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Experimental Work in Cotton Growing.[1]

THE record of the valuable experimental work carried out under the ægis of the Empire Cotton Growing Corporation is brought down to the season 1928–1929 in the seventh volume of the series of reports. The series possesses a double value. It gives, as a continuous record, the progress of the experimental work in each country, from which it is possible to trace how one problem, by its solution, has led to another. It also contains a record of the latest work in each country and should be of the greatest assistance to those faced with similar problems and difficulties elsewhere.

The function of the stations from which reports are issued is to achieve practical results for the benefit of those growing cotton in the areas they represent. To achieve those results it may be necessary to extend investigation by the inclusion of work of a more academic nature. But by their practical results they will be judged. It is pleasant, therefore, to note the considerable success achieved in this direction. In the Jassid resistant *U4* cotton, South Africa has received a strain which can reasonably claim to have saved the situation, for, without it, cotton growing within the Union appeared to be doomed. Pessimism is giving place to optimism, and, what is more, the success does not appear to be confined to the Union alone but it extends also to the two Rhodesias and Nyasaland. In Fiji, too, the introduction of a Kidney cotton from New Guinea promises a definite benefit to the island in that its produce will no longer be confined to the narrow market for Sea Island cotton.

The individual reports afford complete justification of these experiment stations by the indication given of appreciation of the practical results achieved. In these are to be traced the influence of the particular economic conditions. In South Africa it is the need for a Jassid resistant strain that has dominated the work ; in Queensland it is cultural methods. In the Sudan, matters are more complicated by the very diverse systems under which cotton is grown—systems which embrace the canalised area of the Gezira, the flood areas of Kassala and Tokar, all three of which are suited to Sakel, the pump irrigation systems of the Nile valley with their American strains, and the rains areas of the southern Sudan where American cotton is grown. Here, perhaps, the need for meeting the pests, thrips, black-arm, and now leaf-curl, which

[1] Empire Cotton Growing Corporation. Reports received from Experimental Stations, 1928–1929. Pp. xi+268. (London.) 2*s*. 6*d*.

have successively attacked the crop, is predominant; and behind these lies the curious phenomenon of the suppression of fruiting branches, now interpreted as a conversion of sympodial into monopodial (vegetative) buds under the influence of abnormally high temperatures, which has given a physiological bias to the work. Despite these special demands, however, a broader attitude is being adopted towards the cotton crop, as is apparent from a perusal of the series of reports which have been issued. Increasing recognition is given to the fact that cotton cannot be treated in isolation and must be considered in its relation to other rotational crops. Rotations and fallows receive more detailed attention in the present than in earlier reports.

The reports issued by the Empire Cotton Growing Corporation give a sharp impression of the dominating influence played by insects in determining the success attendant on cotton growing, and of particular interest is the evidence from the Sudan, which indicates that leaf-curl is a virus disease carried by a Jassid. So long as these conditions prevail, cultural problems must predominate. Until effective means of insect control are forthcoming, the problem takes the form of finding a plant sufficiently resistant to withstand the attacks, or of finding the conditions under which those attacks may be rendered least damaging, and any attempt to meet mill requirements and to apply recent knowledge as to the effective lint characters in producing a good-spinning cotton must remain a secondary consideration. It is not surprising, therefore, that but little reference is to be found to this aspect, in which so vast a field remains to be explored.

The reports summarise a vast amount of work in many directions, and there arises a temptation to wonder whether the fullest use is being made of this mass of material. Cotton, in all its varieties, grows under a very wide range of conditions. In the majority of countries it matures on a falling temperature, and a limit to production may be imposed either by cold or by lack of humidity. But in the Sudan it matures on a rising temperature, while in Uganda, Fiji, and, to a lesser extent, in the West Indies, it is excessive humidity that predominatingly determines production. Thus the range of conditions covered by the various experiment stations is very wide.

The more fundamental problems underlying cotton growing may be approached in two ways. Detailed research in field and laboratory at a well-equipped research station can do much. It is the intensive method. But the station must be localised and choice inevitably falls on that locality in which the plant is exposed to the minimum of risk, where, that is, limiting factors rarely come into play. Owing, however, to the variety of the conditions under which cotton is grown on a commercial basis, the question of limiting factors has an importance secondary only to that of pests; they may even be in large measure the cause of the severity of those diseases. With evidence that this is so the reports abound.

In these circumstances there is abundant scope for what may be called the extensive method of investigation—the comparison of different strains under the range of conditions available, so that they may be subject now to one limiting factor and now to another. Many strains are, it is true, at present so grown and must be subjected to a number of different limiting factors. But what steps are being taken to ensure that comparable records of growth are secured, together with comparable records of the various environmental conditions? And, if these steps are being taken, in what way are these records being co-ordinated and the results extracted? On these questions the reports are silent.

Folk-lore of the North American Indians.

(1) *Tales of the North American Indians.* Selected and annotated by Prof. Stith Thompson. Pp. xxiii + 386. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1929.) 27*s.* net.

(2) *Prairie Smoke.* By Melvin R. Gilmore (Pahok). Pp. xiii + 208. (New York: Columbia University Press; London: Oxford University Press, 1929.) 12*s.* 6*d.* net.

A REPRESENTATIVE collection of the legends and traditional tales of the North American Indians might provide both a history and a textbook of the method of folk-lore. In no other part of the world have these stories been collected with greater assiduity and over a longer period of time, and in few, if any, do they cover a wider range of theme. Nearly three centuries have passed since the Jesuit fathers in 1633 first recorded tales current among the Indians with whom they had come into contact. To-day, the Bureau of American Ethnology, the American Museum of Natural History, the American Folklore Society, and the Anthropological Division of the Canadian Geological Survey are still engaged in the task of gathering up such remnants of this once great oral

literature as survive, with some vigour, among the remoter American peoples.

In the relatively long period over which the work of collecting Indian tales has been spread, naturally there have been many changes in the attitude of the collectors towards their material and in their methods. They range from the sentimentalities of Schoolcraft and the conscious attempts at artistry of the early and middle nineteenth century to the severely scientific aim of the Bureau of Ethnology with its elaborately phoneticised text and literal and interlinear translations. Somewhere, perhaps midway, between these come the contributions which educated Indians themselves have made to the record, varying a great deal in value, but often of noteworthy scientific import.

During the last thirty or forty years the work of collection has proceeded apace, and on intensive lines varying to some extent, but not entirely, with the conditions of collection. Thus Prof. Boas has published a large number of texts received from the tribes of the north-west coast and the Eskimo; the late Mr. Hill-Tout specialised in the legends of British Columbia; Dr. Dorsey in the tales of the Plains Indians; James D. Teit in those of the Thompson Indians; while F. H. Cushing made their mythology part of his intensive study of the Zuñi Indians. These are a few only of the better known. It is on the collections of these and others working on the same lines, rather than on original observation, that writers on Indian folk-lore have relied when they have sought either to give a generalised view of the imaginative side of the Indian or have aimed at literary and artistic effect.

(1) While Prof. Stith Thompson aims at a comprehensive and representative collection of Indian legends and traditional tales, both in spirit and in method, he is strictly scientific. Except for certain very slight modifications to meet the requirements of the general public, which will be obvious to everyone familiar with the Indian modes of presentation and phrasing, he has reprinted his stories in the words of the original translation, often happily preserving the style of the Indian narrator. Not only are the stories representative of the various Indian tribal groupings, extending in the geographical sense from the polar north to Mexico, but also they are equally characteristic in the matter of theme. Excepting in the first section of mythical stories, which follows a geographical order, the grouping of the tales is by theme. Of these groups there are six—mythical incidents, trickster tales—a characteristic section which brings out the peculiar and somewhat cynical humour of these people—and hero tales, journeys to the other world, animal wives and husbands, and miscellaneous—a group which is not the least interesting. It must not be thought, however, that the headings indicate the full scope of the interest of the tales to the student of folk-lore *motif*. An appendix of comparative notes reveals how rich American Indian folk-lore is in this respect. There are few of the *motifs* found in the legendary lore of other parts of the world which do not appear either incidentally or in chief in the tales of North America. This appendix in itself, with its large number of references to Indian parallels, is alone a contribution to American folk-lore studies of high value.

Two very interesting questions are those of distribution and the closely related topic of the differentiation between the tales told in the various cultural areas into which American anthropologists divide the peoples of the continent. Upon these points Prof. Stith Thompson touches illuminatingly, if only briefly, in his introduction. Many of the tales are common in their distribution, varying of course in their cultural background according as they are found among woodland, plains, pueblo Indians, and the rest. But he goes on to show that in each group certain characteristic differentiations are to be observed. Among the Eskimo, for example, the tales have a low level of interest, while the tales of the Plateau show a marked individuality; on the North Pacific coast there is a considerable variety, and, as might be expected from their totemic system, tales of animals, of whale and salmon, of ritual and social rank, are prominent, as well as tales of the other world. In California the Indian seems to be interested only in the Creation and in the trickster.

Two sections in addition to those already mentioned have a special interest for the student of modification in folk tales owing to contact. Of these, one includes a number of tales derived from European sources, including Cinderella. It may be mentioned in passing that in the south-eastern States there is also evidence of negro influence. The second group consists of tales drawn from Bible sources. It is rather remarkable, in view of the widespread flood legend, that the story of the flood, as told here, is concerned entirely with the incident of Lot and his daughters, which is transferred to Noah.

(2) "Prairie Smoke", more popular in form, may yet be taken as not unworthy of a place on the shelf with Prof. Stith Thompson's more

elaborate work. It deals with the Indians of the prairies, and while it consists in the main of their legends classified under sections to exhibit their modes of life and thought, it illustrates these with incidental descriptions of their culture and by references to events in their history.

The Astrolabe.

Early Science in Oxford. Vol. 5: *Chaucer and Messahalla on the Astrolabe.* Now printed in full for the First Time with the Original Illustrations. By R. T. Gunther. Pp. ix + 234 + 25 plates. (Oxford: Dr. R. T. Gunther, Magdalen College, 1929.) 42*s*.

UNTIL the use of the quadrant became universal towards the latter half of the eighteenth century, the astrolabe was one of the most important scientific instruments at the disposal of astronomers and travellers. It seems to have been invented in the time of the Greeks, and a number of elaborations made it in the medieval period not only an efficient observing instrument but also a portative set of astronomical tables. It was of simple construction, not readily put out of order, and its graduation presented no great difficulties to skilled workmen. There does not seem to be any reason, indeed, why it should not be reintroduced for making observations not requiring any high degree of accuracy.

The astrolabe consists of a circular plate of metal from four inches upward in diameter. In the portative forms a ring is attached for suspension from the finger. A raised rim on the front makes a bed for a perforated plate called the 'net'. On the back is a revolving bar with sights raised at each end. The circle is graduated in degrees, days, and months concentrically, and there is in the middle a scale for measuring heights, etc. On the front are concentric circles for the tropics and equinoctial line, a set of circular arcs giving altitudes, azimuth lines dividing the horizon into twenty-four parts, and twelve similar arcs showing planetary hours. The net lies over this, revolving freely; it marks the longitude and latitude of the principal fixed stars, and the zodiac. The astrolabe was usually graduated for a particular latitude, but one form is adapted for use anywhere. By it the altitude of the sun or a star, the time by day or night, the position of the moon, the height or depth of any point accessible or otherwise, and the hour of high tide, among other things, were found by simple observations.

Chaucer's treatise on the astrolabe, written for the use of a child of ten, is a very satisfactory elementary text-book, provided that the pupil has the instrument in his hands; without this aid an understanding of the working requires attention. Still, the disuse of astronomy as a foundation for astrology, and the alteration in our views on the solar system, have not altered the facts of the daily change in the aspect of the starry heavens, and if some simple form of the astrolabe could be brought into use in our schools, a standing blot on our educational system might be removed. It is little short of lamentable that a boy may go through school and university without being able to point out any feature of the sky but the Plough and the Pole Star. It is perhaps hopeless to expect any change from this in our town-bred civilisation.

