



SATURDAY, DECEMBER 17, 1932

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Control of Animal Pests

IT is a commonplace of biological science that no man can reckon where the repercussions of interference with Nature will end. Although examples of interference, made deliberately and with the best intention, which have turned out disastrously are abundant, new examples are always instructive if only for the reason that the lesson of far-reaching results seems to be a difficult one to learn.

No better instance of the kind is to be found than that which is developing before our eyes at the present moment. Five years ago muskrats (musquash) were introduced into Great Britain to be bred for their fur; some individuals escaped or were released, and now they occur in certain areas in such numbers that they form a very serious menace to agriculture and other vital interests. In the House of Lords, on December 7, the Earl de la Warr stated that in Shropshire thirty trappers are catching sixty to eighty muskrats each week. Even so, they are but touching the fringe of the problem in that area, and there are many other areas where muskrats are at large. Here is a grave problem to which we hope to return in these columns.

Yet another example of unforeseen results is afforded by the intensive destruction of predatory animals which has been taking place in parts of the United States, often under the auspices of Government departments. It is due in great part to the desire of increasing numbers of American citizens to shoot something, and to the difficulty, where hunters are so numerous, of obtaining something for all to shoot. The first impulse has been to organise the slaughter of the reputed enemies of game, the beasts of prey.

Already it begins to be apparent that this may be a mistaken policy. Poisoning campaigns tend directly to weed out the wrong as well as the right animals, and reports from California show how serious the threat may be to native birds as well as to mammals. This, however, is but an accident in the carrying out of a policy; it is of greater moment that the policy itself may be at fault. In September, Science Service (Washington, D.C.) reported from Ann Arbor some of the results of an investigation carried out by Dr. Ned Dearborn, of the School of Forestry and Conservation in the University of Michigan, into the food of nine predatory animals generally reputed to be harmful to farm stock or game birds and

*Editorial and Publishing Offices :*

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Telephone Number : WHITEHALL 8831

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Advertisements should be addressed to

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Telephone Number : City 1266

No. 3294, Vol. 130]

animals — fox, skunk, weasel, mink, 'wild cat' (lynx), opossum, raccoon, coyote and badger. For two years the food habits of these creatures have been studied, 3,000 specimens of stomach-contents have been examined, and the result suggests that the ordinary judgments usually wrong the predator. The skunk, for example, gains more than 57 per cent of its diet from insects, while birds comprise only 2.35 and eggs 0.11 per cent.

The fox, to take even a more striking example, is looked upon as the arch-enemy of the hen roost and of game birds, but according to these studies in Michigan, its food in 1931 consisted of 91 per cent mammals, of which rabbits and hares made up 81 per cent, followed, in order, by mice, rats, squirrels, deer, moles and shrews. Of the remaining 9 per cent of the total, 3.42 was insect food, 3.64 wild fruits, and only 1.12 per cent birds. In the 1930 collections, bird and egg delicacies formed a greater share of the diet, with 11 per cent. Similar results were found with regard to the other creatures tested: the larger part of their animal diet was made up of rabbits, supplemented by rats, field-mice, moles and shrews.

Dr. Dearborn holds that flesh-eating and plant-eating animals must complement one another: predators through the ages have killed off weak herbivores, thus building up strong strains, while, on the other hand, alert herbivores escape and starve out weak predators. Man upsets this balance and then tends to lay the blame on the animal group which seems to him least desirable.

With what unexpected and contrary results interference may be repaid was well shown by Mr. M. A. C. Hinton in a valuable paper on the biological principles of the control of destructive animals, recently read before the Linnean Society of London (*Proc. Linn. Soc. London*, pt. 4, p. 111, 1931-32). Two examples will illustrate his point.

The mountain lion (*Felis cougar*), once widely distributed in the United States, has been killed off until it is now represented by very few individuals. In the Kaibab National Park, in the Grand Cañon district, it has been practically exterminated, with the result that deer, deprived of their natural enemy, have multiplied without check. In 1924 there were 30,000 of them, more than the area could support; when the grass had been eaten and trees had been bared as far as the deer could reach, the animals starved. Although the numbers have now been somewhat reduced, vegetation even yet can make no headway against their depredations. Instead of pro-

tecting the deer, the slaughter of the mountain lion threatens their existence. Starvation, coupled with inactivity and over-breeding, Mr. Hinton points out, have sapped the strength of the deer, so that they may fall before the first epidemic disease or first bad year they encounter, and also suffer extermination.

The story of the rivalry in Great Britain between the old black or ship rat and the brown or Norwegian rat is well known. Neither could have survived in its hordes had we not provided it with food and shelter, and at the same time destroyed its natural enemies. But the brown rat, more hardy and robust, on its arrival in Great Britain in the early part of the eighteenth century, quietly wiped out the black rat, which since has been able only to found sporadic colonies, generally in the neighbourhood of sea-ports. By strenuous efforts, enforced by legislation and stimulated by anti-rat propaganda, the brown rat is now being ousted from many places which it used to frequent. New buildings are rat-proof from the start, old buildings are being made rat-proof.

'Brown-rat-proof' one ought to say, for Mr. Hinton reminds us that while concentrating on the destruction of the brown rat, we have been forgetting the black rat which it kept in check. His description is well worth quoting, as a warning and as a vivid picture of unlooked-for consequences. "We have shut the rival out, established lovely attractive kitchens on the roofs fitted with plenty of nice open sky-lights, and we have linked up roof and roof, and bridged the horrid streets with a lovely network of telephone wires and cables. No primitively arboreal species could imagine a nearer approach to paradise. Every night there is a procession along these cables and over the roofs; new colonies are established in every possible place. *R. rattus* [the black rat] is now once more the Common Rat in many parts of our great city. To show how quickly it works: Bankers move in to a brand-new building on Monday; on Wednesday they think they have rats. During the week-end the backs are eaten off many of the new books, and on the following Wednesday the rat-catcher takes more than sixty out of the up-to-date roof-kitchen. We are thus fast getting back to the state of affairs which existed in the seventeenth century not only in London, but in many other of the larger ports. If this goes on we shall certainly be once more in peril of plague."

It is the old story that is ever new. J. R.

## A New Philosophy of Biology

*Grundzüge einer allgemeinen Biologie: die Organismen als Gefüge-Getriebe, als Normen und als erlebende Subjekte.* Von Prof. Dr. Richard Woltereck. Pp. xvi + 629. (Stuttgart: Ferdinand Enke, 1932.) 40 gold marks.

PROF. WOLTERECK'S ponderous volume contains, in our opinion, a work of fundamental importance which we earnestly recommend to the attention of readers of NATURE. True to the thoroughness characteristic of his countrymen, the author has examined the problem of life from all its aspects, psychological as well as physiological, and has come to far-reaching conclusions with many of which we agree. It is greatly to be desired that the book should find a translator; but when he is found we do not envy him his task: for the author has followed the custom of German philosophers and has expressed his views in a complex syntax with many dependent clauses the unravelling of which in many cases is like making out a puzzle.

Within the compass of a review of manageable length it is impossible to give a general account of the line of argument pursued in the book; all we can do is to select certain outstanding features of Prof. Woltereck's position and discuss them.

The first thing to be noted is that the author is an uncompromising vitalist. He does not believe that it is possible to explain *any* of the phenomena of life as the workings of a machine; that is, as the result of an arrangement of unlike substances or parts in fixed relations to each other. Always, he maintains, between the beginning and end of an action there intervenes the unseen regulating vital factor.

In the view of the circumstance that vitalism has been denounced as obscurantism by high scientific authority in Britain and is supposed to be confined to systematists and morphologists, it may be interesting to notice that Woltereck is the third great German biologist to pass from materialism to vitalism; and according to what he says in his preface it required twenty years for him to make the passage. The first biologist to pass over was Driesch; the second Uexküll, and none of the three could be described as either a systematist or a morphologist. Driesch laid the foundation of the great science of experimental embryology; the core of his work remains unshaken until the present time and none of his arguments has been successfully answered. Uexküll in his

epoch-making work on Echinoderm physiology anticipated by twenty years discoveries in muscle physiology, which when they were rediscovered by human physiologists, excited the greatest interest and astonishment.

Woltereck's great scientific achievements may not be so familiar to non-zoological biologists, and therefore a brief notice of them may be inserted here. He worked out in minute detail the embryology of the primitive Annelid *Polygordius* and laid the foundation for our understanding of the meaning of the trochophore larva. He showed that this larva has at the beginning of its development a radial structure which is fundamentally that of a primitive Ctenophore, and he gave a suggestive theory as to the manner in which this Ctenophore ultimately became a worm. His work is comparable in importance with Sedgwick's description of the embryology of *Peripatus*. Of late years Woltereck has devoted his attention to the experimental modification of development and has chosen for his subject the minute crustaceans belonging to the group Cladocera (*Daphnia* and its allies) and he has proved up to the hilt the inheritability of induced modifications—in plain language, acquired characters. Some of his experiments, such as transplanting a German strain to Lake Nemi in Italy, have lasted twenty years.

The fact is that, when we think the matter out, vitalism is not obscurantism but common-sense. For as Woltereck insists, we must begin our analysis not with matter but with experience, because matter is only a name for 'our' interpretation of part of this experience which is presented to 'us'. In a word, there is no such thing as experience *in vacuo*; it is always the experience of some one; and this knowledge of our own life, which is immediate and certain, is the safest guide to the real nature of the life of other beings. So Woltereck is driven to the conclusion that there is something, however dim and rudimentary, analogous to feeling even in plants.

Woltereck endeavours to show that in its final analysis life can be reduced to a series of 'impulses' or strivings. These impulses may be 'answers' to something in the environment, or they may be autogenous, the latter term referring especially to the successive impulses which carry development from the egg to the adult form. But all these 'impulses' show the same fundamental character. They are directed to the

attainment of an 'end', and if prevented from reaching this end in one way they will seek it in another. This is seen equally when a *Stentor* seeks to avoid an irritating shower of chalk particles by sweeping them away by ciliary action, then by bending its head to one side, and finally by swimming away, as by a distorted egg constructing the future embryo out of totally different materials from what it would have used if left undisturbed.

When he comes to consider the question of racial evolution, Woltereck is scathing in his references to 'natural selection'. He says that the doctrine that the orderly growth of one species into another can be explained by 'chance' variations, has produced some of the most curious mental aberrations in the history of psychology. On the subject of 'mutations' he takes up what seems to us a perfectly sound position: he says that ninety per cent of them are pathological (we should have said a hundred per cent), that they deal with 'additive' characters which do not affect the real constitution of the organism and have therefore had nothing to do with racial change. He is inclined, we think, to take the crude conceptions of the Morgan school as to the 'genes' being in the chromosomes too seriously, even admitting their identification with the 'chromioles' seen in stained preparations, but he insists that the hereditary substance is not made up of genes (therein the late Dr. Bateson would have agreed with him): these he regards, like hormones, as secretions of this substance which have certain definite effects.

When Woltereck considers the Lamarckian theory of evolution, it is clear that he does not really understand what that theory is, and that many of his difficulties would have disappeared if he had grasped its meaning. He refers to the theory as the "direct influence of the environment" and asks if it be a real explanation of evolution why in a uniform environment there should be such a varied fauna. His own experiments on the inheritance of induced modifications he discounts, because the altered progeny when returned to the original conditions, slowly through a considerable number of generations, reverted to the typical form.

Now if there is one thing on which Lamarck insisted it was that the environment exercised *no direct influence on the organism whatever*: it caused, however, the animal to adopt new habits; and it was the exercise of these habits which modified structure. Woltereck mentions the case

of the perch-like fish, the *Cichlidae*, in Lake Tanganyika, all of which seem to be modifications of one or at most two ancestral species introduced into the lake but which now are divisible into many species. This case has been studied in detail by Dr. Tate Regan, and he has shown that the cause of the differentiation of these species is the different kinds of food which they have selected and the various ways in which they seek it; in a word, their habits. Mr. Hinton, keeper of mammals in the Natural History Museum, has mentioned a case where three different species of rodent with different colours of fur inhabit the same burrow in the arid parts of Syria. Here is a case which seems to prove that colour is independent of environment until it is discovered that one species is diurnal, one nocturnal, and the third crepuscular, in its habits.

Coming now to the reversion of induced modifications to type when replaced in the typical environment, which Woltereck (and also Przibram) considers as a bar to regarding them as the real producers of new species, two things are forgotten; namely, (1) that this is what was to be expected, (2) time. For if change in environment will modify organisms in one direction a change back again will tend to modify them in the opposite direction; but the longer a habit has been exercised and the more deeply it has affected structure, the more it will resist modification; and the changes in habit embodied in specific distinctions are very old things. Lamarck with prophetic insight insisted on the importance of time in his theory of evolution, asserting that only habits which had persisted *a long time* had an effect on structure. It is significant, as Woltereck informs us, that at the Congress on Hereditary Science, held in Germany in 1929, practically all the palaeontologists adopted a Lamarckian position.

Woltereck does himself less than justice when he suggests that Lamarckian evolution may have played a part in the formation of species within a phylum, but that for the start of a new phylum a sudden beginning—a new 'mutation'—must be assumed. For his own work on the trochophore has enabled us to connect together such diverse groups as the Annelida, the Mollusca, the Rotifera and the Polyzoa, and to show that they are all descendants of the same ancestral group and to discover the changes in *habits* which led to the original separation of two different phyla. Such an event was at first slight in itself but led in the course of ages to such momentous consequences,

and such a fundamental cleavage in structure, that even first-rate biologists like Woltereck are deluded into supposing that the cleavage must have commenced with a miracle.

To the invocation of 'mutations' as explanations of radical differences, we are fundamentally opposed because this method of dealing with difficulties seems to us mere indolence of thought. Does an embryologist discover in some member of a vertebrate family a very aberrant type of development? It is not clear to him how it originated; therefore it must be due to a 'mutation'. Does a botanist discover on the top of a mountain an aberrant species of a genus other species of which flourish on the lower slopes? What is easier than to explain the new species as due to a 'local mutation'? In fact, the mutation is used exactly as the 'joker' is employed in the games of euchre and coon-can to supply the place of any card needed to complete the trick. Subsequent research has shown that the supposed 'local mutation' is found on other mountain tops and is in fact the remains of a northern species finding its last retreat on the cooler heights, and we have no doubt that in time a satisfying explanation will be found for the aberrant type of development.

The vitalistic views of Woltereck will certainly awaken the most determined opposition on the part of many biologists, but in our opinion these views constitute a valuable contribution to biological science. Opponents of vitalism fall into two groups. There are first out-and-out materialists, or, as it is now the fashion to call them, 'mechanists', who believe that matter and energy are the sole realities in the universe. To discuss the difficulties of this position would lead us too far; it is sufficient to notice that it was emphatically repudiated, at any rate in his later days, by T. H. Huxley. But there is a second and more moderate group which, whilst admitting that there may be a non-mechanical factor in all living things, think that the only scientific method of approach is to treat them *as if* they were mere masses of carbon compounds and to endeavour to explain their activities as outcomes of their chemical composition. The legitimacy of this view is beyond question; its value will be determined by its success in practice, but to our mind it is like attempting to solve an equation whilst completely disregarding one of the unknowns. In this way at best only a partial solution could be hoped for, and it is significant that so far along

this road no complete solution of even the simplest living phenomenon has been attained. In fact, as Prof. J. S. Haldane has remarked, the failure has been colossal. When we approach the problem of development even the faintest semblance of an explanation on mechanistic lines becomes impossible, and it was this circumstance that originally converted Driesch to vitalism. If instead of dismissing the unknown factor, as a mysterious entelechy, which was the procedure adopted by Driesch, we endeavour with Woltereck to come to some understanding of the laws of its action, a distinct advance will have been attained.

Let us conclude by giving one example of this latter procedure, admirably described by Woltereck. A young Radiolarian, he remarks, is a mere sphere of clear protoplasm containing a central nucleus. From its periphery stream out delicate interlacing strands of almost fluid protoplasm. As the Protozoon grows older, delicate needles of silica, each adorned with characteristic outgrowths, sprout out from it, until in the end a series of concentric baskets of silica may result. The shape, branching and arrangement of these needles is a fixed specific character. They are laid down, however, by fluid strands of protoplasm. To what is this fixity of pattern due? Certainly not to the arrangement of molecules in the protoplasm, for these are constantly rolling over each other like the molecules of any other fluid. Woltereck, like some other leading German biologists, is driven to the assumption of a 'biological field', which like a magnetic field compels particles entering it to arrange themselves in certain definite patterns. The biological field itself is due to an influence radiating from a centre, presumably the nucleus, but it cannot be explained on mechanistic lines. In Woltereck's opinion, the production of these fields is the mode by which the vitalistic activity present in the ovum ultimately builds up the adult body. To sum up, vitalism regards an organism primarily not as a substance but as an activity; and the activity to a considerable extent controls the constitution of the substance.

As we finish this review we are painfully conscious of its inadequacy and of the numerous profound thoughts in Woltereck's book which it has been impossible to mention. To do justice to these would require a treatise rather than a review. If what we have written induces readers of NATURE to become acquainted with Woltereck's book themselves we shall be satisfied.

E. W. MACBRIDE.

### Algebraic Plane Curves

*A Treatise on Algebraic Plane Curves.* By Prof. J. L. Coolidge. Pp. xxiv + 513. (Oxford: Clarendon Press; London: Oxford University Press, 1931.) 30s. net.

THERE was a time, not so very long ago, when the words geometry and mathematics were almost synonymous. To-day the pure mathematicians, in every country except one, are nearly always analysts; even the minority who still call themselves geometers generally occupy themselves with some of the differential aspects, avoiding diagrams and filling their pages with symbols, as if they felt that their continued existence depended upon conforming as much as possible to the fashions prescribed by the all-powerful analysts. But we need not despair; rare animals have been saved from extinction by measures of protection taken just in time, and now Prof. J. L. Coolidge comes to the assistance of algebraic geometers with a book written in the spirit of and dedicated to the geometers of Italy, the only land in which they still flourish.

There is a great need for such a book, for Salmon's great work has long been obsolete, belonging to an age that knew nothing of Nöther's fundamental theorem and was content with a naïve process of counting constants. Recent English books give a good account of curves of the third and fourth order or other special topics, but they have very little about general theorems. Perhaps the best account of general methods is given in Severi-Löffler's "Vorlesungen über algebraische Geometrie", but this omits many important parts of the theory, and Severi's "Geometria algebraica" has as yet reached only its first volume.

Prof. Coolidge's treatment is very extensive, so far as the general theory is concerned. His only important omissions are just those special topics which are readily accessible elsewhere. It is useless to look here for the properties of the bitangents of a quartic, but there is something about curves classified by their genus, such as rational curves, elliptic curves, and so forth. The emphasis is on Nöther's theorem (now the foundation of the subject), Plücker's equations, Cremona transformations, and the theory of correspondences (treated in a special case by Chasles, discovered intuitively by Cayley, and first proved by Brill). A useful feature is the inclusion of a brief treatment of invariants, including the Aronhold symbolic notation, which is used later in dealing with

apolarity. The notation of the tensor calculus is also used, though not very often.

In studying linear series of point-groups on a curve, much use is made of Abelian integrals, the leading properties of which are briefly explained. At this point the analysts will chuckle. There seems no reason why algebraic geometers should not be able to work out all about algebraic correspondences by strictly algebraic methods, but the melancholy fact is that they cannot; and up to the present they continue to upset the already unfavourable balance of trade between geometry and analysis by importing devices foreign to their subject, such as Abelian integrals.

There are a few minor points upon which the book seems open to criticism. The frequent avoidance of homogeneous co-ordinates by using unity as a variable and differentiating with respect to it is admitted to be "rather bizarre" (p. 7) and a "curious trick" (p. 12). The definition of circular points at infinity (p. 14) appears artificial, and moreover contains an unfortunate misprint which may puzzle a beginner. The treatment of asymptotes could have been improved. But on the whole, the book will be of great use to students in providing a source, perhaps the only accessible source, of a subject which, though at present unfashionable, must remain one of the "invariants, matters of abiding interest and importance, which deserve to be always held in honour".

H. T. H. PIAGGIO.

### Ethnology of Mysore

*The Mysore Tribes and Castes.* By the late H. V. Nanjundayya and Rao Bahadur L. K. Ananthakrishna Iyer. Vol. 4: K-V. Pp. x + 677 + 68 plates. (Published under the auspices of the Mysore University.) (Bangalore: Mysore Government Press, 1932.) 12.8 rupees; 20s.

MR. ANANTHAKRISHNA IYER and his late colleague have now supplied us with the third of the four volumes in which the castes and tribes of Mysore are described on the lines laid down in 1902 for the Ethnographic Survey of India. The first volume, which is to be issued last and will summarise the contents of the other three, will be awaited with special interest.

The present volume presents two specially noteworthy features. It contains an account of the Lingāyats, that un-Brahmanic Hindu community numbering many millions which presents the remarkable aspect of a reform movement starting on

a non-caste basis and gradually succumbing to the caste prejudices of the later converts. Panchamsalis with the full eightfold sacraments, non-Panchamsalis with the same privileges, and the lower orders without these rites roughly represent the Virashaiva community in its present-day form.

The compiler of this volume has drawn copiously on an article in Hastings' "Dictionary of Religion and Ethics" for his materials. The value of the account would have been greatly increased by some mention of the sub-divisions of Mysore Lingāyats on the lines of those given in "Tribes and Castes of Bombay". A similar omission may be noted from the article on Musalmans. The author of this work is to be congratulated on the new and valuable materials given in the articles on Kurubas, Madigas, Morasu Okkalu, Nayinda, Sadaru, Oddars, and Uppars, which bring to notice the important exogamous sections known as *bedagus*, which are equivalent to the well-known Marātha *devaks*. Some novel and suggestive trees, plants, and animals will be found in these lists, which are the real indication of the origin of such social elements, however these may be hidden in popular tradition.

