. Who kills a man, kills a reasonable creature; but he who destroys a book kills reason itself, kills the image of God. We should be wary therefore what persecution we raise against the living labours of public men, how we spill that seasoned life of man, preserved and stored up in books; since a kind of homicide may be thus committed, sometimes a martyrdom; and if it extend to the whole impression, a massacre, whereof the execution ends not in the slaying of an elemental life but strikes at the breath of Reason itself; slays an Immortality rather than a Life."

Milton saw that freedom of thought is possible only under free social conditions. Many British men of science appear to be indifferent to the application of this essential principle of progress. They hold aloof from the great social questions of the day and seem to disregard the activities of forces destructive to the very world of science. We would not wish men of science to become politicians, but surely they should indicate with no uncertain voice their determination to resist those dark forces of unreason implicit in the regimes that would destroy scientific ideals.

Mathematical Biology

Biologie mathématique
Par Prof. V. A. Kostitzin. (Collection Armand Colin : Section de biologie, No. 200.) Pp. 223. (Paris : Armand Colin, 1937.) 13 francs.

THIS is an admirable little book. It does not pretend to teach a biologist mathematics : it does not deal with the ready-made mathematics (so to speak) of the snail-shell, the fir-cone or the honeycomb : it opens our eyes to a variety of biological problems which lie remote from elementary or conventional mathematics, but may nevertheless be brought under mathematical treatment with great advantage. To learn, *ad hoc*, this or that chapter of mathematics, does a biologist little good ; all he wants—and what a deal it is—is to lap up something of the spirit of mathematics, to learn how the mathematician economizes thought by his symbols, simplifies argument by his equations, starts from unequivocal postulates, uses an ancient and traditional logic, and has his own unmistakable ways of saying what he knows and what he wants to know. These are the advantages, or some of them, which bring one science after another under the spell and dominion of mathematics.

The first-found alliance between mathematics and biology came by way of 'statistics', when Quetelet, prompted by Malthus, studied the growth of a population, and dealt with the stature and proportions not of men but of mankind. From Quetelet's right hand Raymond Pearl, after rediscovering Verhulst's 'logistic law', raised up the new science of demography ; from his other hand Karl Pearson, valiantly helped by Weldon to begin with, took the new art and science of biometrics. The study of the growth of a population, or of the mean growth of an individual, is in neither case an easy thing. What population, higher than a cluster of yeast-cells, can be deemed simple and homogeneous ? By what graph or formula can we hope to represent a creature's growth, which begins in its mother's womb, is fed by its mother's milk, bends under the sexual hormones, has its spell of untrammelled vigour, and lingers on under the burden and the disabilities of age ? We must start afresh, with easier and simpler things. Imagine a population not even approximately homogeneous, but definitely heterogeneous, where half is at war with the other half, and one half is the other's inevitable and helpless prey ; or again, imagine a population consisting of host and parasite. In either case, the 'growth of the population'—of the mixed or heterogeneous population—is a theme for the mathematician. Here and round about, in a class by themselves, to be dealt with after a fashion of their own, lie many curious problems ; and Dr. A. J. Lotka on one side of the Atlantic, and Prof. Vito Volterra on the other, were the first to see their mathematical bearing and to devise the differential equations to which they lead. This, then, is the main but not the only theme of Dr. Kostitzin's little book, which is the first to deal in a general way with this class of problems. To the mathematician the book looks like a useful collection of examples of differential equations ; to the naturalist it is obviously a well-chosen set of problems in evolutionary biology. When we realize that it is both of these rolled into one, we begin to see what an eye-opening book it is.

When we study a 'mixed population', it must be no vast and complicated 'fauna' ; we may be well content if we can deal with some local association of two or three species whose lives are plainly interlinked together. Even so, their complex and changing interrelations might seem beyond the scope of mathematics, and the fact that they are not so is nothing short of a great discovery. We begin by learning to symbolize the conditions of existence by coefficients of vitality and mortality ; we must be prepared for critical changes when one constituent of a population has greatly dwindled or preponderantly increased ; we cannot fail to recognize a tendency towards equilibrium—but we end by discovering that equilibrium is never to be attained ! An everlasting ebb and flow, a mean level and a tide, is our nearest approach to equilibrium. A typical illustration, the very one which led to what we call Volterra's law, is that of two associated fishes, one feeding on the other—call them shark and cod. While the shark are few the cod multiply ; when cod are plentiful the sharks wax fat and multiply in turn ; the predaceous horde plays havoc with the shoals of cod, and at length the poor sharks go short of food and their numbers dwindle. We find analogous cases everywhere. The whalers equip fleet after fleet while whales are plentiful ; sooner or later the whales are reduced to vanishing point, the trade ceases to pay, and the few whales left have time to breathe and breed again ; and so on, and so on, in a long, slow cycle of trade. But so simple a differential equation is soon complicated, the worse for the whale. The older whale-fishery was so eked out by seals, narwhals, walrus, bottlenose

and beluga, that it went on long after the whales had grown too scarce to pay the cost of a voyage. The modern whale-fishery, again, is or was based on the great blue whale; but increasing scarcity confers no respite or immunity on this poor monster, for less valuable species live alongside, and serve to keep the industry in being and prolong the epoch of destruction.

The lack of permanent equilibrium, the inevitable flux and reflux, may be seen everywhere: in the battles of the bulls and bears, the alternation of slump and boom, the vicissitudes of party politics and the hopeless dream of a world where there shall be no more war. From Volterra's first equation, Dr. Kostitzin (following M. E. Fischer-Piette) takes us to a sea-shore abounding in mussels, but starfish came in from every side (just as they do on oyster-beds), and the mussels soon grew few; in the mixed population were also dog-whelks (*P. lapillus*), which feed on mussels and on barnacles, by choice the latter. In a good mussel-year mussel-spat covers everything, the rocks, the barnacles and the old mussel-shells; the whelks turn, perforce, to a diet of mussels, and flourish exceedingly. The mussels diminish, and leave the rocks bare for a new invasion of barnacles; and in a year or two, as these grow up, the whelks forsake the now scanty mussels, and come back to barnacles as their proper food. All these facts and phases can be easily symbolized. If p_1, p_2, p_3 be the population of barnacles, mussels, whelks, then (for example) to begin with, p_1^1 (the initial population of barnacles) $= \varepsilon_1 p_1$ (where ε is a coefficient of vitality) $- h_{13} p_1 p_3$ (where h_{13} is a coefficient of interrelation, and symbolizes the effect of p_3 on p_1) $- h_{12} p_1 p_2 - h_{11} p_1^2$ (this last being the fight among the barnacles themselves for food and foothold). For each phase, for each scene of the drama so to speak, we have a new set of such equations as these; and these several groups of differential equations combine, pass from equilibrium to inequilibrium, and show the ups and downs of one species after another. After this simple fashion, without talking over our heads, Dr. Kostitzin shows us how his differential equations are built up. It is not his fault if their solution, even their qualitative solution, turns out to be a harder matter.

The wolf, the goat and the cabbage: the great carnivorous lizards, the little herbivorous mammals and the normal vegetation of Komodo: the little mite-populations which survive when both are few, but of which one goes under when the other multiplies: the various associations of infusoria, *Paramœcium*, *Bursaria*, *Didinium*: these are a few of the cases to which Dr. Kostitzin fits his protean differentials. From vague and transitory associations we pass on to more stable relations of symbiosis and of parasitism. One of these—we never dreamed of old of its being open to mathematical analysis—is that of *Adamsia* and *Eupagurus*, the sea-anemone and the hermit-crab. The larvæ of these are free and independent, and each lives in its own country; but we must not suppose that mere chance, apart from any pre-adaptation or predisposition, brings them together. The partnership brings its recognizable advantages, all the greater the earlier it is formed; and while other hermits and anemones may associate temporarily and fortuitously, in this particular case they so draw together as to be at last inseparable.

The growth of a population prepares us for that of an individual organism, which is indeed a population in itself, a cluster of organs or a multitude of cells. These, *mutatis mutandis*, are alike to a first approximation; but, to take only one of many differences, reproduction, which should be a function of all the individuals of a population, is by no means common to all the cells of a multicellular individual. The author points out, in passing, that the growth of man, from youth to age, is singularly complete and unusually instructive; for we follow it even into extreme old age, all through the phase of senility which wild Nature cuts away, but in man alone is permitted and assisted to endure.

A short chapter follows, on the forms of living things—a somewhat trivial chapter, below the level of the rest of the book; and the book closes with a chapter on evolution, a short one but long enough to let the author's originality appear. He points out the cardinal distinction between local and general evolution. In the world at large things really tend towards equilibrium, dropping down into their most probable state: entropy goes on increasing, and all the wheels are slowly, slowly, running down. But this does not hold for all the local, isolated cases; the less probable gets its chance now and then. We must on no account suppose, as some did in early Darwinian days, that evolution is going on here, there and everywhere, that organisms are everywhere and evermore growing better, finer and more beautiful; in the vast duration of geologic time and the vast range of the living, a notable step in organic evolution is always a rare and most unlikely thing. This being so, life is no negation of the law of entropy; it only illustrates and confirms it. What, then, lies at the root of evolution? To begin with, there is the principle of selection, the struggle for existence, through any or all of those things that in our various equations add ever so little to the coefficients of mortality. Every grade of advantage and disadvantage,

every stage of disqualification up to extinction itself, may be symbolized and analysed mathematically; of selection as a factor in evolution there can be no doubt at all. Next comes the occurrence of mutations. As Jachin and Boaz, so are mutation and selection the two pillars of the house:— Given these two, the origin of species is so far explained. But when all is said and done, then ignorance lays hold of us again. Our author assumes, apparently, that the origin of species is an unlimited process and that species (or 'phenotypes') vary all but continuously and without end: but the fact is we begin by marvelling at the wealth of species in the world, and end by realizing that, in contrast to an infinite variety, they are astonishingly few. Mutation has its narrow limits, so far as ever we see: and the science of genetics does not explain the mechanism of evolution. Again, when mutations do occur, what leads to them? What chromosomes look like we know well; But what are they, and what do they really do? Biology will have come at last into its kingdom when we shall have found a simple answer to these and a few other simple questions.

D'ARCY W. THOMPSON.

Britain's Scenic Beauty

The Scenic Heritage of England and Wales

By O. J. R. Howarth. Pp. xxv+190+48 plates. (London: Sir Isaac Pitman and Sons, Ltd., 1937.) 8*s*. 6*d*. net.

THE Councils for the Preservation of Rural England and of Rural Wales have rightly judged that their efforts may be strengthened by interesting senior pupils of our schools in that beauty which is such a feature of Great Britain in spite of the disfigurements that have been multiplied so disastrously since industrialism classed our cities under Dr. Jacks's general name of 'Smokover', and 'bungalitis' spread along so much of our coast. To the appreciation of scenic beauty our minds, variously stored with early memories and the results of study of many kinds, may bring diverse contributions, but these associations are beyond standardization and it is difficult to communicate them far and wide, so Dr. Howarth has in the main focused this book upon sheer physical characteristics, while appropriately bringing in man-made features in many connexions. Dr. Vaughan Cornish, with the artist's eye, sees that our venerable trees that have been allowed to grow in their own way, instead of being lopped as are so many on the Continent, are a splendid part of our heritage and essentially a British feature, and he has striven in an introduction to suggest the changes of the scene around the year.

Dr. Howarth bases his study upon the geology of our country, which is to such a remarkable, almost a unique, extent an epitome, in miniature, of the story of the rocks of the world; but his chapter on historical aspects exhibits a wise perspective, illustrated as it is by "Long Meg and her Daughters", for the prehistoric; Fountains Abbey and Salisbury for the ecclesiastical; and Charles Darwin's garden at Downe for the scientific phase of our social evolution. There is a very soberly written tribute to London that may be more effective than the more enthusiastic account of our incomparable capital that some of us would have composed. It is good to see that the author has learned from Lethaby. The Weald, the Chalk, the East, the Hampshire Basin, the Secondary Limestones, the Midlands, the Western Marches, the South West, Wales, the Pennines, the North-east and the Lake District are treated successively, and there are forty-eight full-page illustrations from well-chosen photographs. One hopes that the book may spread both among the general public, and, in particular, the motoring and the hiking sections of the community, as well as in the schools, and that second and third editions may soon be called for. If that is the case, the promoters of the book will be well advised if they increase still further the number of good illustrations. It is probable that we can do most in the desired direction by educating the eye, and one looks forward to such a development of this book, without increase of price, as will make pictures its mainstay, though our appreciation of the thoughtful character of the text is likely to grow.

The low and dissected plateau of newer rocks was the basis of our English nationalism and of the Puritan tradition, now become essentially conservative. Its quiet scenery, its picturesque villages, too often still needing better sanitation, its trees still shading the parish churches that are such a feature of England, all help to give it a character of its own that John Constable expressed as few others could. The wilder areas of older rocks, the south-west, Wales and the north, all with stronger infusions of the Celtic heritage that is nowhere entirely wanting, were of old the basis

of warlike vigour and regionalism, of the Cavalier tradition and the associations of John Peel. But it has been their strange fate to be transformed, in patches here and there, into the industrial slums that sprawl over the West Riding, South Lancashire, the Black Country, and what were once gems of beauty like the Rhondda Valley in South Wales. So it comes about that nests of ancient survivals and hives of nineteenth century industry, not a few now half derelict, are interspersed. And now industry is spreading into the old England of the newer rocks. Have we learned our lesson? Dr. Howarth is hopeful about Corby.

Since 1895, many beauty spots and some four thousand monuments of our past have been placed under the protection of trusts concerned solely with our heritage of beauty and our historic record. This is a worthy record of piety, but it suggests some uncomfortable questions. What will our successors preserve as the records of the Britain of industrial and commercial imperialism? Shall we put a fence around some condemned slum area in Manchester or London and call it a historic monument? Might we not dedicate the slagheaps and discarded railway station of Landore? Are we not perhaps on the way towards sublimating Crewe Junction into the realms of history? Can we not consider a recent suggestion to move the great majority of the statues of booted and frock-coated or robed worthies that encumber rather than adorn our streets and squares into out-of-the-way corners of parks? H. J. F.

The Preservation of Food

Canning Practice and Control

By Osman Jones and T. W. Jones. Pp. xii + 254 + 65 plates. (London: Chapman and Hall, Ltd., 1937.) 25*s*. net.

THE great changes in the conditions of life brought about by the industrial developments of the last century have necessitated an increased consumption of preserved foods. Of the various processes used in commercial practice, that of sterilizing in hermetically sealed tinplate containers—more commonly referred to as 'canning'—has rightly assumed pride of place, and foods properly preserved in this manner are not only in a form convenient to the housewife but are also at least as nutritious as similar products cooked in the home. The steady growth of the canning industry in size and efficiency has been aided throughout by researches which have covered a wide field, ranging from investigations connected with the growth of suitable raw products through the many problems associated with the technical processes of industry to studies of a more academic nature in bacteriology and metallurgy. It is a little difficult for the general food chemist to keep track of this widespread literature, and for that reason we must welcome any attempt to consolidate the existing knowledge of the science and art of food canning.

The title of the present book is perhaps a little misleading, as there is a noticeable lack of balance between the treatment of the sections on canning practice and laboratory control, and it seems a pity that the authors have limited their discussion of the practical side to about a fifth of the book. On the other hand, the chapters dealing with scientific control as applied to the duties of the works chemist or bacteriologist are more comprehensive than would appear to be necessary.

After a preliminary chapter dealing with the statistics of production and consumption of canned foods, the authors go on to describe the construction and equipment of a cannery and then give a brief outline of canning processes in general. The latter chapter can scarcely fail to be disappointing to the practical canner on account of the many very obvious errors it contains. To take but one example, it is incorrect to say that the majority of canners make their own cans, as almost every firm engaged in the canning of fruits and vegetables obtains its supplies from one of the companies which specialize in making the standard open-top can. Nor are the cans made by these companies supplied in the flattened form, this method of packing being intended only for export purposes.

Adequate space is given to methods of chemical analysis, but greater stress might have been laid on the difficulty of estimating copper in the presence of tin and iron. The bacteriological side of laboratory control occupies about a quarter of the book, and much of the descriptive matter concerning the elementary aspects of the subject could have been omitted with advantage.

The book contains much material of interest and value to the food chemist, the cultural notes on the principal food spoilage organisms being particularly worthy of mention. The text is well supplied with references, and there are many excellent illustrations, the numerous photomicrographs of bacteria being remarkably good.

F. H.

Einführung in die klassische Elektrodynamik

Von Dr. Johannes Fischer. Pp. viii + 199. (Berlin : Julius Springer, 1936.) 13.80 gold marks.

THIS small volume on the classical electric theory contains a general, but not very novel, survey of the portions of the mathematical-physical theory which are still relevant in the broader technical applications of the subject. Starting with electrostatics, the author carries his readers carefully through all the important physical ideas underlying the static field theories of Maxwell and Faraday, including the theory of dielectrics. Following this, he introduces in a small chapter the field and energy relations of the magnetostatic field, basing himself on the analogy with the electrostatic field. The first section of the book closes with a brief survey of the kinematical problems of current flow in conducting media.

In the second section, the usual laws of electrodynamics are discussed in some detail, together with their application in current theory and its bearing on the problems of electro-technics. The treatment is based on the ideas underlying Maxwell's equations, which are given in explicit form and used in the last chapters to develop the main ideas of the theory of the propagation of electromagnetic disturbances.

The author lays some stress on an endeavour to circumvent the difficulties in the assumptions underlying presentations of this subject via the æther theories, but one cannot but feel that he has been successful only to the extent to which he has avoided discussion of these difficulties. He gives, for example, the Kelvin-Larmor discussion of the polarization constituent of the total electric displacement, but says nothing whatever about the other constituent—the 'æthereal' one. His use also of the magnetic circuit to overcome some of the difficulties of the magnetic formulation really introduces more difficulties than it overcomes. He still fails to realize that the difficulties in the old-fashioned formulation of the magnetic relations all result from the use of the fundamentally faulty electric-magnetic analogy. It is also noticed that, like all Continental writers, the author still adheres to the form of the Maxwell stress deduced originally by Helmholtz by an argument which Larmor showed more than forty years ago to be physically unsound.

These are, however, perhaps small blemishes on a very brave and generally successful attempt to present in about 170 pages a reasoned account of a subject which most of us feel demands nearly four times this space. G. H. L.

The Annual Register :

a Review of Public Events at Home and Abroad for the Year 1936. Edited by Dr. M. Epstein. Pp. xii + 304 + 190. (London, New York and Toronto : Longmans, Green and Co., Ltd., 1937.) 30*s*. net.

THERE can be few events in the political or social history of Great Britain or the Empire that escape record in the pages of this widespanned annual. A dispassionate review of the year ranges over a field wide enough to include reduction in telephone charges and non-intervention in Spain. The Dominions and India follow, and then comes a long section treating of foreign history, preceded by several pages on the League of Nations. A few States have had a year so happily uneventful as to escape inclusion in the survey, but this is exceptional.

Part 2 of the book has the usual arrangement of a chronicle of events ; a retrospect of literature, art, science, finance and law. Science of the year is reviewed in epitome : much is mentioned in an extremely condensed form. Two among other general trends are noted : the growing disquiet among men of science at the frustration and prostitution of science for anti-social ends, and also the clear realization that advance in scientific thought can only come through intellectual freedom. Among the public documents published in full is the new Soviet constitution. An admirable index much facilitates reference.

The Tropical Garden

Its Design, Horticulture and Plant Materials. By Loraine E. Kuck and Richard C. Tongg. Pp. xi + 378 + 16 plates. (New York : The Macmillan Company, 1936.) 12*s*. 6*d*. net.

THE authors of this volume are writing primarily for gardeners in the Haiwaiian Islands, though, as the climate in this part of the Pacific is fairly typical of the moderate tropics everywhere, the information they give will be of use to a much wider public. They treat their subject from two angles, design and choice of suitable plants. In twenty-three chapters these two aspects are fully explored. The book is written in a popular and lively style, but is, nevertheless, scientifically accurate—as is to be expected from the list of helpers given in the preface.

The numerous photographs add to the value of the text, and the volume is well produced. A greater use might, however, have been made of italics for Latin names. The volume is a welcome addition to the rather meagre list of works on gardening in the tropics.

Technical Electricity

By H. T. Davidge and Robert W. Hutchinson. Fifth edition. Pp. x + 520. (London : University Tutorial Press, Ltd., 1936.) 12*s*. 6*d*.

WE can commend the fifth edition of this book highly. It is easy to understand, has been thoroughly brought up to date and will appeal to students, teachers and engineers. The answers are given to the problems set and many of them are completely worked out. Electrical engineers can refresh their memory about the fundamental facts of atomic disintegration, thermionic valves and photo-electric cells. They will even find something instructive said about tariffs and the British Grid. We think, however, that the authors' résumé about the laws governing the sizes of fuses and the temperature rise in cylindrical conductors could have been improved. They have not laid sufficient stress on the important part played by thermal convection currents in this connexion. A better rule than the one given is that, within certain limits, the fusing current varies as the 1·25th power of the radius of the wire. A proof is given by Russell (*Proc. Phys. Soc.*, 22, 450).

The Bermuda Oceanographical Station

By Prof. E. W. MacBride, F.R.S., Chairman of the Advisory Committee of the Development Commission on Fishery Science

THE British Government has decided to grant a sum of money in order to establish and carry on for a period of five years an oceanographical station in the Bermuda Islands. The management of the station has been vested in a Committee, of which I have the honour to be chairman, nominated by the Royal Society, and hence it seemed appropriate that I should endeavour to give to readers of NATURE an account of the reasons which led to the decision to found the station and the objects which it is hoped to attain by its activity.

At a time when taxation is so heavy in the United Kingdom, some members of the general public may think it a piece of quixotic extravagance to subsidize what might be regarded as a Colonial institution. The answer to this objection is that the station is not being established for the benefit of the Bermuda Islands but to help British fisheries.