The treatise was printed sixty years ago by Skeat for the Chaucer Society with a very full apparatus, including the text of the astronomical work which had been followed in its composition. No better or fuller book on the subject has yet appeared. The very handsome and well-printed volume before us covers much the same ground as Skeat's edition, though with less help to the reader in the way of explanatory notes. The title-page is a blot upon the book, a monumental piece of vandalism. A page of a Chaucerian manuscript has been reproduced with the central portion of the text faded out to allow the insertion of the name of the work, of its editor, and of the claim that it is "now printed in full for the first time with the original illustrations".

This claim has only a modified justification. The volume contains a modernised form of Chaucer's text, together with much of Skeat's text in the original spelling; some passages completing the subject from Chaucerian manuscripts (whether by Chaucer or no); and the "original illustrations". Of these, less than one-third are photographic reproductions from manuscripts of the astrolabe; the remainder are to all appearance photographed from modern copies of presumably medieval diagrams. How far this justifies the editor's claim is a matter of opinion.

The larger part of the volume is devoted to Messahalla, the author from whom Chaucer drew his information. We are given the Latin text of his two treatises on the construction and on the use of the astrolabe together with a translation at once accurate and readable. The texts were printed by Reisch in the sixteenth century and one of them by Skeat. In addition to these the editor has given a facsimile of a Cambridge manuscript of the "De compositione astrolabii". There can be nothing but praise for this feature of the volume—every

important manuscript ought to be photographed at the earliest possible moment—but reproductions expose their editors to trying comparisons. A single page of the MS. (fo. 62v) compared with the corresponding pages of expanded text reveals seven slips in copying. The page was taken at random, and the slips were not important enough to affect the meaning.

What is rather more important is that the editor should have neglected the opportunity of using his own powers of exposition to make the subject as clear as possible to the scientific reader. At least he ought to have given us a series of photographs of an ordinary astrolabe bringing out its constituent parts, such as were published some years ago by the Indian Archæological Survey. It is quite understandable that Dr. Gunther should wish to include Chaucer's treatise in his collection of "Early Science in Oxford", but it then became incumbent on him to bring it home to modern readers. R. S.

Kant's "Critique of Pure Reason".

Immanuel Kant's Critique of Pure Reason. Translated by Prof. Norman Kemp Smith. Pp. xiii + 681. (London: Macmillan and Co., Ltd., 1929.) 25*s.* net.

IT is astonishing how long the English-speaking public has had to wait for an adequate translation of Kant's epoch-making work. The "Critique of Pure Reason" was published in 1781, all but a hundred and fifty years ago, and the first English translation did not see the light until 1838. The translator enlarges in his preface on the difficulty of rendering "so entirely novel and original a mode of philosophising", and almost disarms criticism by the modesty with which he acknowledges "how frequently, with every endeavour to be correct, he may have failed in a right understanding of his author". Meiklejohn, who next essayed the task, in 1855, produced a version which, in lack of a better, was destined to serve the needs of successive generations of students for three-quarters of a century. It is true that in 1881, the centenary of the original, a fresh translation was given to the public with an authoritative gesture by Max Müller. This was certainly in point of accuracy and general effect distinctly better than Meiklejohn's, but by an unfortunate error of judgment the translation was made from Kant's first edition, whereas the second edition of 1787, in which Kant re-wrote important sections, must be regarded for ordinary purposes as the authoritative text of the work. Unfortunately, too, the translation, at least as originally issued, was encumbered, by way of introduction, with a crudely written historical sketch of all previous philosophy by Prof. L. Noiré, extending to no less than 360 pages. For its irrelevance and lack of all proper perspective, this so-called introduction was drastically characterised at the time by the late Prof. Adamson as "comprehended under the well-known definition of dirt: matter in the wrong place". Under these disadvantages it was no wonder that the centenary translation failed to 'catch on', and Meiklejohn continued to be the ordinary student's vade-mecum up to the present day. This was perhaps scarcely to be regretted; for, although of course absolutely competent in his knowledge of German idiom and his mastery of the English language, Prof. Max Müller was, after all, not a professional philosopher, and Adamson in his careful and appreciative review of the book for *Mind* felt "constrained to add that the ideal translation does not yet seem to have been attained". After giving examples of his meaning, he concludes in fact that the translation "stands in need of a thorough revision from the philosophical point of view".

The ideal is, I suppose, under human conditions never fully realised, but I think Prof. Kemp Smith's translation must at least come very near to satisfying Adamson's exacting demands. Prof. Kemp Smith is in the best sense of the word a philosopher by profession, and moreover he has devoted the maturity of his powers to an exhaustive study of the Kantian philosophy and more particularly of the "Critique of Pure Reason". His "Commentary" on that work was recognised at once on its appearance, in 1918, as raising the study of Kant in Great Britain to a higher level. There is room, of course, for difference of opinion in regard to certain of his conclusions; but his firm grasp of the whole subject was everywhere apparent, especially in the use he made of his extensive literature which has grown up round the "Critique" in Germany since 1880. A better preparation for the work of translation can scarcely be imagined, and students of philosophy may congratulate themselves that he has found leisure to carry through what must have been of necessity a laborious and often an irksome task. For, as he truly says at the outset of his "Commentary", "the 'Critique of Pure Reason' is more obscure and difficult than even a metaphysical treatise has any right to be". In his other works Kant often writes as clearly and forcibly as anyone could wish, but

in this "Critique" there can be no doubt that many of the difficulties which embarrass a translator (and as Prof. Kemp Smith says, "multiply rather than diminish upon detailed study) are due to the circumstances in which the work was originally published". Kant has told us himself how he pondered the subject for at least twelve years, whereas the book itself was hurriedly "brought to completion" within four or five months, in the fear lest, if further delayed, it might never see the light at all. This was for long taken to mean that the whole work was written during these four or five months of 1780. But much light has been thrown more recently upon Kant's habits of working by the publication of "Reflexionen" and "Lose Blätter" found among his papers; and it is practically certain that Kant must have possessed similar drafts of portions of the "Critique", written at different times during the twelve years of incubation. These he would naturally use to piece out his argument, without noticing possible inconsistencies in detail with the positions in which he had finally come to rest. Patient criticism has indeed succeeded in establishing that the "Critique" is to that extent a composite work, different parts of which belong to different stages in the development of Kant's views.

The present translation follows the text of the second edition, but gives at the foot of the page all the passages from the first edition which have been omitted or altered in the second. The pagination of the two editions is also given in the margin as A and B. Where emendations of the German text have been suggested by successive editors, Prof. Kemp Smith gives in a footnote the reading which he follows; and wherever there might be a doubt as to the precise meaning of an English word or phrase in the translation he has similarly added in a note the German equivalent. This critical apparatus is welcome, and was indeed essential in the present edition, but for the ordinary student, not conversant with German and intent only on a trustworthy translation, it is in a sense a luxury. As Prof. Kemp Smith's version must now rank as the definitive and authoritative English translation, it is to be hoped that the publishers may soon see their way to issue an edition of the text alone at a more popular price. In such a text-book it would be desirable to make the translation of the second edition read continuously and to relegate the variations of the first edition, including the two long sections re-written by Kant, to an appendix.

A. S. PRINGLE-PATTISON.

Our Bookshelf.

Die Salzkäfer der Nord- und Ostseeküste: mit Berücksichtigung der angrenzenden Meere sowie des Mittelmeeres, des Schwarzen und des Kaspischen Meeres; eine ökologisch-biologisch-geographische Studie. Von Hanns von Lengerken. Pp. iv + 162. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1929.) 8·75 gold marks.

THIS is a very useful account of the beetles which inhabit the salt-water coastal regions of the North Sea and Baltic. The author divides them into three groups which he calls 'Haloxenen', 'Halophilen', and Halobionten'. The first is omitted as the beetles are only brought into the salty region by outside agencies, such as winds and storms; the second includes those species which are not dependent on salt but are chiefly found in salty situations; the third are truly dependent on salt and never found elsewhere.

At present, however, there seems to be nothing positive known as to the influence of salt on the beetles. The only truly marine species in the region is *Macroplea mutica*, although such brackish-water forms as the *Ochthebius* species may also be admitted. By far the most of the salt-water Coleoptera come under the heading 'Coastal beetles', and there are a large number of these belonging to 63 genera and 17 families. A detailed study of distribution is given, and, for the purposes of comparison, neighbouring coasts other than the North Sea and Baltic are reviewed as well as the Mediterranean, the Black Sea, and the Caspian Sea.

This ecological, biological, and geographical study is of great value and the notes on the various species are extremely interesting, for, besides morphology, habitat, and food, the life-histories are included whenever possible. Much of this is the author's own work, and one reads with pleasure his detailed accounts of *Cicindela hybrida marina* living on fine sand and in sandy burrows, and *Hæmonia* (*Macroplea*) *mutica* which is in all stages peculiarly adapted for breathing under water. So delightful and life-like are the pictures of *Cicindela* that one wishes there were more figures in the book. One also misses a detailed index, only a table of contents going as far as the genera being given. There is a good bibliography, most of which is divided geographically.

The Economic Life of the Ancient World. By Jules Toutain. Translated by M. R. Dobie. (The History of Civilization Series.) Pp. xxvii + 361. (London: Kegan Paul and Co., Ltd.; New York: Alfred A. Knopf, 1930.) 16*s.* net.

THE 'Ancient World' with which M. Toutain deals is that of the Mediterranean area, or rather of Greece and Rome with other countries considered only as subsidiary to these. He begins his story with the Greece of Homer and Hesiod and traces its economic development down to the end of the Hellenistic period. He then turns to Rome and the western Mediterranean, but before dealing with Italy and Rome's historic rival Carthage, to pro-

vide a background for the picture, he analyses the economic activities of prehistoric man. Thence the economic system of Rome is traced until it reaches its culmination under the Antonines and finally breaks up before the inroads of the barbarians.

M. Toutain's subject is one of some difficulty, for outside certain aspects which were the problems of ancient society, such as the agrarian question at Rome, direct evidence is scanty. The author shows little inclination towards generalisation and theory. He prefers matters of fact and deduction from historical evidence in the stricter sense. Sound as this method may be, it has its obvious limitations. When, for example, he deals with the question of land tenure in early Greece, he holds that the whole of the evidence is to be interpreted in favour of individual tenure or, doubtfully at most, tenure on behalf of the *genos* or family group. In his opinion, geographical conditions imposed this organisation inevitably on Greece, and the communal tenure of land of primitive man, or even of such social groups as those of Russia, he holds, is not analogous. But the literary evidence at best is ambiguous or indecisive, and it would be legitimate to interpret it in the light of what is known of the social system of the invaders from the north in their own land. M. H. Baer in his introduction provides the generalisations on ancient economics from which the author has refrained; but even without these, the book will be for the student a convenient and valuable compendium of the economic and social facts.

Introduction to Theoretical Physics. By Prof. Arthur Haas. Translated by Dr. T. Verschoyle. Vol. 2. Second edition. Pp. xi + 492. (London: Constable and Co., Ltd., 1929.) 21*s.* net.

THE second edition of Vol. 2 of Prof. Haas's "Introduction to Theoretical Physics" deserves special mention, because in the four years which have elapsed since the publication of the first English edition (NATURE, vol. 117, p. 687) great strides have been made in the development of atomic theory. The changes in outlook consequent on the introduction of the wave theory of matter and of the new quantum mechanics are reflected in Part III., which has been almost entirely rewritten. It is significant of the new point of view that the chapter on the principles of atomic mechanics begins with a description of de Broglie's theory, which is followed by an account of Schrödinger's theory. It is not until the following chapter that we meet with a detailed statement as to atomic spectra, and the explanation of the spectrum of hydrogen by means of Bohr's model. Prof. Haas has written a separate volume on "Wave Mechanics and the New Quantum Theory", in which these subjects are treated at greater length, but it is convenient to have such a concise and clear account of the new developments as that given in the book here noticed.

In Part IV., which deals with the theory of heat, several new sections have been supplied, and we have noticed several minor additions to the text which make for completeness. There is no doubt that in its revised form the work will meet the needs of many students of physics, and it deserves success. H. S. ALLEN.