The compiler of the work, who has quoted somewhat lavishly from published accounts of Marāthas, might have added some original matter describing the Marātha *devaks* found in Mysore, as a contribution to the subject. The article on Kurubas is perhaps one of the most informative in the volume. There seems to be a close parallel, suggesting more than mere resemblance, between the Kāla Kunbi (or Kare Vakkal) of the Bombay Presidency and these Kurubas of Mysore. The costume of the women is strikingly similar, and there are many other points of contact.

A number of excellent illustrations exhibit typical specimens of the types described in the work. Unfortunately, one of the best, the Sanyāsīs (p. 571), has suffered much in reproduction.

The criticism that has so frequently to be passed on works of this nature produced in India, and which has been applied to the two previous volumes of this series, is a want of care in revising proofs, resulting in misspellings and varying forms of the same word which might easily be avoided and do much to disfigure the pages. In spite of six errata, an incorrect version of the name of the author of "Tribes and Castes of Bombay" has remained uncorrected (p. 476). We find such curious slips as Myroba jam (p. 277) for the well-known myrabolam or *hirda*, and *manganefera* for the *mangifera* or mango. Okkalu is spelt in four different ways.

The assistance of well-known works on Indian

trees and shrubs might well have been invoked to enable the writer to give the botanical equivalents of the numerous terms mentioned in the vernacular for the totem articles, which are of great importance. In India, with its wealth of languages, the work of comparison of these useful lists is only possible if the common botanical equivalent is shown against the local designation. The *ari* or *benni*, for example, is not readily identifiable with the *apta* unless it is shown as *Bauhinia racemosa*. Similarly, we do not connect the *muttaga* with the *palas* unless we are told that it is the *Butea frondosa*. The *nagare* and *kare* lack the revealing *Calophyllum tomentosum* and *Diospyros assinilis* which would expose their identity to the general reader.

With these remarks, relating to small defects that could readily have been avoided, this notice may be brought suitably to an end by acknowledging very cordially the debt that students of ethnology owe to the University of Mysore and Rao Bahadur Ananthakrishna Iyer for the three important volumes of which the present is the conclusion. Such works pave the way to a further and much-needed undertaking. This should deal, on the basis of published materials, with the tribes and castes of India taken as a whole, rising above the limitations inseparable from the artificial restrictions of provincial and State boundaries. It is to be hoped that such a work may be put in hand before it is too late.

R. E. E.

### Short Reviews

- (1) *Heimskringla: or the Lives of the Norse Kings*. By Snorre Sturlason. Edited with Notes by Erling Monsen and translated into English with the assistance of A. H. Smith. Pp. xxxviii + 770 + 12 plates. (Cambridge: W. Heffer and Sons, Ltd., 1932.) 18s. net.
  - (2) *The Culture of the Teutons*. By Prof. Vilhelm Grönbech. (Published at the expense of the Rask-Ørsted Fund.) Translated into English from "Vor Folkeæt i Oldtiden", I-IV., Copenhagen, 1909-12, by W. Worster. Vol. 1. Pp. v + 382. Vol. 2. Pp. 340 + 142. (London: Oxford University Press; Copenhagen: Jespersen og Pios Forlag, 1932.) 30s. net.
- (1) "HEIMSKRINGLA", the history of the Norse kings compiled by Snorre Sturlason, of Iceland, probably only a few years before his death in 1241, is a historical document of the first importance. Not only does it give a vivid picture of the culture and society of early Scandinavia, but also it has value as a record of the racial movement from the north which harried medieval Europe, written from the point of view of the raiders themselves. Moreover, it covers the voyages of the Norsemen

to Greenland and the discovery of Winland, that is, some part of the American mainland, although the chapters in the narrative which deal with the voyage of Leif Ericson have been held under suspicion as an interpolation. With this judgment, however, the present editor does not agree. The *Ynglinga Saga* dealing with events up to the birth of Halvdan the Black in 820, where Snorre's more detailed history of the Norse kings begins, gives a view of paganism and the early history of Scandinavia which is distinctly individual among early chronicles in its attitude to such matters.

Students will be grateful for this translation, in which style and language are happily adapted to the subject-matter. The editor has provided an introduction which deals with the life and writings of the author, the manuscripts, the Norse kings and the Nordic races, the Danes in England, and cognate matters. He also annotates the text.

(2) "The Culture of the Teutons", a translation of a work by the professor of the history of religion in the University of Copenhagen, might almost be termed a psychological handbook to the early literature of Scandinavia and Iceland. Although it refers to Anglō-Saxon, Burgundian and Lombard, as well as the Germanic tribes, it is concerned mainly with the Norsemen. Institutions are analysed in detail on the basis of the indications afforded by the literature, but with reference to their psychological content rather than their form. In other words, the author aims at a reconstruction of Norse society from the point of view of the Norsemen themselves. As he points out, the reader of the epics and sagas enters upon a new world which is open to misinterpretation if regarded from the modern point of view. The book is a valuable contribution to a study of many obscurities, and a translation into English is welcome.

*Probleme der Wasserwellen.* Von Dr. H. Thorade. (Probleme der kosmischen Physik, herausgegeben von Prof. Dr. Christian Jensen und Prof. Dr. Arnold Schwassmann, Band 13-14.) Pp. viii + 219 + 11 Tafeln. (Hamburg: Henri Grand, 1931.) 20 gold marks.

ALTHOUGH it is usual, in expounding the elements of wave motion, to refer to water waves as examples, there is probably far less known of the behaviour of real waves on water than there is of the behaviour of waves of light or sound. The study of both the experimental and theoretical aspect of, for example, ocean waves, or of the generation of waves by wind, encounters formidable difficulties, and the complexities of tidal problems are well known. From the time of Scott Russell to the present day labours of, among others, Proudman and Havelock, the subject of water waves has received substantial contributions from British men of science, and there will probably be many British readers who will welcome Dr. Thorade's book, which appears as Nos. 13 and 14 of the series "Probleme der Kosmischen Physik", edited by Profs. Christian Jensen and Arnold Schwassmann.

While the book outlines the methods and results of the chief mathematical investigations, including the most recent, it is free from detailed mathematical expositions, for which the reader is referred to the standard textbooks, such as that of Lamb, and to the original papers, of which there is an extensive bibliography. It gives a very good and clear account of tidal waves and surface waves in their many aspects, and a discussion of what is known of their mechanism, with special reference to outstanding problems. Particular mention must be made of the many diagrams, excellent alike in planning and execution, which help considerably with the discussion. There are, in addition, five beautiful photographs reproduced as plates. Many physicists with no specialised knowledge of water waves will find the volume of great interest.

*Nature Photography.* By Oliver G. Pike. With Chapters on Big-game Photography, by Major Radclyffe Dugmore; Marine Photography and Low-power Microscopy, by F. Martin-Duncan; Photography of Plant Life, by E. J. Bedford. Pp. xii + 196 + 53 plates. (London: Chapman and Hall, Ltd., 1931.) 12s. 6d. net.

WITH the coming of the cinematograph and the large aperture lens, and with the great improvement in the quality of telephoto lenses, Nature photography has made such strides that excellent photographs of pre-War days seem childish beside the modern product. There are many who would follow the new technique did they know how, and to them the revelations in this book will be welcome and helpful. There are hints on cameras and lenses, on the construction of 'hides' and methods of approach, on cinematograph work, special chapters by experts on big-game, marine and plant photography and on low-power microscopy, accompanied by illustrations of the art and an anecdotal narrative that makes the book good reading for the field-naturalist as well as for the Nature photographer proper.

*Flotation Plant Practice.* By Philip Rabone. Pp. xi + 141. (London: Mining Publications, Ltd., 1932.) 10s. 6d.

MANY physicists interested in the application of physics to industry will welcome the appearance of a work dealing with flotation practice which is not so detailed as to be burdensome, and is yet full enough to come down to such practical details as costings. Mr. Rabone's book deals, in less than 150 pages, with such topics as crushing; grinding; flotation reagents, machines and methods; and concentrate and tailing disposals. He has found space to devote a few pages to the theory of the method, and although he remarks that some may think that his treatment of the theory of flotation "is more extended than the scope of the book warrants", this section could certainly be expanded with advantage.

The book is compact in size, well produced and illustrated, and may be recommended. A. F.



## The Internal Photoelectric Effect in Crystals

By A. H. WILSON, Cavendish Laboratory, Cambridge

THE extensive work of Gudden, Pohl and others has to a certain extent clarified the behaviour of insulating crystals which become electrical conductors under the influence of light. In these substances the photo-conductivity is entirely electronic, and we leave out of consideration electrolytic processes in which massive ions transport the current. Crystals can in the main be divided into two groups—idochromatic crystals which are photosensitive in the pure state, and allochromatic crystals which only become photosensitive after being treated with X-rays, or which owe their sensitiveness to the presence of impurities. It has so far proved impossible to correlate these complicated photo-effects with the theory of the solid state, but in view of the recent advances in the theory of poor conductors and of the influence of impurities on conductivity,<sup>1</sup> it seems worth while to see if any unification is now possible.

If we examine the possible types of photo-effect which can take place in what we believe to be a fairly correct model of an insulator, we find that we are able to explain a large part of the phenomenon known as the primary photoelectric current, which is that part of the current which is proportional to the intensity of the light. The explanation offered here is similar in many respects to the explanations put forward during the past decade by Gudden and Pohl, and may be considered as a justification of their main hypotheses. In what follows, the theoretical principles which govern the photo-conductivity will be outlined only, no attempt being made to discuss the subsidiary phenomena. A good account of the experimental results will be found in a recent article by F. C. Nix.<sup>2</sup>

It is now well known that the energy spectrum of an electron moving in a perfect lattice splits up into bands of allowed and disallowed energies, and if there are just sufficient electrons present to fill up one of the allowed bands, there can be no conductivity at absolute zero temperature. Further, if an electron is placed by any process in an unoccupied band, it becomes a 'free electron', and again, if there are not quite enough electrons present to occupy a band fully, then the resulting 'holes' are free to move through the crystal, and behave like free electrons with positive charge. In an insulator in the pure state, there are just sufficient electrons present to fill up one of the bands, and any conductivity is due to the presence of impurities, or has been produced artificially by electron bombardment or by the action of light. We consider as a typical allochromatic insulator sodium chloride, and for simplicity restrict ourselves to a one-dimensional lattice of  $n$  sodium atoms and  $n$  chlorine atoms arranged

alternately. We further idealise the problem by leaving out of account all the electrons except one of every atom, and we therefore have  $2n$  electrons to deal with. Since the sodium chloride crystal is an ionic one, the highest occupied band belongs to the chlorine atoms, and the motion of an electron in this band represents an electron jumping from one chlorine to another. This 'chlorine band' contains  $n$  energy levels, equal to the number of chlorine atoms present, and these energy levels will just accommodate the  $2n$  electrons, since according to Pauli's principle not more than two electrons can ever occupy the same energy level.

When a quantum of short wave light is absorbed to sensitise the crystal, its effect is to transfer an electron from a chlorine to a sodium atom. In this state the crystal is not conducting, and so

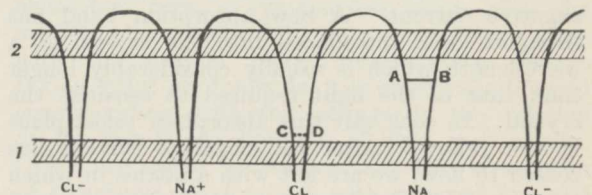


FIG. 1.

we must assume that the electron has not been excited into a band of the crystal but into a discrete energy level. The correct way of describing the crystal when it is in this sensitised state is to say that it is built up of  $(n - 1)$  positive sodium ions and  $(n - 1)$  negative chlorine ions in which are imbedded two impurities, a neutral sodium and a neutral chlorine. The energy levels of this system are illustrated in Fig. 1. The potential energy of an electron is drawn, and the shaded band 1 represents the chlorine band which is fully occupied, while the band 2 represents the lowest unoccupied band. Although the neutral chlorine and sodium are drawn as neighbours, it is not implied that this is necessarily so in an actual crystal.

The band 1 has  $(n - 1)$  energy levels, and these will just accommodate the  $2(n - 1)$  electrons belonging to the ions. The neutral sodium and chlorine have the remaining two electrons in discrete states. The energy level of the electron on the sodium is represented by  $AB$ , and the energy level of the 'hole' caused by the removal of the electron from the chlorine ion is represented by  $CD$ . The whole crystal is non-conducting provided the energy level  $AB$  lies below the band 2, and provided  $CD$  lies above 1. In thinking of these bands, it is essential to remember that they are energy bands, and not localised in space, so

that we have drawn band 1 crossing both the sodiums and the chlorines, although it is a chlorine band. Only the discrete states can be thought of as belonging to one particular atom. The crystal in this excited state cannot be stable, but since in some cases, of which rock salt is an example, it can exist for years, it must be in a metastable state. Since any electron from the band 1 of the original crystal may be excited into a state such as  $AB$ , the absorption of light is continuous over a range of frequencies corresponding to the width of the band 1. The continuous absorption is therefore due to the initial state belonging to a continuum and the final state being a discrete one, whereas in atoms and molecules it is the final state which belongs to a continuum. In rock salt the absorption which sensitises the crystal takes place in the ultra-violet and X-ray regions, though in the silver halides the absorption extends into the visible.

If the crystal is now placed in an electric field and illuminated with light of such a wave-length that the electron in the state  $AB$  is ejected into the band 2, a current will be observed, and this constitutes what is known as the primary negative current. A new absorption band has therefore been introduced into the crystal at a wave-length which is usually considerably longer than that of the light required to sensitise the crystal. In rock salt this absorption takes place in the yellow. After the negative current has ceased to flow, we are left with a lattice in which there are  $n$  sodium ions,  $(n - 1)$  chlorine ions and one neutral chlorine atom, among which are to be divided the  $(2n - 1)$  electrons. Of these electrons,  $2(n - 1)$  are just sufficient to fill the band belonging to the chlorine ions, and the remaining one is attached to the chlorine atom in a discrete state, so that the crystal is once more non-conducting.

This is not the only possible state of the system. Another possible configuration is that in which there are  $n$  positive sodium ions, and  $n$  exactly similar chlorine ions with  $(2n - 1)$  electrons distributed among them. In this configuration the crystal would be conducting, the conductivity being caused by the vacancy in the shell of electrons forming the chlorine band, and this 'hole' behaves like a positive electron. In rock salt this state of the crystal has greater energy than that in which one of the chlorines is neutral, and we may represent the state of affairs schematically by saying that the neutral chlorine atom has a vacant energy level  $CD$ , which can take up an electron from the band 1 if an amount of energy is supplied represented by the difference in energy between  $CD$  and the band 2. This energy may be supplied by illumination with infra-red light, or by heating, in which case the energy is supplied by the lattice vibrations.

Provided the temperature is low enough, it is possible to keep the crystal in the non-conducting state for a long time, and to let it pass over slowly into the conducting state, thereby separating out

the positive current from the negative current, which appears immediately the crystal is illuminated. Gudden and Pohl ascribe the possibility of this separation to the sluggishness with which the 'holes' move through the crystal. According to the present theory, the 'holes' in a band can move through the lattice as quickly or nearly as quickly as the free electrons, and the sluggishness of the positive current is due to the slowness of the change from a non-conducting lattice with a neutral chlorine imbedded in negative chlorines to a conducting lattice in which all the chlorines are on the same footing.

It might quite well happen that the state  $AB$  does not lie below the band 2, but actually in it. In this case  $AB$  can no longer be thought of as being discrete, but belongs to the band 2. The electron on being removed from band 1 immediately becomes a free electron, which is the characteristic of an idiochromatic crystal, a typical example being diamond. In diamond the configuration of the crystal with lowest energy, after an electron has been ejected, seems to be made up of a positively charged carbon atom imbedded in neutral carbons, and the 'hole' which is left therefore corresponds to a discrete state of exactly the same nature as  $CD$  in Fig. 1. So for diamond, as for rock salt, the negative and the positive currents can be separated. In order to bring the diamond into a state in which a positive current can flow, it is necessary to supply energy in the form of infra-red light or heat, and then the crystal passes over into the state in which all the carbon atoms are on the same footing, and in which there are not quite enough electrons to fill up a band.

A further possibility is that, when an electron is ejected from the band 1, the state of lowest energy is that in which all the atoms are on the same footing. In this case the positive and negative currents must flow simultaneously, and there would be no possibility of separating them. This case would be represented by the level  $CD$  lying below the top of the band 1, a state of affairs which seems to be realised for sulphur. The 'hole' cannot then be considered as being attached to any particular atom. However, it should be borne in mind that the conducting state may merely have lower *free energy* than the non-conducting state, and that at very low temperatures sulphur might behave in the same way as diamond.

We may conclude from the above discussion that the theory reproduces quite naturally many of the most striking features of the internal photo-effect, and that there is no essential difference between idio- and allochromatic crystals, or between those in which the negative and positive currents can be separated and those in which they cannot. The criterion for distinguishing the various cases is whether an electron in a pure insulator goes into a discrete state such as  $AB$  on absorbing light or into a band such as 2, and whether the resulting 'hole' corresponds to a discrete state such as  $CD$  or whether the 'hole' lies in the band 1.

It must, however, be admitted that there are still many puzzling features of the primary current. In allochromatic crystals the photoelectric response and the absorption of light correspond very well, but in idiochromatic crystals the photoelectric response has a maximum near the long wave edge of the absorption band and falls off very rapidly in the interior of the band where the absorption is large. It therefore seems that, when the absorption is large, there is no conductivity (the absorption of the light which produces the photo-effect in allochromatic crystals is always small). This seems to mean that, when many electrons are excited in say diamond, they

go into discrete states and not into a band. One can see vaguely that, when many atoms have electrons excited, the original classification of states into bands, based on the properties of a perfect lattice, is likely to break down, and to be replaced by a classification based on the properties of the individual atoms, but such an explanation cannot be considered as satisfactory. This and many other problems must await further developments of the theory before they can be tackled successfully.

<sup>1</sup> A. H. Wilson, *Proc. Roy. Soc., A*, **133**, 458; 1931: and **134**, 277; 1931.

<sup>2</sup> *Reviews of Modern Physics*, **4**, 723; 1932.

## Hormones and Evolution

By J. T. CUNNINGHAM

ACCORDING to the most advanced results of genetical research, evolution is to be investigated by statistical and mathematical methods. The researches and conclusions of the geneticists are governed by the conceptions of species and divergence. It is obvious that the production of the many varieties of rabbits, dogs, and other mammals, and of birds, under domestication, to say nothing of plants, is an example of evolution; and it may possibly be to a great degree, if not entirely, explained by random mutation and survival. But the geneticists ignore many other phenomena which are equally or more important than the origin of varieties or species, especially the phenomena of adaptation. They regard survival as equivalent to selection, but that term as used by them means usually indirect selection. The survival is attributed to greater viability or fecundity, not to the utility of diagnostic characters. Genetics include extraordinary discoveries concerning sex-linkage, but almost nothing about sex-limited characters, which are known to be inherited by both sexes but developed exclusively or to a greater degree in one.

The doctrine of genes appears to be satisfactory in relation to variation and the origin of varieties and species, but it fails to explain adaptive evolution. When we consider the origin of terrestrial from aquatic vertebrates, the various adaptations of limbs to flight in birds, mammals, and some extinct reptiles, the reversed adaptation of air-breathing vertebrates to aquatic life, and many other obvious and direct adaptations, it is a truism to say that their development in the individual depends on genes in the nuclei of ova and sperms, but it has not yet been shown that they can be explained by any random mutation of the genes. The difficulty is still greater when we consider metamorphosis. It may be admitted that the metamorphosis of the flat-fish is the result of its genetic constitution, although

we do not know precisely how the genes produce the hereditary characters in development. But here we have a change in important structural characters from a symmetrical phase with the median plane vertical to an asymmetrical phase with the median plane horizontal, a change taking place gradually in post-embryonic life and corresponding with the change in the relation of the fish to the direction of light and gravity.

We are asked to believe that this co-relation of structural development with external forces is not due to any effect produced by those forces, but to random mutations in the genes which were independent of the external forces, and the survival of those mutations which had the complex co-relation which we see. If we used the mathematical symbols of which the modern geneticist is so fond, how should we express the probability of the production of such an adaptation by random mutation and selection? The gene theory in this case must assume that every conceivable mutation may occur, including those which determine the change from symmetry to asymmetry in the individual, and that sooner or later each is bound to occur, so that selection is omnipotent. But there is no evidence of the occurrence under experiment or observation of the occurrence, uninfluenced by external conditions, of anything like the distortion of the skull which causes the change in the position of the eyes in the flat-fish, and leaves the symmetry of the anterior and posterior regions of the skull unaffected.

The problem of evolution can be attacked from either end of the ontogeny, from the genes to the development of the characters, or from the characters back through development to the genes. Adaptation does not consist merely in the possession of characters which are supposed to be useful or beautiful like the spots on the back of a beetle or the ocelli in a peacock's tail, but also of the functions of organs and their relation to the organism's

mode of life. One of the most curious phenomena to be explained is the influence of internal secretions or hormones on development and function. In the case of the antlers of stags the exclusive development in the male is due to the hormone secreted by the testes. This is an example of the sex-limitation of organs only indirectly related to the reproductive function. In the female mammal the functional cycles of the accessory reproductive organs which form such a remarkable difference in them from the birds and reptiles, are also controlled by hormones. In 1908 I put forward the theory that the origin of the influence of the testicular hormone on characters limited to the male could be explained by the inheritance of the effects of external stimulation. In the case of the stag, the development of the antlers according to this theory was due to the mechanical stimulation of the periosteum of the frontal bone by blows and friction in the fighting between rival stags, and both this development and its association with the presence of the testicular hormone were transmitted to the reproductive cells or gametes, in modern terminology to the genes. No theory of random mutation originating in the genes affords any reason for the evolution of this peculiar association of the sex-limited character with the internal secretion of the testis.