At one time it was thought that by the artificial hatching of the eggs of our edible fish, and by then releasing the fry in the coastal waters, the fisherman's catch could be increased. Not so very long ago, haddock fry were thrown into the sea off the east coast of Scotland and herring fry were released in Loch Fyne, just as to-day lobster fry are poured into the sea near Barra Head in the Isle of Man. It was that brilliant zoologist and oceanographer Prof. Johan Hjört who first clearly showed the futility of this procedure. He pointed out that if one counted up the total number of fry hatched at one of the fishery stations and expressed this total in terms of the number of females necessary to produce them, the whole work of the station was equivalent to adding at enormous expense a few dozen female fish to the teeming millions already in the sea. The main service which fishery research can render to the fisherman is to tell him where to find his fish and what the magnitude of the catch in the coming season is likely to be.

In certain cases, however, the fishery expert can perform the additional service of proving that in some areas of the narrow seas, such as the Flemish Bight, too heavy a toll is being levied on the young fish and that the remedy for this is to make it illegal to sell fish below a certain size, and to insist on the nets used having a certain width of mesh so that the smaller fish can escape through them.

Prof. Johan Hjört was perhaps the first to predict successfully the future yield of edible fish and to find spawning grounds off the coast of Norway hitherto unknown. All honour should be given to him for leading the way; but as he would be the first to admit, the conditions of the North Atlantic near the coast of Norway are simple compared to those obtaining in the North Sea, in the English Channel and in the Western Atlantic where it bathes our shores. Nevertheless, by hard continuous labour and the piling up of innumerable data, which constitute the only road to success in zoological science, the fishery experts of the Scottish Fishery Board and those of our own Ministry of Fisheries, under the guidance of the chief scientific adviser, Dr. E. S. Russell, have succeeded in predicting the yield of the haddock fishery in Scotland and of the herring fishery off the East Anglian coast, in each case about six months ahead. In other areas, baffling and hitherto unsolved problems confront them. One small example of these problems may be given.

For many years, Mr. E. Ford, now vice-director of the Plymouth Marine Biological Station, has been investigating the herring fishery in the south-west area of the English Channel. He has found that during the past five or six years there has been a steady decline in the yield of this fishery and that this decline has been due to the fact that the fishermen have been drawing on the same stock of fish, which every year has been growing older and fewer in numbers. Far too few herring fry are entering the Channel to replace the losses in the older fish. The cause which Mr. Ford has found for this deficiency is the falling off in the stream of highly saline Atlantic water entering the Channel. This water is rich in phosphates and supports a large number of micro-organisms on which the fry feed. Mr. Ford has strong suspicions that the fry which should have entered the Channel are to be found farther afield; and that the fishery which the men of Devon and Cornwall exploited is now to be sought for off the south coast of Ireland.

This brings us to the central problem of British fishery research, namely, the cause of the periodic variation in the pulse of warm Atlantic water—popularly known as the Gulf Stream, though the actual Gulf Stream cannot be distinguished east of Newfoundland—which washes our shores. If we could solve that problem, we should be able to

give our fishermen a guidance out of all proportion greater than that which has been so far afforded to them. The so-called Gulf Stream, as is well known, travels in a north-east direction from the coast of Florida and pours through the Faeroe Channel, north of the Shetlands, into the North Sea. Strange to say, the stream, when strong, does not bring with it an abundant fishery but the reverse. Our most valuable food-fish loathe it like poison. Poor catches of herring, haddock, plaice and sole go along with a strong Gulf Stream. This stream brings with it enormous numbers of jelly-fish of all kinds and of gelatinous algæ which are avoided

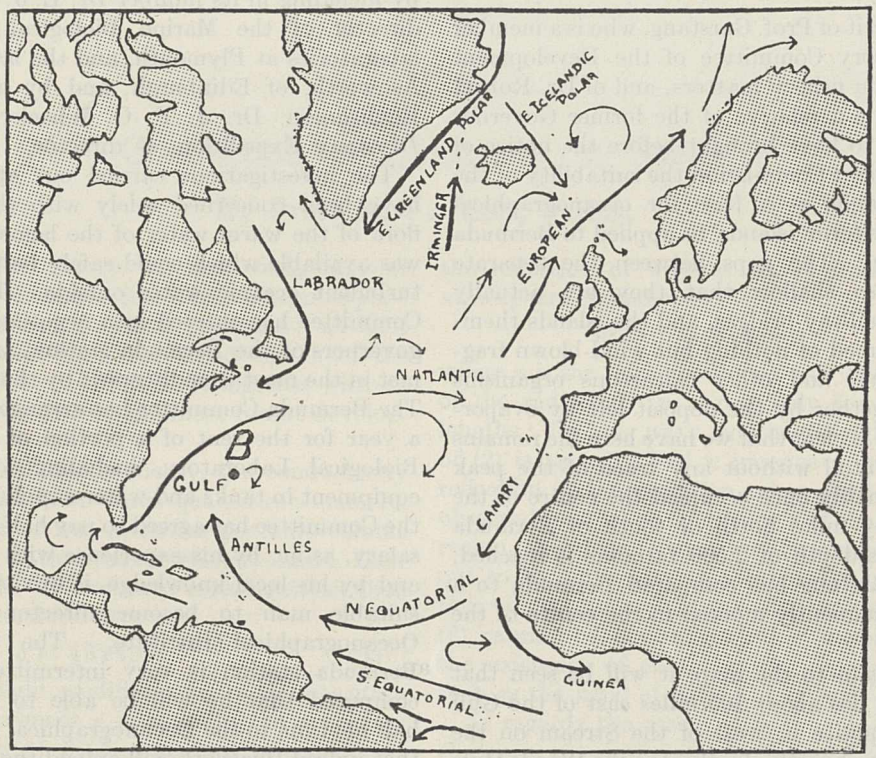

Fig. 1.

THE PRINCIPAL ATLANTIC CURRENTS. B = BERMUDA

by our fish. The cold current which streams down the coast of Norway—unlike the Channel water—is very rich in phosphates and gives support to an enormous multitude of minute Crustacea on which herring, haddock and plaice feed.

As most people are aware, a similar current, known as the Labrador Current, flows down the eastern shores of North America as far as Cape Hatteras, where it dives under the Gulf Stream. Its temperature is very low (in the neighbourhood of 40° F.) and yet it is teeming with life. On one occasion Prof. W. Garstang when crossing the Atlantic eastwards tested the relative abundance of life in the Gulf Stream and Labrador Currents respectively by attaching a piece of bolting cloth to the bath tap of the steamer through which sea-water freshly pumped up was continuously passing. The bolting silk was afterwards rinsed in a bottle of formalin. After a few minutes passage of Labrador water, the contents of the bottle resembled a thick opaque emulsion, whereas after several hours passage of Gulf Stream water only a few grains were found in the bottle. The Labrador Current varies in width and when it invades the territory of the Gulf Stream it causes the death of the fish which live in the warmer water. On one notable occasion the 'file-fish' (*Lopholatilus*), which is allied to our sea-bass and is prized as a food-fish in America, was found floating dead in millions at the surface of the water. The passage from Gulf Stream to Labrador Current is a dramatic experience—which has happened to me on several occasions. Leaving the north of Ireland in the early autumn, one encounters the familiar type of mild stormy weather accompanied by drizzling rain, so unhappily associated with Irish summers. The bath water was exceedingly mild, as indeed is the sea-water encountered in bathing off the Irish coast in September. In a few hours the whole aspect of the sky changed. The weather might become dazzlingly clear or grey and foggy. The temperature fell and the bath-water became icy.

We have used for the warm water the term "so-called Gulf Stream" advisedly. The term 'Gulf Stream' in the narrower sense means the

water issuing from the Gulf of Mexico. But as a glance at the map (Fig. 1) will show, this current is joined by another termed the Antillean—which is fed by two currents, the North Equatorial and the South Equatorial, running west from the coast of Africa, and the water flowing through the Straits of Florida forms only one fifth of the total volume of the warm current. When this water reaches the coast of Africa, part of it turns south as the Canary Current which eventually joins the North Equatorial Current, so that it will be seen that in this way a huge vortex is constituted in the centre of which lies the calm water of the Sargasso Sea.

It is the merit of Prof. Garstang, who is a member of the Advisory Committee of the Development Commission on fishery matters, and of Dr. Robert Gurney who is a relative of the former Governor of Bermuda, to have brought before the notice of the Development Commission the suitability of the Bermuda Islands as a base for oceanographical research. The term 'islands' as applied to Bermuda is misleading. The gaps between the separate islands are so shallow that they are actually spanned by railway bridges, and the islands themselves are formed of nothing but wind-blown fragments of coral and other calcareous organisms cemented together by the deposit left by evaporating rain. It is clear that we have here the remains of a typical atoll without any trace of the peak which presumably once occupied the centre of the lagoon. Fifty miles north or south of Bermuda the enormous depth of 2,500 fathoms is reached, and Prof. Garstang has compared Bermuda to a lightship permanently moored in the centre of the ocean.

Turning again to the map, it will be seen that Bermuda (*B*) lies about 100 miles east of the Gulf Stream. Opposite it, west of the Stream on the coast of Massachusetts, is situated the Woods Hole Oceanographical Station, not to be confounded with the Woods Hole Biological Station, which is a totally distinct institution. The scheme of research planned by the Bermuda Committee is one to be carried out in the closest and most friendly co-operation with the Woods Hole Oceanographical Institute. The American corporation has a suitable research steamer, and the Bermuda Committee has appointed a sub-committee to draft plans for buying or building a suitable motor-boat. It is arranged that the two boats at suitable intervals shall penetrate about 100 miles into their respective sides of the Gulf Stream and take observations on the temperature and salinity at various depths. From these observations it can be shown that by an easy mathematical calculation the volume and velocity of the Gulf Stream can be computed and therefore the variation in volume over a series of years can be ascertained. In five years' time it is confidently anticipated that the correlation between these variations and the fluctuations in British fisheries will begin to emerge from obscurity, and the justification for continuing the research will become obvious.

As most people are aware, a Bermuda biological station has been in existence for about forty years. This is controlled by a Board of Governors of which until quite recently Prof. E. G. Conklin, of Princeton, the very distinguished American embryologist, was chairman. This corporation has in recent years endeavoured to widen its appeal by including in its number Dr. E. J. Allen, former director of the Marine Biological Association's laboratories at Plymouth, and the late Prof. J. H. Ashworth, of Edinburgh, and by appointing an Englishman, Dr. J. F. G. Wheeler, late of the *Discovery* Expedition, as director.

The investigations carried out at this station have been concerned solely with the fauna and flora of the warm water of the lagoon, as no boat was available which could safely be trusted in the turbulent oceanic water outside. The Bermuda Committee has entered into negotiations with the governors of the Bermuda station, and have been met in the most friendly spirit by that corporation. The Bermuda Committee has arranged to pay £250 a year for the rent of a portion of the Bermuda Biological Laboratory, including, of course, its equipment in tanks and water-supply. In addition, the Committee has agreed to pay half Dr. Wheeler's salary, as he, by his experience with the *Discovery* and by his local knowledge, is obviously the most suitable man to become director of the new Oceanographical Institute. The work of the Bermuda station is very intermittent and it is computed that he will be able to allot at least half his time to the Oceanographical Institute, and that indeed this work will extend the opportunities of ordinary biological workers at Bermuda, who may thus gain some acquaintance with the oceanic fauna.

The decision of the Government to support the Bermuda scheme was arrived at only on December 24 of last year and was immediately communicated by cable to the Bermuda corporation. The money is to be furnished in the first instance from the funds of the Ministry of Fisheries and thereafter by the Development Commission. As the whole scheme originated with the Commission, it may seem strange that the Commission did not at once assume the management of it. But the Commission was advised that its function was to criticize schemes put before it, not to initiate them, and the Royal Society was asked to nominate a committee to manage the new Institute. Of this Committee, Dr. Stanley Kemp, formerly leader of the *Discovery* Expedition, now one of its governors,

and the new director of the Marine Biological Station at Plymouth, is secretary. The Committee met about two months ago and considered the grant of money necessary to carry out its plans; it applied for this grant to the Development Commission, which unanimously approved it. It then became possible to co-opt to the Committee two distinguished civil servants, namely, Mr. H. G. Maurice, assistant secretary of the Ministry of Agriculture and Fisheries, and Dr. E. S. Russell, chief scientific adviser on fishery matters. Needless to say, the assistance of these two members will be an invaluable addition to the powers of the Committee.

The staff to be appointed consists of Dr. Wheeler as director, a hydrologist, who will proceed to Woods Hole to be trained in the mathematical methods employed by that institute, and a director's assistant, who will be a naturalist.

It is perhaps vain to endeavour to lift the veil which shrouds the future, but it is to be remembered that the research work at Plymouth is really mainly oceanographical in character and with prophetic vision Dr. Kemp looks forward to the time when the Plymouth research will extend into mid-Atlantic and there meet in cordial co-operation with an eastward extension of the work of the Bermuda station.

Conduction of Electricity in Solids*

By Prof. N. F. Mott, F.R.S.

THE modern theory of the conduction of electricity in solids has already been applied to a large number of special problems; all that can be attempted here is a broad sketch of the fundamental ideas of the theory, together with an account of one or two of the most recent developments.

In the classical Drude theory, the conductivity of a metal depends on three quantities; namely, N, the number of free electrons per unit volume of the metal; v, their mean velocity, and l, their mean free path. Elementary considerations then give for the conductivity, σ,

$$\sigma = \tfrac{1}{2}Ne^2l/mv \qquad (1)$$

With certain slight modifications (in the quantum mechanical treatment v is actually the *maximum* electronic velocity) this formula may be transferred to the quantum mechanical treatment; the new theories are, however, important when we come to estimate N, l and v.

In monovalent metals we should expect that each atom would contribute just one to the total number of free electrons, so that N will be equal to the number of atoms per unit volume. For the alkali metals there is direct experimental evidence that this is the case. R. W. Wood[1] has shown that thin films of these metals deposited on glass are transparent to ultra-violet radiation below a certain wave-length, the transition from the opaque to the transparent region being rather sharp. Now as Zener[2] was the first to point out, one can apply to the reflection of light from a metal, provided that the absorption is neglected, the same formula as that used in the theory of the reflection of wireless waves from the upper atmosphere, namely,

$$n^2 = 1 - Ne^2/\pi m\nu^2 \qquad (2)$$

where n is the refractive index and ν the frequency of the radiation. n is real only for short wave-lengths; for long wave-lengths the right-hand side of (2) is negative and n imaginary, so that total reflection of the radiation takes place. From the observed long wave-length limit of the transparent region, therefore, N can be determined; it turns out to be quite near to the number of atoms per unit volume for each of the alkali metals. Formula (2) cannot be applied to other metals owing to the existence of characteristic absorption bands, such as the band at 3100 A. in silver.

As regards the mean velocity v of the metallic electrons, classical statistics, treating the electrons as a perfect gas, demand that their mean kinetic energy shall be $3kT/2$, corresponding to a velocity of $1{\cdot}2 \times 10^7$ cm./sec. at room temperature. The application of Fermi-Dirac statistics, first made to this problem by Sommerfeld[3], leads to the conclusion that the mean velocity has a very much greater value. The general ideas of the Fermi-Dirac statistics are most clearly seen by considering an idealized 'one-dimensional' metal, consisting of electrons free to move up and down a line of length L. We neglect first the interaction of the electrons, both with one another and with the atoms of the lattice. Now the velocity v of an electron is connected with its de Broglie wave-length λ by the well-known formula

$$\lambda = h/mv.$$

For an electron confined within a metal of length L, the de Broglie wave associated with the electron

* Substance of a course of lectures delivered at the Royal Institution on January 19, 26 and February 2.

must have the form of a standing wave. The wave-length must therefore have one of the values

$$\lambda = 2L/n, \qquad (3)$$

where n is an integer, and the energy of an electron will be

$$E = \tfrac{1}{2}mv^2 = n^2h^2/8mL^2, \qquad (4)$$

For values of L of the order of a centimetre, these values of the energy will be so close together as to be practically indistinguishable, so that to all intents and purposes the energy can take a continuous series of values. Nevertheless, our quantization of the energy is of importance for the following reason. According to the Pauli exclusion principle, not more than *two* electrons can be in any one quantized state. At the absolute zero of temperature, all the electrons will be in

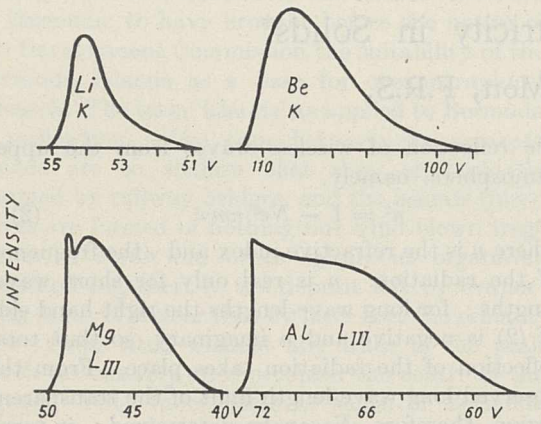

Fig. 1.

K AND L_{III}-EMISSION BANDS FOR LIGHT METALS; THE WAVE-LENGTHS ARE SHOWN IN ELECTRON VOLTS, ACCORDING TO THE EQUATION $eV = hc/\lambda$.

states of as low energy as possible; thus according to formula (3) two electrons only will have the lowest energy, corresponding to a wave-length $2L$. If the total number of electrons is N, the electrons will have all wave-lengths from $2L$ down to a minimum $4L/N$. With one electron per atom, this is equal to four times the interatomic distance a. The velocities thus have all values from practically zero up to a maximum $h/4ma$; with $a = 2 \times 10^{-8}$ cm. this corresponds to $v = 9 \times 10^8$ cm./sec., or an energy of 2·3 electron volts. Similar results are obtained when the motion of the electrons in three dimensions is taken into consideration, the maximum energy being

$$E_{\max.} = \frac{h^2}{8m}\left(\frac{3N}{\pi\Omega}\right)^{2/3} \qquad (5)$$

where Ω is the volume of the metal.

At finite temperatures a few of the electrons will be excited into higher states (these electrons give a small contribution to the specific heat, linear in the temperature), but since kT is small compared with $E_{\max.}$ up to the melting point, the change in the energy distribution of the electron is insignificant.

Experimental evidence that the conduction electrons have a series of energies lying in a range of several electron volts is provided by observations of the soft X-ray emission bands, of which those of O'Bryan and Skinner[4] (Fig. 1) are typical. The X-ray quantum is emitted through one of the conduction electrons making a transition to the K- or L-level; since the energies of the conduction electrons are distributed in a wide range, an emission band instead of an emission line is observed. The sharp cut-off at the high frequency limit will be noticed.

The Mean Free Path

Using values of N and v obtained in these ways, one can, by using formula (1), deduce the mean free path from the *observed* electrical conductivity; the following are some values for silver:

Temperature (degrees Kelvin)	273	76	4·2
Conductivity (ohm-cm. $\times 10^5$) observed	6·8	36	(960)[5]
l (cm. $\times 10^{-4}$)	1·14	6	(163)

The very long mean free paths, far greater than the interatomic distance, will be noticed. These values, quite inexplicable according to the classical theory, are easily understood for a crystalline metal in terms of wave mechanics, as follows:

The model which we have used to derive the energies of the conduction electrons is highly artificial, neglecting as it does the interaction of the electrons with each other and with the ions. To remedy this, in all recent work each electron is treated as moving in the field of all the positive ions together with the *average* field of the electrons The approximation is exactly that used by Hartree[6] in his calculation of the self-consistent fields in atoms. Thus, in a crystalline metal, if we use this model, we must think of the electrons as moving in a periodic field having the period of the lattice. In order to calculate the distance that an electron will move without being scattered we must apply the methods of wave mechanics, and picture a plane de Broglie wave moving through the metal with wave-length rather greater than the interatomic distance. We then obtain a result entirely at variance with classical ideas. Each metal ion scatters a wavelet, but since the metal is crystalline these wavelets build up a new plane wave front. There is therefore no resultant scattering of the wave. Hence, in a perfectly crystalline metal in which the ions are at rest in their positions of equilibrium, there is no scattering of the electrons and hence no resistance whatever.

Resistance in a pure metal arises from the fact that at any finite temperature the ions are not at rest in their positions of equilibrium, but are vibrating about them. The period of the atomic vibrations ($\sim 10^{-12}$ sec.) is very large compared with that of the de Broglie waves (10^{-16} sec.); the wave scattered by any displaced atom will therefore be slightly out of phase with that scattered by any other. A certain amount of incoherent scattering will take place. This incoherent scattering, and hence the resistance, will increase as the temperature is raised. Detailed calculations give good agreement with experiment both at high and low temperatures; though of course the model has proved totally unable to give an explanation of supraconductivity.

Although the periodic field of the crystal lattice does not lead to a finite mean free path, it has other effects; for example, the effective mass of an electron in a metal is found to be not exactly equal to that of a free electron. The further developments of the model, such as the explanation of the existence of insulators and semi-conductors by Wilson[7], cannot be discussed here.

Some attempts have recently been made to demonstrate these long mean free paths experimentally by measuring the resistivities of very thin wires[8], or of thin films deposited on glass[9]; obviously the mean free path cannot be greater than the thickness of the wire or film along which the current is flowing. We therefore expect the resistivity to increase for very small thicknesses. Such effects are in fact observed.

Resistance of Alloys

As first pointed out by Nordheim[10], the large increase in the resistance of metals due to foreign atoms in solid solution finds a ready explanation in terms of the theory. A dissolved atom taking the place of one of the atoms of the lattice will not in general scatter an electron wave of the same amplitude as the solvent atoms. If the amplitudes of the waves are denoted by A and B, the increase in the resistance will clearly be proportional to $(A - B)^2$. Since the scattering power of an atom depends on the field within it, we should expect the resistance to increase with the horizontal distance between the two elements in the periodic table. This was first pointed out as an empirical rule by Norbury[11]. More recently, Linde[12] has shown that the increase in the resistivity of copper or silver or gold due to one atomic per cent of any metal to the right of them in the periodic table is proportional to $(z - 1)^2$, where z is the number of electrons outside a closed shell (2 for zinc, 3 for gallium, 4 for germanium, 5 for arsenic). Such a simple rule is obviously susceptible of explanation in terms of this theory[13].

The explanation of the resistance given here does *not* depend on the strained state of the metal round the impurity atom. In general, the surrounding atoms will certainly be displaced from their mean positions, and this will give rise to an increase in the resistance, but the effect of this is probably small compared with the effect considered above.