Greenland. (Published by the Commission for the Direction of the Geological and Geographical Investigations in Greenland.) Editors: Prof. M. Vahl, Vice-Admiral G. C. Amdrup, Dr. L. Bobé, Prof. Ad. S. Jensen. Vol. 3: *The Colonization of Greenland and its History until 1929.* Pp. v + 468. (Copenhagen: C. A. Reitzel; London: Oxford University Press, 1929.) 35*s.* net.

WITH this volume the great work on Greenland, which embodies all available knowledge of the island, is completed. An introductory chapter on types of European colonisation is an excellent geographical introduction to a detailed study of the colonisation and trade of Greenland and the economic and social condition of the Greenlanders. Little of this matter has been previously accessible in English.

Other chapters deal with the status of Greenland in international law and the sanitation and health conditions. Admiral Garde discusses the navigation of Greenland waters and gives some indication of the old Norse routes. So far as can be judged from scanty directions, the old Norse ships followed courses that are suitable to-day, and they afford no evidence of material changes in ice conditions. Prof. Böggild adds a short chapter on mining, which relates chiefly to cryolite. The volume concludes with an etymological glossary of Eskimo place names, and an index to the folded map of Greenland on a scale of 1 : 4,000,000 is combined with the index to the three volumes.

The British Hydracarina. By Chas. D. Soar and W. Williamson. Vol. 3. (Ray Society Volume No. 115, for the Year 1928.) Pp. viii + 184 + plates 41-60. (London: Dulau and Co., Ltd., 1929.) 37*s.* 6*d.*

WE welcome the appearance of Vol. 3 of Messrs. C. D. Soar and W. Williamson's monograph published by the Ray Society on the British Hydracarina. It treats of the remaining species of the subfamily Pioninæ, together with the Aturinæ, Mideopsinæ, and Arrhenurinæ, and at the end of the book there is an index to the genera and species dealt with in the complete three-volume series. It is well up to the high standard attained by the Ray Society publications and is profusely illustrated by nineteen plates, of which the first six are coloured. Each species is separately figured and there are many illustrations of detailed characters. A work of this description which provides a ready means for identification is always a stimulus to the further study of the group concerned, and we trust that it will result in this section of the British mites becoming much better known. Workers in the group are very few and far between, and there is a wide scope for the collector to extend our knowledge of the distribution of many of the species and to bring new forms to light.

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.*]

School Science and Educational Values.

I HAVE no word but of thanks to A. A. E. for his kindly comments in NATURE of Mar. 8 upon my articles in the *Kentish Mercury*, yet I cannot but take up the challenge he gives in saying that it can scarcely be supposed that I am attempting to deny the appropriateness of an independent test in helping to determine how a pupil is reacting towards his educational environment. Big words these! To me, it seems that there is little *educo* about the business and far too much environment: that it is a case of crowding quarts into pints: you just test how far the poor little beggar examined happens to be inflated at the moment.

I am not clear whether my critic question my denial of the *appropriateness* of any external examination test that may be applied or my objection to *any independent test*. I object to both, as physically, mentally and morally harmful to all concerned, to teachers and taught, to parents and examiners. The system is of quite recent growth in Great Britain, a modern industry, in fact. The men who have made the British Empire have not suffered under it, nor have most of the leaders of to-day. As the gift of leadership is going from us, we cannot claim that we are now gaining from it. Scots have been trained to be efficient, in days gone by, in the smallest country villages, without external interference. To-day they are officially, hopelessly over-examined and by no means so dangerous to the south as they were—the more as they no longer eat oatmeal. It is sad that a great people should lose intelligence and individuality through an ill-chosen educational test and an attenuated diet. The public schools, to save themselves trouble, have adopted a common entrance examination—the result is that the preparatory schools are obliged all to tar with one brush. That the product lacks character to-day is in no way surprising. We do our best to eliminate the quality we most need: individuality and strength of character. It is a disaster that we no longer trust teachers.

The great pioneer of the heuristic method, Mr. Squeers, we may be sure, not only taught his boys how to spell 'winders' practically but also himself examined into their being well and truly cleaned: he doubtless was careful to drive the whole lesson home: his chronicler make no mention of any external examiner. The two colleges with which I have been connected, the Finsbury Technical College and the Central at South Kensington, long flourished without external examinations, using material—in my day—which was neither 'matriculated' nor 'school-certificated'. The Central product had courage, went out into the world and did well: to-day, I am told, it will not venture abroad.

Our bondage comes in large measure from the anti-heuristic, unpractical University of London and the wicked example it has set—by opening the matriculation to others than those who were proceeding to its degrees. The University of London has lived upon matriculation fees—these are the main support of the large and ever-growing army of bureaucratic officials. The School Certificate examination is now a most dangerous option to the London Matriculation, as boys may pass it when under fifteen and then specialise.

Most unfortunately, the fact is, man cannot let man alone: he ever tends mercilessly to oppress the child: he never recognises his own great individual ignorance and inability to guide himself, let alone others, through the maze of life. He thinks in his own superior terms of disciplined ignorance all the time, not in those of the child's quenchless thirst and desire to develop intelligence.

In our gardens, when plants begin to show signs of healthy growth, we do not take them up to examine their roots. We regard them lovingly, knowing that if we wish them to flourish we do well to let them alone and merely take care that their surroundings be kept normal and healthy: in due course they flower and fruit—we test the fruit by eating it, not by examination. The bad is obviously bad. Teachers, if and when competent, know full well how far their pupils—to use terms of the phrase rule—are reacting towards their environment. Examination tests are advocated, to-day, because they give employment to testers. I have been eye-witness of the insidious rise of the whole system. Fortunately, my children have escaped from it but I am obliged to see my grandchildren suffer.

The continued failure of the schools and universities to make proper use of the vast fund of knowledge and experience now available—to be scientific—is by far the blackest sign to-day of our inability to avail ourselves of the gift of intelligence the Gods would give us. All we can do is to extend the use of machinery and create more and more unemployment: soon, we shall examine for this and make the occupation competitive. Our own marvellous mechanism is in no way used intelligently. We allow those, the merely literary, who have no experimental sense, to govern.

HENRY E. ARMSTRONG.

UNFORTUNATELY, I find some difficulty in following Prof. Armstrong's argument. He complains both that teachers are incompetent and that we do not trust them; both that we fail to apply scientific method to education and that we use similar standards to measure the results of similar experiments by different experimenters. Were Prof. Armstrong to confine himself to urging far more intimate contact and closer co-operation between teachers and examiners (usually themselves teachers) he would, I think, serve the interests of the examined, while preserving our admittedly approximate, but only, method of differentiating degrees of ability. Whether or no all independent tests are universally harmful, whether or no examining bodies levy an unjust tax on students, whether or no there is still time to promote fruitfulness when the fruit is ripe, Prof. Armstrong provokes us to consider such questions anew. Let us apply to them our "vast fund of knowledge and experience", even although he finds that we are ignorant, and that we are unintelligent; a conclusion which the best informed and most sagacious of us will be the last to deny.

A. A. E.

The Homogeneous Isothermal Reaction $2CO + O_2 = 2CO_2$ in the Presence of Water Vapour.

DURING the past two years I have studied the oxidation of carbon monoxide, in silica bulbs, by a manometric method. A satisfactory interpretation of the complicated reaction kinetics has not yet been found, but it may be permissible to state in outline the results obtained, since the reaction is of general interest.

(1) In a mixture of $CO + O_2 + H_2O$ (0·13 per cent upwards) at total pressures from about 70 mm. upwards,

a homogeneous reaction can be measured in clear silica bulbs, between 530° and 730° C.

(2) The presence of water vapour appears to be essential for this reaction: there is approximate proportionality between water concentration and velocity: for example, at 580°, with excess of carbon monoxide:

pH$_2$O 1·8 6·2 9·0 18 mm.
velocity 5·3 18·7 25 49 per cent per minute.

Using oxygen and carbon monoxide which had stood over phosphorus pentoxide for one day only, the rate was 0·2 per cent per minute at 600° C., while with a mixture which had been standing for several weeks over phosphorus pentoxide the rate first became measurable at about 700° C.

(3) The rate (with concentration of water molecules constant) is roughly proportional to concentration of carbon monoxide molecules when oxygen is in excess, and proportional to a power of the concentration of oxygen molecules approximating to zero, when carbon monoxide is in excess, for a given total concentration.

(4) The reaction has a chain mechanism, with 'stable' chains at pressures exceeding a certain limit. The evidence for this is the increase in temperature coefficient as the temperature rises, and the retardation in a 'packed' bulb with a surface: volume ratio increased 18·5 fold.

H. Kühl (*Zeit. phys. Chem.*, **44**, 385; 1903) studied the oxidation of carbon monoxide in porcelain bulbs, and attributed the irregularity of the results to catalysis by the walls. The present results in silica bulbs are rather more reproducible, but it is now clear that the reaction measured by Kühl must also have been a chain reaction in the gas phase, because of the general similarity of the two sets of results. In particular, the rate in comparable reacting mixtures is about the same at the temperature at which Kühl worked (575° C.).

It should be mentioned that the reaction has also been studied by Prof. Bodenstein (Bodenstein and Ohlmer, *Zeit. phys. Chem.*, **53**, 166; 1905) in silica bulbs, with results completely different from my own. Rapid combination was observed at temperatures so low as 318°-230° C. It seems most probable (as suggested by Benton and Williams, *Jour. Phys. Chem.*, **30**, 1487; 1926) that the reaction was caused by traces of impurity on the walls—a possibility suspected by the authors themselves, in some of their experiments.

(5) When a sudden addition is made of oxygen, carbon monoxide, or carbon dioxide to a mixture reacting at a steady rate in the region of the stable chain mechanism, the reaction is retarded in each case, provided that the concentration of water molecules is kept constant. If, on the other hand, the *total concentration* of such a reacting mixture is progressively decreased by removal of gas from the bulb, the absolute reaction rate at first decreases, passes through a minimum, and then increases again rapidly, until at a definite concentration inflammation sets in. A typical example is that at 570° a 2CO + O$_2$ mixture + 2·5 per cent H$_2$O decreases in rate of combination from 500 mm. to a minimum at about 90 mm., and increases again rapidly to a critical pressure of 65 mm., at which the mixture explodes.

(6) The reaction in the stable chain region is accompanied by a violet glow. I am indebted to Mr. A. L. Carrad for the following observation: the glow, observed in a wide quartz tube with a quartz window, at 570° C., becomes more intense as the reacting gas is pumped out of the tube, until near the critical pressure a rapid increase in brightness culminates in a vivid flash. Thus the inflammation at this (upper) critical pressure completes a region of increasing velocity, and may therefore be a case of thermal acceleration following upon the increase in velocity which arises in the first place from diminished deactivation of reaction chains in the gas phases.

In a recent paper Prof. Semenoff and co-workers (*Zeit. phys. Chem.*, B, **6**, 307; 1930) have investigated carefully the upper and lower pressure limits for inflammation of CO + O$_2$ mixtures expanded from a mixture originally saturated with water vapour. So far as my own observations go (made upon the upper limit only), the results agree with those already published by Prof. Semenoff; in addition, I find that both the existence of the critical limit for inflammation and the behaviour of the 'slow' homogeneous reaction described in paragraphs (5) and (6) are dependent upon the presence of a sufficient proportion of water vapour; otherwise the reaction rate decreases continuously as the total concentration is reduced, and there is no minimum and no inflammation.

It has been shown by Prof. Garner ("The Initiation of Flame in Mixtures of Carbon Monoxide and Oxygen", Garner and Gomm, *Trans. Farad. Soc.*, **24**, 470; 1928) that the *lower* pressure limit for inflammation (5-10 mm. total pressure, from 660° to 850° C.) is the same whether the original mixture is dried by passage over 10 cm. of phosphorus pentoxide, or is saturated with water vapour. This is interesting and unexpected in view of the dependence of the *upper* pressure limit and the 'slow' homogeneous reaction upon water vapour concentration.