With regard to the female mammal, I suggested that the origin of the reproductive cycle and its hormonal control could be traced to the retention of the ovum in the oviduct during its development, and the stimulation of the uterine walls by the nutrition and growth of the embryo and by the placenta. Similarly the mammary glands on this theory were primarily due to the mechanical stimulation of the skin by the sucking of the young which led to the hypertrophy of dermal glands. Afterwards it was discovered that the anterior lobe of the pituitary produces one or more hormones which influence oestrus and the formation of corpora lutea in the ovary. Cases of precocious sexual maturity in the human subject have been found associated with tumours of the adrenal body. In order to cover such facts, I extended my theory to all the endocrine organs, postulating that the hypertrophies caused by the developing foetus were inherited not merely in association with the hormone of the ovary or ovarian follicles, but also in association with the normal hormone complex, so that excess or defect in any one of the more active of these organs caused abnormalities in the sexual cycle: injection of pituitrin, for example, causing formation of corpora lutea, the modification in mammals of the ovarian follicles from which ova have been discharged.

Apparently the secretion of the pituitary is the most active of the hormones not derived from the reproductive system itself, and it has the most marked influence on the ovary in the mammal. But it has no such effect on frogs or oviparous reptiles or birds, although it produces the same

secretion in these animals. If the formation of corpora lutea were the effect of gestation, this result at the beginning of the evolution of gestation would occur in association with the presence of pituitrin in the body. If the acquired character were transmitted to the genes it would still be in association with pituitrin, so that injection of the latter would cause the formation of corpora lutea when there was no ovum or foetus in the uterus. The action of a hormone on this theory suggests an analogy with that of the associated stimulus in a 'conditioned reflex'.

The physiologist finds that the secretion of the pituitary affects the phases of the reproductive cycle, and concludes that the gland goes through a cycle which causes the reproductive cycle. But that is no explanation; the question still remains what causes the pituitary to pass through such a cycle in mammals and other viviparous vertebrates and not in oviparous forms. On the theory that the external stimulation, that is, the presence of the developing ova in the oviduct, was the original cause and that the effects of this were inherited in association with the hormone plexus, we have an explanation, whereas genetics and physiology give none. This extension to the whole hormone complex of my theory of the association of secondary sexual characters and the female sexual cycle in mammals with the hormones of the reproductive organs was communicated to the Second International Congress for Sex Research, held in London in 1930.

Having given so much attention to the subject, I was very much interested in the letter by Prof. Landsborough Thomson on the evolution of hormones published in NATURE of October 8. This is the first discussion by any other biologist than myself, which has come to my notice, of the evolution of the relation between hormones and development, especially with reference to sex-limited characters and accessory reproductive organs. Prof. Thomson naturally uses technical physiological terms which are unfamiliar to other biologists, such as 'integrative mechanism' for the action of one part on another by which the functions of the organs are co-ordinated. He refers to the evidence that some of the chemical linkages have been established by the evolution of a tissue responsive to a substance already present in the organism. He thus agrees with me on the point that the hormones were in existence before the responsive tissues or developments were evolved.

It is therefore not the evolution of the hormones which has to be explained, but the evolution of the response to the hormones. I hope that Prof. Thomson will consider the theoretical suggestions which I have published and agree that external stimulation (regarding the ovum and developing embryo in the oviduct or uterus as really external to the organism) affords a reason for the evolution of the special responses, while the doctrine of random mutation cannot be applied to this case because the obvious association of the new development, whether corpus

luteum, mammary gland, or antlers in the stag, with a new stimulation is inconsistent with the term random.

Prof. Thomson refers to the vestigial survival in the mammal of the substance which causes expansion of chromatophores in Amphibia and teleosts. But is not the fact rather that the pituitary remains the same while the chromatophores have disappeared in the mammal? He also refers to the discovery that the development of the crop gland in the pigeon is stimulated by a (or, the) hormone of the pituitary which also stimulates the development of the mammary glands of the guinea pig. Here is an instance in which it is evident that the conception often implied in such terms as 'the œstrus-producing hormone' is not strictly correct, that the hormone does not cause the special development of tissue but that its presence is necessary to the development of which the potentiality is present in the genetic constitution. The testis hormone is necessary to the normal development of the antler in the stag but does not produce antlers in the stallion. Usually in experimental biology the pituitary of the ox is employed for researches on vertebrates of various classes, fishes, amphibia, birds and mammals, which implies the assumption that the internal secretions of the organ are essentially similar in all these classes. My theory that the mechanical stimulation, in one case of the membrane of the bird's crop, in the other of the dermal glands of the mammal, caused hyper-

trophy which in course of time affected the genes within the reproductive cells in association with the hormones of the pituitary, so that the hypertrophies became hereditary, is in harmony with the facts to be explained.

The case is quite similar to that of male sex-limited characters in mammals, where the testis hormone influences the development of antlers in stags, of teeth in the boar, and of the snout in certain seals. There are different responses to the same hormone, but the different responses correspond with different external stimulations. If it be replied that there is no evidence that the effect of such stimulations on the soma can produce any change in the genes, I can only point out that the association of the external stimulation with the presence of the hormones corresponds with the associations of the hormones with genetic development, and that it is impossible to ignore the fact that the hereditary hypertrophy controlled by hormones is physiologically of the same nature as the effects of the external stimulation, and the other fact that the stimulation is not merely hypothetical and supposed to have occurred at some remote period in the past but continues at the present day.

## REFERENCES

- Cunningham, J. T. *Archiv für Entwicklungsmechanik*, Bd. 26, 1908; "Hormones and Heredity." London, Constable and Co., 1921; "The Evolution of Secondary Sexual Characters and of Accessory Reproductive Organs." *Proc. Second Internat. Congress for Sex Research*, 1930.

## Obituary

CANON JOHN ROSCOE

WHEN in the 'nineties of last century I had the great good fortune to make the acquaintance of my valued friend, the late Canon John Roscoe, he was settled as a missionary of the Church Missionary Society among the Baganda, the great tribe or nation which has given its name to Uganda, in Central Africa. But he had previously resided in the same capacity for some years in that part of East Africa now called Tanganyika, which was afterwards taken over by Germany and known as German East Africa. Of his life in that country and his observations of the native tribes he has given a brief account in a volume published long afterwards, "Twenty-five Years in East Africa". The account includes the notice of a curious form of human sacrifice practised by the natives which he succeeded in suppressing. He left the country at the time when the Germans took possession of it, and falling into the hands of the Arabs, who opposed the German invasion, he and his wife narrowly escaped being put to death by their captors, the messenger who brought their ransom only arriving about an hour before the time fixed for their execution.

It was not until he settled among the Baganda, however, that Roscoe began systematically to

investigate and record the customs and beliefs of the natives among whom he lived. The results of his observations were first published in a series of valuable articles in the *Journal of the Anthropological Institute*, which are perhaps not wholly superseded by his systematic work on the subject, "The Baganda", which appeared some years later, in 1911. In his researches among the Baganda, he received important aid from his friend, the native prime minister of Uganda, who was not only himself versed in the lore of his people but also brought as informants from all parts of the country old men acquainted from their youth with the ancient traditions and customs which even then, at the beginning of the twentieth century, had passed or were passing out of use and even out of memory. Thus by his timely intervention, and the efficient help of his native informants, Roscoe was able to put on record a large body of information on the old life of the Baganda which otherwise would inevitably have been lost to science. His writings on the Baganda must therefore remain for all time the standard authority on that important tribe, one of the most powerful and most politically developed of all the Bantu peoples.

While his researches were in the main concen-

trated on the Baganda, Roscoe's anthropological enthusiasm, which never flagged, led him to extend his investigations to many other peoples of the Uganda Protectorate. He availed himself of his holidays to visit and examine some of them, particularly the Banyoro (or Bakitara), the Banyankole, and the Basoga, all of whose territories border on that of the Baganda, as well as other and more distant tribes, including the savage and cannibal Bagesu, on the slopes of the lofty Mount Elgon. The scientific results of these excursions he published in "The Northern Bantu", a volume replete with interesting information concerning these tribes, about which comparatively little had been previously known.

Even after Roscoe had returned to England in 1909 and was living in his quiet rural rectory at Ovington, near Thetford, in Norfolk, to which, in recognition of his eminent services to science, he had been presented by the University of Cambridge in 1912, his interest in these tribes of Central Africa remained unabated, and he longed to revisit them and push his investigations farther among them and among fresh tribes as yet untouched by European influence. Representations made on his behalf to the Government to enable him to undertake an expedition for this purpose were sympathetically received by Mr. Harcourt, then at the head of the Colonial Office, but they finally came to nothing. At last, after the War, his opportunity came, when the enlightened munificence of the late Sir Peter Mackie furnished him with the means of carrying out the wish of his heart. The funds provided by the generous donor were administered by a committee of the Royal Society, under the auspices of which Roscoe set out in 1919, and after spending about a year in the field returned in 1920. He husbanded his resources and secured complete freedom of movement by travelling alone except for the necessary bearers. It had been his wish and intention to examine the almost unknown tribes in the north-east, between Lake Rudolf and the southern border of Abyssinia, but unfortunately political complications in that region compelled him to abandon this important part of his programme, and that part of the ethnographical survey still remains undone, though I understand that there is some prospect of the blank being supplied before long by a younger investigator.

Thus restricted in the scope of his inquiries, Roscoe was obliged to retrace his steps over what to him was, in some measure, beaten ground. Still he made, in his year of absence, a wide circuit of the Protectorate, revisited his old friends the Banyankole, the Banyoro, the Bagesu, and the Basoga, and collected much additional information about them, besides breaking fresh ground among new and almost unknown tribes on the wilds of the lofty Mount Ruwenzori and elsewhere. The scientific results of his expedition were published by the Cambridge University Press in three volumes, "The Bakitara or Banyoro", "The Banyankole", and "The Bagesu". He also pub-

lished a more popular account of the expedition under the title of "The Soul of Central Africa", in which descriptions of the native tribes are agreeably varied by graphic descriptions of scenery and incidents of travel—personal details which he always rigidly and rightly excluded from his strictly scientific writings.

On this expedition Roscoe devoted most time to the Banyoro or Bakitara as the most important and formerly most powerful tribe of the Protectorate after the Baganda. In his inquiries among them he received much help from the native king, who took great interest in the work and was at pains to supply Mr. Roscoe with the fullest and most authentic information. Thus my friend was enabled to do for the Banyoro what he had already done for the Baganda, to supply a great African tribe with an accurate account of its present state and past history, so far as these could be ascertained by personal observation and the most trustworthy native tradition.

As a field anthropologist, Roscoe had in his day few equals and probably no superior. He was a first-rate observer, with a keen sense of what is important and deserving of record; entirely free from theoretical bias, he always contented himself with stating in clear and simple language the results of his observations and inquiries; for him it was enough to record the facts; he did not attempt to explain them by his own or other people's theories. Still less did he fall into the trap, into which too many field anthropologists have tumbled, by comparing his African facts with facts raked together from all the ends of the earth: all such explanations and comparisons he rightly left to be elaborated by comparative anthropologists at home working in libraries on the reports of field ethnologists like himself. As one of these workers at home who have profited immensely by his researches in the field, the results of which he freely and generously communicated to me by letter and word of mouth as well as in his published writings, I desire to place on record my sense of the deep debt of gratitude under which he has laid all students of ethnology by his long and devoted labours in Central Africa. As documents of first-rate authority on the tribes of the Uganda Protectorate, his writings can never be superseded; they will remain imperishable monuments of the people and of the man.

But while his writings attest to the world the tenacity of purpose and the strength and keenness of the intellectual powers which enabled Roscoe to accomplish his great work under all the distractions of a laborious profession, and all the difficulties and hardships of long journeys performed in a tropical climate, for the most part in days when modern facilities of travel were still unknown, only his intimates knew the kindly sympathetic nature which endeared him to his friends and won the hearts of his dusky flock in Africa, as afterwards of his parishioners at home in England.

Of that, however, it is for others to speak. But

it would be wrong to conclude this brief and imperfect notice of Canon Roscoe's anthropological work without directing attention to one feature of it which added greatly to its value. All his information, I believe, was obtained directly from natives in their own language without the aid of interpreters, his own long and intimate familiarity with Bantu speech enabling him to dispense with those dangerous intermediaries in all his intercourse with the Bantu tribes who form the great bulk of the inhabitants of the Uganda Protectorate. Thus his reports of native customs and beliefs are entirely exempt from one most fruitful source of doubt, ambiguity and error which infests and tends to corrupt and falsify all testimony in passing through the medium of an interpreter, who, even if he be honest, may unconsciously pervert the purport of the communication he is charged to make through his imperfect acquaintance with one or both of the languages of which, as a go-between, he is obliged to make use. Readers of Canon Roscoe's works have, therefore, the satisfaction of knowing that the stream of his discourse flows pure and clear from native sources, unsullied by passing through the too often turbid and weedy channel of an intermediary. J. G. FRAZER.

BY the death of the Rev. John Roscoe, honorary canon of Norwich, at Ovington, Norfolk, on December 2, at seventy-one years of age, anthropological studies in Great Britain have lost a highly valued worker and the foremost authority on the beliefs and customs of former days among the Baganda and related peoples of East Africa.

John Roscoe, the son of James J. Roscoe of Liverpool, was trained as a civil engineer, but turned to mission work. After a period of training in the Church Missionary Society's college at Islington, he went out to Africa as a lay worker in the service of the Society in 1884. He was not ordained until 1893. In 1899 he became principal of the theological school at Mengo and, after holding this post for ten years, retired from mission work in 1909.

The early years of Roscoe's work as a missionary in Africa covered a stormy period in the history of Uganda, in which the intrigues of the king, Mwanga, and still more of his Lubare priests, played English and Protestants against French and Roman Catholics and Islam against both, until the establishment of a protectorate was forced on Great Britain as a virtual necessity. As the powerful king Mutesa had died only shortly before his arrival in the country, Roscoe had the advantage, inestimable for his subsequent studies, of seeing something of the working of a great African kingdom, even though in disturbed conditions, before it had been modified by European control. Further, in his studies of Baganda institutions his own first hand observation was supplemented by the help of his friend, Sir Apolo Kagwa, the native *katikiro*, or prime

minister of Uganda, who not only gathered in his house for Roscoe's benefit old men from distant parts of the country, who were repositories of obsolete custom and belief, but also submitted Roscoe's material to the test of his own knowledge and critical judgment. Roscoe had taken up anthropological inquiry as a relaxation from teaching; but his early papers published in the *Journal of the Anthropological Institute* showed that he was a meticulously accurate observer, who at the same time was competent to see his facts in their broader relation. His reputation was confirmed and enhanced by his books, "The Baganda" and "The Northern Bantu".

On his return to England, Roscoe received an honorary M.A. degree from the University of Cambridge for his services to anthropological science, and lectured in the University on the anthropology of Africa. After a period of service as curate of Holy Trinity, he was presented by the University to the living of Ovington, which he held for the remainder of his life.

For eighteen years of his stay in Africa, Roscoe had been in close touch with Sir James Frazer. This association of field-worker and comparative anthropologist had proved little less fruitful on both sides than the similar association between Sir James and Baldwin Spencer in another field. In 1919 Roscoe was invited, through the efforts of Frazer, to undertake further work in East Africa as leader of the Mackie Ethnological Expedition under the aegis of a committee of the Royal Society. This was a one-man expedition, most of which was accomplished by bicycle. Roscoe visited a number of peoples on the Uganda-Congo border and on Mount Elgon, again keeping constantly in touch with Frazer by correspondence and report, as he maintained, to the great advantage of the work of the expedition. His results were embodied in three volumes, each with separate title, published in 1923, while a popular summary appeared as "The Soul of Central Africa". A general review of his life as missionary and anthropologist had already appeared in 1921 under the title "Twenty-five Years in East Africa". It is a book which by its restraint reveals the strength of his character.

WE regret to announce the following deaths:

Mr. Treacher Collins, formerly president of the Ophthalmological Society of the United Kingdom and of the International Congress of Ophthalmologists, known for his scientific investigations on the eye, on December 13, aged seventy years.

Prof. W. S. Thayer, emeritus professor of medicine in Johns Hopkins University, Baltimore, formerly president of the American Medical Association and president (in 1897 and 1913) of the International Medical Congress, known especially for his work on the pathology of the vascular system, on December 10, aged sixty-eight years.

## News and Views

## Warren Hastings and Science

MUCH has been written in the newspapers during the past week or so respecting the career of Warren Hastings in India, commemorative of the two-hundredth anniversary of his birth. Hastings was born on December 6, 1732, in Oxfordshire, and he died in 1818 at Daylesford, in Worcestershire. Little attention has been given, however, to Hastings' connexion with the world of science of his time. Six years after he had laid down office as Governor-General of India and had returned to England (1785), he was, on June 25, 1801, elected a fellow of the Royal Society. His certificate described him as a gentleman of great and extensive knowledge of various branches of science. He was living then in Berkeley Square, London. Among names appended in support were: James Rennell, Count Rumford, John Bruce, Caleb Whitefoord, and Mark Augustus Pictet. The first two were Copley medallists of the Society. Rumford's support of the ex-Governor-General of India is a particularly interesting feature of the candidature. In due course Warren Hastings attended and signed the charter book. It may be mentioned that in the last year of his administrative work in India, Hastings founded the Asiatic Society of Bengal, the first president of which was Sir William Jones. Though in itself nothing more than a coincidence, it is nevertheless of historic interest that the name of Capt. William Bligh, later (1805) Governor of New South Wales, who had accompanied Cook on his second voyage around the world, appears, along with Hastings, in the list of fellows elected into the Royal Society in 1801. His certificate was signed by Henry Cavendish and William Herschel, among others.

## Centenary of Sir John Kirk

MONDAY next, December 19, marks the centenary of the birth of Sir John Kirk, naturalist, and exploring colleague of David Livingstone. Born at Barry, near Arbroath, Kirk was educated at the University of St. Andrews, graduating there in the medical faculty in 1854. He served on the civil medical staff during the Crimean War; afterwards, for six years as naturalist and second in command of Livingstone's exploring expedition in Africa. Entering the consular service, he became consul-general at Zanzibar (1873), and ultimately (1880), political agent. In the latter capacity his influence was of high importance in the administrative affairs of East Africa. Kirk accompanied the Sultan of Zanzibar on a visit to England in 1875, a treaty for the abolition of slavery in that potentate's dominions having been concluded. Sir David Prain has recorded that Kirk's memory is perpetuated in many ways: geographers allude to the Kirk Range, west of the Shire River; zoologists to Kirk's gazelle; and botanists to the genus *Kirkia*. Kirk was elected a fellow of the Royal Society in 1887, and the Royal Geographical Society awarded him its patron's medal in 1882. Kirk was created G.C.M.G. (1886) and K.C.B. (1890). He died on January 15, 1922.

## The Dyestuffs (Import Regulations) Act

IN the House of Commons on December 8, an amendment for the omission of the Dyestuffs (Import Regulation) Act from the Expiring Laws (Continuance) Bill was defeated at the committee stage by 196 votes to 59. Replying for the Government during the debate, Dr. E. L. Burgin, Parliamentary Secretary to the Board of Trade, stated that the Government is still fully alive to the necessity of maintaining a flourishing dyestuffs industry in Great Britain, and referred to the definite cleavage of opinion between the users and makers of dyestuffs revealed in the third report of the Dyestuffs Industry Development Committee. This difference of opinion has been duly considered by the Government, and it is proposed to accept neither the majority nor the minority recommendations of the Report, but to extend the operation of the Act for a further year, during which period the Import Duties Advisory Committee will be asked to inquire into the whole circumstances of the dye industry and how the general interest may best be served. The whole matter will be referred to an impartial committee with all kinds of expert opinion available to it. When the Advisory Committee has reported it will then remain the duty of the Committee of Imperial Defence to intimate how the essential interests of national defence will be affected by any recommendations which may be made. The matter cannot be regarded as a purely industrial question. In the course of his speech, Dr. Burgin referred to the enormous advantage to Great Britain of the inclusion of the British dyestuffs industry within the international agreement between the German, French, Swiss and Italian makers. Careful inquiry has satisfied him, he said, that in regard to price the international agreement is not operating disadvantageously to Great Britain and the gold prices of the same colour do not vary to the disadvantage of the country.

## Prevention of Distemper

THE inquiry into the causation and prevention of dog distemper started in 1922 has now been brought to a successful issue by the *Field* Distemper Council, Dr. P. P. Laidlaw and Mr. G. W. Dunkin, the Medical Research Council and the staff of the Wellcome Foundation at Beckenham. The disease has now been accurately defined and distinguished from other dog illnesses with which it used to be confused; it has been shown to be due to an ultramicroscopic virus and efficient methods of prevention have been worked out in the laboratory and confirmed in large-scale practical trials on packs of foxhounds and other dogs. Dogs are first given an injection of an emulsion of the organs of an animal which has died of acute distemper in which the virus has been killed with dilute formalin; in response, the animal develops a moderate degree of resistance which makes it possible, a fortnight later, to give it a dose of live virus which stimulates the animal to become definitely immune. The blood serum of such immune animals



can protect against the virus and is of use in treating cases of the disease and also in making a vaccinating mixture with live virus, which has the practical advantage of needing only one dose instead of two. These immunological reactions also make it possible to identify the disease with far greater certainty, and the new methods of prevention are available for ferrets, silver foxes, fitches, minks, etc., in which it has been found to occur.