The theory of the conduction of electricity in alloys is certainly capable of further development. One phenomenon to which it may possibly be applied is that of age hardening. This is generally believed to be due to the precipitation of very small crystals of solute metal from a supersaturated solid solution[4]. The resistance of an alloy during age hardening usually shows an initial increase, followed by a marked fall. The initial increase has been ascribed to strain, but this does not seem to be the only possible explanation. Since the wave-length of the electron waves is rather larger than the diameter of the solute atoms, one would expect the initial stages of the precipitation, in which small crystals of 20–30 atoms are formed, to increase the resistance. It is only when the crystals become large compared with the wave-length that any decrease in the resistance is to be expected.

If this explanation be correct, the phenomenon has a certain analogy with the passage of light through moist air. The water vapour molecules, being smaller than the wave-length of light, do not scatter it much. If, however, they condense into small drops of size comparable with the wave-length, a more or less opaque fog is formed. If they condense still further into rain drops, the atmosphere becomes again transparent.

Conduction in Insulators

Some light on the very complicated phenomena of photoconductivity has been shed by the recent theoretical researches of Landau[15], Frenkel[16] and others[17]. Their ideas will be illustrated most clearly by considering the alkali halide crystals, which have been investigated in great detail from the experimental side by Pohl and his school. The alkali halide crystals are built up of positive metal ions and negative halogen ions. The electrons in both these ions have the rare gas configuration, and do not make any contribution to the conductivity. If, however, an electron is added to one of the metal ions, one would expect that it would be able to jump quite easily from one metal ion to the next, and theoretical calculations[18] confirm this; such electrons ought to have a mobility of the same order of magnitude as the electrons in a metal.

If, however, a halide crystal is illuminated with ultra-violet light, a new absorption band is formed

in the visible (the F-band), the rock salt thereby acquiring a yellow and silvine (potassium chloride) a blue colour. The F-band is generally recognized to be due to electrons attached to metal ions, and can be produced in other ways; for example, by heating in alkali vapour, so that positive ions and electrons diffuse into the crystal. The coloured crystal is, however, an insulator at low temperatures, and shows photoconductivity only when illuminated with wave-lengths in the F-band. It is therefore often stated that these electrons are located at internal surfaces or cracks, which might be expected to play some role in rendering the electron immobile[19]. The work of Landau shows, however, that this hypothesis is unnecessary; this will now be explained.

The large dielectric constant of polar crystals is partly due to an actual displacement of the positive and negative ions from their mean positions by an external field. The time taken to polarize the medium is of the order 10^{-13} sec., and since the electron jumps from atom to atom in a time comparable with 10^{-15} sec., it will not in general have time to polarize the medium as it goes. If, however, the electron remains in the neighbourhood of one metal ion for a sufficiently long time, it will polarize the surrounding medium, the positive ions moving into new positions of equilibrium nearer to, and negative ions farther from, the electron. The electrostatic field round the electron falls from $-e/r^2$ to $-e/\varkappa r^2$, where $\varkappa$ is the dielectric constant. Therefore, in the field of the polarized medium, the potential energy of the electron is

$$V(r) = -\left(1-\frac{1}{\varkappa}\right)\frac{e^2}{r}$$

In the 'potential hole' thus created, the electron will have a series of bound stationary states, similar to those for an electron in the field of a hydrogen atom, for which $V(r)$ is $-e^2/r$. The absorption band (F-band) corresponds to the removal of the electron from this potential hole and is thus analogous to the ionization of a hydrogen atom; the electron is then free to move through the crystal, and the potential hole disappears.

These trapped electrons have, according to Frenkel[16], a certain very small mobility, since the electron can jump from ion to ion and the surrounding ions move into displaced positions at the same time. Since by a well-known theorem of electrostatics a charged particle in a dielectric medium is repelled by any boundary of or hole in the medium, the most stable positions for trapped electrons will be as far as possible from any internal crack!

The theory of trapped electrons outlined here is quite general and can be applied to any polar solid; in future developments of the theories of the conduction of electricity in semi-conductors and insulators, it may prove of considerable importance.

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[15] *Sov. Phys.*, **3**, 664 (1933).
[16] *Sov. Phys.*, **9**, 158 (1936).
[17] Blochinzev, *Sov. Phys.*, **10**, 431 (1937); von Hippel, *Z. Phys.*, **101**, 680 (1936).
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Obituary Notices

Prof. A. R. Ling

ARTHUR ROBERT LING, whose death took place on May 14, owed his career as a research chemist to the inspiration of Prof. H. E. Armstrong, under whom he studied at the Finsbury Technical College in 1883 and thereabouts. He was encouraged to work on halogen derivatives of the nitrophenols, and he afterwards extended his investigations to similar derivatives of quinones, and in this began his long association with Julian Baker. The latter was continued when, as chemist to the London Beetroot Sugar Association, he carried out his routine work in the daytime, and in the evenings and at week-ends prosecuted with Baker his extensive investigations on the constitution of starch.

It is in the fields of starch and sugar chemistry and as an authority on brewing that Prof. Ling was best known. Ling's work during the decades preceding and succeeding the beginning of the century is recognized as being of sound character, and the interpretation of many of his results in the light of present-day knowledge and concepts adds materially to the known chemistry of starch and the mechanism of its degradation by diastase. It had, among other things, the important effect of preventing a hasty acceptance of erroneous views which were widely held at the beginning of the century.

After leaving the Beetroot Sugar Association, Ling practised as a consulting chemist, his special fields being the brewing and sugar industries. From 1895,

that is, the time of its commencement, until 1920, he was editor of the *Journal of the Institute of Brewing*, and for many years technical editor of the *Brewers' Journal*, work for which he was most admirably suited and which he performed in a most competent manner. During the War period his work on the subject most dear to him, starch, was apparently almost at a standstill.

In 1920 Ling was appointed professor of brewing at the University of Birmingham, where he brought about the institution of an honours degree in biochemistry of fermentation. Now with better facilities than had hitherto been at his disposal, he was able to resume his work on starch. It was one of the great griefs of his declining years that this later work was incomplete. Nevertheless, more recent knowledge of the enzymes which were present in some of the preparations used by him at that time, now known to be composite, reveals that many of the results he obtained in conjunction with Nanji can be explained, although not in the way put forward at the time. In 1931 Ling retired from the chair at Birmingham, and generously bequeathed to the University the whole of his library of scientific books and journals.

To those who were privileged to know him well Ling was a kind-hearted man, to whose encouragement many younger men owe a great deal. His enthusiasm for research was inspiring and his knowledge of the literature in his field amazing. In his domestic life he was dogged by ill fortune, serious illness and death being frequent visitors, culminating in the loss of his wife in 1935. Notwithstanding the latter and his own persistent ill health in the last two years, he maintained an active interest in scientific and technical work right up to the week of his death. R. H. HOPKINS.

WE regret to announce the following deaths :

Prof. Alfred Adler, founder of the Society for Individual Psychology, originally called the Society for Free Analysis, at Vienna, on May 28, aged sixty-seven years.

Prof. Ladislas Natanson, formerly professor of physics in the Jagellonian University of Cracow, on February 26, aged seventy-three years.

Prof. A. G. Perkin, F.R.S., emeritus professor of colour chemistry and dyeing in the University of Leeds, on May 30, aged seventy-five years.

News and Views

Soviet Expedition to the North Pole

THE comprehensive Soviet scheme for the exploration and utilization of arctic territories has been carried another step forward by the institution of a polar research station within twelve miles of the North Pole. An aeroplane carrying Prof. O. Schmidt and several others left the meteorological station on Rudolf Island, Franz Josef Land, in lat. 81° 47′ N. on May 21 and flew over the Pole before landing on a convenient floe. A few days later three other aeroplanes arrived with materials for the hut, instruments, stores and fuel. The way between the station and Rudolf Island has been marked every thirty miles by bombs of dye-stuff. The hut, which is of metal, wood and rubber, is to be maintained for a year. It will be in wireless communication with Moscow, which will receive daily weather bulletins. The chief object of the enterprise is meteorological research, since only casual data have hitherto been obtained north of lat. 80° N. Such data will have a practical bearing on the proposed air route between the Soviet Union and the United States. The station is, of course, afloat and is reported to be drifting at the rate of about half a mile an hour. The direction is not stated : it may be rotary or more likely towards north-east Greenland. However, so long as the station remains in a high latitude, its purpose will be fulfilled, for its location actually at the Pole has more dramatic than practical value. A moving station will certainly facilitate hydrographical work. There is little likelihood of the floes disintegrating unless they drift into a much lower latitude or approach the area of ice pressure off northern Greenland.

The Thames Barrage Proposal

A DEBATE in the House of Lords on May 26 revived the publicity given about two years ago to a somewhat grandiose scheme for impounding the tidal area of the Thames above Woolwich by means of a dam, or barrage, across the river at that point. The scheme received a notable degree of attention at the time as it presented a number of attractive features, and was put forward with considerable plausibility of argument by its promoters, who have since been busily engaged in propaganda work through the agency of an organization, called the Thames Barrage Association. That a number of the promoters' contentions are true, or rather that they have a basis of fact, cannot be gainsaid by a fair-minded critic. There are undoubted defects to which, in some degree, the scheme might afford a remedy, principally, perhaps, in regard to mitigating the pollution, by tidal reflux of sewage effluent, of the river above the suggested dam. The promoters claim that the evil would be entirely eliminated ; but this could scarcely be the case in view of the direct discharge, into the area proposed to be impounded, of sewage-laden tributaries. In all probability, there would be intensification of pollution immediately below the dam for lack of current movement.

THERE are, however, other serious counter arguments which cannot be disregarded or minimized. London, in addition to being a metropolis, is a great port, one of the largest in the world, and the requirements of shipping must therefore claim an important degree of consideration. As was pointed out by Lord

Ritchie, chairman of the Port of London Authority, in opposing the appointment of a Government commission of inquiry, which was the object of the debate, the substitution of half a dozen lock entrances at the barrage for an unimpeded fairway would mean obstruction to navigation and congestion of river traffic. On last year's figures, some 43,000 ships and 463,000 craft of various kinds would have to be locked through annually: the operation, he said, would be physically impossible. Moreover, the traffic is continually increasing. Other cogent reasons against entertaining the proposal were marshalled by the Earl of Erne, speaking for the Government, who explained the antipathetic views of the Ministries of Transport and Health and of the Board of Trade. In the issue of NATURE of December 7, 1935, we said that "an enterprise of this magnitude cannot be embarked upon without a considerable degree of risk to important interests, however propitious the general circumstances may appear to be" and, in view of the announcement that the estimated outlay is 4½ millions sterling, the need for a cautious attitude is greatly increased. Indeed, the objections already put forward are of so weighty a character that the trouble and expense of a public inquiry were considered unjustified by the Government and, under protest, the motion was withdrawn.

A Suggested Botanic Garden in South Florida

THE attempts to raise tropical plants under the extremely artificial conditions imposed by a temperate climate limits greatly the scope and usefulness of botanic gardens in the latitude of North America and Europe. The suggestion, therefore, which has been put forward, to found a tropical botanic garden in the United States, is warmly welcomed; for this will, in a way, bring the tropics within the reach of American botanists and plant breeders ("An Argument for a Botanical Garden in South Florida, to be called the Fairchild Botanical Garden", by Marjory S. Douglas. Kells Press, Coral Gables, Florida). The only possible site appears to be that suggested, which is in a frost-free area in the extreme south of Florida. This is close to Chapman Field, where the United States Department of Agriculture has its Plant Introduction Garden, with which the name of David Fairchild is so closely associated. Here are grown tropical plant introductions for the needs of the Department of Agriculture. It serves a very useful purpose in this respect, but it differs from a botanic garden in that it does not offer a permanent home to tropical trees and plants. It is strictly utilitarian and is not laid out with that æsthetic taste which one associates with botanic gardens and which has so large an educational effect on the visiting public.

THOUGH the United States are fortunate in having a site for a tropical garden within their boundaries, and therefore of easy access to those who wish to visit it, the establishment of such a garden will be a costly undertaking. The soil of this region is extremely shallow, and much of it exists in crevices in the soft limestone which is often exposed on the surface. The principal agricultural industry in this area is fruit growing, and extensive orchards of mango, avocado and citrus have been established. Formerly, planting holes for the trees were blasted out of the soft rock, but it was found that the roots were strictly confined to the filled-in excavation thus formed. In recent years, soils have been made by 'scarifying' the surface with very heavy engine-drawn cultivators. The exposed soil with the limestone rubble is then collected into low, wide ridges along the top of which the trees are planted. It is found that a more extensive root system is thus formed, and the trees suffer much less from violent wind storms which occasionally visit this coast. Such calcareous soils are usually associated with the dry tropics, and it is possible that many species from such regions may thrive here, but in the humid tropics, which are so rich in their floras, the soils are generally acid and contain very little lime and, though many species of palms with their peculiar root system may be able to adapt themselves to local soil conditions, it is a different matter for many evergreen, broad-leaved species. To obtain the desired luxuriant tropical growth it may, therefore, be necessary to transport suitable soils in large quantities in which to grow such trees and plants, and this—if it proves to be necessary on an extensive scale—requires generous contributions towards the funds for founding these tropical botanic gardens.

Central Asiatic Gold Mines of the Bronze Age

THE sources from which prehistoric peoples obtained their minerals and other raw materials of industry afford valuable clues to their intercourse and cultural and economic contacts. A new source of gold in Central Asia is reported in the announcement of a discovery of prehistoric workings at Kazakhstan by a Russian expedition sent out by the Soviet Government (Soviet Union Year Book Press Service). The mines had been worked by a large number of workmen who used some implements of bronze, but for the most part of stone and the bones of animals. There were no traces of iron. Near the shafts were primitive ore-crushing plants, consisting of stone slabs and hammers. Two skeletons of these bronze age miners were found, who had met their death by a fall of the roof. On one of the skeletons was a necklace of glass and clay beads and in one hand was a bronze chisel and in the other a stone hammer. They were not Mongolian, as was indicated by their skulls. The mines were 0·75 m. wide and 20–25 m. deep. They were connected by underground passages 100–150 m. long. These passages had natural ventilation, and for illumination it is probable that fat in shallow bowls was employed. Some of these bowls have been found. Stone cross pieces were used as props. Polished slabs and triangles of stone have been found which appear to have been used on the steppes of Kazakhstan as sign-posts to guide caravans on their way to the mines. The slabs were orientated and polished on the eastern side. The Soviet Government is sending out another

expedition this year to explore the mines further, and to work the ore which was left unextracted by the ancient miners.

Atmospheric Pollution

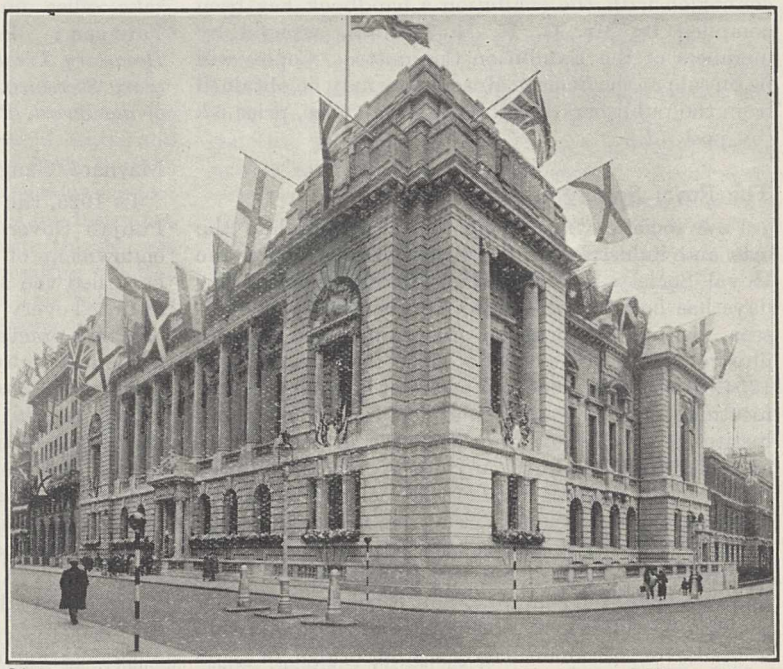
THIRTY-EIGHT representatives of local authorities and other organizations co-operating with the Department of Scientific and Industrial Research met on May 31 at the offices of the Department in the usual half-yearly conference. Dr. G. M. B. Dobson, chairman of the Atmospheric Pollution Research Committee, presented, as usual, a report on the progress of the investigations carried out under the Committee. Systematic observations in connexion with the intensive survey of the pollution in and around the City of Leicester were begun on April 1. During the preceding four months, the survey staff were installing different standard measuring apparatus at twelve sites. The decision of the authorities at Leicester to equip and maintain a station for regular meteorological observations was greatly welcomed. The Conference also recorded its appreciation of the valuable assistance given by the public analysts of Glasgow, Hull and Sheffield, in an investigation of the possibility of combining a dust filter with apparatus for the determination volumetrically of sulphur dioxide in the atmosphere. A report was submitted through the Medical Officer of Health for Leeds on the analysis of dust samples collected in Leeds, Halifax and Huddersfield. The Conference endorsed a proposal made by the Research Committee that a meeting should be convened of public analysts and others who are directly responsible for making observations on behalf of co-operating bodies, to discuss technical problems and to interchange ideas on the measurement of atmospheric pollution. Mr. Brownhill Smith retired from the chairmanship of the Conference, having served for the maximum period of three consecutive years. Alderman David Adams, a representative of Newcastle-upon-Tyne, was elected chairman for the ensuing year.

Study of Bird-Migration

The British Trust for Ornithology has accepted responsibility for the future conduct of the principal scheme in Great Britain for the study of migration and other aspects of bird-life by the ringing method. This scheme was instituted in 1909 by Mr. H. F. Witherby, editor of *British Birds*, and has been maintained with the co-operation of readers of that journal. More than half a million birds have been marked to date, and the recoveries of a proportion of these have already added greatly to knowledge of the subject. Important facilities for the work have at the same time been granted by the Trustees of the British Museum (Natural History), who are providing accommodation for the headquarters of the scheme in the Bird Room at South Kensington and permitting the Museum's address to be used. Rings will in future be inscribed "British Museum Nat. Hist. London", instead of "Witherby High Holborn London", with an individual identification number in addition as before. The scheme will now be directed by a special Bird-Ringing Committee, constituted as follows: Dr. A. Landsborough Thomson (chairman); Mr. A. W. Boyd; Mr. A. B. Duncan; Mr. P. A. D. Hollom; the Earl of Ilchester; the Earl of Mansfield; Mr. H. F. Witherby; and Miss E. P. Leach (hon. secretary). The headquarters' work will be in the hands of Miss Leach, who has had much experience of it as Mr. Witherby's collaborator in recent years. *British Birds* will continue to be the medium for publishing results.

Institution of Civil Engineers

WHEN the foundation stone of the present building of the Institution of Civil Engineers was laid in 1910 by the late Sir James Charles Inglis, then president of the Institution, the north-west corner could not be completed owing to the existence of a lease covering offices flanking that corner of the site. The demolition of the offices was, for various reasons, deferred until 1936; but the corner, with the consequent internal modifications in the library and reading-room, is now practically completed (Fig. 1), and Princes Street, which is to be known as Rennie Street from July 1, 1937, has also been widened to



Photo] [*Bedford Lemere*

Fig. 1

COMPLETED BUILDING OF THE INSTITUTION OF CIVIL ENGINEERS

its full width. The rebuilding of the north-west corner has allowed of an extension to the main library, in addition to extensions to the rooms on the other floors, and advantage is being taken of this extension to house, at the west end of the main library, the original collection of books, etc., presented by Thomas Telford to the Institution in 1820, which formed the nucleus of the existing library, now containing more than 62,000 volumes.

Television Exhibition

PARTLY with the view of demonstrating that television has now emerged from the experimental stage, partly to illustrate the general principles which underlie the modern technique, and partly to foster the widest possible appreciation of television as a home entertainment, a special exhibition has been organized by the Science Museum, South Kensington, in co-operation with the British Broadcasting Corporation and the leading manufacturers. The exhibition will be opened by Lord Selsdon, chairman of the Television Advisory Committee, on June 10. The exhibition incorporates a historic section dealing briefly with early proposals for television, and a number of exhibits describe the developments of the past ten years. There is a working demonstration of the low-definition television which was broadcast by the Baird process a few years ago, there are demonstrations on modern cathode ray receivers supplied by the various manufacturers, and a demonstration of large-screen television by a mechanical-optical process. In order that these demonstrations can be given when there is no B.B.C. transmission available, a local transmitter has been installed which will provide programmes from cinema films. In connexion with the exhibition a handbook has been compiled by Mr. G. R. M. Garratt, assisted by members of the Exhibition Committee. Copies will be on sale at the Science Museum, or may be obtained from the publishers, H.M. Stationery Office, price 6*d*. (by post 7*d*.).

The Royal Society of Arts

FEW societies have done more to stimulate the arts and industries of the British Empire than the Royal Society of Arts, which during the last few days has had on exhibition, for the benefit of overseas visitors, a series of documents and objects illustrating its achievements since its foundation in 1754. Before the modern practice of holding frequent meetings to hear papers and lectures, the Society instituted awards for improvements in science, art and manufacture ; and many of the objects exhibited illustrate the work of some of the Society's medalists. Hanging on one side of the room in which the exhibition was arranged was the first geological map of Great Britain prepared by William Smith. The map was published in 1815, Smith being assisted by a grant of £50. On the other side of the room were a model of Abraham Darly's iron bridge of 1788 (happily still standing) ; a model of Greathead's lifeboat and Bell's lifeline-throwing mortar for ships, for which medals were awarded. On another stand were samples of coco-nut oil, cinnamon, silk, tea, nutmegs, cloves, mace, wool and indigo from the Colonies, all representing products the cultivation of which has been stimulated by the Society. In addition to these and similar objects, were many books, prints and letters recalling the history of the Society and its never-ceasing activity.