(7) I have once or twice encountered an induction period prior to explosion, under conditions similar to those of the following instance: 258 mm. carbon monoxide, roughly dried by phosphorus pentoxide, added to 118 mm. oxygen similarly dried, remained quiescent for 2 minutes and then exploded.

A point which I hope to decide by further experiment upon this phenomenon and the general kinetics of the 'slow' homogeneous reaction is whether the initiation of the reaction chains involves the silica surface, through the catalytic effect upon the water-gas reaction, with H$_2$, and H$_2$O$_2$ or OH as links in the chain.

B. Topley.

University College,
London, Feb. 18.

Group Velocity and Wave Mechanics.

If it be true that Nature is built up not of particles but of waves, it is obviously of great importance to gain clear ideas as to the characteristics of wave motion. In dealing with any oscillatory motion, Dr. Albert Campbell suggested several years ago the use of the term *pulsatance* (an alternative form sometimes used is *pulsance*) for $2\pi\nu$ where ν is the frequency (*Proc. Phys. Soc.*, vol. 31, p. 80; 1919). Thus the pulsatance is the number of vibrations in 2π units of time. I have found this term of very great service in teaching, as it economises time in discussion and space in writing or printing. Even the elementary student appreciates its value when he recognises that it corresponds to angular velocity in the reference circle in defining simple harmonic motion. Such a motion is represented by the equation $y = A \sin pt$, where A is the amplitude and p the pulsatance.

Similarly, in discussing wave motion, it is convenient to introduce a quantity expressing the number of waves, each of wave-length λ, in 2π units of length. I propose, tentatively, to call this quantity $k = 2\pi/\lambda$, the *undulatance*. The equation for the simplest type of wave motion, the progressive harmonic wave, is now $y = A \sin(pt - kx + \epsilon)$. The phase of the wave motion is determined by $\phi = pt - kx + \epsilon$, and the phase velocity, $u = p/k$, is obtained by dividing

the pulsatance by the undulatance. This follows from the fact that if we substitute $t+t'$ for t, and $x+\frac{p}{k}t'$ for x, the equation is unchanged in form.

The discussion of group velocity (see, for example, Sommerfeld, "Wellenmechanischer Ergänzungsband", or Haas, "Wave Mechanics", Chap. ii.) may now be abbreviated as follows. When there is approximate agreement of phase among the waves belonging to a group, the resultant vibration is relatively large. The 'centre of energy' of the wave group is characterised by the fact that the partial differential coefficient of the phase with respect to the pulsatance must vanish, or $\partial\phi/\partial p=0$. This condition results in the equation $x=\frac{dp}{dk}\left(t+\frac{d\epsilon}{dp}\right)$, showing that the centre of energy moves with a velocity g, the group velocity, given by $g=dp/dk$ (Rayleigh, "Theory of Sound", vol. 2, p. 297). This leads quite simply to the more familiar expressions for the group velocity in terms of frequency (de Broglie) or wave-length.

Assuming that a mass particle, m, moving with velocity v is associated with a system of waves, it can be shown by employing Einstein's principle that the phase velocity $u=p/k=c^2/v$, and is accordingly greater than c, the velocity of light. The pulsatance p is related to the pulsatance p_0 referred to a system of co-ordinates moving with the body by the Lorentz equation $p=p_0(1-v^2/c^2)^{-\frac{1}{2}}$, so that $p^2(1-v^2/c^2)=p_0^2$, or $p^2-c^2k^2=p_0^2$. From this we find $g=dp/dk=c^2k/p=v$, and so we see that v the particle velocity is the same as the group velocity g.

It will be seen that this derivation of the result is shorter and more direct than that usually given, although there is nothing essentially new in the method. The phraseology here suggested will be found useful in dealing with the wave mechanics of Louis de Broglie and of Schrödinger.

In this connexion it may be pointed out that it would be a great convenience in theoretical work to have a recognised symbol to represent $h/2\pi$, the quantum unit of angular momentum. A small letter, not a capital, is desirable, and after considering various possibilities, it is suggested that the letter b may be suitable. We should then write $b=h/2\pi$ and the fine structure constant would be given by $\alpha=e^2/bc$. According to Eddington's recent calculation $bc/e^2=137$. The letter b may serve to recall the name of Niels Bohr, although it should be remembered that J. W. Nicholson was the first to employ the quantity $h/2\pi$ in his work on the spectra of nebulæ and the solar corona (1911–12).

H. S. ALLEN.

The University,
St. Andrews, Mar. 22.

The Acquired Characters of *Alytes*.

THE reading again, after many years, of von Nägeli's account of his experiments with Alpine plants[1] has suggested to me the possibility that Kammerer's experiments with *Alytes* may have no bearing upon the inheritance of acquired characters, even if we accept all the results he claimed, and all that others have claimed on his behalf.

May I give a very brief sketch of von Nägeli's experiments? He took some Alpine plants from their ordinary surroundings and placed them in rich soil, under the usual conditions of cultivation, in the Botanical Gardens at Munich. The plants thus removed from their normal environment changed in their characters so much that, had he not seen the transformation taking place, von Nägeli would not have recognised them. The seeds of these plants grown in the Botanical Gardens under the same conditions, reproduced the characters that their parents had developed under cultivation, and this went on for about thirteen years. But when, at the end of this period, some of the plants were removed to poor and stoney soil, they reverted to the characters of their Alpine ancestors, which characters had not appeared for all these generations. Moreover, the seeds of the plants in the Botanical Gardens when grown under Alpine conditions produced the characters of their comparatively remote ancestors and not those of their parents for thirteen generations back.

A comparison of this with what happened in Kammerer's *Alytes* is, I think, very illuminating. *Alytes* and its young pair, hatch out and live on land, and, though the embryo has a gill, it loses this before coming out of the egg. The male *Alytes* does not develop the nuptial pad present in other toads and in frogs; such a pad would be useless to it. When, however, *Alytes* was kept warm and given free access to water in sufficient quantity, a change in several of its characters was produced. Pairing took place in the water, and the eggs, after fertilisation, instead of being carried about by the male, were deposited as are those of other allied species and genera. The larvæ from these eggs, hatched out in the water, had gills. The males, it is stated, developed nuptial pads similar to those of other male toads and frogs, though these pads were imperfect, and this continued in succeeding generations.

But—and this is to me the crucial point—all the subsequent generations were given free access to water. Indeed, had they not been able to breed in the water, several of these changes of character must have proved fatal to the offspring.

The question is whether, had these subsequent generations of *Alytes* been deprived of access to water, they would not have reverted to the characters of their ancestors, including the disappearance of the nuptial pads? I gather that nothing of this kind has been tried, and until it is, these new characters appear to me to mean no more than did the new characters of von Nägeli's Alpine plants. What happened in both cases may be explained most simply by the presence in the germ-plasm of potentialities to respond in a definite manner to changes in the environment; and to me the simplest explanation appears most likely to be true. Any other would require quite unnecessary assumptions.

Until, therefore, some enterprising biologist who has the facilities, completes the experiment as I have suggested, the question must remain open. My personal belief is that the answer will be that *Alytes* will behave much as did the Alpine plants. It would be too much to expect that the two cases would be parallel in detail, but I suggest that the general result will be the same.

CHARLES WALKER.

The University of Liverpool,
Mar. 14.

[1] C. von Nägeli. "Mechanisch-physiologische Theorie der Abstammungslehre." Münich and Leipzig, 1884.

A Singular Behaviour of Striæ in the Positive Column of an Electrical Discharge through Hydrogen.

THE following behaviour of some striæ in the positive column of an electrical discharge through rarefied hydrogen seems to be of sufficient interest to warrant a description. The distances between adjacent striæ in hydrogen change with gas pressure in an anomalous manner first noted by Willows (*Proc. Camb. Phil. Soc.*, **10**, 302; 1900), in that, with reduction of pressure,

they at first increase in magnitude, pass through a maximum value and then in turn through a minimum value. This minimum occurred at about 1·5 mm. pressure in the discharge tubes I used, which had an internal diameter of 11 mm. The striæ here were bluish in colour, whereas at the other pressures their colour was reddish. The phenomenon to be described was only observed in this narrow pressure region where the striæ were most closely packed. The discharge current was kept constant at 6 milliamperes and it passed between cold electrodes consisting of aluminium cylinders 2 mm. in diameter.

When the critical pressure was reached, a very slight reduction of pressure caused the stria nearest the cathode to leave the positive column and move slowly across the whole Faraday dark space up to and beyond the end of the cathode. Here it remained as a distinct band of light encircling the cylindrical cathode. During all this time the remainder of the positive column remained unchanged in position. A further reduction of pressure caused a second stria to detach itself from the positive column and in turn to proceed slowly up to the cathode and to merge there with the first stria. A still further reduction of pressure often made a third stria repeat the performance of the first two. When the pressure was now very slowly increased the reverse process took place; one of the striæ detached itself from the band of light around the cathode containing the merged striæ and marched slowly back until it resumed its original place in the positive column. Then in its turn the second stria, and finally the third, did the same thing. The whole procedure could be repeated at will.

No explanation of this curious behaviour of these striæ has been found. It is known that the electric field throughout the Faraday dark space is very small compared to the average field prevailing in the positive column. The existence of this dark space seems to be dependent upon a copious supply of electrons coming from the negative glow as well as upon electric charges on the walls of the discharge tube. The Faraday dark space is thought of as a unit, the cause for the existence of which proceeds from the cathode. How, then, is it possible to divide this region of low field intensity into two parts by the intrusion of a stria with its presumably much larger fields? In other words, when the Faraday dark space has once terminated at the isolated stria, what brings it into existence again beyond this stria? It would appear that conditions at the surface of the walls of the tube play a large rôle in the phenomenon described, and that these conditions are markedly affected by a slight change of pressure at the critical value here involved.

Other observers have remarked upon the fact that at a certain pressure the discharge through hydrogen undergoes a sudden change during which a number of the striæ from the end of the positive column jump to the cathode. The observations noted above show that the change is not a discontinuous one, but that during a very slow reduction of pressure the whole process may be followed continuously in detail.

JOHN ZELENY.

Sloane Physics Laboratory,
Yale University, Feb. 26.

Mounting Media for Microscopic Work.

IN the examination of colourless transparent objects under the microscope, it is important to have sufficient difference of refractive index between the objects and the mountant to retain visibility of outline under critical conditions of illumination. In addition to this, it is essential that there shall be no effect on the structure of the preparation, such as the swelling produced in some dehydrated materials by aqueous mountants. To fulfil these conditions I prepared a new medium with a cellulose ester base, the refractive index of which could be varied within quite wide limits ($n = 1{\cdot}45$ to $1{\cdot}57$) by the addition of a plasticiser of suitable refractive index and a volatile solvent to dissolve the mixture.

A medium giving a refractive index of 1·42 when liquid, rising to 1·47 when hard, which is very useful for unstained cellulose materials ($n = 1{\cdot}52$ to $1{\cdot}54$), has the following percentage composition:

Cellulose nitrate (extra low viscosity type—Nobel's H.X.2)	25
Triacetin	25
Methyl ethyl ketone	50

Mixed together and stirred until dissolved.

The medium is applied in the same manner as Canada balsam and allowed to harden either with or without heat. During the hardening process the ketone evaporates and the refractive index rises from the lower to the upper value.

The refractive index data of other media in which various plasticisers have been substituted for triacetin, but without any other change, are given below, together with comparative values for euparal and Canada balsam resins. It will be seen from the table that these new media give a considerably extended range, from which in most cases a suitable one may be chosen, though there are naturally many others available.

Mountant.	Refractive Index.	
	Liquid.	Hardened.
Cellulose nitrate, methyl ethyl ketone and		
Triacetin	1·417	1·471
Resorcinol diacetate	1·435	1·517
Benzyl alcohol	1·442	1·525
Tricresyl phosphate	1·448	1·545
Benzophenone	1·461	1·573
Euparal	1·481	1·525
Canada balsam (Xylol)	1·530	1·545

Cellulose acetate can be used in place of cellulose nitrate and is found to give somewhat lower values of the refractive index with the same plasticiser. However, in the case of the acetate, more dilute solutions must be used in order to obtain a sufficiently fluid medium.