#### Halley Stewart Laboratories of Physical Research

It seems to be a remarkable coincidence that during the past century much of the research by the professors of physics in King's College, London, has been directly applicable to distant communication. Wheatstone appears to have been the pioneer and is known to all by his ingenuity and his discoveries which led to the invention of telegraphy. Maxwell, whose genius covered a wide range of study, is best known for work which is the theoretical basis of wireless transmission to-day. Richardson's work on the emission of electrons from hot bodies is applied in every wireless set. To-day, Appleton is in the forefront of the workers who are studying conditions in the upper atmosphere which control wireless transmission. But however comfortably his predecessors may have worked in the friendly atmosphere of the College, the conditions have so changed in the surroundings that Prof. Appleton finds himself obliged to work in a continuous electromagnetic storm—an atmosphere unsuitable to the character of the work in which he, his colleagues and his students are engaged. The work is already past the stage of a direct study of the conditions of wireless communication and has become of great importance in the study of the structure and nature of the upper atmosphere. By the refraction of wireless waves within the upper atmosphere, information is being obtained about the distribution of ionised regions. Thus hypotheses already applied in other branches of geophysical work come within the reach of direct experimental investigation.

THE problems which Prof. Appleton is attacking are of great complexity and it is clearly desirable not to add to the difficulty by working in a region so disturbed electrically as the Strand. Thus the generosity of the Halley Stewart Trust in providing new laboratories at Chesterford Gardens, Hampstead, is very opportune and is welcomed by the College and especially by the Physics Department. The work now in progress involves observations of a protracted nature—often over twenty-four hours—so that the convenience of a special laboratory with the director of research housed on the spot cannot be overestimated. The other branch of research to be undertaken in the building is concerned with the physical problems arising in the medical application of radium. This work is proceeding apace in London and one of its objects is to introduce scientific accuracy into the therapeutic use of radioactive substances. Already a number of students working under the direction of Dr. H. T. Flint are engaged in King's College and in Westminster Hospital

Annexe on urgent problems in this branch of physics. The proximity of the new laboratories to Westminster Hospital Annexe will still further promote the close co-operation of the work in the two places.

#### Protein Swelling and Allied Phenomena

A CONFERENCE devoted to the subject of protein swelling, held under the auspices of the British Section of the International Society of Leather Trades Chemists, was held on December 1 at the Leathersellers' Hall, London, E.C.3. The introductory address was given by Prof. F. G. Donnan on the theory of membrane equilibria and the osmotic pressure of protein gels, in the course of which points connected with the Procter-Wilson theory of osmotic swelling were touched upon, and attention directed to the difficulty of applying this theory quantitatively to close-packed micellar systems such as hide. Mr G. S. Adair dealt with the osmotic pressure of the proteins, and described the assistance afforded by analysing such pressure into two partial pressures, one due to the protein ions and the other to the unequal distribution of ions. Dr. H. Phillips discussed the interaction of gelatin with acids and alkalis from the points of view of the electronic theory of valency and Bjerrum's *Zwitterion* constitution of amino acids. Mr. F. C. Thompson explained the two types of salt effect on the swelling of gelatin, one, an osmotic repressive effect on acid or alkali swollen gelatin, and the other a lyotrope effect on neutral non-ionised gelatin. Dr. R. H. Marriott, in his paper on swelling in alkaline solutions, put forward his views on the mechanism of the fixation of calcium by collagen, and the influence of the chemical constitution of keratin on its resistance to osmotic swelling.

THE more practical aspects of swelling and its bearing on leather manufacture were summarised by Dr. C. H. Spiers, who considers that plumping of hides is associated with a twisting and folding of the polypeptide chains in the crystallites of the fibrils. Dr. Dorothy Jordan Lloyd put forward explanations for the observed reductions in swelling power of proteins with increasing compactness of molecular organisation. The structure of wool keratin and its relation to swelling phenomena, was the subject of Dr. J. B. Speakman's paper, while the last paper was given by Mr. W. R. Atkin, on swelling in weak acids, in which it was pointed out that a careful consideration of Kuhn's work shows that the maximum swelling of gelatin in weak acid is at an external equilibrium of pH 2.4 in agreement with the earlier work of Procter.

#### Cinematograph Films of Cyclic Phenomena

MESSRS. DANCE-KAUFMANN, 18 Upper Stanhope Street, Liverpool, have produced some useful technical films which aim at the representation, by means of moving pictures, of phenomena which are cyclic, or may be considered so, for the purposes of exhibition. The operation of a diagram for the composition of rotating vectors; the summation of three alternating fields displaced in space and time;

or the action of the Oldham coupling are among the many subjects which are illustrated by the films. The diagrams appear as black lines on a lighted field, the dimensions of which are about 2 ft. by 1 ft. 6 in., with the 16 mm. film, and with a 50 watt projector; the visibility is sufficiently good with a shaded screen to provide for a class of thirty or forty students, and for a larger number in a darkened room. The fact that the films are in the form of endless bands and may be repeated indefinitely, and that the film may be arrested at any point for the purpose of measurement or explanation, should render them valuable for instruction in junior and for demonstration in senior classes. The range of films in the firm's catalogue is extensive and representative, including most branches of physics and engineering, and the presentment of the subjects is well considered. The cost of the films and projector is moderate and orders are accepted for special films to suit the requirements of individual lecturers. 35 mm., 16 mm. and 9.5 mm. films are available at the same price.

#### Gyroscopic Tops

At the Friday evening discourse on December 9 at the Royal Institution, Prof. J. G. Gray discussed gyroscopic tops and combinations. After showing some preliminary experiments to illustrate the fundamental properties of the gyroscope, Prof. Gray proceeded to describe methods and technique he has devised for the production of self-erecting gyroscopes. Gyroscopes fitted axially with special point and ball pegs, mounted on cup supports, were shown to be self-erecting, the stability being the result of the special construction of the gyroscopes and their accessories. In some of the tops exhibited, devices called erectors are mounted on the casings of the gyroscopes; rotation of these erectors endows the tops with stability or instability according to the direction of rotation of the erectors. Generally speaking, an erector consists of a normally horizontal plate on which rest spherical masses, or to which masses are pivoted, the construction being such that when the top is vertical the masses, as a consequence of the rotation of the plate, dispose themselves symmetrically with respect to the axis of the top; but when the top is inclined to the vertical, and the plate to the horizontal, the masses move about relatively to the plate in such manner that, providing the plate is rotating in the direction of spin of the gyroscope, the top experiences an erecting couple, and thus becomes endowed with a sense of the vertical. Gyroscopic tops were shown which are self-erecting as a result of the special construction of the pegs on which their casings revolve. Further tops exhibited are rendered stable, or unstable, at will by rotation of the cups on which the pegs are supported. Members of this latter family of tops were caused to erect themselves from initial positions in which their axes of spin were horizontal to those in which their axes were vertical, and then to return to positions in which their axes were horizontal.

#### Development of the Electrical Industry

In the third of the series of lectures on industrial affairs at the Imperial College of Science, Mr. Maurice Solomon discussed certain aspects of the electrical industry. He emphasised that further development of the industry would involve a more widespread use of electrical appliances in the household. Such appliances must be properly standardised so as to be readily interchangeable. Moreover, there must be standardisation of quality, for it is of the utmost importance that the user shall acquire and retain confidence in the safety and smooth working of electrical apparatus. As an indication of the extent to which electricity may be applied in the modern household, Mr. Solomon said that in his own house there are some twenty-eight different types of electrical appliance in use. The electrical industry is still young and there is no lack of appreciation of the importance of research in its future development.

#### Organisation and Co-operation in Industry

MR. SOLOMON then discussed the general proposition that the organisation of an industry into large firms or groups of firms is advantageous to that industry and to the general community. In Great Britain we have looked askance at the cartel as tending to the raising of prices and the stultification of progress through the elimination of competition. Actually, the cartel does not eliminate competition but merely reduces it to a reasonable level, and there is now a growing appreciation of the evils of unrestricted competition. In any event, competition is by no means the only incentive to progress: markets may be extended by fostering a wider public demand as well as by capturing the existing trade of competitors. Moreover, criticism by the public is an ever present incentive to progress, even in the case of a monopoly. On the other hand, the small concern which puts on the market a standard article at cut prices is taking advantage of the results of research which it could never have carried out for itself, and is thus shirking responsibility for the progress of the industry and for service to the community. A large firm or group of firms by efficient organisation can maintain a large output of products of a high and standard quality under conditions which enable those engaged in the industry to earn a reasonable living; and by control of production and prices, can minimise the evils arising from alternations of slump and boom. The co-operative research which an association of firms can undertake affords the key to future progress not only in the industry immediately concerned but also in cognate industries.

#### Television in the United States

In the *Journal of the Television Society* for September, there is an interesting paper by Mr. A. Dinsdale on "Television in America To-day". He points out that those concerned with television development are either research workers or companies interested in existing equipment. For the last two years, the Bell Telephone Laboratories have been experimenting with a two-way television

system over telephone lines between two buildings in New York which are two miles apart. Even when perfected, it is not certain whether there would be a commercial demand by the public for a costly facility which would enable them to see the person telephoning. At the General Electric Company's laboratories at Schenectady, experiments are being made on the transmission of television signals along a light beam instead of by wire or radio. Nothing very novel has recently been published in connexion with cathode ray television. The National Broadcasting Company is building a new television studio on the eighty-fifth floor of the Empire State Building at a height of 1,000 feet above the street. The short-wave transmitting aerial is on the top of the airship mooring mast and is 1,250 feet above the street. The received images will be six inches square and will be seen directly on the end of a cathode ray tube. Transmissions will be made from the Empire State studio on wave-lengths of 5-7.5 metres.

#### Supply Undertakings and the Grid

IN an article in the *Times Trade and Engineering Supplement* for November 19, Mr. Charles D. Taite, of the Lancashire Electric Power Company, discusses the grid from the point of view of the supply undertakings affected by it. We are glad to learn that the supply undertakings, several of which strongly opposed the Act of 1926, are now willing to co-operate with the Central Electricity Board in making the schemes which have been carried out under the provisions of the Act a success. This is wise, seeing that they pay the whole of the charges in connexion with the grid and are therefore vitally interested in its success. Since the Act came into operation, a wave of industrial depression has swept over the world and although the use of electricity in Great Britain has continued to expand, the growth is less than it would have been under normal conditions. In some areas, factories have closed down. In textile areas, many mills have gone permanently out of commission. On the Clyde and the Tyne, shipbuilding has fallen on evil days. On the other hand, new openings have been found for electrical development; rural electrification has commenced and electricity is being more widely used by the householder. But beneficial as these developments are, their effect is comparatively insignificant compared with the enormous growth which would take place with a return to good trading conditions. Some indication of what might be expected was experienced in the textile areas of Lancashire last autumn, following the revival which took place in the demand for textile goods. The load on many undertakings expanded by 15 per cent, and had the revival been maintained throughout the year, another 15 per cent improvement would have been reached. The heavier the load the less will the supply companies' fixed charges per unit to the Central Electricity Board be and the cost of electricity would be cheaper. In Mr. Taite's opinion, there is still an almost unlimited field for electrical enterprise.

#### Outdoor Museums in the United States

PUBLIC museums in the United States of America have been increasing in numbers in recent years at the rate of one every fortnight, and their standard of efficiency as educational agencies has been rising. The American Association of Museums has been taking stock of the museum resources of the country, and has made available a considerable mass of new statistical information on which the Association's director, L. V. Coleman, has based an interesting report on "Recent Progress and Condition of Museums". This has been published by the United States Office of Education as Bulletin No. 30, 1931. Among recent developments is the appearance of museums of science in national parks. The underlying idea of these is that museums attempt, too often without success, to tell indoors, with the aid of objects that are fragments or imitations, stories that should be told where Nature has provided genuine illustrative exhibits. 'Trailside' museums, each given over to a restricted subject, are found to be more useful for some kinds of instruction than cases in a museum building. The first demonstration was made a few years ago in the Yosemite, and the most recent is an extensive series of 'trailsides' in the Yellowstone National Park. Simultaneously with this exploitation of the resources of the national parks, museums in cities have been moved to search local parks for natural features that can be explained on the spot. The influence of the movement has spread into the field of history also, as in the George Washington birthplace national monument, and a newly appointed park historian is developing history education, just as the park naturalist has developed natural history education. The number of museums doing good educational work a decade ago was not more than a dozen; now it is in the hundreds.

#### The Auckland Museum and Institute, New Zealand

THE Auckland Institute and Museum, now in its second year of occupation of the fine Memorial Building, has of necessity been undergoing a revision of its extensive collections. But in addition it has been able to carry out a very successful expedition for the investigation of the natural history and ethnology of the northernmost portion of the North Auckland peninsula (Annual Report for 1931-32). Another notable activity of the staff is the furthering of the educational side of the Museum by lectures within the building and in the district, the Sunday afternoon public lectures having proved specially attractive; as well as by the formation of clubs for boys and girls, the preparation of exhibits for schools, and the arrangement of special exhibitions. An exhibition of antique plate, chiefly of the seventeenth and eighteenth centuries, increased the attendance by a thousand a week during its course; the weekly average number of visitors throughout the year was 2,856. The membership, like that of most similar bodies, shows a slight falling off in numbers, but the present roll still includes 588 names, 157 representing life members with a capital subscription fund exceeding £2,000.

### The Problem of Wilkes Land

IN the United States Exploring Expedition of 1838 Charles Wilkes reported various landfalls near the antarctic circle south of the Indian Ocean. A number of soundings also showed a continental shelf. On this evidence, Wilkes suggested the existence of an antarctic continent and the lands were long referred to collectively as Wilkes Land. D'Urville at the same time found Adélie Land, which appeared to be part of the same coast-line. Subsequent explorations in these waters, principally by Capt. R. F. Scott and Sir Douglas Mawson, failed to establish all Wilkes's landfalls in the position originally assigned. This had led to the suggestion that he was mistaken and the tendency is to restrict the use of the name, Wilkes Land. Prof. W. H. Hobbs in an article in the *Geographical Review* for October 1932 discusses this problem and publishes a map on which subsequent discoveries have been printed over those of Wilkes. If Wilkes's latitudes were wrong in many cases, his longitudes show considerable correspondence to actual land. Pack-ice prevented his close approach and the distance of his 'lands' had to be estimated. Allowing for the liability to underestimate distances in the remarkably good visibility, and the lack of cross-bearings to fix position, Prof. Hobbs argues that recent work has re-established Wilkes Land in the wider sense and exonerated Wilkes from the charges that have been brought against him. The name is a useful one to embrace many small lands and might well be retained.

### Radium from Canadian Pitchblende

THE Industrial Information Bureau of Canada announces that a new commercial process of radium extraction has been successfully accomplished by R. J. Traill and W. R. McClelland of the Department of Mines at Ottawa. On account of the high-grade character of the pitchblende ores from the Great Bear Lake area, and partly because of the simplified technique that has been developed, it is believed that the costs of radium production will be considerably less than has hitherto been practicable. Instead of some forty operations involved in the Belgian method, radium salts can now be produced in the Government Laboratory with less than half that number of steps and in six weeks instead of three months. The chief cost in radium separation arises from the necessity of using about three tons of chemicals for the treatment of every ton of ore. The new process has been adapted to treat with almost equal success both siliceous ore and the silver carbonate ore with which pitchblende is found associated in the Great Bear Lake field. Ten tons of ore are estimated to produce about 1 gm. of radium. Already some 4,000 gm. of radium concentrates have been extracted in the preliminary experimental work. Canada's first radium refinery is now being established at Port Hope, Ontario, to which point the ore will be brought for the extraction of radium and various by-products such as uranium, lead and silver.

### The Personality of Britain

THE valuable synthetic study of prehistoric Britain as an environment of man which Dr. Cyril Fox delivered as a lecture to the First International Congress of Prehistoric and Protohistoric Sciences (see *NATURE*, Aug 13, p. 247), has now been published by the National Museum of Wales under the title "The Personality of Britain: its influence on Inhabitant and Invader in Prehistoric and early Historic Times" (Cardiff: National Museum and Press Board of the University of Wales, pp. 84, price 2s. 6d.) In a preface, Dr. Fox points out that publication has been undertaken appropriately by the National Museum since not only does Wales form an integral and important part of the highland zone which he differentiates in the course of his argument, but also characteristic examples of the objects of material culture with which he deals may be seen in the galleries of the Museum. The value of the text as published is much enhanced by a full series of distribution maps, most of them based on material which Dr. Fox himself has collected in the course of the past five years and in the preparation of which he has had the assistance of Miss L. F. Chitty. Archaeologists will be grateful to the National Museum of Wales for having so speedily made accessible this valuable and comprehensive study of the influences of geographical environment in Great Britain between *circa* 2500 B.C. and A.D. 1000.

### Tea Cultivation

TEA is an unusual crop from the point of view of the cultivator because it is necessary to keep the bush in vigorous vegetative growth and at the same time continue to remove the young vegetative shoots, which are plucked by breaking them off with the thumb and forefinger, the bud and the next two open leaves being thus removed. Naturally, therefore, pruning methods, manurial treatments, etc., will be controlled by different considerations than where an orchard tree is cultivated for its flower and fruit production. Interest is now being taken in the cultivation of tea in Malaya, where the central highland regions are being opened up. Mr. E. A. Curtler was therefore sent on tour to Ceylon and India to obtain the most recent information on methods of tea cultivation and manufacture, and his impressions and experiences are embodied in an interesting publication of the Department of Agriculture of the Federated Malay States (General Series No. 9, 1932).

### The Psychology of the Family

DR. PRYNS HOPKINS, in the *Sociological Review*, vol. 24, No. 2, considers the psychology of the family. He reviews the nature of the chief instincts concerned and he stresses their liability to fixation at, or regression to, any of the numerous stages in their development. Consequently, he suggests that in the pre-marital state, moderate promiscuity should be sanctioned as most likely to promote healthy and complete development, and wise choice of the permanent partner. In the

marital state, he insists that the sole bond must be that deep affection which may be a concomitant of desire, and is the cause and justification of monogamy. Finally, he pleads for frankness towards children in matters of sex, and asserts that those who do receive this from parents obviously fond of them, and not strained in their personal relationship, are most likely to grow up healthily and happily. The greater freedom for experiment which he demands that society introduce into the convention of the family is well supported by his argument. The paper is naturally controversial, but it would benefit by the suppression of the sentimental note which is occasionally apparent.

#### King's College (London) Engineering Society

THE "King's Engineer", the annual of the Engineering Society and the Engineering Branch of the Old Students' Association of King's College, London, which has recently been published, is one of the most interesting publications of its kind and affords evidence of the engineering activity of the College. Fourteen papers were read by the members of the Engineering Society during the year, and four of these are reprinted in the annual. The paper on the "Development of High-Speed Compression Ignition Engines", by V. H. F. Hopkins, was the prize essay. Another paper of considerable interest is that by A. H. Jenkins on "China-Clay and China-Clay Mining in the West of England". The number is issued as a memorial volume to Prof. Ernest Wilson, who for more than thirty years was professor of electrical engineering, and who endeared himself to all King's College students. Prof. G. Cook gives an appreciation of Prof. Wilson's work, and a list of his papers.

#### Survey of India

THE Survey of India has published its report on map publication and office work for the year ending March 31, 1931 (Calcutta, 1932. 1 rupee). The most important part of the publication is the series of index maps of all the maps of India, including the 'Million Map' sheets. Practically the whole of India, but not Burma, and also Afghanistan, Baluchistan and Persia now appear on the useful southern Asia series of one in two million, while the greater part of India is also published on the one to a million scale of the Carte Internationale du Monde. The larger scale maps make good progress and some two hundred new sheets on different scales have been published during the year.

#### Electric Supra-Conduction in Metals

PROF. J. C. McLENNAN writes as follows: "It is regrettable that in my article on 'Supra-Conduction in Metals' published as a supplement to NATURE of December 10, there were two undetected typist's errors that should have been corrected. In the third section of the article the words 'copper sulphate' should read 'copper sulphide' and in the last section the words 'wire lattice' should read 'ionic lattice'. It may be of interest to state here, too,

that Prof. R. de L. Kronig's paper on the electron lattice theory of supra-conduction in metals appeared in the *Zeitschrift für Physik*, Bd. 78, Heft. 11 and 12."

#### Announcements

THE annual meeting of the British Association will be held next year in Leicester on September 6-13 under the presidency of Sir F. Gowland Hopkins, president of the Royal Society. The following sectional presidents have been appointed: Section A (Mathematical and Physical Sciences), Sir Gilbert Walker; B (Chemistry), Prof. R. Robinson; C (Geology), Prof. W. G. Fearnside; D (Zoology), Dr. J. Gray; E (Geography), the Right Hon. Lord Meston; F (Economic Science and Statistics), Prof. J. H. Jones; G (Engineering), Mr. R. W. Allen; H (Anthropology), the Right Hon. Lord Raglan; I (Physiology), Prof. E. D. Adrian; J (Psychology), Prof. F. Aveling; K (Botany), Prof. F. E. Lloyd; L (Educational Science), Mr. J. L. Holland; M (Agriculture), Dr. A. Lauder.

MR. J. BERNARD CALKIN, Wychwood School, Bournemouth, states that in his letter entitled "Implements from the Raised Beach at Slindon Park, Sussex" (NATURE, Nov. 26, p. 813) the reference "to the Cannon shot gravels as being of interglacial age was an oversight. As they are actually a glacial deposit, I conclude that most of the Slindon beach belongs to the preceding interglacial period."