Institute of Physics

THE annual report for the year 1936 of the Institute of Physics presented at the annual general meeting held on May 26 shows that the total membership has continued to increase in a very satisfactory way. The membership at the end of the year was 902. An informal discussion on the training of industrial physicists was held on February 11, 1936, at which appointed representatives of nearly every university and college in Great Britain and Ireland, of firms employing physicists and of research associations and Government establishments were present. As a direct result of this discussion, a scheme was inaugurated whereby registered students of the Institute are enabled to gain first-hand experience of industrial research and development work in physics during their vacations. The report records that in its first year this scheme proved most successful. The fifth conference of Australian physicists and astronomers was convened by the Australian Branch of the Institute and was held in Sydney on May 25–28, 1936. A London and Home Counties Branch of the Institute was founded in November. The general improvement in industry is reflected by the report of a great increase in the activities of the appointments register and panel of consulting physicists maintained by the Institute. The following officers have been elected to take office on October 1 : *President*, Mr. C. C. Paterson ; *Vice-President*, Prof. W. Makower ; *Honorary Treasurer*, Major C. E. S. Phillips ; *Honorary Secretary*, Prof. J. A. Crowther ; *New Members of the Board*, Prof. J. Chadwick and Mr. D. C. Gall.

Maynard Ganga Ram Prizes

IN 1925, the late Sir Ganga Ram, presented to the Punjab Government a sum of Rs. 25,000 for the endowment of a prize of the value of Rs. 3,000 to be called the Maynard Ganga Ram prize and to be awarded every three years, for a discovery, invention, or a new practical method which will tend to increase agricultural production in the Punjab on a paying basis. The competition is open to all. The first award, due in 1929, was made in 1931 to Dr. C. A. Barber, late Imperial sugar expert, for his fundamental discoveries which resulted in the production of Coimbatore sugar-cane. During the last five years, no further awards have been made owing to lack of suitable entries. The 1932 award has now been made to T. A. Miller Brownlie, lately agricultural engineer to the Government of Punjab, for his invention of a slip strainer suitable for water augmentation supplies derived from bores sunk in open wells. This strainer has the particular merit that it is not affected by alkaline sub-soil water—a defect from which many of the earlier metal strainers

suffer. By its use, owners of well-irrigated lands can increase the output of water from their wells. The 1935 prize has been awarded to R. S. L. Jai Chand Luthra, professor of botany, Punjab Agricultural College, Lyallpur, for his new method of treating wheat seed against the fungal disease called loose smut. The wheat seed to be treated is merely soaked in water at ordinary temperature for four hours during the morning of a day in summer. Thereafter the soaked grain is spread in the sunshine until it is thoroughly dried. Experience has shown that this treatment is effective in controlling the disease without damaging the germinating power of the seed. Entries for the next award should reach the Director of Agriculture, Punjab, Lahore, on or before December 31, 1938.

Aquarium Notes

THE *Aquarist and Pond-Keeper* of March–April 1937 (**7**, No. 7) contains a good article (to be continued) on the freshwater sunfishes (family Centrarchidæ) by A. Fraser Brunner. These fishes are natives of North American freshwaters, their nearest relatives being the perches. A key to all the species is given with notes, and a double-page illustration together with a coloured plate comprises most of the species which can be kept in aquaria. Among other interesting contributions is one entitled "The Ways of the Natterjack" by Eric Hardy. The author states that he finds no difficulty in obtaining specimens in early spring and late summer on the brackish slacks of the west Lancashire dunes below Southport, and others may be found at the Solway marshes, in the Prestatyn district of the Conway estuary, North Wales, at Hilbre Island in the Dee Estuary and on the Leasowe marshes of the West Cheshire coast. He has kept this toad successfully in indoor aquaria.

Birth-rate in the United States

THE birth-rate in the United States, based on returns from thirty-four of the forty-eight States and covering only the first nine months of 1936, was the lowest on record, according to a provisional report recently issued by the Metropolitan Life Insurance Company (*Med. Rec.*, Feb. 17). The death-rate was slightly higher than that of any year within the last five, so that the natural excess of the birth-rate over the death-rate fell to a minimum of about 5 per 1,000.

A Heidelberg Correction

WITH reference to the article in our issue of January 16, 1937, "University of Heidelberg and New Conceptions of Science", Dr. E. Wolf, Privatdozent of the University of Heidelberg, writes to us from the Biological Laboratories at Harvard University under date April 20, as follows: "I had already left Heidelberg in Fall of 1931 with the consent of the Minister of Education and that of the Faculty of Science, to accept an invitation from Harvard University. Since then I have been on a leave of absence from Heidelberg and I can assure you that I regard it always an honour to be a member of the Faculty of the University of Heidelberg".

Göttingen and the Massachusetts Institute

IN response to requests for information on the extent of the Institute's participation in the celebration on June 30 of the two hundredth anniversary of the founding of the University of Göttingen, the Massachusetts Institute of Technology has issued the following statement: "Although the Massachusetts Institute of Technology will not send an official delegate from Cambridge to attend the celebration of the two hundredth anniversary of the founding of the University of Göttingen, the rector of the university has been notified that Werner T. Schuarte, a technology alumnus of the class of 1914, who lives in Germany, will represent the Institute as an academic courtesy to a university which during the past two centuries achieved world-wide renown through distinguished scholarship and notable contributions to the advancement of scientific knowledge. This action is not intended to condone changes in or restrictions placed upon German universities in recent years."

Canadian National Research Council Scholarships

WITH the view of encouraging postgraduate training in scientific research, chiefly in the graduate schools of Canadian universities, the National Research Council has awarded forty-seven scholarships for the year 1937–38. These include three fellowships of 700 dollars each, twelve studentships of 600 dollars and twenty-seven bursaries of 500 dollars, all of which will be held in departments of science at the universities. Five other scholarships, tenable in the National Research Laboratories at Ottawa, will enable the holders, all of whom have already done postgraduate research at the universities, to gain experience in the field of industrial research before engaging in commercial work. The awards show that chemistry in its various branches heads the list with twenty-five, physics comes next with twelve, followed by four in biology, two in genetics, and one each in botany, geology, mathematics and mechanical engineering. Applications were received from graduates of eighteen Canadian universities, and awards have been made which will enable the holders to work in the Universities of Dalhousie, Laval, McGill, Montreal, Queen's, Toronto, Western Ontario and Saskatchewan.

Congress of French Physiologists

THE eleventh Congress of French Physiologists will be held on June 7–9 at the Paris Faculty of Medicine under the presidency of Prof. Cardot, of the Lyons Faculty of Science. The principal subjects for discussion will be trophic sensibility, introduced by A. Pi Suner, professor of physiology at Barcelona; comparison of histological and biochemical data in ossification, introduced by Profs. Policard, of the Lyons Faculty of Medicine, and Roche, of the Faculty of Medicine at Marseilles, and exploration of organic functions by the electrical manifestations of their activity, by Prof. Ryart of the University of Brussels. Further information can be obtained from M. R. Gayet, Laboratoire de Physiologie Pathologique, 1 rue Lacretelle, Paris.

British Waterworks Association

THE twenty-sixth annual general meeting of the British Waterworks Association will be held in London on June 22–26 under the presidency of Sir William Prescott. The following papers will be read and discussed: "The Inland Water Survey", by R. G. Hetherington; "Present-day Aspects of the Purification of the London Water Supply", by Lieut.-Colonel C. H. H. Harold; "The Work of the Freshwater Biological Association of the British Empire", by Prof. P. A. Buxton, of the London School of Hygiene and Tropical Medicine; "The Present Aspects of the Rivers Pollution Prevention Problem", by H. F. Atter. Further information can be obtained from the Secretary, British Waterworks Association Office, Grand Buildings, Trafalgar Square, London, W.C.2.

Agricultural Abstracts

UNDER a recent agreement between the Central Agricultural and Scientific Bibliography and the Bureau of Chemical Abstracts (Chemical Society and Society of Chemical Industry) it has been arranged that the staff of abstractors engaged on abstracting work for that Bureau will be invited to act as abstractors in the interests of the C.A.S.B., to the extent that while engaged on their ordinary work they will also prepare a comprehensive list of those articles and papers published in the same journals, which should in their opinion be specially useful to subscribers to Section 1 (Agriculture and Allied Industries) of the C.A.S.B. The scheme has been in operation since January 1, 1937, and it is proposed to issue shortly the first bibliography in this series to all subscribers to the C.A.S.B. Further information can be obtained from W. P. Dreaper, Hon. Secretary, C.A.S.B., Science Museum Library, South Kensington, London, S.W.7.

Announcements

THE Albert Medal for 1937 of the Royal Society of Arts has been awarded to Lord Nuffield, "for services to Industry, Transport and Medical Science". The Medal was instituted in 1862 as a memorial of H.R.H. the Prince Consort, for eighteen years president of the Society, and is awarded annually for "distinguished merit in promoting Arts, Manufactures, or Commerce".

DR. MARCUS FRANCIS has been appointed director of research to the British Pottery Manufacturers' Federation. The Federation, in conjunction with the Department of Scientific and Industrial Research, is to establish a new research station in the extension of the North Staffordshire Technical College, Stoke-on-Trent. Dr. Francis is at present on the technical staff of the Munitions Technical Planning Establishment.

THE annual general meeting of the Research Defence Society will be held at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1, on June 15 at 3 p.m., when the eleventh Stephen Paget Memorial Lecture will be delivered by Prof. G. Grey Turner. The subject of Prof. Turner's lecture will be "What Research Owes to the Paget Tradition".

THE Emil Chr. Hansen Gold Medal and a prize of 3,000 Danish crowns has been awarded to Prof. Aurelio Quintanilha, professor of botany in the University of Coimbra, for his valuable investigations on sex in the Hymenomycetes.

THE forty-eighth annual conference of the Museums Association will be held at Newcastle-upon-Tyne on July 5–9, under the presidency of C. Squire. Further information can be obtained from the Secretary, E. W. Wignall, Chaucer House, Malet Place, London, W.C.1.

THE annual summer meeting of the Association of Technical Institutions will be held at Blackpool on June 25–26 under the presidency of the Right Hon. Lord Kennet. Further information can be obtained from Dr. H. Schofield, Loughborough College, Loughborough, Leicestershire.

THE German Röntgen Society has recently founded a Röntgen Institute at Munich containing a museum and library. Publications should be sent to Ottostrasse 5, München.

THE second World Congress on Mental Hygiene will be held in Paris on July 19–23 under the auspices of the French League for Mental Hygiene. Further information can be obtained from the Secretary of the National Council for Mental Hygiene, 76 Chandos House, Palmer Street, London, S.W.1.

THE third Annual Conference of the National Federation of Personal Health Associations will be held at the British Medical Association's House, Tavistock Square, W.C.1, on June 24 at 2.45 p.m. The chief subjects for discussion will be the Government campaign to promote the physical fitness of the people and the part to be played by local authorities and individuals in co-operating with the National Advisory Council to ensure the success of the campaign.

WITH reference to the paragraph in NATURE of May 29 (p. 915) including the names of new officers of the Linnean Society, the Assistant Secretary informs us that, "owing to an error on our part, the name of Mr. Fred Howarth as a new member of council was omitted from the notice sent". Five new members of Council are elected annually.

ERRATUM. The X-ray photographs of nitrided steel reproduced as Fig. 6 in Sir William Bragg's article "Recent Crystallography" printed in NATURE of May 29 were incorrectly ascribed to Dr. G. Shearer. The photographs are due to Mr. W. A. Wood, of the National Physical Laboratory.

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 969.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Dry Crossings of the Nile

ATTENTION has been directed on page 351 of NATURE of February 27, 1937, to a natural bridge "so strong that it bears the elephant from one bank to another", near Nimule, which is situated at the point where the Albert Nile, as it is commonly called to-day, becomes the Bahr el Jebel. It is clear that Dr. Hurst finds difficulty in believing in any such phenomenon, for in his review of May H. Lindsay's translation, the "Life Story of a River", from Emil Ludwig's work, he says: "Nobody else has ever reported this bridge." This is not so.

So far as I can discover, I was the first European to see and describe a natural bridge, or dry crossing, near this point, or to know of its existence; and it seems clear that Emil Ludwig obtained his information from a short illustrated account that I wrote of it. I first saw this dry crossing from the air in 1930 when I supposed it to be a temporary blockage by sudd which had been burnt; and three years later I crossed it on foot. It is or was situated, for I hear that it is slowly breaking up, at a point about seven miles below the Folar rapids.

The following is taken from the account above referred to[1]:—

"The dry crossing is a blockage some 1,200 feet in length and about 370 feet across and occupies the entire width of the Nile at that place. Its surface consists of soft soil with a very high percentage of vegetable matter, supporting an herbaceous land flora, but no papyrus. It is edged on its upstream side with a broken line of tree trunks (for the most part boles of palms) leaning steeply upstream and thus recalling a raked stockade. Apart from being soft and powdery the ground is unyielding, except near the right bank where it responds to the foot as a mattress does on a spring bed; but there is so little danger of going through into the water below that elephants cross over the surface, as some fresh spoor clearly indicated".

"About 570 feet upstream of the usual path over the crossing extending for a length of seventy-five feet an oily-looking pool breaks the dry surface, and from time to time ugly swirls appear upon it, and immediately downstream of the path is a much smaller pool of a similar kind, while in line with this at the downstream end of the blockage there is an exposed channel along which water can be seen swiftly flowing. It would appear that the main course of the Nile under the blockage is by the right bank." The flow of the Nile in this part of its course is powerful.

A similar dry crossing has been described by Sir Samuel Baker who, on page 455 of his "Albert Nyanza Basin of the Nile," 1892, says: ". . . we arrived at the junction of the Bahr el Gazal, and turning sharp to the east, we looked forward to arriving at the extraordinary obstruction that since our passage in 1863 had dammed the White Nile."

"There was considerable danger in the descent of the river upon nearing this peculiar dam, as the stream plunged below it by a subterranean channel with a rush like a cataract. A large diahbiah laden with ivory had been carried beneath the dam on her descent from Gondokoro in the previous year, and had never been seen afterwards."

E. J. WAYLAND.

Geological Survey,
Entebbe, Uganda.
April 7.

[1] Wayland, E. J., "A Dry Crossing of the Nile", *Uganda Journal*, 1, No. 1, 68–69 (1934). Another note of interest in the present connexion is the following: Pitman, C. R. S., "A Dry Crossing of the Nile and its possible Influence on the Distribution of Mammalian Species", *Uganda Journal*, 2, No. 1, 86–89.

I HAVE read with interest Dr. Wayland's letter on the subject of a natural bridge over the Nile some eleven miles below Nimule. Unfortunately, I had not seen his note in the *Uganda Journal* when I wrote my review of Dr. Ludwig's book or I should have realized that "A natural bridge has grown at Nimule, such as hardly another river on earth possesses in this form, consisting of rank water plants, so strong that it bears the elephant from one bank to the other, and so powerfully rooted that when floods have destroyed it, it closes up again of itself" was merely an inaccurate way of describing a sudd block, and did not relate to some entirely new phenomenon of vegetative growth.

So far as I know, "sudds" (the word "sudd" is Arabic for a blockage) have not previously been reported on the stretch of river between Nimule and Rejaf, where the rapid stream is unfavourable to their formation, but farther north in the area known as the Sudd Region, where the Bahr el Jebel flows through swamp, they were of common occurrence in the last century. One of the first pieces of work undertaken on the Nile after the reoccupation of the Sudan was the removal of these blocks, and this was successfully accomplished in the early years of the present century. Since then, owing to the regular navigation of the Bahr el Jebel by steamers, blocks have rarely occurred, as it has been possible to remove obstructions before they became consolidated.

A full account of the formation and history of these sudds on the lower Bahr el Jebel was given by Sir Henry Lyons[1] and a shorter account by Phillips and myself[2].

Similar blocks have occurred on the Victoria Nile at its exit from Lake Kioga, on the Pibor, and on the Bahr el Ghazal where in 1880 the steamer of Gessi, one of Gordon's officers, was completely shut in for some weeks, and many of his company died.

The blocks which occurred on the lower Bahr el Jebel were composed mainly of papyrus, reeds and um soof, large masses of which with earth clinging to their roots were sometimes torn loose by the combination of strong winds and a rising river and found their way into the main stream, where they were arrested at a sharp bend or a narrow part of the channel. As these masses were sometimes acres in extent, the channel became blocked by floating vegetation, and so its section was reduced while the velocity of the water below the mass increased. Fresh vegetation as it arrived was sucked under the old and caught in the narrowing section, so that the block increased and became consolidated by the heading up of the water behind it. In this swampy region the water sometimes found another channel, but sometimes the block burst under the pressure of the water.

The block to which Dr. Wayland directs attention was no doubt formed from vegetation uprooted on the swampy reach above Nimule in the same way as has just been described. The conditions, however, are different inasmuch as the river at the block is in a narrow rocky valley and not in swamp, and the velocity of the water is greater than on the lower Bahr el Jebel. Some interesting points mentioned in the article in the *Uganda Journal* are, that natives say that the blockage is not permanent but that there have been several at the same spot each lasting for a few years, and that their formation is in no way related to the height of the river.

In 1924 I was at what appears to be the spot described by Dr. Wayland, and at that time a block must have been just beginning to form, for at a point where the river narrowed suddenly there was an accumulation of floating dead vegetation, mostly um soof, covering the whole width of the river and extending for perhaps thirty yards upstream. It was, however, not at all consolidated nor was it a serious obstruction to the river.

The Bahr el Jebel draws the greater part of its water from Lake Albert, and in the dry season only changes its level slowly; but in the rainy season from April to October it is liable to rises and falls due to torrential tributaries entering it between Lake Albert and Nimule.

I would suggest that, as in the case of the lower Bahr el Jebel, a rise of the river accompanied by strong winds occasionally detaches a mass of vegetation large enough to form a block at the constriction, and that the block increases and consolidates as I have already described. As there is no possibility of the river opening a new channel, the block can only be removed by bursting. This would probably take place when the river rose considerably; perhaps also after a time the barrier is weakened by the rotting of the lower layers of vegetation. Thus both the formation and destruction of the sudd would depend to some extent on rises of the river and not on its actual level, in accordance with native report.

In the past it has been suggested that the site of a dam to convert Lake Albert into a reservoir might be at Nimule. One of the objections raised against this choice of a site was the danger of vegetation accumulating above the dam and blocking the sluices. Weight is added to this objection by the fact that a sudd can form at present near the proposed site.

I am sorry to have doubted Dr. Ludwig on a point which had a sound foundation, but my doubt has had the good result of directing attention to Dr. Wayland's description of a very interesting phenomenon.

As Imperial Airways have a regular service passing near the site of the block, it might perhaps be possible for their pilots to keep notes of its state, so that the conditions which lead to its formation and destruction may be investigated.

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[1] "The Physiography of the River Nile and its Basin". Lyons. (Cairo: Government Press, 1906).
[2] "The Nile Basin". Vol. 1. Hurst and Phillips. (Cairo: Government Press, 1931.)

Radioactivity Produced by Gamma Rays and Neutrons of High Energy

WHEN lithium is bombarded by protons of energy of about 450 kV., gamma rays of about $17{\cdot}5 \times 10^6$ eV. energy are emitted. Recently Bothe and Gentner[1] have observed that these gamma rays can produce radioactivity in many elements. In all the cases reported, the primary process probably consists in the emission of photo-neutrons. In six cases they have observed the formation of new radioactive isotopes. These are gallium (60 min.), bromine (5 min.), silver (24 min.), indium (1 min.), antimony (13 min.) and tantalum (14 min.).

We have repeated some of their experiments with similar results using lithium metal targets bombarded by magnetically separated protons of about 520 kV. and 10–20 μ amp. ion currents as gamma ray source. We have also observed a weak 'photo-radioactivity' in oxygen with a half-period of about 2 min. This is probably due to the formation of the known radioactive isotope ^{15}O (2·1 min.) according to the reaction:

$$^{16}O + h\nu \rightarrow {}^{15}O + {}^{1}n.$$

The threshold energy for removal of a neutron from a stable isotope is presumably well below $17{\cdot}5 \times 10^6$ eV. for most elements. We have therefore attempted to produce the new radioactive isotopes by means of gamma rays and also by neutrons of energy smaller than that of the lithium gamma rays. Radioactivity produced by 'neutron loss' (as opposed to 'neutron capture') was first observed by Heyn[2] in copper bombarded by the neutrons from lithium + deuterons.

We were able to produce five of the new radioactive isotopes reported by Bothe and Gentner, by using the neutrons of lithium + deuterons and boron + deuterons (energy $\leqslant 13{\cdot}5 \times 10^6$ eV.). For a voltage of about 520 kV. and equal ion current (deuterons or protons) the yield in radioactivity was usually much higher in the case of neutrons than in the case of lithium gamma rays. We were unable to detect any radioactivity with the gamma rays from boron + protons (energy $\leqslant 14 \times 10^6$ eV.) and beryllium + protons (energy $\leqslant 6{\cdot}5 \times 10^6$ eV.). Our results concerning radioactive isotopes which cannot be obtained by neutron capture are summarized in the accompanying table.

As antimony has only one known slow neutron period but two isotopes, we specially verified that the 13 min. period cannot be produced by slow neutrons, the upper limit for its intensity being $1/10^5$ of the activity produced by slow neutrons in indium (54 min.). It seems therefore very likely that the 13 min. period is due to ^{120}Sb, and not to ^{122}Sb.

After bombarding with neutrons of lithium + deuterons we sometimes noticed a short-period radioactivity which we finally found to be due to oxygen. This element can be activated very strongly. Its activity decays with a period of 8 seconds, which is apparently identical with that observed in fluorine bombarded by fast neutrons, and long presumed to be due to ^{16}N. We may therefore account for this period by the reaction :

$$^{16}_{8}O + ^{1}_{0}n \rightarrow ^{16}_{7}N + ^{1}_{1}H.$$

We could also produce this radioactivity with the neutrons of boron + deuterons, but not with those of beryllium + deuterons or with slow neutrons. We were unable to detect this period in nitrogen bombarded by slow neutrons (beryllium + deuterons + paraffin).

RADIOACTIVE ISOTOPES OBTAINED BY 'NEUTRON LOSS'.