J. M. PRESTON.

The Dyehouse,
College of Technology,
Manchester, Mar. 15.

THE mountant suggested by Mr. Edwin E. Jelley in NATURE of Feb. 22 raises some points of interest. Visibility of uncoloured microscopical objects is dependent on a difference in refractive index between the object, or any part of it, and its environment, usually a mountant. The principles involved were expounded for petrological specimens by Mr. Sorby and for diatoms by Mr. Stephenson fifty years ago.

Many mountants have been tried for diatoms, and I. D. Möller especially mounted some of his type-slides in mono-brom-naphthalene. One, belonging to the Geological Department of this University, now shows minute globules, probably aqueous, on the under surface of the cover-glass. Theoretically there appears to be little advantage in Mr. Jelley's mountant for diatoms and crystals. If a slide with such a mountant is not rung with a suitable protective, evaporation of the mono-brom-naphthalene will slowly occur and

eventually the mountant will be simple Canada balsam. If the slide is to be rung, it would generally be better to mount in the brom-naphthalene alone and thus obtain the advantage of a higher refractive index. Should, however, such a mixture be required, styrax, which is also soluble in mono-brom-naphthalene and has a higher refractive index than Canada balsam, would generally be a preferable ingredient. A workable combination has a refractive index of 1·62.

In October of last year I carried out an investigation on the influence of the refractive index of mountants on biological tissues which I hope shortly to publish. Tissues were mounted in media of varying refractive index from 1·34 to 2·1 (phosphorus). The mountant of highest refractive index that could be conveniently used was a saturated solution of sulphur and arsenious sulphide in methylene iodide. Such a mixture is of a canary yellow colour and has a refractive index of 1·804. It is apparently stable, since it has been kept in an open test-tube, apparently unchanged, for five months. Mounts in this liquid, however, need ringing. A higher refractive index, namely, 1·87, is obtained with a solution of phosphorus in methylene iodide, but the golden yellow liquid soon becomes cloudy on exposure to air.

WILFRID MARSHALL.
Pharmacological Laboratory,
University of Aberdeen,
Mar. 4.

Isolation of the Radical Ethyl.

WE have been successful in preparing the free radical ethyl (in the same way as we obtained the free methyl) by decomposing lead-tetraethyl in a hydrogen stream at reduced pressure by means of heat (compare Paneth and Hofeditz, *Ber. Deuts. Chem. Gesells.*, **62**, 1335; 1929. NATURE, **124**, 161; 1929). The free ethyl is not less aggressive than the free methyl. It converts the metals zinc, cadmium, antimony, and lead into volatile compounds which (under atmospheric pressure and at room temperature) form limpid liquids. The zinc compound has been studied in some detail: the presence of ethyl could be established by converting the ethyl groups into alcohol and identifying the latter by the iodoform test; the metal revealed itself as zinc free from lead, and the melting and boiling point of the compound coincided with those known for zinc diethyl. As the zinc metal before conversion into this compound had been located at a distance from the place of decomposition of the lead-tetraethyl, it seems to be demonstrated that the radical ethyl can be obtained in the free state and carried by a gas stream over several centimetres before recombination takes place.

A fuller report of the experiments on free ethyl will be published in the *Berichte der Deutschen Chemischen Gesellschaft*.

F. PANETH.
W. LAUTSCH.
Chemisches Institut der Universität,
Königsberg i. Pr., Mar. 17.

The Maladaptation of Trout Spermatozoa to Fresh Water.

THE finding of Prof. Huxley (NATURE, Mar. 29) that the addition of salts to fresh water prolongs the period of activity of trout spermatozoa confirms results of other workers. There are several papers bearing on this subject, but those of Scheuring [1, 2] and Gaschott [3] treat specifically of the spermatozoa of the trout and salmon. Analogous results have been obtained with amphibian material, and it is perhaps general that an osmotic pressure approximating to that of the tissues is favourable to the maintenance of the integrity of the cell, notwithstanding the fact that fertilisation may normally take place in a hypotonic medium. The problem is, however, not a simple one, and the specific effect of various solutes, more particularly their ions, on the cell must be taken into consideration.

Apart from the problems of physiological interest which are raised, the results have, as Prof. Huxley suggests, an interesting bearing on the evolution of species in their transition from marine to estuarine, fluvial, and terrestrial forms. The necessity for a reduction in the time of exposure of the gametes or their protection from the external environment is perhaps reflected in many modifications of sexual mechanisms and behaviour. Copulation with internal fertilisation is the most complete solution of the difficulty. At present I am collecting references and experimental data which I hope will enable me to write more explicitly on the subject in the near future.

ARTHUR WALTON.
School of Agriculture,
Cambridge, Mar. 31.

[1] Scheuring, L. Biologische und Physiologische Untersuchungen an Forellensperma. *Arch. Hydrobiologie*, Suppl. 4, pp. 181-318; 1925.
[2] Scheuring, L. Weitere biologische und physiologische Untersuchungen an Salmonidensperma. *Zool. Jahrb.*, **45**, pp. 651-706; 1928.
[3] Gaschott, O. Beiträge zur Reizphysiologie des Forellenspermas. *Arch. Hydrobiologie*, Suppl. 4, pp. 441-478; 1925.

Mating during Pregnancy in the Mouse.

IT would seem that mating during pregnancy in the rat and mouse is an exceedingly rare occurrence. Nelson (1929) [1] has recorded one instance in the rat, and Long and Evans (1922) [2] refer to two others. So far as we know, mating during pregnancy has not been recorded in the case of the mouse. It seems worth while to place on record, therefore, the following facts which have presented themselves to our notice during the course of an experiment in which 100 females have been examined daily for six months for vaginal plugs—evidence of mating. The animals were continuously kept with males so that every opportunity for mating was given.

Date when 1st Vaginal Plug was noticed.	Date when 2nd Vaginal Plug was noticed.	Date of Parturition.	Number in Litter.	Number of Days between 1st and 2nd Vaginal Plugs.
22.8.29	7.9.29	10.9.29	4	16
5.8.29	9.8.29	24.8.29	6	4
2.10.29	12.10.29	21.10.29	8	10
20.9.29	5.10.29	10.10.29	8	15
27.10.29	5.11.29	15.11.29	8	8
25.12.29	8.1.30	12.1.30	5	14

In our experience, then, out of 100 females under observation for six months, 6 presented trustworthy evidence that during pregnancy mating had occurred without in any way affecting the course of pregnancy. It is seen that during the course of a single pregnancy mating occurred only once in our experience, and that it occurred not always at the same time during pregnancy though always at a time when, had the animal not been pregnant, it would have been expected.

F. A. E. CREW.
L. MISKAIA.

[1] Nelson, Warren O. Œstrus during Pregnancy. *Science*, vol. 70. No. 1819. Nov. 1929.
[2] Long and Evans. The Œstrous Cycle in the Rat. *Memoirs Univ. Calif.*, p. 58; 1922.

Reaction of the Phagocytes of Arthropods to their Internal Insect Parasites.

By Dr. W. R. THOMPSON, Imperial Bureau of Entomology.

IN his celebrated work on the pathology of inflammation, first published in 1892, E. Metchnikoff [1] made a general survey of the phenomena of phagocytosis in the animal kingdom and pointed out that there exist between the various groups very striking differences in the behaviour of the white blood cells towards internal parasites. He stated that among the Arthropods the phagocytic reaction is, in general, rather feeble, and suggested that this condition is perhaps related to the development of a chitinous cuticula in these animals, and that since this cuticula prevents the entrance of parasitic organisms the defensive activity of the phagocytes is less marked than in organisms which do not possess this protection. Several years later L. Cuénot, in his "Études sur la physiologie des orthoptères", criticised the views of Metchnikoff on the ground that the cuticular armature of the Arthropods, in spite of its thickness, is a very inefficient means of defence against parasites. Cuénot had, indeed, observed that the parasites of Arthropods in their habitual hosts are not usually attacked by phagocytes, but he explained this fact on the hypothesis that the parasites have developed the power of resisting the phagocytes, by which they would otherwise be destroyed. According to this idea, when a new parasite arrives in an Arthropod it ought to be attacked by the phagocytes and destroyed by them.

In a later paper Cuénot [2] modified these views to some extent, having found that living parasites of Arthropods may be surrounded by the blood cells, although the encystment has not, necessarily, a fatal result. Cuénot did not, however, put forward any satisfactory evidence for the view that the insect parasites of Arthropods are ordinarily attacked by phagocytes when in a healthy and living condition.

In his admirable studies of the biology of the Diptera parasitic on insects (1898, 1910), J. Pantel,[3] whose conclusions were based on the study of a large number of species, stated that as a general rule the free and healthy larvæ of entomophagous parasites are not attacked by phagocytes. The phagocytes of the infested organism, according to Pantel, are always inactive in relation to normal parasites. They intervene in cases of bacterial infection by the integumental sheath and accumulate about sick or dead parasites or moult skins.

The results of my own studies on this subject, of which a summary up to that date was published in 1915,[4] confirm those of Pantel. Nevertheless, the view that even in Arthropods the phagocytes constitute a defensive mechanism against parasitic enemies of all kinds, that the destruction and death of parasites entering hosts to which they are not adapted is due to phagocytic attack, and conversely, that the process of adaptation to a specific host consists essentially in the elaboration by the parasite of anti-phagocytic secretions or the development by it of structures constituting a defence against the blood cells, still continues to be advocated. To give only one example, this is the view put forward by Caullery [5] in his book on parasitism and symbiosis (chap. x. p. 250). It seems, therefore, desirable to give a brief general summary of the facts concerning the tissue reactions of Arthropods to their internal insect parasites. No attempt will be made in this article to discuss the relation between the blood cells of Arthropods and protozoan, fungous, or bacterial parasites, because the physiological relations between these organisms and the hosts they infest are very different from the relations between internal insect parasites and their hosts.

Taking, then, the internal insect parasites of Arthropods, which infest their hosts, for the most part, in the larval condition, we may classify them according to the exact nature of their relations with their hosts into three principal groups.

1. The first group includes those parasites the larvæ of which lie free within the body cavity of their host. To this group belong the vast majority of the internal Hymenopterous parasites and a minority of the Diptera. So far as I have observed, the living larvæ of parasites of this group are never attacked by phagocytes. There is no particular reason to suppose that they *repel* the phagocytes. The phagocytes seem simply to be *indifferent* to the parasite larvæ as they are to the organs of the host itself.

2. The second group comprises the parasites which penetrate into some organ of the host, in which they pass a considerable period without, however, causing any extensive and rapid destruction of tissue. Examples of this type are the Diptera *Sturmia scutellata* R.-D., which lives during the first larval stage in the muscle fibre of the caterpillar which it infests; *Sturmia sericariæ* Corn., the parasite of the silkworm, which lives in a ganglion of the ventral nerve-chain of the host; and *Blepharidopsis nemea* Meig., which lives in a lobe of the fat-body. The larvæ of these species develop slowly, absorbing nutriment from the organs into which they have penetrated, and sometimes cause marked pathological changes, but no rapid and extensive destruction of tissue. The reactions produced in the host tissue which they enter are in no way either advantageous to the host itself or detrimental to the parasite; on the other hand, no phagocytic accumulations are formed around the bodies of these larvæ.

3. The third group of parasites includes species which enter into anatomical relations with the host in such a way that extensive and sometimes rapid destruction of tissue is produced. Such are the numerous Tachinids which enter the body of the host through the skin and leave the extremity with the posterior spiracles embedded in the body-wall, and those which after entering force the posterior extremity either into the lumen of a trachea or through the body-wall in order to obtain access to the outer air. The Tachinid, *Plagia trepida* Meig., which enters a muscle fibre in the first larval stage and immediately begins to devour the muscular substance, can also be placed in this group. Around

larvæ of this kind, or adjacent to them, accumulations of phagocytes are frequently observed. These accumulations appear to depend upon the diffusion into the blood of substances from the destroyed tissues, or, as Pantel suggests, on the diffusion of toxins from bacteria which have penetrated into the body of the caterpillar through the opening made by the parasite. Sometimes the accumulations of phagocytes are very extensive and completely surround the parasite, but they never penetrate into its body, nor is there any good evidence that they impede its development.