IN commemoration of the seventieth birthday of Sir P. C. Rây, founder, foundation-president and patron of the Indian Chemical Society, a jubilee volume, of some 350 pages, is being published by the Society, containing contributions from many eminent chemists in India and abroad. Orders for the volume should be sent to the Honorary Secretary, Indian Chemical Society, P.O. Box 10857, Calcutta.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A head of the Chemistry Department of the Municipal Technical College of Kingston-upon-Hull—The Director of Education, Education Offices, Guildhall, Hull (Dec. 31). A librarian and keeper of records in the Department of Antiquities, Palestine—The Director of Recruitment (Colonial Service), 2, Richmond Terrace, Whitehall, London, S.W.1 (Dec. 31). An examiner in domestic science and assistant examiners in mathematics, chemistry and other subjects for the School Certificate Examination for 1933 of the Central Welsh Board—The Clerk to the Central Welsh Board, Cardiff (Jan. 14). A head of the Civil and Mechanical Engineering Department at the Northampton Polytechnic Institute, St. John Street, London, E.C.1—The Principal (Jan. 20). A professor of experimental physics at the Queen's University of Belfast—The Secretary (March 18). A professor of zoology at the University of Leeds—The Registrar. A secretary to the Society for Cultural Relations between Great Britain and the U.S.S.R.—The Chairman, S.C.R., 1, Montague Street, London, W.C.1.

### Letters to the Editor

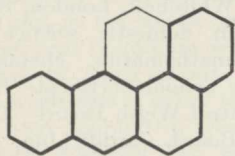
[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

#### Coal Tar Constituents and Cancer

THE nature of the cancer-producing constituent (or constituents) of coal tar has been under investigation in this and other laboratories for some years past, but hitherto no known constituent of tar has been found to have definite cancer-producing properties, and no new carcinogenic constituent has been isolated. The isolation has now been accomplished by concentrating active fractions of coal-tar pitch, making use of the method of fluorescence spectroscopy introduced here by W. V. Mayneord. This brought to light a spectrum which was found to be common to many carcinogenic mixtures.<sup>1</sup> The methods adopted have included fractional distillation, solvent extraction, and crystallisation of picrates and of the products of their decomposition with alkali.

In this way a very active carcinogenic hydrocarbon has been obtained, which in the pure state has the typical fluorescence spectrum to which reference has been made above. For reasons which cannot be detailed here, we formed the opinion that this hydrocarbon was possibly 1:2-benzpyrene. This compound was unknown, but has now been synthesised here from pyrene by way of  $\beta$ -1-pyrenoylpropionic acid,  $\gamma$ -1-pyrenylbutyric acid, and 4'-keto-1': 2': 3': 4'-tetrahydro-1:2-benzpyrene. The synthetic sample of 1:2-benzpyrene produced cancers of the skin in mice just as rapidly as the material isolated from pitch.

The tumours appeared, so far as can be judged from the limited number of experiments on mice yet carried out, in approximately half the time required for tumour production by 1:2:5:6-dibenzanthracene, so that 1:2-benzpyrene is much the most active carcinogenic hydrocarbon yet known. We do not claim that this is the only carcinogenic compound present in coal tar. The relationship of this new hydrocarbon to 1:2-benzanthracene, the parent substance of the group of cancer-producing hydrocarbons already described,<sup>2</sup> is shown by its structural formula, the benzanthracene ring-system being indicated by heavy lines:



In addition, we have also isolated from coal-tar pitch the other two hydrocarbons,  $C_{20}H_{12}$ , composed entirely of benzene rings; namely, perylene and 4:5-benzpyrene. The identification of the latter hydrocarbon was effected by synthesis. Moreover, we have isolated 1:2-benzanthracene from the chrysene fraction of coal-tar. None of these four hydrocarbons had previously been recognised as a coal-tar constituent. A more complete account of these experiments is being prepared for publication.

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We gratefully acknowledge our indebtedness to Prof. E. L. Kennaway for his helpful encouragement during a somewhat long and arduous task.

J. W. COOK.  
C. HEWETT.  
I. HIEGER.

The Research Institute,  
The Cancer Hospital (Free),  
London, S.W.3.  
Dec. 2.

<sup>1</sup> Hieger, *Biochem. J.*, **24**, 505; 1930.  
<sup>2</sup> Cook, Hieger, Kennaway and Mayneord, *Proc. Roy. Soc., B*, **111**, 455; 1932.

#### Tribulosis and Methæmoglobinæmia in South African Sheep

IN the investigation of the disease 'tribulosis' or 'geeldikkop' (literally, 'yellow-thick-head'), which causes heavy mortality among sheep in the Karroo area of South Africa, it was observed by one of us<sup>1</sup> that death from methæmoglobinæmia followed administration of the press juice of the plants held responsible for the causation of the disease. Animals grazing upon different *Tribulus* species (*Zygophyllacæ*) at certain periods of the year (summer months) evince a marked photosensitivity accompanied by more or less intense icterus. The swellings of the lips, ears and head, those parts least protected from the sun's rays, are followed by necrosis and mummification of these parts, which may be so intense that the animal is quite unable to eat or drink. Death follows from inanition, toxæmia and jaundice.

Methæmoglobinæmia has never been recorded as a clinical symptom. With the exception of the jaundice, the clinical picture very closely simulates that produced by experimental *Hypericum* or hæmatoporphyrin sensitisation.<sup>2</sup>

The rôle of the plants mentioned in causing the disease has been established by feeding tests carried out at the scene of an outbreak, but so far no clue as to the nature of the toxic substance responsible has been obtained, neither has the disease been produced experimentally outside the areas in which it normally occurs. Outbreaks are very spasmodic, even capricious, in appearance. It is felt by us that a certain set of physiological conditions is necessary, both of the plant and of the animal, for the characteristic syndrome to develop.

In testing the toxicity of *Tribulus* plants at Onderstepoort, death invariably resulted from methæmoglobinæmia within 3-4 hours of dosing (by stomach tube) with the freshly expressed juice of the green plant, or water extracts of the dried, powdered material. Although the symptoms of such poisoning differed markedly from those of the disease as it is seen in the field, it was decided to attempt the isolation of the responsible substance.

We have succeeded in proving that the formation of methæmoglobinæmia is due to nitrite, not present as such in the plant, but formed from nitrate by an extremely active reducing system.

Determinations of nitrate content by the method of Strowd<sup>3</sup> (except that extracts were made with boiling water), showed that our dried, powdered samples of *Tribulus* plants from various localities contained between 3.2 and 2.2 per cent, reckoned as  $KNO_3$ , on the dry weight basis. Since conversion of nitrate to nitrite and reaction of this with amino bodies, etc., takes place during the drying process, the actual amount of nitrate in the fresh plant is

probably considerably greater even than these figures indicate.

Crystalline potassium nitrate was isolated from the material in fair yield. The enzyme system appears to be insoluble or bound to the denatured proteins and it was found possible to wash the plant powder free from nitrate and then to effect enzymic reduction of added nitrates. Reduction may proceed slowly, beyond the nitrite stage, and the various intermediates, such as hydroxylamine, have been under consideration as possible toxic factors.

By analogy with the work of Warburg and Negelein<sup>4</sup> upon the alga *Chlorella pyrenoides*, it may be assumed that reductive processes are so controlled in the living tissues of the higher plant that nitrites are not produced in any appreciable concentration from the reduction of nitrates. Nitrite may be looked upon as a product of a deranged metabolic activity. This explains why methæmoglobinæmia is not observed clinically in sheep grazing upon living *Tribulus* plants.

Incidentally, we have also demonstrated that if fairly large doses of nitrates are given by stomach tube to normal sheep, the reducing activities of the bacteria, yeasts, etc., in the rumen may be great enough to produce sufficient quantities of nitrite to cause death from typical methæmoglobinæmia: for example, with daily doses of 10–20 gm. in two to three days.

What relation, if any, this toxic factor present in *Tribulus* plants bears to the causation of the disease 'tribulosis' we are not at present prepared to say. The fact that, in both, pronounced hæmoglobin changes, in one case leading to methæmoglobin formation, in the other to excessive bile pigments, are the predominant pathological findings, may be of some significance. On the other hand, we have failed to reproduce either the photosensitivity or the icterus of 'tribulosis' by prolonged administration of dried *Tribulus* plants, potassium nitrate, potassium nitrite, hydroxylamine hydrochloride, hydrazine sulphate and ammonium carbonate either alone or in combination.

'Geeldikkop' is apparently not caused only by species of the genus *Tribulus*, since an identical condition, usually of less severity, has been observed in areas where no *Tribulus* grows, and in these cases, lucerne, *Panicum* spp., *Setaria* spp. and possibly other widely differing plants have been incriminated.

For these reasons we believe that the true causative factor of 'tribulosis' is not a specific substance, peculiar to the genus *Tribulus*, but, as stated, we are inclined rather to the view that some simple substance arising either in the animal or the plant as a result of disordered metabolism, possibly through wilting, and acting in conjunction with a peculiar set of conditions, are to be held responsible for the disease.

Normally the plant is an excellent fodder plant. We would welcome any suggestions or comments that would help to throw light upon this obscure and involved problem.

J. I. QUIN.

CLAUDE RIMINGTON.

Onderstepoort Veterinary Research Laboratory,  
Pretoria, South Africa.

Oct. 19.

<sup>1</sup> Quin, J. I., 16th Rept. Dir. of Vet. Services and Animal Industry. Union of South Africa. Aug., 1930.

<sup>2</sup> Quin, J. I., 17th Rept. Dir. of Vet. Services and Animal Industry. Union of South Africa. Aug., 1931.

<sup>3</sup> Strowd, H. W., *Soil Science*, 10, 333–342; 1920.

<sup>4</sup> Warburg, O., and Negelein, E., *Biochem. Z.*, 110, 66–115; 1920.

### Photochemical Reaction of Hydrogen and Chlorine

THE recent appearance of a note by W. H. Rodebush and W. C. Klingelhofer<sup>1</sup>, in the course of which they mention that they find water vapour to have no effect on the length of the chain reaction induced in a mixture of hydrogen and chlorine by chlorine atoms, suggests to us that a mention of experiments of our own of a similar nature would be of interest to others. Like the above authors, we were aware of the results of Prof. Bodenstein, who courteously informed us last May that, in the course of comprehensive experiments, he had been unable to inhibit the photochemical reaction of hydrogen and chlorine by intensive drying.

The first indications of this sort in our case were noticed in the summer of 1930,<sup>2</sup> when the reaction in question was found to proceed without hitch at chlorine pressures so low as 0.012 mm., a figure controlled by immersing a side tube of the apparatus, containing solid chlorine, in a bath of melting allyl chloride (136.6° K.). The vapour pressure of ice at this temperature is of the order of 10<sup>-9</sup> mm., apart from the possible formation of chlorine hydrate. The soda-glass apparatus was well evacuated and baked out before use. Subsequent work during the last two years under similar, though modified, conditions has always given the same type of result. As, however, there was the possibility of slow distillation of water vapour through the reaction zone from some part of the apparatus which had been insufficiently baked out, and, in particular, as in many of our recent experiments we had employed taps lubricated with phosphoric acid (private communication from Mr. D. L. Chapman) it was decided to submit the point to a more rigorous test.

The soda-glass apparatus was provided with a sealed-in palladium tube at the end remote from the pumps, and the whole, including the Pirani gauge (Rollefson's pattern) was thoroughly baked out in a rapid stream of hydrogen admitted through the palladium. The prevailing pressure of this gas during the process was of the order of 1 mm. After cooling in the gas stream and evacuating, chlorine was distilled into a side tube immersed in liquid air, the greater part of it distilled out again, and liquid air replaced on the side limb. The baking out in the hydrogen stream of the whole apparatus, with the exception of the chlorine supply tube, was repeated for eight hours at a temperature of 200° C., and the apparatus was sealed off from the pump whilst the hydrogen stream was still running. After cooling, the liquid air on the chlorine supply was replaced by a bath of melting methyl-cyclohexane (*p*<sub>cl</sub>, 0.11 mm.), and the apparatus, which contained about 0.5 mm. of hydrogen, insulated by light from a metal filament lamp filtered through a 5 mm. glass plate. Several successive runs gave perfectly normal reaction rates. Blank experiments showed that any formation of hydrogen chloride at the palladium tube surface was negligible.

A. J. ALLMAND.  
H. C. CRAGGS.

King's College,  
University of London.  
Nov. 25.

<sup>1</sup> *Proc. Nat. Acad. Sci.*, 18, 531; 1932.

<sup>2</sup> Bateman and Craggs, *Trans. Faraday Soc.*, 27, 445; 1931.

### Dependence of Electrical Conductance and Dielectric Constant upon Frequency in Mixtures of Strong Electrolytes

THE properties of the ionic atmosphere in the new electrostatic theory of strong electrolytes are very important in regard to reversible thermodynamic and irreversible processes.<sup>1</sup> They enable us, for example, to develop a theory of the irreversible conductivity processes and of the irreversible mechanism that is involved in the viscosity phenomena in the case of a simple electrolyte. We have recently been able to find the general relation between frequency and electrical conductance and dielectric constant in mixtures.<sup>2</sup> From our general equation of the force of relaxation one can now derive a detailed discussion of the quantitative limiting laws of the conductivity and the dielectric constant in mixtures of strong electrolytes. The special discussion—for example, of the problem of 3-ions and 4-ions and so on—is very complicated and will occupy some time.<sup>3</sup>

We thought it desirable, however, to give at once a theoretical explanation of the new experimental work done by Spaght.<sup>4</sup> Spaght has inquired into the dispersion of the conductance of two mixtures of strong electrolytes. His results can be explained theoretically—in a qualitative manner at least—by a further generalisation of the calculations made by Bennewitz and Wagner-Küchler, who have worked out only the stationary case, where a relatively small quantity of ions of sort (3) are mixed with an electrolyte consisting of ions of sorts (1) and (2). Our calculations deal with the non-stationary case and give the expression for the mobilities and the dielectric constant of an electric field alternating with high frequency. Even in this simple case, the expressions for the electrical conductance and the dielectric constant are relatively complicated. We will not give this expression now, as it will be published shortly.<sup>5</sup>

It would be very interesting to compare the theoretical results with further systematic experimental studies which will have to be carried out in the future. In the case of a simple electrolyte, this has been done successfully by many workers who obtain quantitative agreement with the theory of Debye-Falkenhagen. (See the monograph by Falkenhagen, loc. cit.) It should be possible to investigate not only the dependence on frequency of the electrical conductivity but also that of the dielectric constant effect by means of the method worked out by M. Wien.<sup>6</sup> The latter effect is based on the fact that we have a phase difference between the field strength and the ionic velocity produced. That means an electric field produces two components of the electrical current; one of them has the same phase as the field strength and the other one is in phase with the differential quotient of the field with respect to the time or the Maxwell displacement current. The quantity of the displacement current is proportional to the dielectric constant. Hence we get an alteration of the dielectric constant (relatively to the dielectric constant of the pure solvent) which is dependent on the frequency of the field.

It is easy to see that we have to deal with an increase of the dielectric constant. Consider a quick displacement of a central ion; the consequence of the finite time of relaxation of the ionic atmosphere is that a quasi-elastic force will arise which will repel this central ion to its original position. This

quasi-elastic binding between the ions means an increase of the dielectric constant. In the case of more concentrated solutions and relatively very high frequencies, there will be, of course, other interesting effects on the conductance and the dielectric constant, for example, the quantum mechanical forces, dipole effect, effect of solvation and so on.

One important point of view in the development of the theory of electrolytic solutions has yet to be considered. The Debye theory is applicable only in the case of sufficiently dilute solutions and gives the quantitative limiting laws. The electrostatic theory makes use only of the Coulomb forces between the ions. Not only are the electrostatic forces, which means the Coulomb forces and the forces of polarisation, significant, but also the quantum mechanical forces and the interionic dispersion forces are of great importance. The latter correspond to the van der Waals' forces in the case of gases and are not only of electrostatic nature but also of quantum mechanical nature in the sense of London, Eisen-schitz and Margenau.

Taking into account these ideas one has to replace the interionic forces *in vacuo* by the corresponding forces in a solvent; that means that in the first approximation one has to substitute  $e^2/Dr$  for  $e^2/r$  in the formulæ developed by the quantum mechanics, where  $D$  is the dielectric constant and  $e$  the electric charge.

It would be very interesting to extend the theory in this direction. We believe that it would be possible to develop a statistical treatment of more concentrated solutions in the sense mentioned above. This is one of the most interesting problems in the field of electrolytic solutions.

HANS FALKENHAGEN.  
WALTER FISCHER.

Physical Institute,  
University, Cologne.

<sup>1</sup> A complete treatment of the modern theory of electrolytes and critical handling of the experimental data has been tried in the monograph "Elektrolyte" by H. Falkenhagen, Leipzig, S. Hirzel, 1932. The English translation will be published in the series of monographs edited by Prof. R. H. Fowler (Cambridge University Press).

<sup>2</sup> H. Falkenhagen and W. Fischer, *Phys. Z.*, in press.

<sup>3</sup> One of us (Fischer) will give the special discussion in a forthcoming dissertation.

<sup>4</sup> Spaght, *Phys. Z.*, **33**, 534; 1932.

<sup>5</sup> A paper to be published in the *Physikalisches Zeitschrift* (1933).  
<sup>6</sup> M. Wien, *Phys. Z.*, **31**, 793; 1930. **32**, 183; 1931. *Ann. Phys.*, (5) **11**, 429; 1931.

### Infra-Red Absorption of Quartz

IN 1895 Merritt,<sup>1</sup> observing the infra-red absorption in the  $2.9\mu$  region of a beam passing at right angles to the axis in crystalline quartz, found a definite difference when the radiation was polarised in planes at right angles and parallel to the axis. That is, the ordinary and extraordinary rays respectively were differently absorbed. The absorption of a beam parallel to the axis was, as was to be expected, similar to that of the ordinary ray in the first case. Koeningberger<sup>2</sup> in 1897 made like observations.

I am unaware of any subsequent investigation of this effect in this region and wish to direct attention to its importance, especially as the absorption bands for radiation passing parallel to the axis may be required to serve as standards of wave-length in the infra-red. Dreisch<sup>3</sup> has published a curve showing four bands in this region though he only states the wave-lengths of three of them.

I have recently examined specimens of quartz with



unpolarised radiation passing parallel and at right angles to the axis and have been fortunate in having available, by the courtesy of Messrs. A. Hilger Ltd., unusually large thicknesses of the material. The differences in both intensity and structure of the bands for the two directions are striking as may be seen from Fig. 1. The figure also shows the curve of galvanometer deflections (III) using a small 'hohlraum' as source. The bands recorded by Dreisch for crystalline quartz parallel to the axis appear in this curve and are due to the prism, which was of quartz. There is an apparent wave-length discrepancy between curves I and III, because I is referred to a horizontal datum and III to an energy curve falling fairly steeply to the right. This causes an apparent displacement of the bands in III to the right.

It appears, from curve I, that the ordinary ray is completely absorbed between  $2.83\mu$  and  $3.02\mu$  in 63 mm. of quartz. In the 83 mm. used for curve II there is nevertheless a measurable fraction of radia-

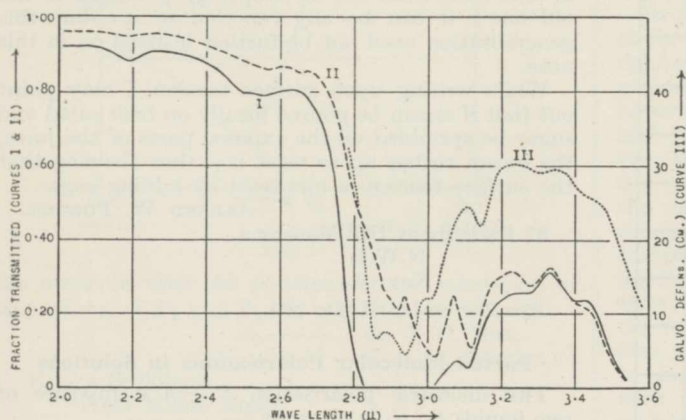


FIG. 1.—Infra-red absorption of quartz. I. Path 63 mm. parallel to axis. II. Path 83 mm. perpendicular to plane of optic and electric axes. III. Galvanometer deflections without specimen.

tion transmitted, which must be ascribed to the extraordinary ray. Allowing for a 50 per cent initial loss from the beam by absorption of the ordinary ray, it follows that the general intensity of absorption of the extraordinary ray must be considerably less than that of the ordinary ray in this region. Further, a comparison of curves II and III suggests that the band structures will prove different. The wave-length of maximum absorption of a band will therefore vary with the direction and state of polarisation of the beam in the quartz. The differences extend some distance on each side of the region mentioned, although here they are not so directly interpreted, and it is interesting to note that Barnes<sup>4</sup> has recently obtained indications of similar dichroism in the band at  $38\mu$  in the far infra-red.

In curve I the band at  $3.11\mu$  is, I think, to be identified with Dreisch's fourth band, the wave-length of which he does not state. The bands at  $2.19$ ,  $2.27$ , and  $2.41\mu$  as well as some structure between  $2.5$  and  $2.7\mu$  have not, so far as I know, been recorded before. I have also found a band in fused silica at  $2.23\mu$  which is of a similar order of intensity to that at  $2.19\mu$  above. This is interesting in view of Barnes's results (*loc. cit.*) indicating bands in fused silica in the far infra-red which, it is suggested, are in some way related to bands occurring in crystalline quartz at rather shorter wave-lengths.

Further work on this subject has been unavoidably held up for some months but I hope shortly to carry out a more extensive investigation of the effects using polarised radiation.

D. G. DRUMMOND.

Physics Department, Armstrong College,  
(Newcastle-on-Tyne),  
Durham University.