Source		Gamma rays			Neutrons			Radio-isotope produced	Half-period (min.)
		Li+H	Be+H	B+H	Li+D	Be+D	B+D		
Energy in 10^6 eV.		17·5	⩽6·5	⩽14	⩽13·5	⩽4·5	⩽13		
Element irradiated	Isotopes								
8 O	16, 17, 18	2		—	—	—	—	^{15}O	2·1
29 Cu	63, 65	**100**	—	—	1200		300	^{62}Cu	10·5
31 Ga	69, 71	40		—	1200	—	500	^{68}Ga	60
35 Br	79, 81	20	—	—	500	—	600	^{78}Br	5
47 Ag	107, 109	25	—	—	700	—	300	^{106}Ag	24
49 In	113, 115	35	—	—	300	—	100	^{112}In	1
51 Sb	121, 123	10	—	—	2000	—	300	^{120}Sb	13

The figures give the relative initial activity (measured with a tube counter) observed in thick samples bombarded by gamma rays or neutrons. The values are expressed in arbitrary units and are reduced so as to correspond to samples of equal size, to equal ion current (at about 520 kV.), and to infinite time of exposure.

In gallium bombarded with neutrons from lithium + deuterons and boron + deuterons a new radioactivity decaying with a half-period of about 5 min. and having an intensity similar to that of the 60 min. period has been found. As this period seems to be identical with one of the periods produced in copper by neutron capture, it is probably due to ^{66}Cu, formed according to the reaction :

$$^{69}_{31}Ga + ^{1}_{0}n \rightarrow ^{66}_{29}Cu + ^{4}_{2}He.$$

We wish to thank Dr. W. B. Lewis and Mr. W. E. Burcham for putting their apparatus at our disposal, and Prof. E. N. da C. Andrade for lending us a sample of pure gallium.

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[1] Bothe and Gentner, *Naturwiss.*, **25**, 90, 126, 191, 284 (1937).
[2] Heyn, NATURE, **138**, 723 (1936). *Physica*, **4**, 160 (1937).

Absorption of γ-Rays Measured by their Photo-effect in Beryllium

IT results from recent determinations of atomic masses, that in the photo-nuclear effect of radium C γ-rays in beryllium, only the hardest groups, namely, $2·2 \times 10^6$ eV., $2·0 \times 10^6$ eV. and $1·8 \times 10^6$ eV., can be efficient. The absorption of these γ-rays measured by the number of neutrons produced in beryllium should therefore be very nearly exponential without any preliminary filtering. However, Gentner[1] has found that the absorption curve obtained by this method exhibits a flat maximum for small thicknesses of absorbing material (lead or aluminium) and then decreases, at first with a coefficient corresponding to $0·9 \times 10^6$ eV., and afterwards more slowly. Gentner interprets these results by assuming that the observed maximum corresponds to the maximum intensity of the $0·9 \times 10^6$ eV. rays developed by the Compton effect from the primary rays, and that this quantum energy represents twice the energy necessary for extracting a neutron from the beryllium nucleus.

In view of these discrepancies, I have repeated these experiments using the following arrangement. About 120 gm. of beryllium contained in a thin-walled zinc box, 5 cm. × 5 cm. × 5 cm., was placed at 4 cm. distance from the source of γ-rays (50 mgm. of radium contained in platinum tubes kindly lent by the Maria Curie-Skłodowska Radium Institute, Warsaw). The activity excited in a silver foil placed against the box opposite the source was measured as a function of the thickness of different absorbers interposed between the box and the source. Paraffin wax was placed behind the box in order to increase the efficiency of the neutrons. The front side of the box exposed to the radium was covered by a sheet of cadmium in order to minimize the back-scattering of slow neutrons from the absorbing material. The results for absorption in lead, copper and aluminium are represented in Fig. 1.

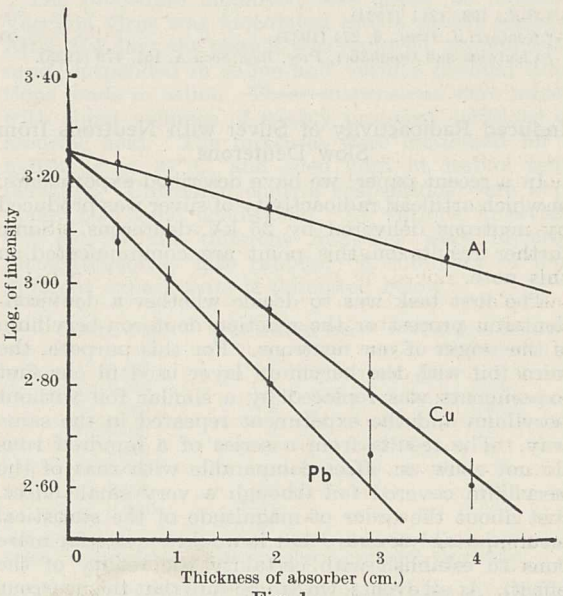

Fig. 1.

The curves are exponential, the half-value thicknesses being 14 mm., 19 mm. and 52 mm. for lead, copper and aluminium respectively. I deduce for the atomic absorption coefficients : $\mu_{at.}^{Pb} = 1{\cdot}51 \times 10^{-23}$, $\mu_{at.}^{Cu} = 0{\cdot}434 \times 10^{-23}$, $\mu_{at.}^{Al} = 0{\cdot}215 \times 10^{-23}$. The best value found by comparison of theory and recent experimental work[2] for radium Cγ-rays filtered through 10-15 cm. lead is $\mu_{at.}^{Pb} = 1{\cdot}53 \times 10^{-23}$, and the values calculated for these rays for copper and aluminium using the figures given by Gentner[2] are $\mu_{at.}^{Cu} = 0{\cdot}439 \times 10^{-23}$ and $\mu_{at.}^{Al} = 0{\cdot}195 \times 10^{-23}$. The agreement is very satisfactory and shows that the efficient wave-length for neutron production is about equal to the mean wave-length—6·3 X.U., corresponding to $1{\cdot}96 \times 10^6$ eV. quantum energy—of rays filtered through 10-15 cm. lead.

The divergent results obtained by Gentner must probably be attributed to the back-scattering of slow neutrons from small thicknesses of the absorbing material. I performed some experiments in which the box was *not* protected by cadmium, and obtained a curve which without showing a maximum was nearly flat at the beginning. The effect of scattering is small in my arrangement because the sheet of beryllium is 5 cm. thick. With a smaller thickness of beryllium a maximum would certainly be observed.

I have compared also the efficiency of radium C and thorium C″ γ-rays in producing neutrons from beryllium and found, in agreement with Gentner, for equal intensities of γ-rays (filtered by 1 cm. of lead and measured by a Geiger counter) that the first source gives about twice the number of neutrons produced by the second source. This fact may be attributed to a nuclear resonance effect, or alternatively to the smaller efficiency of neutrons of higher kinetic energy, produced by the harder γ-rays of thorium C″[3]. Experiments now in course seem to support the later assumption.

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April 5.

[1] *C.R.*, **199**, 1211 (1934).
[2] Gentner, *J. Phys.*, **6**, 274 (1935).
[3] Chadwick and Goldhaber, *Proc. Roy. Soc.*, A, **151**, 479 (1935).

Induced Radioactivity of Silver with Neutrons from Slow Deuterons

IN a recent paper[1] we have described experiments, in which artificial radioactivity of silver was produced by neutrons delivered by 25 kV.-deuterons. Some further results on this point are communicated in this note.

The first task was to decide whether a deuteron-deuteron process or the reaction deuteron-beryllium is the origin of our neutrons. For this purpose, the mica foil with the beryllium layer used in our first experiments was replaced by a similar foil without beryllium and the experiment repeated in the same way. The results from a series of a hundred runs do not show an effect comparable with that of the beryllium covered foil (though a very small effect, just about the order of magnitude of the statistical errors, possibly exists ; but it would require far more runs to establish with certainty the reality of the effect). At all events, we can be sure that the neutrons which produced the activity measured in our first experiments are due to the process :

$$^{9}_{4}\mathrm{Be} + {}^{2}_{1}\mathrm{H} \rightarrow {}^{10}_{5}\mathrm{B} + {}^{1}_{0}n$$

In order to get information concerning the velocity of our neutrons, we tried to state the relation of the intensities of the two known periods of silver as a function of the velocity of the primary deuteron-ray. Since it is known that the shorter period is far more influenced by the slowing down of the neutrons, one can at least easily establish, by varying the energy of the primary radiation within the small range of our voltages (15–35 kV.), whether the velocity of the neutrons is of the order of magnitude of that of the primary radiation, or not. If the energy of the effective neutrons is of the order of magnitude of 10^4 eV., we should expect a systematic variation of the intensity relation of the two periods ; and conversely, a practically constant intensity relation would mean that the energy of the neutrons is large compared with the energy variation used, namely, about 10^4 eV.

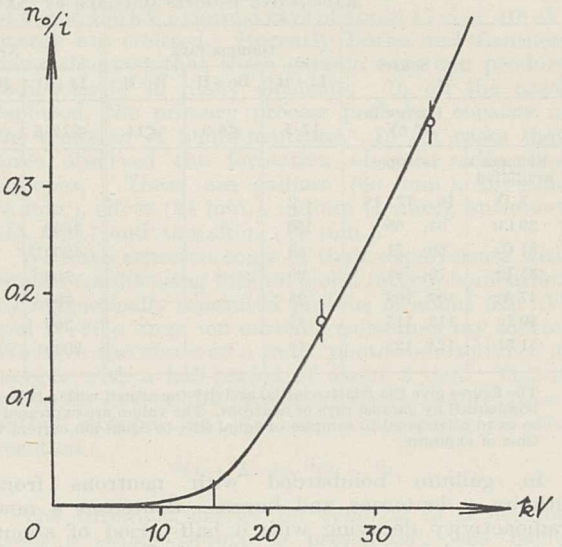

Fig. 1.

Unfortunately, the activity produced by the 15 kV.-beam was too small to permit us to carry out this programme entirely. With this voltage our ion-current was not sufficient to produce in 150 runs an activity exceeding the statistical uncertainties. From 150 measurements with 35 kV. we got very exact decay curves, giving the following results for the half-value periods and the intensity relation (which may be defined by two coefficients C_1 and C_2, where $C_1 + C_2 = 1$) : $T_1 = 24 \pm 5$ sec., $T_2 = 110 \pm 12$ sec., $C_2 = 0{\cdot}58 \pm 0{\cdot}06$. Using these values for the half-periods, one gets the best agreement with the experimental decay curves from the 25 kV.-measurements with $C_2 = 0{\cdot}50 \pm 0{\cdot}07$. The second value is indeed smaller than the first, as might be expected for neutrons of about 10^4 eV., but the variation is just within the possible error, so that it is again impossible to decide with certainty the point in question.

Finally, it is of interest to examine the excitation curve for our low-voltage neutrons. In Fig. 1 we have plotted the total number n_0 of silver atoms transmutated in a single run (extrapolated from the decay curves) divided by the positive ray current in microamperes. We have found the yields : $< 0{\cdot}024$; $0{\cdot}176 \pm 0{\cdot}02$; $0{\cdot}360 \pm 0{\cdot}02$ respectively. Expressed in radium equivalents (that is, the values

resulting from the comparison of our total induced activity with that of a preparation of radium-beryllium with known content of radium element) the yields are: < 0·2; 6·8; 19 mgm.

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[1] Bertl, Fürth, Obořil and Sitte, NATURE, **139**, 716 (1937).

Androgenic Activity of Ovarian Extracts

IT is well known that œstrogenic activity may be shown by extracts of testes and by extracts of urine from the males of certain species. Conversely, androgenic activity can readily be demonstrated in the urine of normal women, and Hill and Gardner[1] have shown that, under certain conditions, the atrophic seminal vesicles of castrated mice can be restored by ovarian grafts. Further, since the comb of the domestic hen atrophies after ovariectomy and responds to male hormone but not to œstrone, its increase in size during the laying season presumably indicates production of androgenic substance by the active ovary.

So far, however, androgenic activity does not seem to have been demonstrated in ovarian extracts, possibly because much larger amounts of male hormone than of œstrone or œstradiol, in terms of crystalline substance, are required to evoke a significant biological reaction. By the use of Fussgänger's highly sensitive modification[2] of the capon test—direct unction of the comb with the extract—we have now been able to demonstrate androgenic activity in two crude alcohol-acetone-ether extracts of pig ovaries. The first extract was qualitatively tested on the combs of two bantam capons and produced growth (L + H) in five days of 11 mm. and 7 mm., a clear-cut response. The second, quantitatively tested on ten Leghorn capons by the application to each of a total of 0·125 c.c. of the oily extract over five days, produced an average growth of 4 mm., about the same as that given by the similar administration of 2·5 γ androsterone, or 1/40 I.U. The yield of extract was 3·9 gm. per kgm. of fresh tissue, so that the androgenic activity of pig ovaries would seem to be rather less than 1 I.U. per kgm. Suitable control tests with arachis oil solutions of œstrone, œstradiol and œstriol gave negative results, and it is likely therefore that the androgenic activity of the ovarian extracts was due to the presence of substances of the androsterone-testosterone group.

This result is of obvious significance in relation to the origin of the androgenic material in the normal human female. A number of observations suggest that the adrenals are one site of elaboration. Thus Reichstein[3] has isolated an androgenic diketone from the adrenal, while, examined by the unction technique, a crude extract of horse adrenal was slightly androgenic, and a highly concentrated discard fraction of pig adrenals, kindly supplied by Dr. Reichstein, gave good growth. Further, Simpson, de Fremery and Macbeth[4] have shown that very large amounts of androgenic substance may be present in the urine of women with virilism of adrenal origin, and Callow[5] has isolated as much as 110 mgm. per litre of *trans*-dehydroandrosterone from the urine of a female child with an adrenal tumour. Finally, in conjunction with Dr. Callow and Dr. Levy Simpson, it has recently been shown that considerable amounts of androgenic material may be found in the urine of ovariectomized women. Nevertheless, the presence of androgenic activity in ovarian extracts shows that the female gonad must also be considered as a possible source of at least a part of the androgenic material found in the normal human female.

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May 4.

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[2] Fussgänger, *Medizin. u. Chem. Z.*, **2**, 194 (1934).
[3] Reichstein, *Helv. chim. Acta*, **19**, 223 (1936).
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Inactivation of Vaccinia Virus by Ascorbic Acid and Glutathione

JUNGEBLUT and his co-workers[1] have shown that the virus of poliomyelitis and diphtheria toxin were inactivated by ascorbic acid. One of us[2] has shown that addition of ascorbic acid to cultures of *C. diphtheriæ* leads to production of relatively atoxic filtrates. Further studies on the nature of this interaction established a reasonable presumption that there was an oxido-reduction between the ascorbic acid and toxophore group of diphtheria toxin.

It occurred to us that if this is the type of reaction involved, other viruses might also be inactivated in the same manner. Experiments conducted with vaccinia virus gave positive results. Relatively small amounts of ascorbic acid inactivated many infective doses of the virus. Similar results were obtained also with glutathione, but this substance proved much less active than ascorbic acid in the same concentration.

The procedure employed was briefly as follows: Vaccinia virus was inoculated into a rabbit testicle. After 3–4 days the testicle was removed, ground with sand, suspended in saline and various decimal dilutions made in saline. These suspensions were mixed with equal volumes of freshly prepared solutions of ascorbic acid. The mixtures were incubated for a half-hour at 37° C. and then kept at icebox temperature. Untreated control suspensions were kept under the same conditions. At various intervals, 0·2 c.c. of the different mixtures were injected intracutaneously into rabbits. A summary of four different experiments is tabulated below:

Vitamin Conc.	Incubation Time	Infective doses inactivated
1 : 20,000	3 hours	10*
1 : 2,000	3 ,,	100
1 : 200	3 ,,	1,000
1 : 20,000	6 ,,	10
1 : 2,000	6 ,,	100
1 : 20,000	24 ,,	10
1 : 2,000	24 ,,	1,000*
1 : 200	24 ,,	10,000

* = incomplete neutralization, that is, delayed reaction and milder lesion. Full number = infective doses completely inactivated.

It will be noted that the ascorbic acid inactivates the virus and that the degree of inactivation depends on the concentration of the vitamin and the time interval during which it is allowed to act.

Similar tests were made with glutathione. This substance proved much less active than ascorbic acid. A dilution of 1 : 20,000 failed to inactivate virus in 24 hours, while a dilution of 1 : 200 inactivated 10 doses completely and 100 infective doses partially.

It appears, therefore, that ascorbic acid has the same effect on vaccine virus as on the virus of poliomyelitis and on diphtheria toxin. Preliminary experiments indicate a similar effect on coli phage. It may well be, therefore, that the phenomenon is a general one and is related to a common or related group in the chemical composition of viruses and diphtheria toxin, effected by oxido-reducing substances, of which ascorbic acid is the most active.

Further investigations are in progress.

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[1] Jungeblut, C. W., *J. Exp. Med.*, **62**, 517 (1935); Jungeblut, C. W., and Zwemmer, R. L., *Proc. Soc. Exp. Med. and Biol.*, **32**, 1229 (1935).
[2] Kligler, I. J., NATURE, **138**, 291 (1936).

Correlation Phenomena and Hormones in *Selaginella*

IT has been known for a long time that the angle-meristems present at every branching of *Selaginella* shoots, which normally give rise to rhizophores, may be induced to develop as leafy shoots instead of rhizophores[1]. This altered development occurs when pieces of shoot including a branching but with the shoot apices removed are used as cuttings. This is illustrated for *S. Martensii* in Fig. 1 *a*, which depicts a specimen from an experiment in which fourteen pieces of shoot were used. Thirteen of these showed the development of leafy shoots from the angle-meristems while the remaining one showed no further development.

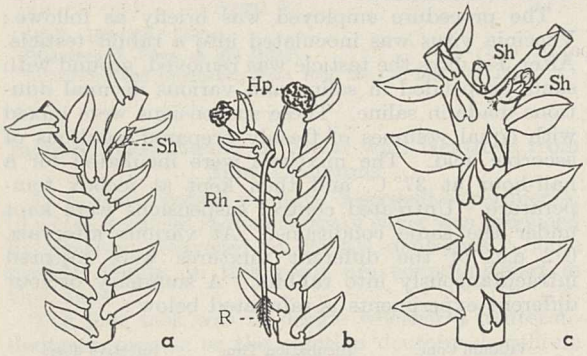

Fig. 1.

Selaginella Martensii. (*a*) UNTREATED LENGTH OF SHOOT; (*b*) LENGTH OF SHOOT WITH HETEROAUXIN PASTE; (*c*) AND (*d*) COMPARABLE LENGTHS OF SHOOT OF *S. Lobbii*. *Sh*, SHOOT; *Rh*, RHIZOPHORE; *R*, ROOT; *Hp*, HETEROAUXIN PASTE. (× 1½).

The presence of a correlating influence diffusing backwards from the shoot apices has been inferred from the known facts, and it seemed worth while to investigate whether hormones such as heteroauxin (3-indole acetic acid) were concerned. Pieces of shoot were prepared as above, and the cut upper surfaces were then smeared with heteroauxin paste (prepared by the method described by Laibach[2]). Twelve pieces of shoot were used, and all showed the development of a rhizophore from the angle-meristem (see Fig. 1 *b*). Comparable results have been obtained with the more strongly growing *S. Lobbii*, which frequently shows two angle-meristems in an active condition at each branching. In an experiment with eleven pieces of shoot treated with heteroauxin paste, seven specimens showed the development of a single rhizophore, the other meristem remaining dormant; two showed the development of two rhizophores (see Fig. 1 *d*); one the development of a rhizophore followed by the development of a shoot from the other meristem; the remaining specimen showed no further development. Similar shoot pieces without heteroauxin paste showed the development of one or two leafy shoots (see Fig. 1 *c*); no rhizophores were formed.

These preliminary experiments indicate that the presence or absence of heteroauxin is an effective factor in determining whether an angle-meristem shall develop as a rhizophore, leafless and positively geotropic, or as a plagiotropic leafy shoot. They do not prove that the correlating influence normally exercised by the shoot apex is in the nature of a hormone mechanism, but they lend support to this view.

A more extensive series of experiments relating to correlation phenomena in *Selaginella* is in progress.

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April 19.

[1] Williams, S., "An Analysis of the Vegetative Organs of *Selaginella grandis*", *Trans. Roy. Soc. Edin.*, **57** (1931).
[2] Laibach, F., "Über die Auslösung von Kallus- und Wurzelbildung durch β-Indolylessigsäure", *Ber. Bot. Gesell.*, **53** (1935).

A Device for the Observation of Root Growth in the Soil

STUDIES of root systems have in the past been accomplished by various methods of excavation *in situ* or by the growing of plants in specially constructed boxes which can be dismantled to allow removal of the soil. It is impossible to conduct developmental studies by this means unless a number of subjects are examined at various stages of their growth, and in any event the process is extremely laborious. In work on fruit trees at East Malling, Rogers[1] has designed observation trenches which are in the form of a walled chamber fitted with plate-glass windows. This gives a view of root-lets impinging against the glass.

The necessity for this type of study upon arable crops and grasses has led me to devise a cheap and convenient means suited to field conditions. Land under rotation on a commercially run farm must undergo cultural operations in winter which make it imperative to move the units after the crop is harvested. Cheapness renders it possible to install a sufficient number of points of observation to satisfy statistical needs. A less permanent and expensive method is therefore desirable than in the case of an experimental orchard.

Glass tubes, closed at the lower end, are let into the soil down holes bored to a slightly larger diameter.

A certain amount of packing with dry soil from the various depths is necessary. The glass cylinder may be specially constructed for the purpose, but lamp glasses cemented end to end to a depth of three or four feet have proved very satisfactory. Half-section drain-pipes faced with glass and other types of shaft have also been utilized. Good quality horticultural glass has been found to take the strain in cases where a lamp glass is not employed. The top of the shaft is closed with a metal lid designed to collect rain-water. The glass may be marked into squares to facilitate observation and sketching

The method of viewing the roots is by a mirror mounted at the end of a metal rod with a screw adjustment to allow tilting to a convenient angle. A small electric bulb is fitted above the mirror and this is connected to a pocket torch fixed to the upper extremity of the rod. One instrument, of adjustable length, to which mirrors of convenient sizes can be attached, serves for every type of shaft.

In preliminary observations on *Lolium perenne*, the lamp glass method has provided a clear image at an inclusive cost of not more than half a crown per square foot of area observed. This is a very small fraction of the cost of the permanent chamber.