The statements just made summarise the data in what may be called cases of natural parasitism. As will be seen, they afford no support for the view that the adaptation of the internal insect parasite to its host consists essentially in the development of substances destined to repel the phagocytes, or in structures designed to afford protection from their attack. To test this point, I carried out several years ago a number of experiments, during which I introduced into the body cavity of living insects sarcophagous or parasitic larvæ, which are never found in the species concerned in Nature. In some of these experiments the parasites introduced into the unfamiliar hosts lived and developed in the normal way, and in that case were never molested by the phagocytes. In other cases they died and the phagocytes gathered around their bodies except when the host was in a very diseased or exhausted condition, but in no case was any accumulation of phagocytes observed around a living parasite. The results of these experiments were confirmed by others, in which the larva of the internal parasite was killed without wounding the host, by blocking up the opening of its respiratory funnel. No accumulation of phagocytes around the parasite larva was observed in such cases so long as it remained alive, but after its death, blood cells began at once to accumulate about it.

It has long been known that phagocytes become extremely abundant during the pupal period and are found during this time migrating into and destroying the degenerating larval tissues, but there is no reason to suppose that this period is especially dangerous for internal parasites, or that they require any protective secretions or structures in order to enable them to survive it. *Chalcis Fonscolombei* Duf., the parasite of Sarcophagids, which attacks its host during the late larval stage and emerges from the puparia, does not possess any sack. The same thing is true of *Alysia manducator* Panz., the Braconid parasite of *Lucilia sericata* Meig. On the other hand, there is no reason to suppose that the trophamnion which occurs in some pupal parasites is a protection against phagocytic attack, for there are many parasites which live within a membrane of this type, but infest their host only during the larval period, as, for example, the polyembryonic Encyrtids.

Finally, the idea that phagocytes break down the tissues of the parasites they attack and that the substance of the latter is built up into the tissues of the host, seems also to be contrary to the facts. The accumulation of phagocytes about the body of a dead parasite appears to continue for a considerable time, but it is not certain that the phagocytes ever disperse. Dead eggs or larvæ may often be found many months after their death has occurred, surrounded by a dense ball of phagocytes, many cells thick, of which the internal layers show manifest signs of cellular degeneration. Within these balls the dead larvæ disintegrate, but the action of the autolytic enzymes would produce this effect without the intervention of the phagocytes, which do not, so far as I have observed, actually penetrate into the bodies of the parasites.

[1] E. Metchnikoff, "Leçons sur la pathologie comparée de l'inflammation". (Paris: Masson, 1892.)
[2] L. Cuénot, *Arch. de Biol.*, **14**, 1er fasc., 1895, and **15**, 1897, Paris—Brussels.
[3] J. Pantel, *La Cellule*, **15**, 1er fasc., 1898, and **26**, 1er fasc., 1910, Louvain.
[4] W. R. Thompson, *Bull. Soc. Zool. France*, **40**, p. 63; 1915.
[5] M. Caullery, "Le parasitisme et la symbiose". (Paris, Doin, 1922.)

Clerk Maxwell and the Michelson Experiment.

WE have received from Mr. Rollo Appleyard, author of "Pioneers of Electrical Communication", a copy of correspondence that he has had with Prof. P. Lenard, of Heidelberg, on the association of Clerk Maxwell with the Michelson experiment. Prof. Lenard suggested that although it is universally acknowledged that Maxwell played an important part in instituting the inquiry, it would be helpful if references could be obtained to Maxwell's own account of his views. Mr. Appleyard accordingly furnished the following particulars, which Prof. Lenard requested might be published in NATURE, in order that full credit might be given to Clerk Maxwell for the part he took in inspiring the Michelson experiment.

At a meeting of the Royal Society on Jan. 6, 1880, Prof. G. Stokes, the secretary, communicated a paper by Prof. Clerk Maxwell, who had recently died; the paper was a letter to Prof. D. P. Todd, who was then Director of the American Ephemeris. This letter suggested that careful observations of the times of the eclipses of Jupiter's satellites, when Jupiter was in different directions as seen from the earth, might show whether the velocity of light varied in different directions, owing to the motion of the solar system through the ether. Clerk Maxwell admitted that he was not an astronomer, and was doubtful whether the eclipses could be timed with sufficient accuracy to test the suggestion. He thought it would probably be agreed that the only class of observations that would be of sufficient accuracy for the purpose would be the photometric ones that were made at Harvard College Observatory, or others on similar lines. Even with these Prof. R. A. Sampson found puzzling anomalies, due perhaps to changes in the character of Jupiter's surface, which is of a cloudy nature, and apparently subject to variations in its transparency.

Clerk Maxwell had thought that terrestrial ex-

periments would be useless to solve the problem, owing to the extreme smallness of the quantity to be measured, which is one of the second order. However, his letter led to an article by Prof. A. A. Michelson, which appeared in the *American Journal of Science* for August 1881, extracts from which are printed below. It will be seen that Michelson refers to Maxwell's suggestion, and notes that the second-order quantity, which Maxwell had considered too small to determine, is "easily measurable". He then gives an outline of what we now know as the Michelson experiment.

Clerk Maxwell's name therefore deserves mention, since apparently his suggestion, though not fruitful in the manner that he hoped, had some effect in bringing about the famous experiment, the result of which laid the foundation of the theory of relativity.

Extract from *American Journal of Science*, Series (3), Vol. 22, p. 120, August 1881.

Art. XXI.—*The Relative Motion of the Earth and the Luminiferous Ether.*

By Albert A. Michelson, Master, U.S. Navy.

Let V be the velocity of light.

v = the speed of the earth with respect to the ether.
D = the distance between the two points.
d = the distance through which the earth moves while light travels from one point to another (on the earth's surface).
d_1 = the distance earth moves while light passes in the opposite direction.

Suppose the direction of the line joining the two points to coincide with the direction of earth's motion and let

T = time required for light to pass from the one point to the other, and
T_1 = time required for it to pass in the opposite direction. Further, let
T_0 = time required to perform the journey if the earth were at rest.

Then

$$T = \frac{D+d}{V} = \frac{d}{v}, \quad \text{and} \quad T_1 = \frac{D-d}{V} = \frac{d_1}{v}.$$

From these relations we find

$$d = D\frac{v}{V-v}, \quad \text{and} \quad d_1 = D\frac{v}{V+v},$$

whence

$$T = \frac{D}{V-v} \quad \text{and} \quad T_1 = \frac{D}{V+v},$$

$$T - T_1 = 2T_0\frac{v}{V} \text{ nearly, and}$$

$$v = V\frac{T-T_1}{2T_0}.$$

If now it were possible to measure $T - T_1$, since V and T_0 are known, we could find v, the velocity of the earth's motion through the ether.

In a letter, published in NATURE shortly after his death [read before the Royal Society on Jan. 6, 1880; see NATURE, Jan. 29, 1880, p. 314], Clerk Maxwell pointed out that $T - T_1$ could be calculated by measuring the velocity of light by means of the eclipses of Jupiter's satellites at periods when that planet lay in different directions from earth; but that for this purpose the observations of these eclipses must greatly exceed in accuracy those which have thus far been obtained. In the same letter, it was also stated that the reason why such measurements could not be made at the earth's surface was that we have thus far no method for measuring the velocity of light which does not involve the necessity of returning the light over its path, whereby it would lose nearly as much as was gained in going. The difference depending on the square of the ratio of the two velocities, according to Maxwell, is far too small to measure.

The following is intended to show that with a wave-length of yellow light as a standard, the quantity—if it exists—is easily measurable. Using the same notation as before, we have—

$$T = \frac{D}{V-v}, \quad \text{and} \quad T_1 = \frac{D}{V+v}.$$

The whole time occupied therefore in going and returning [is]

$$T + T_1 = 2D\frac{V}{V^2 - v^2}.$$

If, however, the light had travelled in a direction at right angles to the earth's motion it would be entirely unaffected, and the time of going and returning would be therefore

$$2\frac{D}{V} = 2T_0.$$

The difference between the times $T + T_1$ and $2T_0$ is

$$2DV\left(\frac{1}{V^2 - v^2} - \frac{1}{V^2}\right) = \tau,$$

$$\tau = 2DV\frac{v^2}{V^2(V^2 - v^2)} \text{ or nearly } 2T_0\frac{v^2}{V^2}.$$

In the time τ the light would travel a distance

$$V\tau = 2VT_0\frac{v^2}{V^2} = 2D\frac{v^2}{V^2}.$$

That is, the actual distance the light travels in the first case is greater than in the second, by the quantity $2D\frac{v^2}{V^2}$.

Considering only the velocity of the earth in its orbit, the ratio

$$\frac{v}{V} = \frac{1}{10{,}000} \text{ approximately, and}$$

$$\frac{v^2}{V^2} = \frac{1}{100{,}000{,}000}.$$

If $D = 1200$ millimetres, or in wave-lengths of light, 2,000,000, then in terms of the same unit,

$$2D\frac{v^2}{V^2} = \frac{4}{100}.$$

If, therefore, an apparatus is so constructed as to permit two pencils of light, which have travelled over paths at right angles to each other, to interfere, the pencil which has travelled in the direction of the earth's motion, will in reality travel $\frac{1}{100}$ of a wave-length farther than it would have done were the earth at rest. The other pencil being at right-angles to the motion would not be affected. . . .

In conclusion, I take this opportunity to thank Mr. Graham Bell, who has provided the means for carrying out this work, and Professor Vogel, the Director of the Astrophysikalisches Observatorium [in Potsdam], for his courtesy in placing the resources of the laboratory at my disposal.

Radio Direction-Finding by Transmission and Reception.*

By Dr. R. L. SMITH-ROSE.

TRANSMISSION OVER SEA AND NIGHT ERROR.

WHEN the transmission is entirely over sea the minimum range for night errors to be experienced is increased to about 100 miles, due to the diminished attenuation of the direct wave resulting from the superior conductivity of sea water. At distances greater than the minimum already mentioned, the errors increase in magnitude for distances up to a few hundred miles. When the distance is very great it is possible for much of the downcoming radiation to arrive at a very large angle of incidence. For example, a section of the earth and the ionised layer drawn to scale is shown in Fig. 4. From this it is evident that, at distances of 1780 and 3560 miles, it is just possible for radiation leaving the transmitter horizontally to return to the earth's surface at grazing incidence. It is likely that the intensity of such waves, after two reflections from the ionised layer and one from the earth's surface, will be much greater than that of waves which have undergone a greater number of reflections, and thus it is the ' downcoming ' wave arriving horizontally which will be chiefly responsible for the received signal intensity. It is evident that only small variations in direction-finder bearings will be expected under such conditions.

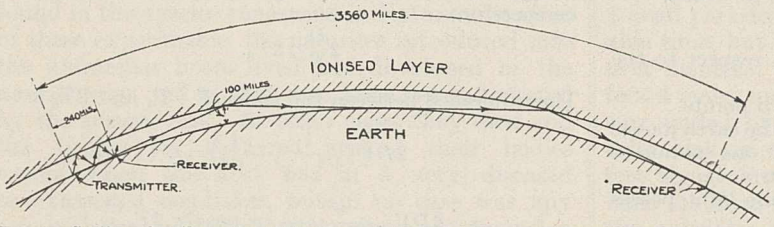

FIG. 4.—Section of earth, radius 4000 miles, and ionised layer at a height of 100 miles, showing the paths of waves from a transmitting station and two receivers at distances of 240 miles and 3560 miles.