Oct. 17.

<sup>1</sup> *Ann. Phys.*, **55**, 49; 1895.

<sup>2</sup> *Ann. Phys.*, **61**, 687; 1897.

<sup>3</sup> *Z. Phys.*, **42**, 426; 1927.

<sup>4</sup> *Phys. Rev.*, **39**, 562; 1932.

### Electrical Ignition of Explosive Gaseous Mixtures

PROF. TAYLOR-JONES, in discussing the thermal theory of the electrical ignition of explosive gaseous mixtures, states that "There is nothing in the thermal theory . . . to suggest that the energy of the translational motion of the molecules, or that of their rotational or vibratory motion plays a preponderating part in the process of ignition" ("Induction Coil Theory and Applications", Pitman, London, 1932). Whilst in complete accord with the first part (up to and including "theory") I cannot agree with this statement as a whole, for the following reasons:

The thermal theory of electrical ignition has been put forward by Taylor-Jones, Morgan and Wheeler<sup>1</sup> in terms stating that "the ignition of a gaseous mixture depends primarily . . . on the heating of a sufficient volume to a sufficient temperature". But this view must involve the supposition that internal molecular energy plays no rôle in ignition, because it is well known that molecules can be excited without at the same time necessarily increasing their translational energy. Thus Taylor-Jones's statement as quoted above should be amended to read "The thermal theory asserts that only the translational energy of the molecules plays a part in ignition", because it cannot be supposed that the ratio between excited and normal molecules in a gas is determined solely and in all circumstances by the temperature.

There are, however, many well-established facts, such as, for example, the photo-ignition of hydrogen-chlorine mixtures, which suggest that internal molecular energy does in fact play a preponderating rôle in ignition and thus appear to contradict the view of the importance assigned by the thermal theory to translational energy. Further, in conjunction with H. H. Thompson<sup>2</sup> I have shown by a crucial experiment that fact and the thermal theory are in direct conflict.

G. INGLE FINCH.

Imperial College of Science and Technology,  
South Kensington, London, S.W.7.

Nov. 22.

<sup>1</sup> *Phil. Mag.*, **43**, 359.

<sup>2</sup> *Proc. Roy. Soc.*, **A**, **134**, 343.

### Surface Tension near the Critical Point

It is well known that when measured values of surface tension are plotted against the temperature a nearly linear law is obtained, but that as a rule the curve is concave upwards and approaches the critical point almost tangentially (even if not quite so) the

surface tension being then zero. It must be borne in mind, however, that this statement is made with respect to the 'measured values'. These, near the critical point, are usually made by means of the capillary tube method and it is tacitly assumed that if the tube is narrow enough to be considered a 'narrow tube' at ordinary temperatures it will still be so at high temperatures.

The principles of dynamic similitude show, however, that this is not the case. The shape and elevation of the meniscus depend not on the radius  $r$  alone but on its relation to  $\beta$  where  $\beta^2$  (the capillary constant) equals  $\sigma/g\rho$ . In fact  $\beta^2/r^2 =$  function of  $h_0/r$  where  $h_0$  is the capillary rise at the mid-point of the tube. The observed quantities are  $h_0$  and  $r$  and from these  $\beta^2$  must be calculated. Now when  $\beta$  is large compared with  $r$  (and therefore  $h_0$  is large compared with  $r$ ) the tube can be considered as narrow and  $\beta^2$  can be calculated by a very simple relation. But near the critical point  $\beta^2$  and  $h_0$  are

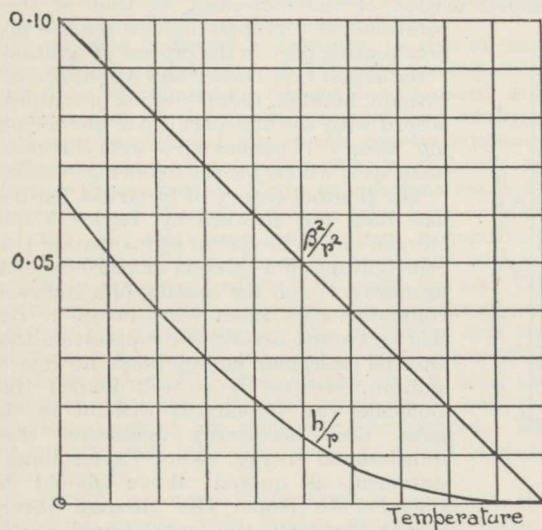


FIG. 1.

very small; the tube now behaves as a very wide one. The functional relation is in such a case much more complicated and it is only since Rayleigh's paper of seventeen years ago<sup>1</sup> that it has become possible to calculate  $\beta^2$  from the experimental observations.

The most important of these observations were made by Ramsay and his co-workers and published so far back as 1893 in the *Philosophical Transactions of the Royal Society of London*. We may be quite certain, therefore, that the only corrections made were those suitable for a narrow tube. If so, the values which are usually quoted and discussed are really values of  $\frac{1}{2}h_0/r$  (or of some quantity very near thereto) and it is to these that the various properties discussed by Baron Eötvös and others relate.

With the help of Rayleigh's equation for very wide tubes it is possible now (and has been for the last seventeen years) to make a proper reduction of the experimental values. This I have done for the special case in which  $\beta^2/r^2$  is assumed to be a strictly linear function of the temperature. The result is shown in Fig. 1, which is drawn to scale. The values of  $h_0/r$  have been calculated from  $\beta^2/r^2$  (by working backward) and are shown on the lower curve. It will be seen at once that this lower curve

has precisely the characteristics which are usually attributed to  $\beta^2$  or rather to the values of surface tension calculated from it.

This suggests that it is quite possible that  $\beta^2$  is a linear function after all; but it is necessary first to find out (if possible) what were the radii of the tubes actually used by various investigators. This preliminary note is written as a warning to those who, like myself, have spent much time in connexion with this question.

The curve shown has very wide applications. The quantities  $\beta^2/r^2$  and  $h_0/r$  are both pure numbers and a single pair of curves gives the relation between the two sets of values. If, for example,  $h_0/r = 0.03$  (whether for narrow or wide tubes) then  $\beta^2/r^2$  at the same temperature has the value 0.07 which is on the same vertical. The scale of temperature is adjustable and is therefore not indicated on the diagram. If by altering this scale the experimental values of  $h_0/r$  fit the lower curve exactly, then at the same time the values of  $\beta^2/r^2$  will fit the upper curve. The altered scale need not be simply proportional to the old one; it can be any function of it: but this generalisation need not be further insisted on in this note.

While writing upon surface tension, I may point out that if cream be poured locally on fruit salad and sugar be sprinkled on the exposed parts of the juice, the cream rushes up to meet it; thus showing that the surface tension is increased by adding sugar.

ALFRED W. PORTER.

87 Parliament Hill Mansions,  
N.W.5.  
Nov. 6.

*Proc. Roy. Soc., A*, 92, 184; 1915.

#### Partial Molecular Polarisation in Solutions

THE dielectric polarisation  $P_{12}$  of a mixture of two liquids  $S_1, S_2$  is given by:—

$$P_{12} = \frac{\epsilon - 1}{\epsilon + 2} \frac{c_1 M_1 + c_2 M_2}{d},$$

where  $\epsilon$  is the dielectric constant,  $c_1, c_2$  the molar fractions and  $M_1, M_2$  the molecular weights of  $S_1$  and  $S_2$ , and  $d$  the density of the solution. Since this quantity has the dimensions of volume, it would appear that the partial polarisations of the two components should be determined by methods similar to those used in evaluating partial volumes, etc.

It has usually been assumed that in solutions containing polar and non-polar components, the molecular polarisation of the non-polar component can be given a constant value  $P_1$ , in which case the polarisation of the other component is given<sup>1</sup> by:

$$P_2 = \frac{P_{12} - c_1 P_1}{c_2} \quad \dots \quad (I)$$

The true value of the partial molecular polarisation  $\bar{P}_2 = (\delta P_{12}/\delta n_2)$  may be evaluated by the method of intercepts.<sup>2</sup>

Both methods give the same value for a substance present in small concentrations and also when the  $P_{12} - c_2$  curves do not diverge greatly from a straight line. If the curve has a maximum, or a point of inflexion, the values of  $P_2$  and  $\bar{P}_2$  calculated in these ways may differ considerably. Fig. 1 shows (1) the experimental  $P_{12} - c_2$  curve of solutions of *n*-butyl alcohol in heptane<sup>3</sup>, curves (2) and (3) the approximate values of  $P_2$  and  $\bar{P}_2$  determined by (I)

and by the method of intercepts; (4) is the constant value of  $P_1$  assumed in calculating  $P_2$  and (5) the values of  $\bar{P}_1$  determined by the method of intercepts. In this case the assumption that  $P_1$  can be taken as constant is evidently far from true. It may also

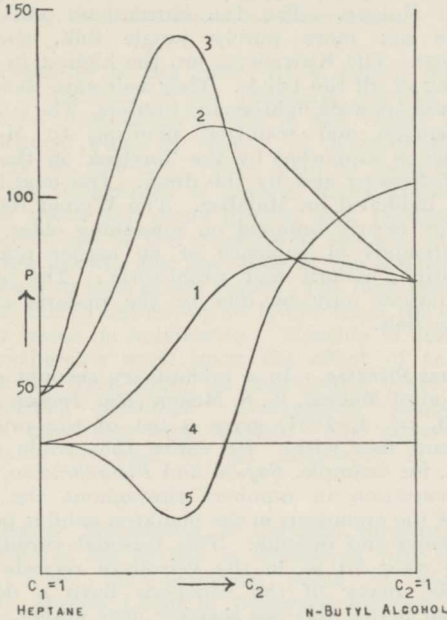


FIG. 1.

be observed that the positions of the maximum of the curves of  $P_2$  and  $\bar{P}_2$  are considerably different.

W. J. C. ORR.

J. A. V. BUTLER.

King's Buildings,  
West Mains Road,  
Edinburgh.

<sup>1</sup> Debye, "Polar Molecules".

<sup>2</sup> Lewis and Randall, "Thermodynamics", p. 38.

<sup>3</sup> Smyth and Stoops, *J. Amer. Chem. Soc.*, **51**, 3318; 1929.

### Colour Changes in Crustacea

COLOUR changes, in response to light and darkness and to background tint, are well known in prawns and shrimps. I have found this faculty to be present in other decapod Crustacea. It is exhibited by *Porcellana longicornis*, *Eupagurus bernhardus*, young *Galathea strigosa* and *G. dispersa*, and in two cases referred to below.

It has been shown by Hogben and his school<sup>1</sup> that colour change in Amphibia is due to two causes. (1) Light acts directly on chromatophores (primary effect), and (2) light reflected from the surroundings acts through the eyes, causing the liberation of hormones into the blood, which in turn act on the chromatophores (secondary effect). In the Decapods there appears to be a similar dual control of the chromatophores. (1) Primary effect: light, acting directly on the chromatophores, can cause expansion of the pigment, while in the absence of light the pigment is contracted.<sup>2</sup> (2) Secondary effect: light reflected from a light-coloured background acts on the eyes with the result that a hormone, contractin, is liberated into the blood from glands in the eye stalks. This hormone causes pigment contraction in the chromatophores.<sup>3</sup> A black background, through optical stimulation, causes another hormone,

expantatin, to be liberated from the rostral gland, with resulting pigment expansion.<sup>4</sup>

Experiments which I have made show that hermit crabs also exhibit this dual control of the chromatophores. The responses of *Eupagurus prideauxi* are as follows. (a) In darkness the crabs become pale (primary effect). (b) On a dark background in light they become dark (secondary effect). (c) On a light background in a dull light they become pale (secondary effect). (d) On a light background in a bright light they become dark, although not so dark as in (b) (balance between primary and secondary effects). Now, the chromatophores on the abdomen and its appendages are functional, although they are concealed within the mollusc shell. When crabs carrying their shells are on a light background in a bright light (d, above) the abdominal chromatophores are less expanded than those on the rest of the body. But when such crabs are removed from their shells, light can act directly on the abdominal chromatophores, and within a few minutes they expand as fully as the others.

In the shore crab (*Carcinus mænas*) dark-coloured adult individuals exhibit no colour changes, but light-coloured animals show a small amount of colour response. Most young individuals (1-2 cm. across), however, exhibit colour responses to backgrounds and to darkness within 30 minutes. As the crabs age, this faculty is gradually lost, individuals of 2-4 cm. requiring one or more days to react. In the dark-coloured adults, which do not change colour, most of the chromatophores beneath the carapace are expanded. Blood from these crabs injected into prawns usually causes them to darken, showing that an excess of expantatin is present. Now, the removal of the contractin glands in *Crangon* has been found to cause the calcium content of the shell to diminish, suggesting that contractin is concerned with calcium deposition.<sup>5</sup> It is possible that the scarcity or absence of contractin in adult *Carcinus* may be connected with the deposition of salts in the thick exoskeleton. In Amphibia, too, there is a connexion between calcium metabolism and colour change. The pars tuberalis of the pituitary is concerned with the colour response of these animals to white background.<sup>1</sup> Now, a fall in blood calcium following pituitary removal occurs in Amphibia,<sup>6</sup> and in a private communication Prof. Hogben writes that Dr. Zwarenstein, working in his laboratory, has recently proved this fall in calcium to be due to the removal of the pars tuberalis.

E. M. STEPHENSON.

Zoological Department,  
University of Birmingham.

<sup>1</sup> Hogben and Slome, *Proc. Roy. Soc., B*, **108**, 10; 1931.

<sup>2</sup> Keeble and Gamble, *Phil. Trans. Roy. Soc., B*, **196**, 295; 1904.

<sup>3</sup> Perkins, *J. Exp. Zool.*, **50**, 71; 1928.

<sup>4</sup> Koller, *Z. vergl. Physiol.*, **8**, 601; 1928.

<sup>5</sup> Koller, *Z. vergl. Physiol.*, **12**, 633; 1930.

<sup>6</sup> Hogben, Charles and Slome, *J. Exp. Biol.*, **8**, 345; 1931.

### Tables for Statisticians and Biometricians, Part II

As some readers of NATURE may have purchased copies of Part II of the "Book of Tables for Statisticians and Biometricians", recently issued from this Laboratory, I should be glad to inform them through the columns of this journal that copies of an errata slip may be obtained post-free on application to the Secretary of the Laboratory.

Biometric Laboratory,  
University College,  
London, W.C.1.

KARL PEARSON.

## Research Items

The Severn Crossing in Roman Times.—During the course of the present year Dr. C. Scott Garrett and Mr. Frank H. Harris, 23 Newerne St., Lydney, Glos., have discovered the foundations of extensive Roman buildings in three fields known as the 'Chesters' on the land between the Severn and Woolaston Pill. In a communication sent to NATURE they suggest that this gives ground for a revision of the current idea that the Roman station of Abone was Sea Mills on the Avon. This identification is supported by Haverfield, Collingwood and the Ordnance Survey map of Roman Britain. It must be remembered that the water level of the Severn was considerably higher in Roman times than it is now, and even to-day the low land behind Caerwent is sometimes flooded, so that the station itself must have been very near to the water when it was built: of this there is abundant archaeological evidence. On the other hand, the erosion on the right bank of the river has been so extensive that only half of Sudbrook camp remains. But this loss has been more than compensated for by the deposition of alluvium on the left bank. Supposing that the Severn once flowed not far from the foot of Shirehampton Hills, then the Roman port was probably either at Sea Mills or on the Severn just to the east of it because the Roman road from Bath to Bitton and on to the north crossed Durdham Downs in the direction of Sea Mills, and if the point of departure had been elsewhere, for example, at Oldbury, it would have been as easy for the road from Bath to go there direct as via the Avon. A road from Sea Mills to Gloucester is marked on the Ordnance map, but this would have been an indirect approach to Oldbury, unlike the usual Roman method of road planning. It has long been known that there was a Roman station at Sea Mills, and when the Portway, the new low level road along the Avon was cut, a few years ago, a great deal more Roman material, including the foundations of buildings, was discovered. On the whole, this site fits well into the position of Abone given in the itinerary of Antonine, though the problem of "Trajectus" has been variously solved by scholars. However, no more distant site would meet the requirements of the twenty-four miles allowed between Bath and Caerwent.

The Wynad.—In "Notes on the Cultural Geography of the Wynad" (*Indian Antiquary*, Sept., Oct., 1932), Mr. F. J. Richards reviews the history and ethnology of the Wynad, which forms the southern bastion of the Deccan plateau. The plateau is hemmed in by the Coorg Hills on the north and the Nilgiris on the south. By its natural features the country is divided up into areas which differ from one another in their cultural affinities. On the Malabar borders it is densely forested, while on the Mysore border is a broad deciduous bamboo belt. An area of about 1,100 sq. miles supports a population of a little more than 100,000. The Wynad has never been studied intensively from the anthropological point of view. Before the introduction of tea and coffee planting, the population was mostly confined to swampy ground along the river valleys, growing paddy. They had no use for the forest land, all the pasture required being provided by the low hillocks which grow from the swamps. Each river valley supported a more or less homogeneous community. The oldest stratum in

the population is, presumably, the curly-headed Paniyar, speaking corrupt Malayalam, whose method of fire-making by 'sawing' links them with the jungle folk of Malaya. The Ten Kurumbars and Shola Nâyaks are more purely jungle folk, speaking Kanarese. The Kurrichans are the highest in social standing of all the tribes. They cultivate their own lands and are keen fighters and hunters. The evidence of language and tradition pointing to Malabar influence is supported by the 'forelock' in the style of hair-dressing and by the dress. The land-tenure is also modelled on Malabar. The Wynad religious cults are clearly imposed on something older. The area abounds in evidence of an earlier populous civilisation, historic and 'prehistoric'. The present depopulation may be due to the malaria of the bamboo belt.

Madras Plankton.—In a preliminary account of the plankton of Madras, K. S. Menon (*Rec. Indian Mus.*, vol. 33, pt. 4, 1931) gives a list of the principal organisms met with. He states that while a few genera, for example, *Sagitta* and *Pleurobrachia*, show little variation in numbers throughout the year, most of the organisms in the plankton exhibit periods of maxima and minima. This seasonal variation is not so clear-cut as in the European records; for example, many of the copepods have a definite maximal period but are scarcely ever absent. This is probably because the weather conditions and changes in the constitution of the sea-water vary less than in colder seas. The plankton of the west coast of India, as recorded by Hornell and Naidu, shows great scarcity of diatoms in December, a secondary maximum in January and February, a fall in March and the principal maximum in May. In the Madras plankton, diatoms are scarce in August and September; the secondary maximum is from November to January and is made up mainly of *Coscinodiscus*. The true phytoplankton maximum is in May; diatoms become fewer in June but in July reappear in large numbers and then disappear rapidly. There is no separate dinoflagellate maximum; it coincides with the diatom maximum in May. The copepod maximum is from November to February inclusive; the difference between this and the condition in European seas is the inhibiting factor of cold in the latter.

Primitive Conducting Mechanisms of the Vertebrate Heart.—Employing as research material larval *Lepidosiren paradoxa*, Dr. Tudor Jones has published an important paper on this subject (*Trans. Roy. Soc. Edin.*, vol. 57, 1932). He has shown that all the conducting mechanisms hitherto described are here represented by purely nervous structures, and that their appearance preceded the general development of cardiac muscular striation. The entire system has been traced out and shown to consist of a nervous continuum consisting of two regions of the medulla oblongata, intermedio-lateral and ventral, with communications involving the sixth aortic arch, the ductus Botalli, the pulmonary artery, the sinus venosus, atria and ventricles of the heart, and, finally, the pulmonary vein. There are also bilateral communications at three levels which are probably of segmental origin. These structures form, at the cardiac end, a nervous complex to which, Dr. Jones

believes, the whole development of the heart may be referred "as to an organic system of developmental foci". It is of great interest to learn that structures, such as the sixth aortic arch, the ductus Botalli, the pulmonary artery and the heart, which were not previously known to be related, are actually so related by their fundamental innervation.

**Biochemistry of Sea Life.**—In a paper, compiled for a symposium at the Pasadena meeting of the American Association ("Life in the Ocean from a Biochemical Point of View". *J. Washington Acad. Sci.*, 22 (9), 246-257, 1932), Paul S. Galtsoff deals with the importance of certain minor constituents of sea water for plant growth and tabulates the concentrations of the elements in the sea, so far as they are known, also the ratio of the concentration in tissues to that in sea water. The high concentration of zinc in tissues, up to 10,000 times the amount in sea water, is noteworthy. Mention is also made of Prytherch's work upon the effect of traces of copper in river water in stimulating oyster larvæ to become attached. Interesting temperature effects have also been quoted. The paper might profitably be read by all interested in marine life.

**Biological Significance of Colloidal Structure.**—The structure of the protein is considered very suggestively from the biological point of view by Dr. D. Jordan Lloyd in *Biological Reviews*, vol. 7, No. 3, July, 1932. The high content of water in actively growing protoplasm is emphasised. This water is a necessity if the metabolic reactions associated with vital activity are to proceed in solution and it is pointed out that the proteins in the living protoplasm probably have highly hydrated polar amino-acids linked to the CH-NH-CO backbone, which itself supplies an element of stability to the structure. The water relation of such a protein system would be highly sensitive to changes in environment. On the other hand, in both plant and animal tissues, fibrous structures are present, constructed of protein in the animal and of carbohydrate in the plant, which are essentially stable and have a low water content. In these fibres the stable backbone of the long-chain chemical structure, which is itself little hydrated, has linked to it comparatively few polar side chains with strong affinity for water, but it is built up of a series of stable ring linkages following one another with periodic regularity, so that X-ray analysis can be employed to unravel their structure. Such structures combine stability and resistance to decay with a low water content and slight affinity for water. Thus from the same colloidal systems structures may be built meeting the very diverse needs of living organisms.