It is hoped, this year, to conduct a series of observations upon such problems as the effect of continual cutting upon the root systems of grasses and the influence of a concentrated layer of fertilizer upon root growth. The progression of the root system in sugar beet will also be observed.

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April 29.

[1] East Malling Research Station. Annual Report (21st Year) 1933, pp. 86–91.

Distribution of Ultra-High-Frequency Currents in Long Antennæ

IN connexion with some problems concerning the action of ultra-short wireless waves on frame aerials, it was found necessary to know how ultra-high-frequency currents were distributed on long straight aerials. It has usually been assumed that such currents were distributed sinusoidally, and Wilmotte[1] has shown both theoretically and experimentally that this is so in the particular case of a long vertical antenna with a concentrated E.M.F. at the foot of the aerial.

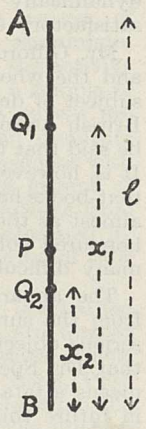

Fig. 1.

If a concentrated high frequency E.M.F. be applied at any point P (Fig. 1), then it can be shown that the currents in the portions of the wire above and below P are distributed sinusoidally with current nodes at half wave-length intervals measured from both A and B. That is, if I_1 be the current at Q_1 and I_2 that at Q_2 then

$$I_1 \propto \sin \frac{2\pi(l - x_1)}{\lambda} \quad \text{and} \quad I_2 \propto \sin \frac{2\pi x_2}{\lambda},$$

where l is the length of the antenna and λ is the length of the wave. Furthermore, the currents in the two parts are dependent one upon the other in such a way that, when AP (say) is an integral number of half wave-lengths, the current in BP is a minimum (theoretically zero) whatever be the length of BP*, and when AP is an odd number of quarter wave-lengths, the current in BP is a maximum. In a similar way, the current in AP is dependent on the ratio of BP to λ.

This current distribution only occurs when the input energy is concentrated at a given point of the antenna, and is therefore applicable to long transmitting aerials if they are coupled by a coil of small dimensions to an ultra-high-frequency oscillator.

With a long isolated receiving antenna in a uniform ultra-high-frequency electromagnetic field, the current distribution seems to be much more complex. Its amplitude variation with distance x along the aerial wire is given by the theoretical expression :

$$I_0 = K \sec \frac{\pi l}{\lambda} \sin \frac{\pi x}{\lambda} \sin \frac{\pi}{\lambda}(l - x),$$

where K is a constant. This reduces to $K \sin^2 \pi x/\lambda$ when $l = n\lambda$. The general expression shows that current nodes occur at intervals of one whole wave-length measured from both ends of the antenna. The nodes measured from one end of the antenna therefore overlap those measured from the other end in such a way that the two central nodes gradually come closer together as the aerial increases in length from one to two wave-lengths, and then gradually separate as the length of the aerial increases from two to three wave-lengths, and so on. The symmetrical disposition of these central current nodes and antinodes and their dependence upon the ratio l/λ will presumably determine the best positions for tapping points for the passage of energy to and from the antenna.

Preliminary experiments have supported the above conclusions, but the practical current distribution graphs for long transmitting and receiving aerials and the measured critical lengths are naturally slightly modified by the fact that the resistance and leakage of the aerial cannot be neglected when compared respectively with the inductive and capacitive reactance components of its impedance.

It is proposed to publish a full account of this work in the immediate future.

L. S. PALMER.
K. G. GILLARD.

University College,
Hull.
April 24.

* With the exception of the special cases when BP is also an integral number of half wave-lengths.

[1] *J. Inst. Elect. Eng.*, **66**, 617 (1928).

Fall in Air Temperature during the Solar Eclipse of December 13-14, 1936

AT a recent meeting of the Royal Astronomical Society[1], a discussion took place on observations of temperature changes made by Dr. John L. Haughton on board the *Strathaird*, during the total solar eclipse of June 19, 1936.

From this discussion, it appears that the amount of fall in air temperature which can actually take place during solar eclipses is very variable. It must depend to a large extent on the time of the eclipse, the meteorological conditions, and the geographical aspect of the point of observation.

During the annular eclipse of December 13–14, 1936, some fairly large falls of air temperature were recorded in New Zealand. Probably the most reliable and complete record is that obtained at the Meteorological Observatory, Wellington. By permission of Dr. E. Kidson, director of Meteorological Services, a tracing of this record is given here (Fig. 1). The record is from the Short and Mason M.O. pattern thermograph, in a Stevenson screen, under standard conditions for recording air temperature, located at an altitude of 415 ft. above sea-level. The thermograph was checked at intervals by comparison with a standard thermometer in the same screen. These check readings are indicated by black dots on the graph. A check reading at 10 hours 30 minutes, New Zealand Mean Time, just before the minimum, shows that the correction to the thermograph at minimum must have been very small. Another check reading at 11 hours, during the rise, indicates a slight

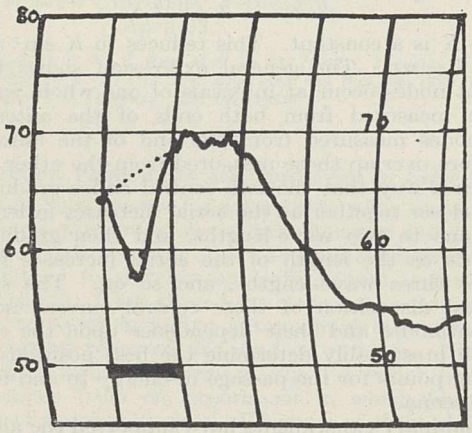

Fig. 1.

THERMOGRAPH RECORD OF AIR TEMPERATURE, KELBURN OBSERVATORY, WELLINGTON, N.Z., DECEMBER 14, 1936. THE PERIOD COVERED BY THE ECLIPSE IS INDICATED BY A BLACK STRIP BELOW THE THERMOGRAPH TRACE. BLACK DOTS INDICATE STANDARD THERMOMETER READINGS.

lag in the rise of the thermograph. Evidently the minimum temperature occurred within a few minutes after the time of maximum eclipse, of which the magnitude at Wellington was 0·85. During the eclipse the sky was cloudless, and the normal course of the temperature curve would probably have been close to the dotted line shown in the graph. The difference between this line and the lowest point of the temperature curve corresponds to a temperature difference of 4·9° C.; which must be attributed to the eclipse. Records of eclipse temperature changes have been summarized by Clayton[2]; and from the figures given, it appears that the fall in air temperature at Wellington during the eclipse of December 13–14, 1936, was abnormally large, particularly for a partial eclipse.

At Pukekohe, near the central line of the eclipse, observations of a thermometer in a Stevenson screen were made by the eclipse party under the leadership of Mr. C. B. Michie. A fall of 2·5° C. was observed during the eclipse, but this value may have to be increased slightly when the normal temperature change is taken into account[3]. The small fall at Pukekohe as compared with Wellington is due mainly to the effect of clouds at the former place. At New Plymouth, a short distance south of the central eclipse zone, a fall of 4·2° C. was registered by a thermometer in the shade[3].

Apart from the indications of the thermometer, the fall in air temperature was most apparent. The day of the eclipse was a public holiday, and at Wellington the weather was fine and warm. Consequently, a larger number of people than usual were out of doors; and to many, the chilliness of the atmosphere was the most outstanding phenomenon accompanying the eclipse.

R. C. HAYES.
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Dominion Observatory,
Wellington.
April 1.

[1] *Observatory*, **60**, No. 752, 1–2 (Jan. 1937).
[2] *Trans. Amer. Geophys. Union*, Seventeenth Annual Meeting, part 1, p. 131.
[3] "Preliminary Report on Observations of the Annular Eclipse of the Sun, 1936 December 13·9d. G.M.T." (I. L. Thomsen); *Southern Stars*, **3**, No. 2, 20–21 (March 1937).

Meteorites and the Craters on the Moon

DR. SPENCER'S article on this subject in NATURE of April 17 will have been read with interest by many astronomers who have held some of the views set forth therein for more than twenty years. I am unable to say who it was that first realized that meteoric impacts on the surface of the moon would be of an explosive nature, and would therefore give rise to circular craters; but, so far as I know, this most important consideration was first brought to the public attention of astronomers by the late Prof. A. W. Bickerton, in the course of discussions at meetings of the British Astronomical Association in 1915[1].

Mr. A. C. Gifford, whose admirable treatment of the subject in more than one publication is referred to by Dr. Spencer, has shown, to my mind conclusively, that the meteoric theory is physically and dynamically sound, and that it affords the only satisfactory explanation of the lunar craters.

Mr. Gifford's work is well known to astronomers, and the whole question has several times been the subject of debate in recent years at meetings of the British Astronomical Association; so it can scarcely be said that the subject has not been duly ventilated. It is, however, a fact that the writers of some recent text-books have shown rather a conservative attitude, almost as though it were desirable to save the time-honoured volcanic theory at all costs, in spite of its many difficulties.

The apparent absence of large explosion craters from the surface of the earth was one of the most serious objections to the meteoric theory; but, now that Dr. Spencer has assured us that this is by no means a fatal difficulty, is it too much to hope that in future this attractive hypothesis will receive the serious attention which it most certainly merits?

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April 18.

[1] *J. Brit. Astron. Assoc.*, **25**, 326, 366-67 (1915).

Determination of the Atomic Parameters in Anthraquinone Crystals

THE space group of anthraquinone crystals was found previously[1] to be D_{2h}^{13} *Pmmn*. The estimates of intensities of reflections from a large number of planes published have been utilized for the determination of atomic parameters. The best agreement has been found with the following orientations of the anthraquinone molecules. One molecule is placed with its centre having the parameters $x/a = 0{\cdot}25$, $y/b = 0{\cdot}142$ and $z/c = 0{\cdot}056$. Starting with the molecule placed with its plane parallel to the *ab* face, the correct position is obtained by rotating it by 1° about the *z*-axis, by 9° about the *y*-axis and by 30° about the *x*-axis. The two oxygen atoms are inclined to the carbon skeleton on the two sides but unsymmetrically. The positions and orientations of the other seven molecules in the unit cell are obtained from the equivalent positions corresponding to the space group D_{2h}^{13} *Pmmn*. The carbon skeleton has a plane structure with true hexagons and C—C distance the same as that in anthracene[2]. This is in very striking contrast to benzoquinone, in which the benzene ring is found to be deformed[3]. The complete details of the parameters and the comparison between the calculated and estimated intensities will be published elsewhere.

In conclusion, I wish to express my sincere thanks to Dr. K. Banerjee for his kind interest in the work.

BHAGAWATI CHARAN GUHA.

Midnapore College,
Midnapore, Bengal.
May 1.

[1] Banerjee, K., and Guha, B. C., *Ind. J. Phys.*, **9**, 287 (1934).
[2] Banerjee, K., *Ind. J. Phys.*, **4**, 541 (1930). Robertson, J. M., *Proc. Roy. Soc.*, A, **140**, 79 (1933).
[3] Robertson, J. M., *Proc. Roy. Soc.*, A, **150**, 106 (1935).

Points from Foregoing Letters

DETAILS concerning a natural bridge, formed by drifting materials, across the Nile below the Folar rapids (to which imperfect reference was made by Emil Ludwig in "Life Story of a River") are given by E. J. Wayland. Dr. H. E. Hurst supplies further information concerning the way in which such bridges come into existence, and suggests that pilots of the Imperial Airways who pass near this particular one during their flights might be asked to collaborate by keeping notes of its change with time.

A table of radioactive isotopes of oxygen, copper, gallium, bromine, silver, indium and antimony, the production of which can only be ascribed to the loss, and not to the capture, of neutrons, is given by W. Y. Chang, M. Goldhaber and R. Sagane. The loss of neutrons was brought about by irradiating with gamma rays of high energy produced by bombardment of lithium, beryllium or boron with protons, or by means of neutrons obtained from the same elements bombarded with deuterons.

J. Rotblat has obtained absorption curves of radium C γ-rays in lead, copper and aluminium, measuring the intensity of the γ-rays by the activity of a silver foil exposed to neutrons from a sample of beryllium irradiated by the rays. The curves are exponential and correspond to the mean quantum energy of $1{\cdot}96 \times 10^6$ eV., showing, in agreement with recent mass data, that only the hardest groups of these γ-rays are capable of extracting neutrons from beryllium nuclei. The divergent results obtained by Gentner are attributed to the back-scattering of slow neutrons.

When beryllium-containing mica is bombarded with slow (25 kV.) deuterons, neutrons are formed which induce radioactivity in silver. These neutrons, according to further experiments by E. Bertl, Prof. R. Furth, F. Oboril and Dr. K. Sitte, arise from the beryllium-deuterium nuclear reaction. The authors describe other experiments intended to determine the energy of the active neutrons, but these have proved, as yet, indecisive. They also give a curve showing the neutrons produced by deuterons of varying energy (0–35 kV.)

The combs of bantam and Leghorn capons can be made to grow, according to Dr. A. S. Parkes, by direct application of an alcohol-acetone-ether extract of pig ovaries, which indicates an androgenic activity of ovarian extracts due apparently to the presence of substances of the androsterone-testosterone group. The author refers to previous experiments which show that the adrenal glands also produce male sex hormones.

Results showing that small amounts of ascorbic acid (vitamin C) can inactivate infective doses of vaccinia virus inoculated into a rabbit testicle are given by I. J. Kligler and H. Bernkopf. Glutathione has a similar effect, but to a lesser degree, and the authors suggest that the action depends upon the oxido-reducing properties of ascorbic acid and glutathione.

Dr. S. Williams describes preliminary experiments on *Selaginella Martensii* and *S. Lobbii* which show that the presence or absence of heteroauxin is an effective factor in determining whether an angle-meristem shall develop as a rhizophore or as a leafy shoot.

A simple method of observing root growth under normal conditions is described by Dr. G. H. Bates. Glass tubes closed at the lower end are let into the soil in holes bored to a slightly larger diameter, and the roots are viewed at intervals by means of an arrangement of a mirror and an electric bulb.

A thermograph showing the falling of air temperature during the solar eclipse on December 14, 1936, at Wellington, New Zealand, is submitted by R. C. Hayes.

The current distribution in a long transmitting aerial, according to Prof. L. S. Palmer and Mr. K. G. Gillard, varies sinusoidally, with current nodes every half wave-length along the two parts of the aerial which are above and below the point of energy input, and the length of one part may be such that the current in the other part is either zero or a maximum. With a long receiving aerial, current nodes occur every *whole* wave-length measured from both ends of the aerial.

Prof. B. C. Guha has determined the atomic parameters of anthraquinone crystals. He finds that the carbon skeleton has a plane structure with C—C distances the same as in anthracene; and that the C—O bonds are inclined unsymmetrically to the carbon plane.

Research Items

Food of the Maya Indians

THREE expeditions to Yucatan have established the fact that male Maya in the Chichen Itza area have a basal heat production averaging from five to eight per cent higher than the commonly accepted standards for white men living in the northern parts of the United States. At the same time, whereas natives of sub-tropical areas usually have a metabolism lower than northern standards, the metabolism of the Maya is relatively high and is combined with a low heart rate and low blood pressure. In view of the possibility of a relation of this condition to diet, a quantitative and qualitative study of the Mayan present-day diet has been undertaken by Dr. Francis G. Benedict, director of the Nutrition Laboratory, and Dr. Morris Steggerda (Carnegie Institution, Washington, D.C.: *Contrib. Amer. Arch.*, **3**, 18). It was also anticipated that this investigation might throw light on the diet and food customs of the prehistoric Maya. In the remoter parts of Yucatan, the diet of the modern Maya is still almost entirely independent of white man's civilization. The basic food is maize, with its products, but beans, squash, chile and native meat are also eaten, with, on the sea coast, some sea-food. Seasonings, such as garlic, pepper, leaves, cloves and chile, play an important part. This diet is essentially the same as is recorded in literary sources for the period 1500–1700, and probably goes back to a much earlier date. Precise analysis of protein, fat, and energy content of many items in the daily diet and of daily meals were made. On the average, 73 per cent of the daily energy intake comes from maize. The daily protein intake per individual averaged 74 gm., low rather than high. The daily energy intake averaged 2,565 total calories, low as compared with the American labourer (*c.* 3,500 calories). The energy intake averaged only 66 per cent above the basal needs shown by measured basal heat production. The basal metabolism is not explained, and may be an environmental or racial factor.

The Electric Eel

THE electric discharge of certain fishes has often aroused scientific interest and popular curiosity, and of all electric fishes, the electric eel (*Electrophorus electricus*) is the largest, and develops most power. In their account of the electric discharge of this species (*Zoologica*, **22**, 1; 1937), C. W. Coates and R. T. Cox summarize the earlier information and pay tribute to the accuracy of Faraday's observations of 1839 and 1844. They themselves have measured the voltages and speeds of propagation of the electric impulse along the body of electric eels, finding that an anterior point on the body is always positive to a posterior point. Peak voltages of the order of 300 and peak wattage of the order of 40 are about the maximum for eels exceeding 50 cm. in length. The velocity of the pulse along the body is between 500 and 1,000 metres a second, and the discharges commonly occur in trains of one minor member followed by three to six major members separated by intervals of about 0·005 sec. The release of the electric discharge is likened to the release of ordinary muscular energy, and the discharge itself must be a cumulative effect of the activity of a large number of cellular elements, which may possibly be fully charged in the inactive state and are connected in series during the discharge.

Citrus Culture in Egypt

BULLETIN No. 44 (1936) of the Egyptian Ministry of Agriculture (Hort. Section) first published in 1924 and written by T. W. Brown, has been revised and brought up to date by Abbas el Sawy. It is a comprehensive treatise on methods of propagation and cultivation of citrus fruits, and should serve as a reliable manual for growers in Egypt with little previous experience of fruit growing. Citrus culture in Egypt has made rapid strides during recent years, the acreage under oranges and mandarines having risen from 6,215 acres in 1923 to 18,229 acres in 1934. In 1925, 7,375,297 kgm. of citrus fruits were imported, while in 1934 this was reduced to 897,808 kgm., and 2,867,469 kgm. of oranges and mandarines were exported. The information provided by the bulletin will undoubtedly prove an invaluable guide in this expanding industry. It is clearly written and contains information on all the cultural operations, including sections on budding and grafting and a critical account of the various rootstocks available. Every phase of the industry is dealt with from the preparation of the ground to the packing of the fruit, particular attention being given to irrigation and manuring. The latter half of the bulletin consists of an excellent catalogue of the numerous varieties of citrus fruits. This is very well illustrated, and the varietal characteristics are given in detail together with notes on the origin and history of the varieties.

Evaporation Records in the Netherlands

IN *Mededeelingen en Verhandelingen*, **39**, 1936, Dr. C. Braak discusses evaporation records in the Netherlands and compares the results obtained with those for certain places in Germany and Switzerland. There are some very long records available in Holland, for example, at the Helder, but unfortunately insufficient continuity of method and lack of precise information about the earlier part of this record greatly reduces its value. For the period 1909–35, comparative figures are available for the evaporation from similar pans containing water at de Bilt and the Helder. The averages for the months of least and greatest evaporation are (1) de Bilt, 15 mm. in December and 133 mm. in July; (2) the Helder, 25 mm. in January and 158 mm. in July. A table is included giving individual monthly totals for de Bilt from May 1897 to December 1935, with a few gaps in 1902 and 1903. Figures for a number of stations with shorter records are compared; but it is concluded that the differences are caused more by variations of instrumental exposure than by climatic contrasts. Observations made with a floating pan in a pond near the Meteorological Institute, de Bilt, since 1932, are compared with similar observations made by Bindemann in a small lake north-east of Berlin (the Grimnitzee), and others made on the Yssel lake (the former Zuyder Zee) are compared

with figures relating to two Swiss lakes. The paper closes with a discussion of the values of the constant in a well-known evaporation formula which makes the evaporation proportional to the saturation deficit, allowance being made for the influence of temperature on the mobility of the water vapour molecules and for the influence of wind speed.

Origin of Cosmic Rays

IN the issue of the *Journal of the Franklin Institute* of April, Dr. M. C. Holmes of the West Virginia University puts forward a theory of a terrestrial origin for cosmic rays. This is based on the Debye water molecule having its positive end heavier than its negative, and in consequence in a gravitational field having its positive end downwards when free to move. Except in polar regions, where it may be frozen, it has its negative end upwards and provides the negative charge known to exist on the earth's surface. Any positive charge produced in the stratosphere by solar radiation will move down towards the earth's negative charge until it reaches the polar air currents of the troposphere, which will carry it towards one of the poles, where positive charges will accumulate. An electric field will be produced between these charges and the negative charge on the non-polar regions, which will supply the 10^9 volts required to account for the production of cosmic rays. Dr. Holmes considers further the application of the same principle to account for the banded appearance of Jupiter, the rings of Saturn and other planetary phenomena.

Reactions of Atomic Deuterium with Paraffin Hydrocarbons

IN addition to an investigation of the photo-sensitized reaction between methane and deuterium, an investigation of the interaction of atomic deuterium with methane, ethane, propane and butane for temperatures up to 310° C. has been carried out at Princeton University (Taylor *et al.*, *J. Chem. Phys.*, **5**, 205; 1937). The nature of the reaction products and the extent of deuteration have been determined by two methods, a fractionation method and a thermal method. For methane, no exchange occurred below 200° C. and at 310° C. the exchange amounted to ten per cent. At temperatures above 27° C. ethane is decomposed by atomic deuterium yielding methane of high deuterium content, but the rate does not become measurable until 100° C., and thereafter increases as the temperature rises. Both propane and butane are relatively slightly decomposed, the products containing a surprisingly large amount of highly deuterated methane. For methane it is impossible to decide between the mechanisms (*a*) $CH_4+D=CH_3D+H$, and (*b*) $CH_4+D=CH_3+HD$ with subsequent reaction of the methyl radical. The C-C bond is readily split by atomic deuterium at room temperatures, presumably by either (*a*) $D+C_2H_6=C_2H_5+HD$ or (*b*) $D+C_2H_6=CH_3+CH_3D$; and of these, (*b*) finds greater favour because of the high deuterium content of the resultant methanes. Above 100° C., deuteration of ethane becomes more pronounced and takes place at the expense of deuteromethanes. The experimental data further show that the deuteration of an alkyl radical occurs much more readily than deuteration of the hydrocarbon. Activation energies have been calculated and from these the bond energies for CH_3—H and CH_3—CH_3 have been deduced.