Now, the distance of 3500 miles is approximately that between the National Physical Laboratory, Teddington, and some of the high-power transmitting stations in the United States of America. A series of systematic observations carried out on two of these stations operating on wave-lengths of 16·4 km. and 16·8 km. showed that the proportion of bearings correct to within 2° was 100 per cent in one case and 94 per cent in the other, the maximum error in the second instance being 3·4°. Under similar conditions, observations made on several European transmitting stations, using wave-lengths between 14 km. and 19 km. at distances of 75—760 miles, showed maximum errors in bearings of 12° to 28°, while the proportion of bearings correct to within 2° was only 16—63 per cent. Reference to Fig. 4 shows that this result is to be expected, since at a range of 240 miles, for example, the angle of incidence of waves arriving at the receiver after two deflections from the ionised layer is of the order of 35°.

* Continued from p. 532.

ELIMINATION OF NIGHT ERRORS IN DIRECTION-FINDING.

It will be evident that any receiving system which is unaffected by horizontal components of electric force will be free from night errors, even though the vertically polarised downcoming waves still produce variations in received signal strength. A direction-finding receiving arrangement which fulfils this condition was patented by Adcock in 1919, but it does not appear to have received practical consideration until Mr. Barfield and I experimented with it in 1926. The simplest form of the Adcock aerial system is a pair of spaced vertical aerials, arranged to rotate about a central vertical axis, thus forming the equivalent of the single closed coil direction-finder. By making all connexions to the centres of the aerials, the horizontal members of the system are compensated so that no electromotive force is induced in the receiver by a horizontal electric force. Preliminary tests with this direction-finder carried out a few years ago showed that the system was effective in considerably reducing the magnitude of the night variations experienced with the closed loop system. The continued development of the system as a practical form of direction-finder free from night errors is still in progress.

THE ROTATING LOOP BEACON.

As an alternative to the direction-finding schemes outlined above, the directional part of the wireless system may be transferred from the receiving to the transmitting end. This is effected in the rotating loop beacon system developed by the Royal Air Force, which employs a vertical closed loop transmitter arranged to rotate about a vertical axis at a uniform speed of one revolution a minute. As the loop rotates, the field radiated in any given direction varies according to a cosine law, passing through successive maximum and minimum values at intervals of 15 seconds. When the plane of the loop is perpendicular to the geographical meridian, a characteristic signal is emitted by the beacon which may be termed the north point. The observer at a distant receiving station upon hearing this signal starts a chronograph. As the beacon rotates the intensity of the received signal varies and will ultimately pass through a minimum or zero, at which instant it is known that the plane of the transmitting loop is at right angles to the great circle through transmitter and receiver. If the reading of the chronograph is observed at this instant of minimum signal intensity, it is evident that the bearing of the transmitter from the receiver can be obtained from a simple calculation.

It is to be noted that since the radiation from the coil is symmetrical about its plane, a second minimum will be obtained after a rotation of 180° from the first. With the beacon making one revolution per minute, therefore, a line bearing is obtainable in the above manner every half-minute. To fix the position of a receiving station it is necessary to obtain line bearings from two or more beacons. Since the timing process mentioned above is but an intermediate step in taking a bearing, it is convenient to provide a stop-watch or chronograph for the purpose, with a dial specially engraved in degrees and points of the compass.

An application of the principle of reversibility in direction-finding makes it evident that the performance of a rotating loop beacon transmitter can be largely predicted from the results and experience obtained with receiving loop direction-finders. Thus, a rotating loop beacon when erected on the same site as the direction-finder will give observations at a distant receiver which will be subject to the same type of local error and night variations, for example, as the bearings observed on the direction-finder when the distant receiving aerial is used for transmission. I have confirmed these deductions in the investigation during the past two or three years, of the performance of a rotating beacon erected at Fort Monckton, near Gosport. In order to ascertain the trustworthiness of this type of rotating beacon as an aid to marine navigation, a number of tests were carried out in ships crossing the English Channel between Southampton and Havre, and Southampton and Jersey. Using the ship's ordinary wireless receiver, observations of the bearing of the beacon were made at intervals during each trip and compared with the bearing as given by the captain of the ship.

As a result of tests conducted on these lines, it was found that in the majority of cases the estimated and observed bearings agreed to within from 2° to 4°. Signs of night effects in the shape of indistinct signal minima and wandering bearings were observed at ranges exceeding 60 miles. In many cases at night and during misty weather when visibility was very poor, the ship was navigated by dead reckoning, and in these circumstances it was frequently considered that the bearing obtained from the rotating beacon was the more accurate. Some of the test runs made between Southampton and Jersey were carried out in a ship fitted with a direction-finder of the Marconi Bellini-Tosi type, and the opportunity was thus provided of comparing the two systems of obtaining wireless bearings under actual sea-going conditions. The observations carried out in this manner showed that in the majority of cases the bearings obtained with the direction-finder and from the rotating beacon agreed to within 5°. In some cases, however, due probably to the pitching and rolling of the ship, the accuracy of the direction-finding bearing was inferior to that obtained from the rotating beacon.

As a result of the success of the experiments carried out with the Gosport station, a more permanent type of rotating loop beacon transmitter was installed at Orfordness and put into operation in June 1929. During the few months that this station has been working, a considerable number of reports have been received from various ships giving the results of observations made on transmissions from the beacon. These reports show that the inauguration of this beacon service has been very well received by the mercantile marine. With the ordinary type of ship's receiver adjusted for continuous wave reception, accurate wireless bearings are obtainable at distances of 50–100 miles. Ships fitted with a more elaborate receiver have reported good and consistent bearing observations up to ranges of 250 miles. At such long ranges, however, it is possible that the observed bearings may be subject to night errors in a manner similar to that observed in wireless direction-finding under the same conditions.

From the similarity of performance of the two systems of direction-finding, it would be expected that the elimination of the horizontal components of the transmitting loop would be of advantage in eliminating or reducing the magnitude of night errors or effects observed when using the rotating beacon. A theoretical analysis of the case has shown this deduction to be justified, and experiments are now in progress towards the development of a rotating beacon transmitter with an aerial system of which only the vertical members are active in producing radiation of electromagnetic waves. If these experiments lead to successful results, it is probable that rotating beacons can be erected with a trustworthy working range of the order of 500 miles, supplying wireless bearings at any time or season with an accuracy which is adequate for both aerial and marine navigation.

Obituary.

SIR WILLIAM MCCORMICK, G.B.E., F.R.S.

FEW if any of the men interested in education since the days of the War have been better known to the vice-chancellors and treasurers of the universities of Great Britain than the late Sir William McCormick. None has had so complete a knowledge of their financial difficulties and of the disastrous effects on educational efficiency of their want of means, and no one has done more to help than he, by his sympathetic treatment of the problems placed before him, his wise advice based on his long experience, and his cordial appreciation of the value of the efforts made to fit the universities for their task, whether it be that of advancing knowledge, or of educating the students that fill their lecture rooms and laboratories. To all, his death on Mar. 22 means a very heavy loss.

McCormick was born on April 29, 1859, and educated at the Universities of Glasgow, Göttingen, and Marburg. For a short time he lectured on mathematics, but the study of the English language and literature soon attracted him, and he became, and continued to the end, a serious student of Chaucer.

After holding various lectureships on English at Glasgow, he was appointed professor of English in University College, Dundee, and then later, when the Carnegie Trust for the Universities of Scotland was established, he was chosen as its first secretary.

But at this time new universities and university colleges were being established in England and Wales, and the question of State assistance to these became urgent. A Treasury Committee, of which McCormick was a member, was set up to deal with this. At a later date (1909) the Committee was transferred to the Education Office and he was made chairman. In 1916 the Committee was again transferred to the Treasury as the University Grants Committee and Sir William remained chairman until his death. The Committee was "to inquire into the Financial Needs of University Education in the United Kingdom, and to advise the Government as to the application of any grants that may be made by Parliament towards meeting them".

Figures perhaps give the clearest account of the magnitude of this work. The recurrent grants made by Parliament are as follows: 1913–14, £361,623; 1919–20, £889,000; 1930–31, £1,800,000. Between these last two periods, Oxford and Cambridge were added to the bodies receiving grants.

The following words of a letter from Mr. G. H. A. Wilson, Master of Clare and member of Parliament for the University of Cambridge, of which he was Treasurer, give some indication of McCormick's method and of the value of his help:

"By the death of Sir William McCormick the University of Cambridge has lost a sympathetic friend and a wise counsellor. As head of the University Grants Committee of the Treasury, he always gave the greatest help and most valuable advice to the University in the many questions which were involved when the grant from the Treasury to the University was made.

"The fears which had been expressed that the receipt of a Government grant might involve undue interference in the affairs of the University by a Government Department proved, under the wise and helpful guidance of Sir William McCormick, to be quite baseless. Whilst prepared at all times to give advice when sought, he always maintained that the University should be left with the greatest possible freedom to manage its own affairs. He was ever willing to meet suggestions as to the forms in which the accounts of the University might be modified to meet the special conditions existing at the University without departing from the necessity that those accounts should present a clear and accurate statement of University finance suitable for the needs of the Treasury."

To quote some words written since his death by one who, in earlier years, was his assistant in much of this work: "His constant sympathy and wise counsel were always given with that peculiar charm that distinguished his personality. The thing I enjoy saying of him most—and I say it with complete sincerity—is that if there was anything I did which was worthy, the credit and more than the credit was accorded to me; if I made mistakes (and there were plenty) he shouldered at once the entire blame. That is the sort of thing that makes a junior worship a chief."

Meanwhile, important changes were in progress; the War had brought home to Great Britain the national importance of scientific research. In May 1915 the Presidents of the Boards of Trade and of Education received a deputation from the Royal Society and other learned societies urging "Government assistance for scientific research for industrial purposes, the establishment of closer relations between manufacturers and scientific workers and teachers, and the establishment of a National Chemical Advisory Committee for these purposes". McCormick had been a member of a small Committee appointed by Mr. Pease, President of the Board of Education, earlier in the year, which was responsible for the scheme ultimately adopted. The Presidents replied to the deputation that the Government proposed to establish machinery with wider powers than those suggested by the memorialists, and a week later, when introducing the Board of Education estimates, Lord Gainford (then Mr. Joseph Pease) announced the impending appointment of an Advisory Council for the supervision and encouragement of scientific research, particularly in relation to industry. McCormick became chairman of the Council of eight members, only one of whom—Sir Richard Threlfall—is still with us. Its first meeting took place on Aug. 17, 1915. The order establishing the Council was signed by Mr. Henderson, who on the change of Government had taken Mr. Pease's place at the Board of Education.

Even before the change, however, further discussions with the Government had taken place, and in these Sir William had borne a full share. The Council had at first been instituted, for reasons of convenience, under the ægis of the Board of Education, but it had been decided—as one of the last acts of Mr. Asquith when Prime Minister—that it should be established as a separate department under the Lord President of the Council, with its own offices. This was announced in December 1916 by Lord Crewe, then Lord President.

The first duty of the Advisory Council was to form a scheme or programme for its own guidance in recommending proposals for research, and for the guidance of the Committee of Council in allocating such State funds as were available, while to finance the work a grant of a million pounds was made, to be expended in accordance with these directions. McCormick was present at the interview with the Chancellor at which the grant was made, and in his humorous way described the need and the discussions he had had with manufacturers when planning how best to meet that need. "When people are starving," he said, "it is no use going to them with the Bible in one hand without a loaf of bread in the other."

To form a scheme was no easy task. A Council of seven distinguished men of science, all of them fellows of the Royal Society, with a professor of English literature as chairman, set to organise under the pressure of a great war the application of science to industry. The Council was fortunate

both in its chairman and its secretary; the reports of the last fourteen years give a record of its work; this is not the opportunity to attempt any detailed account. Individual effort has been hitherto the basis of success of an English manufacturer, who has ever been an individualist. It was clear at the start that grants to individual manufacturers would not accomplish the aims of the Council. Co-operation in research was a new idea; at the same time, if it could be arranged, it was the one plan which seemed really hopeful, and thus research associations came into being, and in numerous cases have proved, by the work already done, the foresight of those to whom their existence is due, and the wisdom of the chairman who, for the past fourteen years, has guided the Council responsible for the supervision and approval of their work.