**A Disease of Dahlias.**—A leaf-spotting disease of dahlias occurred at Wisley in 1930. It was studied in detail by Mr. D. E. Green, who now reports the results of his investigations (*J. Roy. Hort. Soc.*, vol. 57, pt. 2, pp. 332-339). Detailed descriptions of the symptoms are given, and the causal fungus has been identified as *Entyloma dahliae*, Sydow. Various control measures have been tried, and some success has attended the use of Bordeaux mixture used as a spray in August. French growers state that late planting aggravates the disease. No satisfactory

demonstration of the way in which infection spreads in the field has been given, and preliminary experiments on direct infection with spores have not produced the disease. Further work is in progress to try to find how the fungus overwinters.

**Dipterocarpaceæ of the Malay Peninsula.**—From a commercial forestry point of view, the group of Dipterocarpaceæ contains some important timber trees, and yet the knowledge of them so far attained is said to be very incomplete. Mr. H. N. Parker has been studying the Indian and Burman species at the Forest Research Institute, Dehra Dun, and Dr. F. W. Foxworthy, the forestry research officer of the Federated Malay States, has been undertaking investigations in the group in the Malay region, where it forms so important a portion of the forest flora. This work appears in *Malayan Forest Records* (No. 10, Singapore, pp. 289, plates 33 and map, 1932). Dr. Foxworthy states that the knowledge of the group remains very incomplete, in spite of the fact that it contains the most important group of timber trees of the Malay States. Attention has often been directed to the difficulty of obtaining herbarium material because of the very large size of the trees, the scarcity of population in the forests, and the relatively infrequent flowering and fruiting of many species. There have been but few botanists specialising in the group, and collections, until recent years, have been few. The author has worked at the group for a number of years and has had the opportunity of examining types and critical material in the herbaria of Leyden, Kew, Calcutta, Singapore, Buitenzorg and Manila. Dr. Foxworthy's untiring labours have added very considerably to our knowledge of the Dipterocarpaceæ.

**Solar Influence on Cosmic Radiation.**—The Bauer memorial number which constitutes the September issue of *Terrestrial Magnetism and Atmospheric Electricity* contains a short contribution by Prof. Hess of Innsbruck describing the cosmic radiation observatory he has set up on the Hafelekar at a height of 2,300 metres above sea-level. The apparatus is of the same type as that in use at the other observatories which are taking part in the co-operative plan of work organised by Prof. Hess, a list of which was given in a note in *NATURE* of November 26, p. 816. The ionisation chamber contains 22 litres of carbon dioxide at 9.5 atmospheres and the ionisation current to the electrometer is compensated as in Hoffmann's apparatus. The records are taken photographically and from September last year until May this year they show that the ionisation during the day is about 0.2 per cent greater than during the night.

**Mechanism of Gaseous Explosion.**—The November issue of the *Proceedings of the Royal Society* contains two papers on the mechanism of explosive oxidation in the gas phase. One by Hadman, Thompson and Hinshelwood describes experiments on dry carbon monoxide in silica vessels at temperatures around 700°. There is an upper and a lower limit to the pressure range over which explosion takes place, and the reaction goes on slowly outside these limits. The lower limit does not depend markedly on the temperature; its dependence on the size of the reaction vessel is apparently masked by other differences in the

vessels. It is lowered by the presence of inert gases. The upper limit rises rapidly with temperature. A peculiar effect was obtained when the pressure of a mixture was gradually lowered until it was well inside the reaction limits without explosion taking place. This is said to be due to a 'poisoning' of the walls of the vessel by carbon monoxide. The results are explained on the basis of a reaction which starts at the surface of the vessel and proceeds by a chain of reactions. The lower limit is then determined by the diffusion of active centres to the wall of the vessel and is lowered by inert gases which diminish this diffusion. The upper limit is determined by a deactivation process taking place in the gas phase. The second paper, by Hinshelwood and Moelwyn-Hughes, deals with the hydrogen-oxygen reaction in silica vessels, and describes experiments on the lower limit of pressure for explosive reaction. As with carbon monoxide, inert gases lower this limit, and here there is rough quantitative agreement with the assumption that the inert gas prevents the loss of active centres by diffusion to the wall.

**Short Wave Radio Propagation.**—In view of the increasing use of short waves for radio communication, any new facts concerning them are of great interest to engineers. In a paper read before the Institution of Electrical Engineers on December 7, Prof. J. Holling-

worth gave experimental data obtained by examining signals with a cathode ray direction finder, received at distances up to 7,000 miles, having frequencies of the order of 10,000 kilocycles a second. The work carried out is part of the programme of the Radio Research Board. The two outstanding features noted in the research are the systematic appearance of certain cyclic forms on the end of the tube of the direction finder and the large values obtained for the horizontally polarised electric components. An ellipse, which is generally in a violent state of oscillation, is seen in the tube. This shows that there is an abnormally polarised wave present. 'Fading' gives a change in the size of the ellipse without change of shape. An analysis of the ellipse forms is given based on Appleton's magneto-ionic theory. This theory predicts that in general each up-going ray will be split into two elliptically polarised components with opposite directions of rotation, which recombine on emergence from a layer where they have suffered differential phase change and absorption. The author concludes from the evidence that in general the magneto-ionic theory seems to provide a reasonable explanation of the majority of the observed phenomena. The experiments were originally undertaken in a spirit of pure inquiry but some of the results are so surprising that they inevitably challenge accepted ideas.

### Astronomical Topics

**The Leonids.**—The fullest series of observations yet to hand was made by Dr. V. Guth at Stary Smokovec in Czechoslovakia (height 1,020 metres). He gives in U.A.I. Circular No. 408 the following table of his observations :

U.T.	Nov. 16	Nov. 17	Nov. 18	Nov. 19	Nov. 20
0 <sup>h</sup> -1 <sup>h</sup>	16	cl.	cl.	cl.	cl.
1-2	42	cl.	cl.	cl.	3
2-3	40	cl.	cl.	0	5
3-4	57	cl.	cl.	6	cl.
4-5	63	cl.	5	3	3

cl. means cloudy or misty.

On the first night there were 15 meteors brighter than mag. 0. One that was seen at 3<sup>h</sup>36<sup>m</sup> on that night was a detonating meteor, mag. -5. The above figures suggest that maximum may have occurred during daylight on November 16, which would accord with prediction.

Mr. M. A. R. Khan made the following observations of Leonids at Hyderabad: Nov. 8, 11 in 60<sup>m</sup>; Nov. 9, 5 in 30<sup>m</sup>; Nov. 11, 10 in 60<sup>m</sup>; Nov. 12, 9 in 80<sup>m</sup>; Nov. 13, 2 in 30<sup>m</sup>; Nov. 14, 7 in 60<sup>m</sup>; Nov. 16, 20 in 70<sup>m</sup>. Two meteors on Nov. 8, and four on Nov. 16, were noted as bright. The observations were made between 20<sup>h</sup> and 23<sup>h</sup> U.T. on the days named. The nights of Nov. 10, 15, and 17 were cloudy throughout.

**Planetary Perturbations.**—Prof. W. H. Pickering, in an article in *Popular Astronomy* for November, criticises a paper by Prof. E. W. Brown (*Mon. Not. Roy. Ast. Soc.*, vol. 92, p. 80) in which the statement occurs "From time to time statements have been published . . . that the maximum observable effect of one planet on another will take place at or close to conjunction. How completely erroneous such statements are can be shown . . ." Prof. Pickering distinguishes between the largest perturbations and those of sharpest curvature. He admits that the

former take place when the planets are on opposite sides of the sun; but the wave produced by them is so long that in the case of a planet that has only completed one revolution since discovery they cannot be separated from errors in assumed eccentricity and perihelion point. Those that occur near conjunction of the planets, though smaller, are easier to distinguish from errors of the elements, owing to their more rapid change. Prof. Pickering appears to justify this assertion by recalling the circumstances of the discovery of Neptune. Bouvard, in his tables of Uranus published in 1821 (the year of its conjunction with Neptune), rejected all the observations of Uranus made before its discovery in 1781; nevertheless, his tables soon began to exhibit appreciable errors. These were prominently shown in the Cambridge observations of 1828; in 1834, the Rev. T. J. Hussey wrote to Airy suggesting the existence of an exterior planet, and offering to search for it if an approximate position could be given. Bouvard himself had the same idea in 1837. Airy admitted in that year that the "errors of longitude are increasing with fearful rapidity", though he had not much confidence that the position of the unknown could be determined; he said, however, that the facts "tended greatly to impress upon astronomers the absolute necessity of seeking some external cause of disturbance". Prof. Pickering's deduction that an observable effect does occur about the time of conjunction appears justified. It is well known that he tried to deduce from the observations of Neptune the position of an external planet; he made three different determinations of its position, which were published in 1909, 1919 and 1928; the middle one was within 69' of the true place of Pluto at the time of publication, the others were some 27° away from it. In fact, Pluto was photographed at Mount Wilson in 1919 as a result of that prediction, but the images were not detected until 1930.

## The Discovery of Peking Man\*

IN his Croonian lecture on *Sinanthropus* or Peking man, Prof. Davidson Black gave a full and detailed account of the circumstances leading up to the discovery of the skeletal and cultural relics of this primitive human type and of the conditions, geological and other, in which they were found.

The first indication of the presence of early man to be found on the site was in 1921 when Dr. J. C. Anderssen, then mining adviser to the Chinese Government, noticed fragments of white quartz among loose talus at the foot of fossiliferous deposits exposed in the south wall of a disused quarry in the Ordovician limestones at Choukoutien. As no quartz of any kind occurs naturally in this part of the Choukoutien area, he at once inferred the presence of primitive man. From this point Prof. Black described the investigations which led to the discovery of a fossil tooth, first announced in 1926 on a report from Uppsala, where material from Choukoutien was under investigation; the discovery of the fossil tooth by Dr. Böhlin in 1927, upon which was based the recognition of a new human genus, *Sinanthropus*; and the discovery of the first and second of the two skulls in 1929 and 1930 by Dr. W. C. Pei, under the Cenozoic Research Laboratory, which was organised by the Geological Survey of China in 1929 and now functions as an integral part of that service. In 1930 the Geological Survey acquired by purchase full title to the *Sinanthropus* site, which is thus preserved to science for all time.

In 1931 Dr. Pei discovered artifacts and evidence of Peking man's use of fire in an undisturbed fire-blackened stratum. Prof. Black also referred to the other skeletal fragments recently described, as well as to six lower jaw fragments, of which an account is to appear shortly. The endocranial cast which has been prepared indicates that *Sinanthropus* was right-handed and possessed a nervous mechanism for the elaboration of articulate speech.

In his account of the conditions of the discovery

\* Substance of the Croonian lecture delivered by Prof. Davidson Black before the Royal Society on December 8.

Prof. Black was on what was probably to most of his audience less familiar ground. Channels and caverns have been hollowed out of the Ordovician limestone by the solution action of ground water; and after the elevation of the formation, erosion removed the overlying strata. Fissures which formed have been filled and these deposits converted into travertine.

The cavern occupied by *Sinanthropus* was large, of irregular shape, and opened towards the river valley to the east. Throughout the time it was being gradually filled by detritus, it was wholly or in part occupied by *Sinanthropus*. His occupation must have extended over hundreds, probably thousands, of years, for more than thirty metres of undisturbed strata remain, showing evidence of his presence throughout. During the later part of his occupation the fauna did not change, but remained typically that of the upper part of the Lower Pleistocene.

Most of the northern limestone wall limiting the original cave has been removed by modern quarrying operations exposing the solidified detritus. Up to 1932, excavations of the actual deposits have been confined to the regions accessible from the northern face. Work is now progressing along the line of contact between the accumulated deposit and the southern wall of the original cave.

The modern cave of Kotzetang is really the result of recent excavation, made probably by quarrymen, in the relatively unconsolidated portion of the great stratified breccia comprising the eastern portion of the main Choukoutien deposit. The northern wall is part of the original northern wall of the cavern.

Prof. Black also referred to the artifacts and the recent study of them by Dr. W. C. Pei and P. Teilhard de Chardin, from which it is concluded that *Sinanthropus*, "culturally speaking, is to be considered as an early representative of the Old Palæolithic cycle, but his craft displays a crudity which indicates that he but obeyed and never mastered the materials with which he worked".

## Capacitance HygroscoPy and some of its Applications

By Dr. W. LAWRENCE BALLS, F.R.S.

SOME experiments were briefly noted in this journal last April<sup>1</sup> whereby the high dielectric constant of water was used to indicate variations in the water-content of substances contiguous to a leaky condenser, by means of a resonance method. It would seem that other workers are exploring the same track, with the difference that they draw samples which are placed in special condenser-containers for measurement, whereas I prefer to take full advantage of the method in evading the ubiquitous 'sampling-error' so far as possible; even at the sacrifice of some accuracy in the actual determination. Great accuracy is probably unobtainable in any case; the dielectric constant even of free water is not a constant, but the margin of difference between water around 80 and most other common substances below 8 is large enough for most classes of comparative work.

The necessary apparatus is as portable as an attaché case, and is proving itself to be of versatile

utility. Examples will shortly be given. On the analogy of resistance thermometry, I suggest that the general technique might be termed 'capacitance hygroscoPy'.

The arrangement at present used is necessarily capable of improvement in electrical design, but its functions very usefully when its limitations are respected, especially since the discovery of papers by Lattey and his collaborators has allowed voltage-tuning to be incorporated.<sup>2</sup> This is done by applying the resonator voltage to the grid of a second valve, the anode current of which then indicates the voltage, as in the Moullin thermionic voltmeter<sup>3</sup>; the coupling between the generator and resonator can be kept very loose, and a feeble and portable generator used with safety. The triple circuit shown in Fig. 1 is also a plan of the arrangement. It undergoes small zero shifts due to temperature and also to earth-capacity, but these are eliminated by zero-setting with one variable condenser, prior to measurement on the

other one. Variations of resistance in the unknown capacity can also alter the 'capacitance' readings, in spite of voltage tuning, as Lattey has recently pointed out; the elimination of these errors is no doubt possible, but even now it is practicable to obtain accurately comparative readings in repetition work, the voltage indications serving as a warning of abnormal conditions. Definite fixation of frequency by a quartz crystal, capacity coupling, and proper screening, are obvious improvements next to be made.

Three examples of very diverse applications will now be outlined.

SOIL-WATER DETERMINATIONS

The buried condensers are, as formerly described, made from purchased glass web-tube, or from homemade capillary web-tube produced by blowing two bulbs together and then drawing them out. Staybrite steel wire (33 s.w.g.) is used for the final lead-in, to avoid amalgamation. Gutta-percha seals these wires in the entrance to the web-tube. The larger tubes are wrapped in a thin skin of cotton fabric dipped in plaster of Paris, so as to stabilise the capillary water conditions in contact with the glass; an assumption is made here. The leads are made of thin widely-spaced wires inside gas-pipe, so that they may be as insensitive as possible to the soil-water variations until the web-tube is reached at depths of three metres or so, but their design is not yet properly worked out.

Some very complex curves for changes in soil-capacity with changes of moisture have recently been published,<sup>4</sup> determined by a compensated bridge method. They contrast very sharply with such simple curves as Fig. 2, which seem to me to be more inherently probable. Actually even these latter

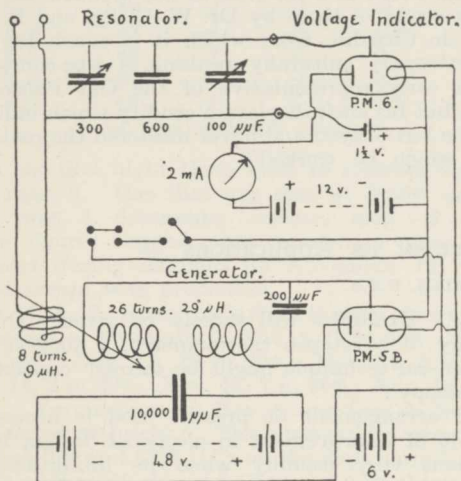


FIG. 1—Circuit diagram and plan.  $\lambda = 150 \text{ m.}; f = 2000 \text{ kc.}; \delta = 0.06$ . Size: 12 cm. x 32 cm. x 38 cm. Weight 8 kgm.

are more complex than those obtainable in deep soil, because the capillary web-tube condensers were buried initially in air-dry soil which was allowed to swell freely on saturation with water, and then to shrink into a compact block as it dried. In the field one would not obtain the volume increase except near the surface. The inflection shown by both curves, representing two separate experiments, near the point at which deep soil becomes water-logged in

the field,<sup>5</sup> marks the upper limit of capacitance under deep soil conditions. The fragment of hysteresis loop obtained after oven-drying and slowly damping again by exposure to air, is probably also abnormal in width, owing to minute air-space cracks developing between the soil and the bare capillary glass.

TESTING COTTON BALES

As president of the Trustees of the new Alexandria Testing House, founded in consequence of an international trade agreement, I have been given exceptional facilities by the pressing firms of Alexandria,

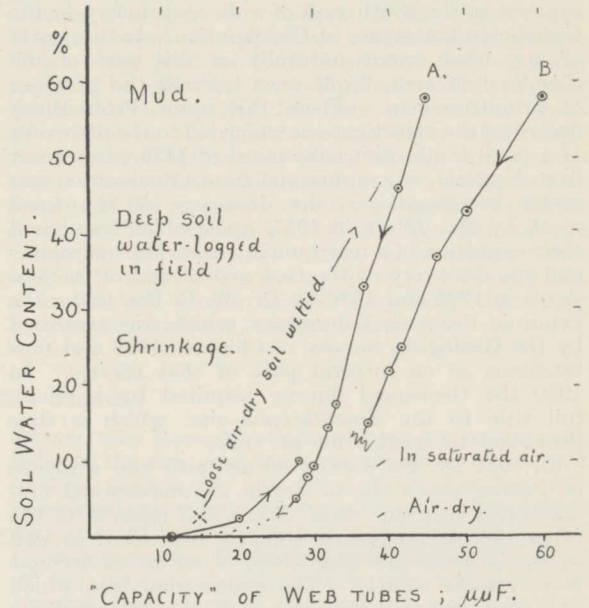


FIG. 2. Soil moisture.

to obtain data from bales specially prepared to various moisture contents, while Mr. D. A. Newby has collaborated in making the oven tests more exact. Capacitance tests are now being taken as routine on the hoops of all bales from which oven-tests are to be made, so as to accumulate several hundred pairs of observations. It already seems likely that so long as the test is limited to freshly pressed and homogeneous bales, as formerly suggested, we have a useful and rapid method of control which can test every bale made, and can do so at much less cost than the usual oven-testing of every tenth bale. Whether it can be trusted to the extent of dispensing with oven-tests at the press-foot remains to be seen.

I excluded the non-homogeneous bale from the original scheme of possible capacitance tests, but the finding of a solution for the special problems created by the presence of a wet or dry outer layer, or even more complex distributions of water in depth, is most alluring. It now appears that differential testing at various depths can be done by altering the grouping of the bale hoops upon which contact is made when the attaché case is hung on the bale. Fig. 3 shows how the drying of the surface during hot dry summer weather, from one day to another, is much more noticeable when successive hoops are 'contacted' (2.4, 6 v. 3, 5) than when deeper penetration of the field of force is secured by missing out three intervening hoops (2.10 v. 6). Such a figure is also a



nomograph for determining moisture content. The case is analogous to resistance measurements in geophysics, but the curve of penetration seems unfortunately to be much flatter.

An incidental fact is that the 'capacitance' observed by our system of using the bale-hoops themselves as condenser 'plates' is almost exactly proportional to the volume of the triple dielectric—air, cotton, water—and not to its thickness. A similar departure from convention is shown by the capacitance of 'hoops in air', namely, a bale-skeleton of hoops spaced out on thin wooden rods; the capacitance of a few wide-

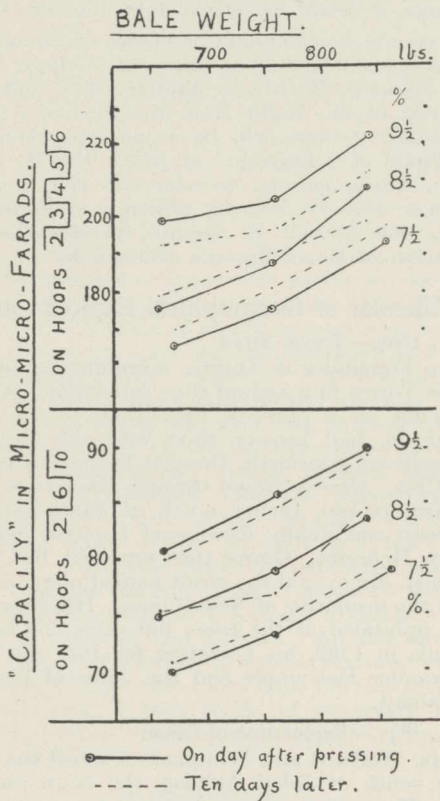


FIG. 3. Cotton bales.

spaced hoops is markedly higher than it should be in relation to the reading from close-spaced hoops.

A trial of the method at Manchester Docks on a day when the weather was typical for the locality, using a hoop-grouping which tested only the surface of the bale, gave the interesting result that the surface moisture content was so high as to be off-scale, although the average of the whole bale when oven-tested was near normal. The bale had gained two pounds in weight since being taken off the ship. The demonstration was a failure from the spinner's viewpoint, but very successful from the exporters'.

INDICATING THE GROWTH OF CROPS

It is common experience that the capacity of a radio antenna is increased by the increasing proximity of branches of trees, but we are not aware that the phenomenon has been used in the inverse direction, to measure the growth of the tree.