New Mercury Vapour Discharge Lamps

ALL types of metal vapour discharge lamps require a series 'ballast' to prevent the current through the lamp rising to too high a value. In the Engineering Supplement to the *Siemens Magazine* of May, a description is given by J. N. Aldington and G. O. Stephens of the new low-wattage mercury vapour discharge lamps taking 80 watts and 125 watts respectively, which are now on the market. The ballast may be in the form of a choke coil or simply a filament which supplies useful light while limiting the current. The inner bulb of the new lamps is made of quartz. This substance can be operated at temperatures up to 1,000° C. without showing harmful discolorations. The quartz interior is mounted inside a lamp bulb of standard shape with a pearl finish. As is common with all types of high-pressure metal vapour discharge lamps, the new lamps require a few minutes after being switched into circuit before the full light output is attained. Under normal working conditions, the full light output is reached in approximately five minutes. When they are switched out of circuit, they require a period of three minutes before the arc will restrike. After this restriking period, full light output is attained in a shorter time. The radiation from the inner bulb is very rich in ultra-violet rays. For this reason, it is important that the lamps should not be operated if the outer bulb becomes accidentally broken. The inner surface of the outer bulb is coated with 'luminescent' powder; very efficient powders of this nature (both fluorescent and phosphorescent) are now prepared on a commercial scale. These powders are used to supply the red and blue light in which the mercury discharge is deficient.

Motion and Figure of the Moon

DR. H. SPENCER JONES has published a paper "The Mean Motion of the Lunar Perigee and Node and the Figure of the Moon" (*Mon. Not. Roy. Astro. Soc.*, **97**, 5, March 1937) in which important conclusions are drawn regarding certain discrepancies in the observed libration results and those obtained by theoretical considerations. Prof. E. W. Brown's computations on the motions of the lunar perigee and node had neglected terms of the fourth and sixth order; these have now been taken into consideration. The motions of the perigee and node contain terms due to solar and planetary actions, the mass of the earth, the figures of the earth and moon, and a relativity correction. Accounting theoretically for all these except the figure of the moon, and comparing with observation, the residuals can be accounted for by the lunar figure. The well-known parameter f has been assigned various values by different investigators, and this has given rise to considerable speculation on certain discrepancies. If A, B, C, be the principal moments of inertia of the moon about its centre, f is defined as the ratio of $(B-A)/(C-A)$, and this can be determined, knowing the mean inclination of the moon's equator to the ecliptic, and also the amplitude of the moon's true libration in longitude. The former is known with considerable accuracy; the latter with less certainty. Dr. Spencer Jones now finds that $f=0{\cdot}68\pm0{\cdot}09$, in good agreement with the values deduced from the librations in longitude. The value of the ellipticity of the earth is found to be $1/e=296{\cdot}08\pm0{\cdot}95$, which is a little smaller than that obtained by Jeffreys, 296·38, who used the unrevised motions of the lunar perigee and node in his computations.

The Cyclol Theory and the 'Globular' Proteins*

By Dr. D. M. Wrinch

A NUMBER of facts relating to proteins[1] suggest that the polypeptides in native proteins are in a folded state[2,3]. The type of folding must be such as to imply the possibility of the regular and orderly arrangement of hundreds of amino acid residues, which to some extent at least is independent of the particular residues in question.

At present two types of folding have been suggested, the cyclol type[3,4] and the hydrogen bond type[5]. The search for other types of folding is being continued. So far, it has not proved possible to discard either theory on the grounds that the type of link postulated is out of the question. It is, therefore, very desirable to test these theories by checking their implications against known facts. Accordingly it is now considered whether the cyclol theory can stand the test of the body of facts relating to the 'globular' proteins, established by Svedberg and his collaborators[6].

The Cyclol Fabric

In previous communications the cyclol postulate has been applied directly to polypeptides, and a number of molecules, cyclol 6, cyclol 18 . . . and the general cyclol fabric (Fig. 1) have been suggested for consideration. These are all of one polyhexagonal type, in which the individual hexagons are alternately '2-way' diazine hexagons sharing opposite sides with triazine hexagons and '3-way' triazine hexagons sharing alternate sides with diazine hexagons. In default of information as to the sides and angles of these hexagons, a mean value is at present adopted for the C—C and C—N distances indifferently, and the tetrahedral angle δ as the valency angle for C. The valency angle for N is also taken as δ, since it has this value in hexamethylene tetramine[7], in which, as in the cyclol fabric, each N atom is joined to three C atoms.

In accordance with these assumptions, the individual hexagons in the cyclol fabric are at present taken to be 'crumpled' as in cyclohexane. The midpoints of the sides of a 'crumpled' hexagon are the vertices of a plane hexagon, and the geometrical problems can be simplified by taking these plane hexagons as the fundamental units in a 'median' network which represents the cyclol in a new way, each 'crumpled' hexagon being replaced by a 'median' hexagon.

In previous communications the cyclols have been considered only in the case when all the median hexagons lie in one common plane. With this limitation there has, of course, been no question of building a closed (that is, a space-enclosing) cyclol. To do so, it is necessary to investigate the conditions under which a cyclol fabric can bend about a line. Evidently it is permissible for two abutting median hexagons to lie on different planes, if the angle between the planes is the tetrahedral angle δ. Thus a cyclol fabric need not have a single median plane, but may turn about certain lines provided that the angle between abutting median planes is δ. The problem of the possible existence of space-enclosing cyclols can then be stated precisely as follows. Is it possible for a cyclol network to bend across one line after another so that it joins up and thus surrounds a portion of space? In other words, can a cyclol network be drawn, not on a plane but on the surface

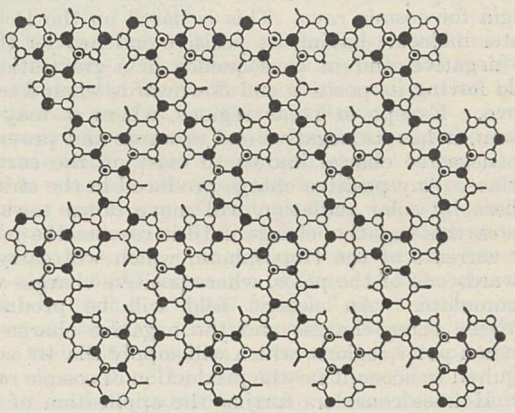

Fig. 1.

THE CYCLOL PATTERN. THE MEDIAN PLANE OF THE LAMINA IS THE PLANE OF THE PAPER. THE LAMINA HAS ITS 'FRONT' SURFACE ABOVE AND ITS 'BACK' SURFACE BELOW THE PAPER.

● = N.
○ = C(OH), PEPTIDE HYDROXYL UPWARDS.
⊙ = C(OH), PEPTIDE HYDROXYL DOWNWARDS.
○— = CHR, DIRECTION OF SIDE CHAIN INITIALLY OUTWARDS.
○– = CHR, DIRECTION OF SIDE CHAIN INITIALLY UPWARDS.

of some polyhedron such that the faces at any edge crossed by the network abut at the tetrahedral angle?

The Closed Cyclols

To solve this problem, all the polyhedra in which some at least of the dihedral angles are equal to the tetrahedral angle will be considered in turn. As a first step it is remarked that among the regular and semi-regular polyhedra[8], only four satisfy the conditions. These are the truncated tetrahedron, the octahedron, the truncated octahedron and the skew triangular prism. On this occasion, as an example of this method of building megamolecules, attention is directed to the truncated tetrahedron, on which it has proved possible to draw closed cyclol networks. These networks form a linear series C_1, C_2, . . . C_n, . . . which comprise 72, 288, . . . $72n^2$, . . . amino acid residues. Figs. 2 and 3 show models of C_1 and C_2 in which the cyclol fabric is represented by the median hexagons. These models have 4 hexagonal faces, 4 triangular faces and 6 slits. The actual distribution of the (C—C—N) groups of atoms in the amino acid residues in the molecule can be inferred from the median hexagons, which are to be regarded simply as a shorthand notation.

The possibility of building closed cyclols on the other polyhedra mentioned above and on polyhedra which are not regular or semi-regular is being investigated. If they can be constructed they will also

* This article is based upon lectures given at the Harvard, Yale and George Washington University Medical Schools and at the Medical Centre, Columbia University, in October and November 1936. Communicated to the Editor of NATURE on March 10, 1937.

exist in linear series, each comprising numbers of residues represented by a quadratic function of the natural numbers 1, 2, . . . n, . . .

The cyclol hypothesis therefore predicts the existence of one or more series of 'space-enclosing' protein molecules, each series comprising numbers of residues given by a quadratic function of the natural numbers 1, 2, 3, . . . n, . . . and in particular of a series C_1, C_2, . . . C_n, . . . having the shape of truncated tetrahedra and comprising 72, 288, . . . $72n^2$, . . . residues.

These predictions are, it is claimed, confirmed by the results obtained by Svedberg and his collaborators[6].

(1) It is found that certain proteins are 'globular' molecules which, in appropriate circumstances, are monodisperse. The cyclol theory implies the existence of space-enclosing molecules containing certain specific numbers of amino acid residues: their polyhedral character is in accord with and offers an interpretation of the nature of this 'globularity'.

(2) It is found that certain molecules exist in different degrees of association in solutions of different *p*H, having a maximum molecular weight in a certain *p*H range and dissociating reversibly into molecules with submultiple molecular weights on one or both sides of this range. This is interpreted to mean that, in certain types of protein, the molecule will form multiple molecules at appropriate *p*H values by linkages between peptide hydroxyls or by salt linkages between side chains, the process of dissociation on changing the *p*H being reversible.

(3) It is found that the molecular weights of proteins are not distributed at random, but fall into a sequence of widely separated classes, the molecular weights in one class varying by as much as 15 per cent from a mean value. This is interpreted to mean that the proteins falling into one of these classes have a common structure as regards the arrangement of the constituent amino acids, and it is further suggested that each class connotes one closed cyclol network or an association of a certain number of such units. The variation in molecular weight within a class is then accounted for by the different selections of residues in the various proteins which can yield

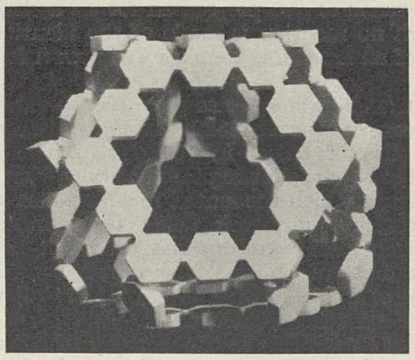

Fig. 2.

an average residue weight varying (say) from 100 to 135, which may also entail the presence of different numbers of water molecules in the molecule[9]. A further modification is also introduced if imino acid residues are present.

These tests are only qualitative. It would be of greater interest to apply more stringent quantitative tests. This will only be possible when data are available which give, for some of the 'globular' proteins, the shape of the molecule, the average value of the weights of the contained amino acid residues, the number of imino acid residues and the numbers of water molecules which form an integral part of the molecular structure.

It is, however, suggested for consideration in the future, that the group of proteins with molecular

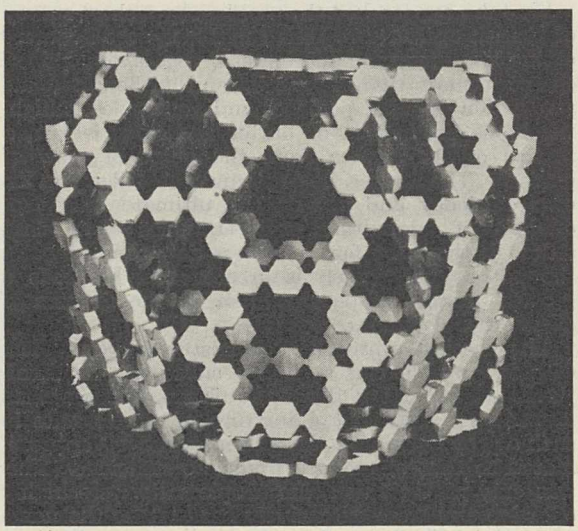

Fig. 3.

weights ranging from 33,600 to 40,500[10] are closed cyclol molecules of type C_2. This molecular weight class is of particular importance, since Svedberg has suggested that very many, possibly most, other proteins have molecular weights which are multiples of (say) 36,000.

Full details of this work will appear shortly.

Postscript added May 28, 1937: My attention has been directed to recent work by Bergmann and his collaborators, which strongly confirms the conclusion reached above. In particular, it may here be put on record that one of the predictions has now been verified: Bergmann and Niemann (*J. Biol. Chem.*, **118**, 301; 1937) deduce from the chemical analysis of egg albumin that this molecule (which belongs to the group of proteins with molecular weights in the neighbourhood of 36,000) consists of exactly 288 residues as predicted by the cyclol hypothesis. Full details of my work are in course of publication in the *Proceedings of the Royal Society*.

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Chemistry and Agriculture

THE thirty-eighth Bedson Lecture was delivered by Sir John Russell, director of the Rothamsted Experimental Station, on "Applications of Chemistry to Modern Food Production", at Armstrong College, Newcastle-on-Tyne, on May 21.

Sir John approached the problem by a short survey of British agriculture. His conclusions are : we are eating less bread but more meat, vegetables, butter, cheese to-day than in 1913, and although home production of milk, potatoes and vegetables is high, the home production of butter and flour is low, a matter of significance from the point of view of defence. The farmer, he said, must be judged on his own efficiency and not on the ultimate bulk production of agriculture, and statistics show that although there are fewer farmers now than in 1913, the output per person is greater and he feeds a greater number of persons than do the farmers of most other countries.

The classical approach of chemistry to the problem of plant growth was to find a substitute for farmyard manure, and at the time this was first broached it was suggested that a mixture of simple salts in such a proportion that the ultimate analysis approximated to that of manure would be sufficient. This was only partly true ; the simple salts were highly effective and were extensively used under the name of artificial fertilizers, but the optimum proportions could be ascertained only by field trial. Interesting consequences followed from the circumstance that these fertilizers contained not only the specified plant nutrient but various amounts of other elements also. Extensive use of chemical fertilizers pushed up production for foodstuffs even where the actual acreage under cultivation has fallen.

Less is known of the more complex problem of the actual elements necessary to plant growth and their action. Science is advancing along two lines of investigation : trial and error methods and systematic statistical investigation. With regard to the function of the necessary elements, a study of plant deficiency diseases has proved useful. Examples of the results are : the addition of borax in certain conditions causes better growth of certain plants ; and traces of manganese, copper and other elements appear to be essential to good growth. Some plants will take up particular nutrients more readily than others, so that the correct choice of a fertilizer will lead to preferential growth of these plants.

The soil is now receiving attention from chemists. One method of attack is to carry out field experiments in different types of soil with the same groups of fertilizers and to correlate the results with those of chemical examination. The method is slow and has to be rigorously controlled on a statistical basis.

Finally, Sir John dealt with the organic constituents of manure and described how experiments are carried out from two directions : the investigation of extracts of manure and the use of known organic compounds in growth tests. Examples of compounds exercising a marked effect on growth are indole-acetic acid and naphthalene-acetic acid.

Macculloch's Geological Map of Scotland

WHEN Henry T. de la Beche was trying, in the early eighteen-thirties, to persuade the Government to allow him to undertake an official geological survey of Great Britain, he encountered many objections of a financial nature. Even in 1840, five years after the "Ordnance Geological Survey", as it was at first called, had been officially established, and de la Beche sought permission to spend the winter in London instead of in the field, a letter from the Board of Ordnance stated that the authorities had "adverted to what occurred in respect of the Scotch Geological Survey, and they desire that special care may be taken to prevent the occurrence of a similar fault in the English Survey".

As a result of the perusal of a Parliamentary paper dealing with the expenses of the "Mineralogical Survey of Scotland", submitted to the Commons in 1830, and of the minute books of the Highland and Agricultural Society of Scotland, Mr. V. A. Eyles has been able to show exactly what transpired in Scotland to make the authorities reluctant to give too free a hand to a man so enthusiastic and energetic as de la Beche.

The circumstances connected with the appointment of Dr. John Macculloch as geologist to the Trigonometrical Survey, and the preparation of his geological map of Scotland, which was not published until 1836, the year after his death, are outlined in a paper entitled "John Macculloch, F.R.S. and his Geological Map ; an account of the first Geological Survey of Scotland" (V. A. Eyles, *Annals of Science*, 2, 114–129 ; 1937). It appears that Macculloch's salary was to be £2 per day during the time he was at work, with an allowance of £1 a day for personal expenses, and 2*s*. for every mile he travelled. There was also an allowance of £90 per season for an assistant, but although no mention is made of the identity or the duties of an assistant, the pay was drawn for several years.

The travelling allowance gave rise to trouble with the Treasury, for in 1828 Macculloch charged for 7,764 miles of travel in 184 days. The auditors pointed out that, allowing for a journey from London to Glasgow, which accounted for 735 miles and four days, and for no work being done on Sundays, Macculloch must have travelled, on an average, 51–52 miles a day, which was, the report continues, "a rapidity of travel, which would hardly allow much time for scientific observation".

It would be unfair to the memory of a great man to refer only to this aspect of his work, for he was hard working and competent, and, as Mr. Eyles points out, in spite of the difficulties arising from a lack of good topographical maps, Macculloch's geological map of Scotland has stood the test of time. It became the basis of all subsequent geological maps of that country, and there are still areas of which little more is known than was recorded more than a century ago by that versatile Guernsey-born Scotsman.

F. J. N.

Science News a Century Ago

The Snake Nut Tree of Guiana

AT a meeting of the Linnean Society held on June 6, 1837, two communications were read from Robert Hermann Schomburgk (1804–65), who in 1831–35 explored British Guiana on behalf of the Royal Geographical Society. The first of these dealt with several new species of Orchideœ found in Guiana, and the second with the snake nut tree. The nut, he said, was the size of a walnut, and when the kernel was opened, and the membrane removed, there was an appearance of a snake lying with its body coiled up, the head, eyes and mouth being very distinct. From this appearance, by some singular analogy, it was employed as a remedy for the bites of snakes, for which it enjoyed a considerable reputation. The colonists were unacquainted with the mode of its growth as they only found it on the banks of brooks and rivulets after floods, but imagined that it grew on a creeper by the side, which explained the reason that it was found on the low islands and in these situations. Having been informed of the whereabouts of the tree, Schomburgk visited it, but it was not sufficiently far advanced for him to recognize the class and order to which it belonged. The tree was of the first magnitude, its branches dividing at a height of 40–50 feet. It contained nothing remarkable except the fruit, which was not known to possess any medicinal properties.

Schomburgk, who was born and educated in Germany, was Government Commissioner for surveying and making boundaries in British Guiana in 1841–43, establishing the 'Schomburgk line'. In 1844 he was knighted.

Vyse's Exploration of the Egyptian Pyramids

IN 1835–37, Colonel (afterwards Major-General) Richard William Howard Vyse (1784–1853) explored the pyramids of Egypt, and some of his discoveries were described in letters read to the Royal Society of Literature on June 8, 1837. The principal results of his exertions were the discovery of three large chambers in the Great Pyramid and the excavation of a remarkable mummy pit in its vicinity. The first of the newly opened chambers was 38 ft. 6 in. from east to west and 17 ft. 1 in. from north to south. This had been named the Wellington Chamber by Colonel Vyse, and he had had that illustrious name inscribed on its northern walls. The second chamber he had named after Nelson, and the third after Lady Arbuthnot, who was present at its discovery. The three chambers were above one another, and it was supposed their object was to lessen the superincumbent weight above the King's Chamber. A great quantity of drawings had been sent home to be engraved, including accurate sections of all the pyramids, and facsimiles of hieroglyphics in the newly discovered chambers.

The Royal Astronomical Society

THE last meeting of the session of the Royal Astronomical Society was held on June 9, 1837, when several papers were read. Baily, the president, who was in the chair, communicated a paper on the non-existence of the star called 42 Virginis, the insertion of which into the British Catalogue of Flamsteed he attributed to an error in computation. Baron Zach had given, in his zodiacal catalogue, a star which he called 42 Virginis, which, however, did not agree with the position given by Flamsteed, but what was very singular, this star also was not then found in the heavens.

Another paper was by Main, principal assistant at the Royal Observatory, on the position of the node, and the inclination of Venus. It appeared that Encke had altered the place of the node from the observations of the transits of 1761 and 1769, and this was found not to correspond with the best modern observations. Main therefore had undertaken the arduous task of determining these positions anew from observations made by Airy at Cambridge.

Premiums offered by the Zoological Society

IN the *Athenæum* of June 10, 1837, it was stated that the Council of the Zoological Society had determined to offer annual medals, or equivalent sums of money, by way of premiums for subjects connected with zoology. The premiums for 1837 were to be awarded for the following: (1) For importing either a pair of musk oxen, or a specimen of the hippopotamus, male or female; or a pair of the *Ornithorhynchus paradoxis*; (2) to the breeder of the greatest number of curassows in the year 1837; (3) to the importer of a male and female Indian pheasant, of a species not already alive in Great Britain; (4) to the breeder of the best specimens of Indian fowls in the year 1837; (5) to the breeder of the most rare or most interesting foreign quadruped in the year 1837; (6) for the best essay on the care and treatment of the species of the genus *Felis* in confinement.

University Events

ABERDEEN.—A capital sum has been given anonymously to the University for the foundation of a part-time lectureship on psychopathology. It is a condition of the gift that the lecturer shall not be an alienist and that the clinical work should be done at the Royal Infirmary. £500 has also been received from Lord Glanely for research in rheumatism.

CAMBRIDGE.—Dr. H. Hamshaw Thomas has been appointed reader in plant morphology; Dr. W. B. Lewis, of Gonville and Caius College, University lecturer in physics; Dr. H. Carmichael, of St. John's College, E. S. Shire, of King's College, University demonstrators in physics; and Dr. W. C. Price (Wales and Johns Hopkins), and Dr. E. A. Moelwyn-Hughes, of Corpus Christi College, University demonstrators in chemistry.

G. L. Clark, of Fitzwilliam House, has been elected to the Sheepshanks Exhibition for 1937.

It is proposed that a second assistant directorship of research in colloid science be established, and that the General Board be authorized to appoint in the first instance to this post Dr. J. H. Schulman.

The following have been approved for the degree of Sc.D.: B. H. C. Matthews, of King's College; R. S. Morrell, of Gonville and Caius College; G. C. Steward, of Gonville and Caius College; and L. R. Cox, of Queens' College.

LONDON.—The University enters upon its second centennium (the completion of its first hundred years was celebrated last July) with a student enrolment

of approximately twenty-five thousand. The report recently presented by the acting principal on the work of 1936–37 gives the number of internal students as 12,734, and of these nine tenths were reading for degrees and diplomas, namely, in science (3,727), medicine (3,309), arts (2,957), engineering (1,351) and economics (1,001). Of the external students, some 11,000 in all, 6,779 entered for examinations, and of these nearly three fifths were receiving instruction in institutions in London (1,200) or elsewhere; two thirds of the remainder were prepared by correspondence courses and the rest wholly by private study. An indication of the world-wide extent of the university's contacts is to be found in the fact that the lecturers in the forty-nine courses of special lectures arranged by the Senate were drawn not only from the British Isles but also from Austria, Belgium, China, France, Germany, Holland, Hungary, Italy, South Africa, Sweden and the United States. The report chronicles a significant event in the field of physical culture: for the first time in its history, the University took part in an international athletic match, namely, between teams from the Universities and from boys' schools of Paris and London.

A Carpenter Medal with a money prize of the value of £20 in all will be awarded this year for work of exceptional distinction on statistical, genetic, comparative or experimental psychology including the functions of the cerebro-spinal system, for which a doctor's degree (other than the Ph.D.) has been awarded during the period of three years ending May 31, 1937. Applications should be made not later than June 10 to the Academic Registrar, University of London, from whom further information may be obtained.

OXFORD.—At Encænia on June 23, honorary degrees will be conferred upon the following, among others:—D.C.L.: The Right Hon. W. G. A. Ormsby-Gore, Hon. R. H. Brand and Sir Herbert Baker. D.Sc.: Prof. Walter Nernst. D.Litt.: Dr. G. P. Gooch.

Prof. W. L. Bragg will give the Robert Boyle Memorial Lecture in the Museum at 8.45 p.m. on June 11. His subject will be, "The Crystallization Patterns of Alloys".

Societies and Academies

Edinburgh

Royal Society of Edinburgh, May 3.

H. H. READ: Metamorphic correlation in the polymetamorphic rocks of the Valla Field Block, Unst, Shetland Islands. Three metamorphisms under widely different physical conditions have affected the rocks of the western part of Unst. The mineral assemblages produced during each metamorphism in rocks of different compositions—pelitic, calcareous, siliceous, migmatitic, granitic and hornblendic—are correlated both isophysically and isochemically. It is concluded that in polymetamorphism the stability of an assemblage depends upon the bulk-composition of the rock, and that minerals cannot be considered apart from the rocks in which they occur.

J. SMALL: Quantitative evolution (2). Compositæ *Dp*-ages in relation to time. Using a geological time scale similar to that of Barrell, but with a longer Pliocene like that indicated by Urry (NATURE, Feb. 20, p. 334), all the five average tribal *Dp*-ages of Compositæ are found to lie on or near a curve with the formula—$Dp.k+n.d.=t_k.2^n$; for Compositæ $k=0{\cdot}6$; $d=0{\cdot}9$; $t_k=1{\cdot}09375$ million years. From this bat curve, it is calculated that the free doubling period is approximately two million years. (3). *Dp*-ages in Gramineæ. The bat curve for Compositæ is applied to the grasses. The evolutionary sequences of *Dp*-ages in terms of time are found to be in almost complete agreement with the views given by Bews in his "World's Grasses".

W. GRAHAM-SMITH and T. S. WESTOLL: A new long-headed Dipnoan fish from the Upper Devonian of Scaumenac Bay, P.Q., Canada. During the summer of 1934, three specimens of a very distinct new Dipnoan were found at Scaumenac Bay, Quebec. These are described under the name *Fleurantia denticulata*, gen. et sp. nov. The species differs from other Dipnoans in having an extreme elongation of the snout. The dentition consists of a series of large conical teeth and a granulation of smaller teeth. The snout-elongation is shown to be probably correlated with the development of a sectorial dentition and with corresponding feeding-habits.

W. J. HAMILTON: The early stages in the development of the ferret: the formation of the mesoblast and notochord. The mesoblastic cells arise from the ectoderm at the site of the future primitive streak. The cells spread anteriorly and laterally as two sheets which meet at the anterior part of the embryonic disk. Henson's Knot does not appear until the primitive streak is well formed and it is separated by a narrow neck from the anterior extremity of the streak. From the anterior part of Henson's Knot the archenteric process with the archenteric canal develops. The cells of the archenteric process become intercalated in the yolk-sac endoderm and form the archenteric plate which terminates anteriorly in the prochordal plate.

W. O. KERMACK and A. G. M'KENDRICK: Some distributions associated with a randomly arranged set of numbers. In a previous paper, certain frequency distributions associated with the occurrence of sequences or 'runs' of continuously increasing or decreasing numbers in a long series of randomly arranged unequal numbers, have been made use of as the basis of a test of randomness. The general mathematical theory of the distributions of such runs is now discussed for (*a*) an infinite linearly arranged set, (*b*) a finite linearly arranged set, and (c) a finite cyclicly arranged set of numbers. The distributions are in general obtained as solutions of difference equations, and expressions are given for the generating functions of these frequency distributions.

K. B. LAL: Immature stages of some Scottish and other Psyllidæ. In the course of previous researches (*Trans. Roy. Entom. Soc.*, **83**; 1934) the author realized the difficulty of associating the immature stages of the thirteen species discussed with their particular species. Full descriptions of these stages are therefore given for each species, and the various characters important in distinguishing the species are clearly and carefully illustrated.

D. S. RAITT: The benthic Amphipoda of the north-western North Sea and adjacent waters. Some 3,000 amphipods secured over the Scottish area by Peterson grab and from haddock stomachs were identified and their distributions studied. When division of the North Sea by the 40 and 100 metre depth contours was adopted, the rates of occurrence of the order in the three zones formed was 3 : 2 : 1.

The species, and their abundances, also varied from zone to zone. The genus *Ampelisca* was outstandingly abundant, however, forming 55 per cent of the grab material, with the single species *A. brevicornis* in complete domination, forming 25 per cent of the total grab captures.

Capetown

Royal Society of South Africa, March 17.

F. G. CAWSTON: Some characteristics of *Bulinus* and *Physopsis*. Considerable variation is observed in several species of *Bulinus*, so that the various shells may resemble one another very closely. *Physopsis africana* Krauss is readily distinguished by its relatively constant columella. It does not adhere so firmly to floating vegetation as allied shells; but, unlike the operculated shells, is a favourite food for ducks.

W. E. ISAAC: Studies of South African seaweed vegetation. (1) West coast from Lambert's Bay to Cape Point.

J. C. SMUTS: (1) The climate and stone implements of Rooikop. (2) Past climates and pre-Stellenbosch stone implements of Rietvlei (Pretoria), and Benoni.

F. E. FRITSCH and F. RICH: (12) Algæ from the Belfast Pan, Transvaal. Belfast Pan is situated in the Transvaal Highveld, 120 miles due east of Pretoria, in a depression on top of a kopje. Samples of the algal vegetation were collected by Dr. E. M. Doidge in 1909, 1913, and 1924. It is remarkably rich in desmids, at least 143 species being present. The wealth of new varieties and forms may perhaps be correlated with the isolation of the Pan. Conjugation was seen in forty species.

M. R. DRENNAN: The Florisbad skull and brain cast.

B. V. SKVORTZOV: Contribution to our knowledge of the fossil diatomaceous flora of South Africa. (1) Fossil diatoms from distomaceous limestones from pan near Franzenkop and Prieska, Cape Province.

Cracow

Polish Academy of Science and Letters, March 8.

D. DOBORZYNSKI: Measurements of the dielectric constant by means of ponderomotive forces (1), (2) and (3). Discussion of the limitations of the method. Application to quartz crystals.

TH. BANACHIEWICZ: The calculation of determinants.

M. KAMIENSKI: The appearance of the Wolf I comet in 1933–34.

L. MARCHLEWSKI and W. BEDNARCZYK: The absorption of ultra-violet rays by certain organic substances (43). Results for lævulose, glucose and some sugars.

L. MARCHLEWSKI and MLLE. R. GRUNBAUM: Absorption of ultra-violet rays by certain organic substances. (44) Results for substances of importance in physiology. Also the spectra of the three isomeric nitranilines. (45) Phenanthrene derivatives.

L. MARCHLEWSKI and W. BEDNARCZYK: (46) Data for 8-hydroxyquinoline, for unsaturated acyclic alcohols, kiketopiperazine, benzophenone and *p*-toluyl-2-benzoic acid.

L. MARCHLEWSKI and J. DABROWSKI: Studies on cellulose from flax. Comparative studies of cellulose from flax and from cotton.

B. SKARZYNSKI: Spectrographic studies of the processes of enzyme hydrolysis of saccharose and of maltose.

A. KOCWA: New syntheses of compounds of the pyrazoquinoline type.

L. CHROBAK: Analyses of the minerals formed on silver coins of the fifteenth century.

J. DEMBOWSKI: Contribution to the problem of instinct.

W. SWIENTY: The earliest stages of development of the blood vessels in the wing of the fowl.

Geneva

Society of Physics and Natural History, February 18.

K. H. MEYER and J. F. SIEVERS: The appearance of rubber-like elasticity in selenium. Grey amorphous selenium, heated to between 70°–79° C., acquires an elasticity recalling that of india-rubber, due to the formation of long directed molecular chains.

J. WEIGLE and H. SAÏNI: The transformation of heavy ammonium chloride. The authors have studied heavy ammonium chloride under X-rays, and have found a sudden change of dimensions of the lattice in the neighbourhood of $-22°{\cdot}5$ C. instead of at $-30°$ C. as with ordinary ammonium chloride.

P. DIVE: The geometry of the rotating disk in the Einstein system. The author maintains that the natural geometry of rigid bodies involved in the rotation of the disk is Euclidian.

G. TIERCY: A differential equation met with in a problem of aerodynamics. This concerns the study of the wind. It is found that the equation in question can be used with difficulty.

P. ROSSIER: (1) The relation between the brightness, colour index and effective wave-length of a star. The brightness is proportional to the colour index. The author generalizes this property in the case of receivers with non-concentrated sensibility. (2) The mean colour index of stars in the neighbourhood of bright stars. This index varies linearly as a function of the guide star. (3) An orthochromatic plate, the sensibility maxima of which have very unequal acuteness. For the Tizian plates, figures for acuteness are found of 41·6 and 940, the ratio of which is the highest known up to the present.

Sydney

Royal Society of New South Wales, April 1.

E. BOOTH: Some tests of thermal constants of glass bricks. Glass bricks are now regularly used for structural purposes; the type provided to the author (by the Australian Window Glass Pty. Ltd.) were hollow and of external dimensions 16·5 cm. by 16·5 cm. face and 10 cm. depth, the thickness of the glass walls being about 0·8 cm. The faces were patterned both inside and outside (crossed cylindrical lenses) on both fronts so as to prevent direct vision through the blocks, and were constructed in two moulded parts, sealed together by an aluminium solder at 1,400° F. so that the hollow was a partial vacuum, being closed at atmospheric pressure at a temperature of 1,100° F. Tests on thermal transmission (apart from radiation) were made between one face at room temperature and one at 0° C., suitable and satisfactory insulating precautions being adopted; the method is described. The result for a block is 1·8 gm. cal./min./cent./deg. per block, being 0·39 gm. cal./hour/sq. cm./cent./deg. face difference.

Forthcoming Events

[*Meetings marked with an asterisk are open to the public.*]

Monday, June 7

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Peter Mott: "A Survey of West Greenland".

Tuesday, June 8

WARBURG INSTITUTE, at 5.30.—Miss Violet Alford: "Carnival and Saturnalia".*

Thursday, June 10

CHADWICK PUBLIC LECTURE, at 5—(at the Chelsea Physic Garden, Swan Walk, S.W.3).—H. Gilbert-Carter: "Plants in Health and Disease".*

Friday, June 11

UNIVERSITY OF OXFORD, at 8.45—(in the Museum).—Prof. W. L. Bragg: "The Crystallization Patterns of Alloys" (Robert Boyle Memorial Lecture).

Appointments Vacant

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

LECTURER IN MECHANICAL ENGINEERING in the Chesterfield Technical College—The Clerk to the Governors (June 7).

ASSISTANT CIVIL ENGINEERS in the Directorate of Factories, War Department—The Chief Superintendent of Ordnance Factories (Advt. No. 140), Royal Arsenal, Woolwich, S.E.18 (June 8).

LECTURER IN GEOGRAPHY in Birkbeck College, Fetter Lane, E.C.4—The Secretary (June 10).

ASSISTANT (grade II) in the External Ballistics Department, Ordnance Committee, Royal Arsenal, Woolwich, S.E.18 (June 11).

ASSISTANT MASTER IN CHEMISTRY (subsidiary biology) in the South-East Essex Technical College, Longbridge Road, Dagenham—The Clerk to the Governors (June 12).

HEAD OF THE DEPARTMENT OF MATHEMATICS AND PHYSICS in the Polytechnic, Regent Street, London, W.1—The Director of Education (June 12).

LECTURER IN METALLURGY and ASSISTANT LECTURER IN ENGINEERING in the Swansea Technical College—The Director of Education, Education Offices, The Guildhall, Swansea (June 12).

HEAD of the Electrical Engineering and Physics Department of Coventry Technical College—The Director of Education, Council House, Coventry (June 12).

LECTURER IN MECHANICAL ENGINEERING in the Merchant Venturers' Technical College, Bristol—The Superintendent (June 14).

FISHERY OFFICER in the Fisheries Department of the Ministry of Agriculture and Fisheries, 10, Whitehall Place, London, S.W.1—The Secretary (June 14).

ASSISTANT MASTER to teach Mathematics and Science in the Cambridgeshire Technical School—The Education Secretary, Shire Hall, Cambridge (June 14).

MANAGER (CIVIL ENGINEER) to the West Cumberland Industrial Development Company, 30, Roper Street, Whitehaven—The Secretary (June 15).

LECTURER IN ELECTRICAL ENGINEERING in King's College, Strand, London, W.C.2—The Secretary (June 15).

ASSISTANT LECTURER IN APPLIED MATHEMATICS in the University of Liverpool—The Registrar (June 18).

ASSISTANT KEEPER on the Higher Technical Staff of the Mechanical Engineering Division of the Science Museum, South Kensington, S.W.7—The Director (June 21).

LECTURER IN MATHEMATICS in the University of Sheffield—The Registrar (June 22).

LECTURER IN EXPERIMENTAL ZOOLOGY in the University of Liverpool—The Registrar (June 23).

RESEARCH CHEMIST at the Indian Tea Association Experimental Station, Tocklai, Assam—The Secretary, Indian Tea Association, 21 Mincing Lane, London, E.C.3 (June 25).

HULME LECTURER IN PHYSIOLOGY in Brasenose College, Oxford—The Principal (June 26).

PROFESSOR OF ECONOMICS in Raffles College, Singapore—The Secretary, Universities Bureau of the British Empire, 88A, Gower Street, London, W.C.1 (June 30).

VETERINARY RESEARCH OFFICER (investigation of contagious bovine pleuro-pneumonia) in Kenya—The Director of Recruitment (Colonial Service), 2 Richmond Terrace, Whitehall, London, S.W.1 (June 30).

LECTURER IN MINING in the South Wales and Monmouthshire School of Mines, Treforest—The Director of Education, County Hall, Cardiff (June 30).

PROFESSOR OF BOTANY in the University of Sydney, New South Wales, Australia—The Registrar (September 15).

ASSISTANT ENGINEERS, ENGINEERING ASSISTANTS AND JUNIOR ENGINEERING ASSISTANTS in the Ministry of Transport, Whitehall Gardens, London, S.W.1—The Establishment Officer.

ASSISTANT TEACHER OF ELECTRICAL ENGINEERING AND ASSISTANT TEACHER OF MATHEMATICS in the Acton Technical College—The Secretary to the Education Committee, 10 Great George Street, Westminster, S.W.1.

TEACHER OF MECHANICAL ENGINEERING in the Rochdale Municipal Technical School—The Secretary.

ROAD ENGINEER in the Public Works Department, Somaliland—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1.

PROFESSOR OF MINING in the University of Peiyang—The Universities' China Committee, 91 Gower Street, W.C.1.

ENGINEERING INSTRUCTOR in the Kingston Technical School, Jamaica—The Crown Agents for the Colonies, 4, Millbank, London, S.W.1.

Official Publications Received

Great Britain and Ireland

Proceedings of the Royal Irish Academy. Vol. 43, Section A, No. 6: Centred Vortex Polygons. By W. B. Morton. Pp. 73–78. 6*d*. Vol. 43, Section A, No. 7: Atmospheric Electrical Conductivity and the Current from Air to Earth. By J. J. Nolan and P. J. Nolan. Pp. 79–94. 1*s*. Vol. 43, Section B, No. 9: A Petrological Study of the Portrush Sill and its Veins. By Norman Harris. Pp. 95–134+plates 3–5. 1*s*. 6*d*. Vol. 43, Section B, No. 10: The Geology of the Curry-wongaun—Doughruagh Area, Co. Galway. By L. M. Ingold. Pp. 135–160+plates 6–9. 2*s*. Vol. 43, Section B, No. 11: River Liffey Survey—The Chironomid Fauna of the Submerged Mosses. By Carmel F. Humphries and Winifred E. Frost. Pp. 161–182. 1*s*. 6*d*. Vol. 43, Section B, No. 12: Some Observations on *Lophophyllum cyathophylloides* (Vaughan). By Louis B. Smyth. Pp. 183–192+plate 10. 1*s*. Vol. 43, Section B, No. 13: The Faunal Succession in the Carboniferous Limestone near Cork. By J. Selwyn Turner. Pp. 193–210. 1*s*. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) [45

Ministry of Health. Costing Returns, Year ending 31st March 1936. Part 1. Pp. 24. (London: H.M. Stationery Office.) 1*s*. net. [45

The Scientific Journal of the Royal College of Science. Vol. 7: containing Papers read during the Session 1936–1937 before the Imperial College Chemical Society, the Royal College of Science Natural History Society, the Royal College of Science Mathematical and Physical Society. Pp. 146. (London: Edward Arnold and Co.) 7*s*. 6*d*. [75

Other Countries

Proceedings of the California Academy of Sciences, Fourth Series. Vol. 22, No. 3: The Templeton Crocker Expedition of the California Academy of Sciences, 1932. No. 32: The Plant Genus Coldenia in the Galapagos Islands. By John Thomas Howell. Pp. 99–110+plates 26–27. Vol. 23, No. 7; The Fishes of the Atlantic and Pacific Slopes near Cajamarca, Peru. By Prof. Nathan E. Pearson. Pp. 87–98+plates 12–13. (San Francisco: California Academy of Sciences.) [115

Jahresbericht der Hamburger Sternwarte in Bergedorf für das Jahr 1936. Erstattet von Dr. R. Schorr. Pp. 22+2 plates. Mitteilungen, Band 7, Nr. 42: Das B. Schmidtsche Verfahren bei der Herstellung der Korrektionsplatten für komafreie Spiegel. Von R. Schorr. Pp. 175–178. Mitteilungen, Band 7, Nr. 43: Beobachtungen des Lichtwechsels der Bedeckungsveränderlichen in verschiedenen Wellenlängenbereichen. Von J. Hellerich. Pp. 179–218. Mitteilungen, Band 7, Nr. 44: Über die Beziehung der Amplituden der Licht- und Geschwindigkeitskurven der δ Cephei-Veränderlichen. Von J. Hellerich. Pp. 219–252. Astronomische Abhandlungen, Band 4, Nr. 9: Untersuchungen der auf der Hamburger Sternwarte in Bergedorf für das Zonenunternehmen der Astronomischen Gesellschaft benutzten Aufnahme- und Messinstrumente. Von Johann v.d. Heide. Pp. 213–236+2 plates. (Bergedorf: Hamburger Sternwarte.) [135

Crohamhurst Observatory. Paper No. 6: The Climate of Australia during the Hypothetical Jovian Sunspot Cycles, 1853–1876, together with the Rainfall Observations taken in Australia since 1822, by Years to 1876, with some Comments on the Evidence of Cyclical Reproduction in that Period. By Inigo Jones. Pp. 39. Report of the Crohamhurst Observatory for the Year ending 31st December 1936. Pp. 10. (Beerwah, Qd.: Crohamhurst Observatory.) [135

Kyoto Imperial University: Publications of the Kwasan Observatory. Vol. 1, No. 3: Zodiacal Charts (Type A) for the use of the Observers of Zodiacal Lights, Gegenscheins and Allied Phenomena. Prepared by the Computing Disivion, Kwasan Observatory. Pp. 2+6 charts. Vol. 1, No. 4: Preliminary General Catalogue of Comets. By A. S. Yamamoto. Pp. 37. (Kyoto: Kyoto Imperial University.) [145

Union of South Africa: Department of Mines: Geological Survey. The Geology of the Country around Mossel Bay, Cape Province: an Explanation of Sheet No. 201 (Mossel Bay). By Dr. S. H. Haughton, Dr. H. F. Frommurze and D. J. L. Visser. Pp. 48+vi. (Pretoria: Government Printer.) 5*s*. (including Map). [185

Smithsonian Miscellaneous Collections. Vol. 95, No. 24: Time Course of Photosynthesis for a Higher Plant. By E. D. McAlister. (Publication 3410.) Pp. ii+17+2 plates. (Washington, D.C.: Smithsonian Institution.) [185

Proceedings of the United States National Museum. Vol. 84, No. 3010: Observations on the Trematode Genus Brachycœlium Dujardin. By Elon E. Byrd. Pp. 183–200+plates 8–9. Vol. 84, No. 3011: New Muscoid Flies (Diptera) in the United States National Museum. By David G. Hall. Pp. 201–216. Vol. 84, No. 3013: A New Sub-species of the Nymphalid Butterfly *Polygonia faunus*. By Austin H. Clark. Pp. 219–222+plate 10. (Washington, D. C.: Government Printing Office.) [185