Some small scale experiments in my English garden, made chiefly on the exceptionally difficult subject

provided by a grass lawn, show that the capacitance hygrometer apparatus is usable to give instantaneous readings of the changes in capacitance consequent on increased water-content due to enlargement by growth. Two forms of 'condenser' have been used, the first being bare wire netting half a metre square, supported on insulation at 5 cm. above the surface of the lawn, with a counterpoise earth of similar netting below it, pegged down firmly; the grass and clover grew through this lower plate of the condenser, the capacity of which rose as shown in Fig. 4, evidently following the varied weather of the period, and the final removal of one-fifth of the grass with a hot iron.

Such arrangements of bare wire suffer from instability, on account of defective insulation, especially when water-drops are present after rain or dew. This is more easily examined by using miniature antennæ of wires stretched under constant tension. If rubber-covered wires are used, including a counterpoise wire, the 'capacity' observed is inversely as the voltage, due to dielectric absorption.

A workable arrangement consists of three such wires, each 3 metres long. One is pegged firmly down to the surface of the freshly mown lawn as a counterpoise, the other two supported above and parallel, forming an equilateral triangle in end view, of 3 cm. side. The field of force between the two upper wires on one hand, and the counterpoise on the other, passes through the growing grass; the initial capacity is about 100  $\mu\mu\text{F.}$ , and may rise as much as seven or eight  $\mu\mu\text{F.}$  in a day. From this starting point we can design longer and more widely spaced antennæ, and it should be a simple matter to string such antennæ across a field of growing crops; the reading could be made continuous by coupling my universal recorder to the condenser dial and operating it by a contact on the milliammeter; the decrement of the circuit as well as the capacity

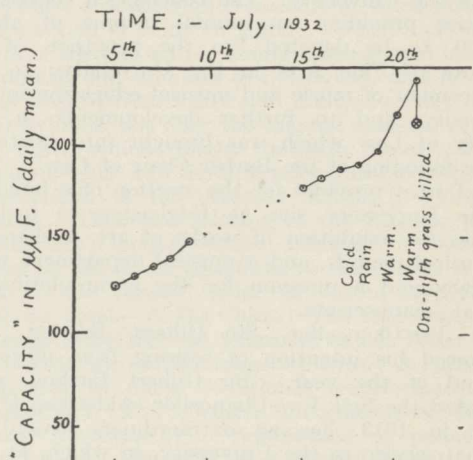


FIG. 4—Condenser of wire-netting on a grass lawn.

would thus be recorded. The method seems eminently suited to cereal crops, which have hitherto presented serious difficulties in growth-measurement. As before, the sampling error becomes trivial.

In all such arrangements it is evident that the capacitance increment for a given volume of growth will change progressively, so that it would be difficult to establish a quantitative relation over long intervals of time. But this is relatively unimportant, since long-period growth is obtainable by cruder methods;

the discrimination between growth-rates on successive days is easy, and this has been the difficult part of field-growth measurement.

An extensive publication of the results obtained in the many thousands of readings which have been taken by this method during the past year does not seem justifiable, since so many of them have been devoted to elucidating electrical difficulties which could probably have been solved *a priori* by a more competent worker. Some detailed publication on the special case of the cotton bale will in any case be necessary, on account of its commercial importance. On the other hand, it is clear, from letters received, that the application to soil alone is of interest to an unexpected variety of scientific students. Therefore it seemed desirable to put together an outline of all the essential facts, difficulties and limitations thus far encountered, so that other workers may be able to develop the application of the technique to their own special problem, and yet may realise that such application is in itself an experimental investigation of the technique and of its many side-issues. The method is qualitative rather than quantitative, and is best used under standardised conditions, until such time as it is more fully worked out; meanwhile, advice and independent effort in so doing would be welcomed.

<sup>1</sup> W. L. Balls, *NATURE*, 129, 505, April 2, 1932.

<sup>2</sup> For example, Lattey and Davies, *Phil. Mag.*, 12, 1111; 1931.

<sup>3</sup> Moullin, E. B., "Radio-Frequency Measurements". Griffin, London, 1931.

<sup>4</sup> *J. Agric. Sci.*, 1932.

<sup>5</sup> W. L. Balls, *J. Agric. Sci.*, 1913.

### University and Educational Intelligence

BIRMINGHAM.—At a meeting of the Council on December 7 the Pro-Chancellor (Sir Gilbert Barling) announced a generous gift by Lady Barber, widow of Sir Henry Barber, founder of the Faculty of Law in the University. The benefaction consists of securities providing an annual income of about £12,000, to be devoted "to the provision of an Institute of Fine Arts in the University; to the advancement of music and musical education in the University, and to further developments in the Faculty of Law which was brought into existence by the founding of the Barber Chair of Law". The deed of trust provides for the erection of a building on the University site at Edgbaston to include galleries for exhibition of works of art, a chamber for musical recitals, and a musical department with a library and a museum for the accumulation of musical manuscripts.

The Pro-Chancellor, Sir Gilbert Barling, has announced his intention of retiring from office at the end of the year. Sir Gilbert Barling, who succeeded the first Vice-Chancellor (Alderman C. G. Beale) in 1913, has an extraordinary record of personal service to the University, in which, at the age of seventy-seven years, he still takes a very active interest.

A grant of £50 has been made from the Lapworth Research Fund to cover the cost of cataloguing pamphlets, maps, etc., of the late Prof. Lapworth for the Lapworth Library of the Department of Geology.

LONDON.—The Mercers' Company and the Fishmongers' Company have decided to make grants to the University in the shape of annual payments extending over a series of years and amounting in each case to a total of £10,000. These gifts will be

applied by the University towards meeting the cost of the new Ceremonial Hall to be erected on the University's site in Bloomsbury.

THE Institution of Naval Architects scholarship, valued at £130 a year for three years, will be offered for competition in 1933. This scholarship is open to apprentices under the age of twenty-three years, from the royal dockyards or private shipyards, and is tenable at the Royal Naval College, Greenwich, or the Universities of Glasgow, Durham (Armstrong College) or Liverpool. Full particulars may be obtained from the Secretary of the Institution of Naval Architects, 2 Adam Street, Adelphi, London, W.C.2.

THE twenty-first annual Conference of Educational Associations will be held at University College, Gower Street, London, W.C.1, on January 2-9, under the presidency of the Right Hon. the Earl of Athlone. On January 2 there will be a joint conference on "The Trend of Education" at which Mr. H. Ramsbotham, Parliamentary Secretary to the Board of Education, Miss W. Mercier, principal of Whitelands College, and Mr. J. E. Barton, president of the Association of Head Masters, will speak.

### Calendar of Geographical Exploration

Dec. 21, 1605.—Torres Strait

Pedro Fernandez de Quiros, accompanied by Luis Vaez de Torres in a second ship, left Callao. Quiros, while pilot on a previous expedition to the Santa Cruz group, had become fired with the idea of a great southern continent, thought by him to lie near Santa Cruz. Quiros passed through the centre of the Low Archipelago, thence north of Samoa and the Fiji group and finally discovered Espiritu Santo in the New Hebrides. Quiros then returned, but Torres continued, discovered the strait named after him and proved the insularity of New Guinea. His discoveries passed unheeded at the time, but after the capture of Manila in 1762, his narrative fell into the hands of Alexander Dalrymple and the value of his work was realised.

Dec. 21, 1835.—Exploration of Oman

Lieuts. Wellsted and Whitelock reached the fertile district south of Jabal Akhdar, the main range of Oman. There they were astonished to see "verdant fields of grain and sugar cane . . . and streams flowing in every direction". Wellsted was the first to explore this south-eastern corner of Arabia scientifically and was, for part of the time, assisted by Whitelock. Political disturbances prevented Wellsted from crossing the desert to Nejd and he returned to India in 1836.

Dec. 23, 1558.—An English Trader in Russia

Anthony Jenkinson reached Bukhara. He was a trader who had travelled in the Levant and went to Russia in 1557. There he set out from Moscow, reached the Volga and sailed down it to the Caspian, making a rough survey of the north of that sea. Thence he travelled to Bukhara, where he spent three and a half months, returning to England through Russia. In 1561 he went to that country again and, following a route along the west of the Caspian, reached Kazvin, the capital of Persia, in October 1562. Though his journeys did much to increase our knowledge of Russia, and the lands to the south-east of it, English trade via that route ceased in 1581, thus giving an impetus to voyages in the Levant.

## Societies and Academies

## LONDON

Geological Society, Nov. 23.—A. E. Mourant: The geology of eastern Jersey. The area described includes the whole of the Jersey volcanic series and certain associated rocks. The oldest formation in the island is the Pre-Cambrian shale series, consisting of grey mudstones and shaly grits. This is succeeded, with a slight unconformity, by the volcanic series, the field relations and petrographic characters of which are described. The volcanic rocks of northern Brittany differ in some respects from those of Jersey. Reasons are given for regarding the Jersey volcanic rocks as Pre-Cambrian. The field relations of the plutonic rocks of the area are discussed.—E. Willbourn and F. T. Ingham: The geology of the Scheelite mine, Kramat Pulai Tin Limited, Kinta, Federated Malay States. There are a number of occurrences of scheelite ore at Kramat Pulai, one of them of considerable dimensions, and the ore is of unusual character, being a coarse-grained intergrowth of fluorite and scheelite, with less than one per cent of other minerals. The granite which built up the great main range of the Malay Peninsula was the source of the ore, as it was also of the rich tin deposits that are worked there. Kramat Pulai is situated on the contact zone between the huge plutonic mass and the limestone into which it is intruded. The limestone was converted to marble by the intense folding and thermal action that accompanied the intrusion, and an interstratified bed of shale and silt was metamorphosed to pyroxene-schist and biotite-schist. Gently pitching anticlinal structures were imposed upon the metamorphosed rocks, and minor faults at right angles to them were occupied by aplite dykes. Re-opening of the fissures brought in pegmatitic material, permitted solutions rich in tungsten fluoride to have access to the limestone below the schist-bed, forming crystalline intergrowth of scheelite and fluorite. All the scheelite-fluorite ore is of identically coarse texture, whether it occurs in a large mass more than 100 feet across, or in a thin vein, 1 inch thick, of secondary origin. The temperature of formation of such thin veins must have been low.

## CAPE TOWN

Royal Society of South Africa, Sept. 22.—J. Groves and E. L. Stephens: New and noteworthy South African Charophyta (2). Descriptions and figures are given of nine new species, also figures of *N. plumosa* and *C. stachymorpha*, and a revision of the species which Braun included under *C. Kraussi* and *C. phæochiton*.—E. D. Loseby: Repeated conjugation in *Closterium pritchardianum*, Arch. Conjugation, following immediately on a period of rapid cell-division, occurred three times within a period of two months in a culture of this species. Each period of active reproduction lasted for about ten days, and there was a fortnight of quiescence between. During the period of quiescence the species was represented by undersized cells, and recurrences of active reproduction occurred when they had reached mature size.—M. R. Levyns: A revision of *Lobostemon*, Lehm., and a discussion on the species problem. In the revision of *Lobostemon* it has been necessary to separate a small section as a new genus *Echiostachys*. *Lobostemon* is divided into five natural groups characterised by well-marked floral characters. Vegetative characters are very variable. Twenty-

eight species of *Lobostemon* and three species of *Echiostachys* are described.—A. Zoond: The mechanism of projection of the chameleon's tongue. Experiments are described dealing with the muscles of the tongue and the hyoid apparatus, and with the lingual nerves, arteries and veins.—H. A. Shapiro and L. P. Bosman: Note on the skin-secreting mechanism of *Xenopus laevis*. The findings of Hogben, Charles and Slome that removal of both lobes of the pituitary in *Xenopus* leads to a cessation of skin secretion in response to mechanical stimulation, are confirmed. This phenomenon as a result of anterior lobe removal takes longer to occur. That the mechanism involved in the skin-secreting response is vaso-motor is unlikely, in view of the fact that injections of histamine have no effect on the secreting reaction, while adrenaline produces a copious viscid secretion.—I. Schrire and H. Zwarenstein: Protein metabolism and the effect of injection of pituitary extracts on normal and castrated animals. Both anterior and posterior lobe extracts decrease the high creatinine excretion in castrated male rabbits almost to pre-castration levels. The effect on the normal rabbits is very slight.—W. J. Copenhagen: Sulphur as a factor in the corrosion of iron and steel structures in the sea. Observations on the film potential of twenty-one iron and steel structures gave a constant value of  $-0.3770$  volts (standard error  $\pm 0.0028$ ). The presence of a primary and a secondary film on sea-water corroded iron and the significance of sulphur in the primary film are discussed, together with the occurrence of sulphur in corroded zinc plates on ships' bottoms and the possibility that the constant film potential is an iron sulphide—carbon dioxide reaction.

## ROME

Royal National Academy of the Lincei: Communications received during the vacation.—G. A. Blanc: Persistence of anisotropic structure in silica obtained by the action of acids on leucite. When a crystal of leucite is treated with a strong mineral acid until all the potash and alumina are removed, and is afterwards washed with water and allowed to dry in the air, it exhibits not only the original external crystalline form—which might indicate mere pseudomorphism—but also the internal crystalline structure characteristic of the complex  $KAlSi_3O_8$ .—Vladimiro Bernstein: Theorems relating to the singular points of Dirichlet's series.—Maria Cibrario: Preliminary studies on the linear equations to the partial derivatives of the second order of mixed hyperbolic-parabolic type.—A. Del Chiaro: The smoothing procedure of Schwarz.—M. Haimovici and E. Popa: Correspondence for parallel tangent planes.—B. Hostinský: Integration of linear functional transformations.—L. Labocetta: The effective integration of discontinuous functions (1): Summation of punctiform functions.—L. Allegretti: The structure of the line 6708 of lithium observed in emission. In agreement with previous results, the distance between the two principal components of this line is found to be  $0.155$  Å. and that between the satellite or less intense component and the component of greater wave-length,  $0.149$  Å.—L. Pincherle: A perturbed series of the spectrum of ionised aluminium. Confirmation is obtained of the interpretation recently given by Shenstone and Russell of certain irregular series in line spectra which diverge somewhat from Ritz's form.—I. Ranzi: New arrangement for investigating the structure of the Heaviside region.—G. A. Barbieri:

Electrolytic preparation of certain complex salts of divalent silver. The preparation of various dipyriddy-argentic compounds from the persulphate is described.—R. Bigazzi: A structural constant relating to changes of state. If  $T$  is the absolute temperature at which any change of state of a compound occurs,  $P$  the molecular weight, and  $p$  the specific gravity at  $15/4^\circ$ , it is found empirically that the formula  $TP/p^2 = \text{constant} = K$  or, since the molecular volume  $V = P/p$ ,  $TV/p = K$  is valid for compounds of similar chemical structure. This expression has an advantage over the parachor, in that it contains only magnitudes which are either known or readily determinable. By the introduction of a factor of complexity  $c$ , which represents the greatest width of the graphic formula for any compound, the expression  $TP/p^2c = K'$ , which gives an approximate constant for the change of state of all molecules of different structures, is obtained.—F. Garelli and G. Racciu: Triphenyl phosphate as a cryoscopic solvent. Cryoscopic measurements show that, at  $50^\circ$ , sulphur dissolved in triphenyl phosphate has a molecular magnitude corresponding with the formula  $S_{10}$ . In the same solvent, iodine exists as  $I_2$ , trimethylenetrinitrotetramine as the trimeride  $(CH_2N.NO_2)_3$ , and indigo as the simple molecule  $C_{16}H_{10}O_2N_2$ .—V. Famiani and V. Zagami: Comparison between the reconstructive food values of certain vegetables and grain. After fasting, pigeons gain in weight more rapidly on a diet based on *Ervum lens*, *Lathyrus sativus* or *Lathyrus cicera* than on one based on *Triticum vulgare*. Moreover, the recovery of a given percentage loss of weight requires appreciably less of the former than of the latter diet.—C. Andreatta: New investigations on bianchite: synthetic bianchite. Crystallisation of a solution containing zinc and ferrous sulphates and sulphuric acid yields an isomorphous mixture of composition approximating to that of natural bianchite, for which the formula  $(Zn, Fe)SO_4 \cdot 6H_2O$ , with the ratio  $ZnO : FeO$  very nearly 2 : 1, is established.

## WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, 18, 567–608, Sept. 15, 1932).—Alan W. C. Menzies: The vapour pressure of liquid water that has recently been frozen. T. C. Barnes has reported that water containing large quantities of trihydrol (associated water molecules) promotes the growth of algae. If recently frozen water contains more such associated molecules than recently condensed water, it might be expected to show a different vapour pressure. Experiments at  $25^\circ$  and  $3^\circ$  with a glass differential pressure apparatus showed no such difference.—Henry B. Ward: The origin of the landlocked habit in salmon. Such races of salmon are known from many rivers of North America and elsewhere, often where there is no barrier preventing the fish from migrating to the sea after hatching in the upper waters. They are generally smaller than the sea-run species from which they probably originated. It is suggested that the chief factor in the production of such dwarf races is temperature of the surface water, rather than a stream barricade or food abundance. For example, a power dam creates a lake with little current, the surface waters of which quickly attain a temperature too high for the young fish; the fish descend to the cooler layers and, finding no outlet, remain there. Glacier action and earth movements in the past may have had similar effects, leading to the appearance of landlocked fish in streams which now have no barriers.—N. A. Wells: The importance of the time element in the determination of the respiratory

metabolism of fishes. Fish were transferred to a constant flow apparatus and their oxygen consumption measured. For the species used, *Fundulus parvipinnis*, of average weight 6 gm. at a temperature of  $13^\circ C.$ , the average value over a period of eight hours after a lapse of twenty-four hours or more in the respiratory chamber represents the normal metabolism. High values are obtained while the fish are settling down in their new environment and any disturbance immediately increases the metabolic rate. The temperature of the environment before entering the respiratory apparatus has little effect on the general trend of the metabolism.—Otto Struve: Thermal Doppler effect and turbulence in stellar spectra of early class. The lines of these spectra have cores of the width required by the theory of Doppler broadening. The fuzzy lines in the spectra of  $A$ ,  $B$  and  $O$  stars are probably due to 'rotational' broadening rather than to turbulence.—O. Struve and W. W. Morgan: On the intensities of stellar absorption lines. A brief report of work in progress at Yerkes Observatory. It is known that the relative intensities of the singlet and triplet lines of helium are not the same in all stars; there are similar differences in the doublets and quartets of singly ionised oxygen and even in the multiplets of other elements. No explanation is offered.—H. S. Vandiver: Note on the divisors of the numerators of Bernoulli's numbers.—G. A. Miller: Non-group operations.—Arnold E. Ross: On representation of integers by quadratic forms.

## Forthcoming Events

MONDAY, DEC. 19

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—H.R.H. Prince Sixte of Bourbon: "Great Routes of the Sahara, Past and Future".

## Official Publications Received

## GREAT BRITAIN AND IRELAND

Institute for Research in Agricultural Engineering: University of Oxford. Increased Production in Agriculture: Papers read at the Meeting of the British Association for the Advancement of Science at York, 1932. By Dr. H. J. Denham, S. J. Wright, A. J. Hosier and D. R. Bomford; with a Commentary by C. S. Orwin. Pp. 35. (Oxford.) 1s.

Transactions of the Royal Society of Edinburgh. Vol. 57, Part 2, No. 13: The Genera *Dictyoconoides* Nuttall, *Loekhartia* nov., and *Rotalia* Lamarck; their Type Species, Generic Differences and Fundamental Distinction from the *Dictyoconus* Group of Forms. By Lieut.-Col. L. M. Davies. Pp. 397–428+4 plates. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 5s. 6d.

Journal of the Chemical Society. November. Pp. iv+2665–2812+ viii. (London: Chemical Society.)

The University of Manchester: The Manchester Museum. Report for the Year 1931–32. Pp. 23. (Manchester.) 6d. net.

## OTHER COUNTRIES

Journal and Proceedings of the Asiatic Society of Bengal. New Series, Vol. 26, 1930, No. 3. Pp. clxxxv. (Calcutta.) 4.8 rupees.

Anales del Museo Nacional de Historia Natural Bernardino Rivadavia, Buenos Aires. Tomo 35. Pp. xi+341+35 plates. (Buenos Aires.)

Sudan Notes and Records. Vol. 15, 1932, Part 1, Pp. iv+157+23 plates. 30 P.T.; 6s. Part 2, Pp. iv+159–280+16 plates. 30 P.T.; 6s. (Khartoum: Sudan Notes and Records.)

Japanese Journal of Physics. Transactions and Abstracts, Vol. 8, No. 1, September 18. Pp. iii+56+20. (Tokyo: National Research Council of Japan.)

The Science Reports of the Tôhoku Imperial University, Sendai, Japan. First Series (Mathematics, Physics, Chemistry), Vol. 21, No. 3, October. Pp. 299–454. (Tokyo and Sendai: Maruzen Co., Ltd.)

U.S. Department of the Interior: Geological Survey. Bulletin 831-B: The Ashland Coal Field, Rosebud, Powder River and Custer Counties, Montana. By N. W. Bass. (Contributions to Economic Geology, 1931–32, Part 2.) Pp. v+19–105+plates 3–27. Bulletin 835: Geology and Oil Resources of the Elk Hills, California, including Naval Petroleum Reserve No. 1. By W. P. Woodring, P. V. Roundy and H. R. Farnsworth. Pp. v+82+22 plates. 60 cents. Bulletin 836-E: The Tatonduk-Nation District, Alaska. By J. B. Mertie, Jr. (Mineral Resources of Alaska, 1930.) Pp. ii+347–443+plate 7. 15 cents. (Washington, D.C.: Government Printing Office.)