How wise he was, with what skill and tact he guided that work, is known to all who were privileged to serve under him on the Council. He has set it, it is true, on the right track, but the chairman himself, with his determination to go forward, along the path mapped out with so much thought and care, his realisation of the importance of its task, and his confidence that in the end success would come, will be greatly missed.

McCormick was not a scientific man, but he has done more for science than many a professor in the subject, and it was a cause of no small pleasure to his friends—not least to the president and council of the Royal Society themselves—when some two years since the president was able to announce the recommendation of the Council, a recommendation unanimously approved, that it was desirable "in the interest of the advancement of Natural Knowledge" that he should be elected a fellow of the Royal Society under the special statute defining such elections. Can we describe him better than the words of his own Chaucer:

> A knyght ther was and that a worthy man,
> That fro the tyme that he first bigan
> To riden out, he loved chivalrie,
> Trouthe and honour, fredom and curteisie.
>
> He never yet no vileynye ne sayde,
> In al his lyf, unto no maner wight.
> He was a verray parfit, gentil knyght.

R. T. G.

PROF. W. ROBINSON.

PROF. WILFRED ROBINSON, professor of botany at University College, Aberystwyth, died on Mar. 7 after several months of ill-health. He was born at Hull in 1884 and early became interested in botany, for his father, J. F. Robinson, a schoolmaster, was author of the "Flora of the East Riding of Yorkshire". He entered University College, Nottingham, and took his London B.Sc. (Hons.) in botany. His first post was science master at Penketh Friends' School, Warrington. In 1912 he was awarded a research studentship at the Victoria University and became successively Platt scholar in botany, lecturer in botany, and assistant to the professor of cryptogamic botany, and then, in 1916, senior lecturer. He was appointed to the chair at Aberystwyth in 1926.

Robinson was a botanist of wide interests, keen in the field and careful in the laboratory. During the War he worked on the microscopic cell-wall characteristics of mechanical strains in timber, a matter of importance in the construction of aeroplane propellors. His main interests for some time, however, were in plant pathology, and he visited the United States in 1924 on behalf of the Cotton Research Association to investigate the diseases of the cotton plant. Several of his researches dealt with the physiology of fungi but, on going to Aberystwyth, he began to study the physiology of seaweeds and the life-histories of some of the less common genera of the neighbourhood.

With such wide interests and a natural flair for teaching, Robinson had an inspiring influence on his students and it is a great loss to cryptogamic botany that he was not spared long enough to enjoy the results of his industry and influence. He took an active part in British Association matters and was recorder of Section K (Botany) until a few weeks ago.

DR. ARCHIBALD RODERICK FEE died on Feb. 23 of septicæmia and broncho-pneumonia, following the extraction of a tooth on Feb. 15. His death deprives the subjects of experimental physiology and experimental biology of an active and devoted worker. Dr. Fee was only twenty-four years of age at the time of his death, and his home was in West Burnaby, British Columbia. He was a man of outstanding personality and possessed remarkable energy and great personal charm. He came to England at the age of twenty with a degree from the University of British Columbia, and had already been engaged there in work for the Board of Fisheries which took him into uncharted waters of north-western Canada. He was a pupil in Great Britain of the late Prof. E. H. Starling, who, like all his colleagues, had the highest opinion of Fee's ability and promise. Dr. Fee, at the time of his death, held a Beit Memorial Research Fellowship.

WE regret to announce the following deaths:

Dr. Henry Faulds, an authority on the finger-print system of detecting criminals, and author of "Dactylography", on Mar. 19, aged eighty-six years.

Prof. Augustine Henry, formerly professor of forestry at University College, Dublin, on Mar. 23, aged seventy-two years.

Dr. J. Y. Mackay, principal and formerly professor of anatomy at University College, Dundee, on Mar. 30, aged seventy years.

Dr. J. W. Robertson, C.M.G., first Commissioner of Agriculture and Dairying for the Dominion of Canada, and a pioneer of agricultural education in Canada, on Mar. 19, aged seventy-two years.

Prof. E. G. R. Waters, professor of Romance languages in the University of Oxford, and an authority on British Micro-Lepidoptera, on Mar. 23, aged thirty-nine years.

News and Views.

THE impending resignation of Prof. J. Arthur Thomson from the chair of natural history in the University of Aberdeen severs the connexion with those occupants of the chair who taught both zoology and geology. In 1908 the arrangement whereby the Department of Natural History was held to cover both zoology and geology came to an end when a separate lectureship in geology was instituted. Prof. J. Arthur Thomson was appointed to the chair in 1899, and thus carried on the old arrangement for nine years. The title of the original chair in Marischal College and University was that of civil and natural history, but when in 1860 the two Universities of King's College, Old Aberdeen, and Marischal College, Aberdeen, were united under the Universities (Scotland) Act, 1858, the chair became one of natural history in the University of Aberdeen. The occupant of the chair of civil and natural history at the date of amalgamation was James Nicol, who had been appointed in 1853. Prof. Nicol resigned and died in 1878, when J. Cossar Ewart was appointed. Prof. Ewart resigned the chair in 1882 on his appointment to the chair of natural history in the University of Edinburgh. He was succeeded by Henry Alleyne Nicholson, who held the chair until his death in 1899.

PROF. J. ARTHUR THOMSON, after graduating at the University of Edinburgh, proceeded to the Universities of Jena and Berlin, and was thereafter appointed lecturer in zoology and biology at the School of Medicine in Edinburgh, from which post he was appointed to the Aberdeen chair in 1899. The complete mastery of his subject, together with the lucidity and charm of his style, have earned for him a wide world reputation both as a lecturer and as a writer. The Universities of Edinburgh and McGill conferred on him the honorary degree of LL.D. In 1915, he delivered the Gifford Lectures at St. Andrews, and he has repeatedly been asked to lecture in the United States. He was Terry lecturer at Yale University, and Morse lecturer at the Union Seminary, New York, while he is at present lecturing in the Zoology Department of the University of California at Berkeley and Los Angeles. Particulars of the conditions on which the chair of natural history in the University of Aberdeen is held may be obtained from the Secretary of the University.

RUMOURS concerning the future of the chair of organic chemistry at University College, London, have already been the subject of comment and protest in the correspondence columns of NATURE. It is not surprising that the suggestion to abolish the title of professor of organic chemistry should arouse suspicion that the future of organic chemistry itself at that college will thereby be jeopardised, and it is even less remarkable that those who have at heart the welfare of industries dependent on the progress of that branch of chemistry should be seriously perturbed by the further belief that a professor who is not an organic chemist may be appointed to fill the chair falling vacant by Prof. R. Robinson's transfer to Oxford. A letter recently addressed by the secretary of the Association of British Chemical Manufacturers to the Provost of University College expresses concern at the effect of such a policy on chemical industry, pointing out that intensive and continuous investigations in organic chemistry are essential for maintaining and improving our industrial position, and that any diminution therein of the facilities for instruction and research, which present experience shows to be still inadequate, may result in our once more becoming dependent on other countries for much that is vital to the health and prosperity of the nation.

WE have been informed by the Provost of University College, London, that henceforward the two chairs will be distinguished simply as the first and second chairs of chemistry, and that this must not be regarded as in any way affecting the position of organic chemistry in the College; it only secures to the College the freedom to make such recommendations as seem best in the interests of the College and of chemical studies as a whole. It appears to us that the only reasons which would justify a change in the title of a position of such influence and standing would be inaccuracy of description of existing conditions and intention to vary them in the future; the former alternative is inapplicable, and it must therefore be concluded that the Provost's statement envisages the latter. This can only mean that the position of organic chemistry at University College, London, is indeed affected; it may lose the status which is its due, it may lose that support and that momentum which can be fully given only by one of its own disciples, and its loss would be felt far beyond the limits of jurisdiction of the University of London. It may happily be, however, that there is no intention of allowing organic chemistry to suffer any such disabilities, in which case it is difficult to understand why any change should ever have been proposed.

THE centenary of the death of Henry Hill Hickman was celebrated at a reception held at the Wellcome Historical Medical Museum on April 2, when Lord Dawson of Penn, president of the Royal Society of Medicine, gave an interesting address on this English pioneer in anæsthesia. Hickman was born on Jan. 27, 1800, near Ludlow in Shropshire, and qualified as a member of the Royal College of Surgeons twenty years later. Like Edward Jenner, he was a general practitioner, and during the ten years of his professional life practised in the country towns of Ludlow, Shiffnal, and Tenbury. At the outset of his career he performed a number of experiments on puppies, mice, kittens, and rabbits, which he rendered unconscious first through partial asphyxiation by the exclusion of air, then by inhalation of carbonic acid and later of nitrous oxide. During the state of 'suspended animation', as he called it, so obtained, he performed incisions, applied ligatures, amputated ears and limbs, without the animals showing any signs of pain and with good surgical results. In 1824 he published a pamphlet entitled "A Letter on Suspended Anima-

tion, Containing Experiments Showing that it may be safely employed during Operations on Animals with the View of ascertaining its Probable Utility in Surgical Operations on the Human Subject". The pamphlet was addressed to T. A. Knight, a fellow of the Royal Society, but no reference to it has been found in the *Transactions*, and contemporary evidence shows that the method was condemned as unpractical and dangerous. Having failed to obtain recognition from his own countrymen, Hickman paid a visit in 1828 to France, where he addressed a memorial to Charles X. requesting permission to develop his ideas in French medical and surgical schools. The request was referred to the Académie de Médecine, where it appears to have met with general derision or indifference, although the famous surgeon Baron Larrey approved of the method and even offered himself for experiment. Hickman returned to England a disappointed man, and died two years later at the early age of thirty years without having brought his work beyond the experimental stage.

NOTHING more seems to have been heard of Hickman's work during the seventeen years following his death, although during this period inhalation of ether and, to a less extent, of nitrous oxide, became an exciting fashionable amusement like the cocktail parties of to-day. It was not until after the publication of the work of Crawford Long, Horace Wells, and W. T. Morton in the United States on anæsthesia that the valuable achievements of Hickman began to receive attention. It is gratifying to learn that Hickman's labours have at last received due recognition. On the initiation of the Section of Anæsthetics of the Royal Society of Medicine, a fund, which has just been closed, was started for the restoration of Hickman's grave and tombstone in the cemetery of Bromfield Church and the erection of a memorial tablet, the balance being reserved for founding a medal for research and original work in connexion with anæsthesia. The tablet, which is the work of Mr. Eric Gill, was unveiled in Bromfield Church by Sir St. Clair Thomson, a past-president of the Royal Society of Medicine, on April 5. A souvenir volume, which was presented to those attending the reception at the Wellcome Historical Museum on April 2, contains an account of Hickman's work illustrated by contemporary portraits, facsimiles of his letters and other relics of him which are now on view in the Museum.

IN the *Times* of April 5 there is an account of an experiment made to find out the time required to transmit the entire front page of a Californian newspaper from San Francisco to New York. It was found that it could be done in three hours, and the inference is drawn that the feat is one of great significance. We are told that the transmission was by radio waves of short wave-length from a facsimile transmitter and that they were received in the laboratory of the General Electric Company at Schenectady. The feasibility of doing this has been known for several years, but no evidence is quoted to prove that the given transmission is at present a commercial proposition. The facsimile transmission of business correspondence by radio is already in established use on the eastern side of the Atlantic. A good many problems will have to be solved, however, before anyone owning a radio receiving set can have his daily newspaper delivered to him every morning by merely attaching a recording apparatus to the set. It is unfair to inventors to publish statements which lead the public to jump to the conclusion that it is only necessary to make slight improvements on known methods to increase their efficiency enormously. Sometimes, also through the Press not understanding the object of an experiment, quite erroneous conclusions are drawn. For example, when the Marchese Marconi sent a signal from his yacht at Genoa to operate a relay which by means of local power closed the switches controlling the electric lamps lighting the Sydney Exhibition 11,000 miles away, the conclusion was drawn that the radio transmission of power 'in bulk' was at last accomplished. Although the experiment was noteworthy, it proved nothing as to the commercial feasibility of transmitting power by radio.

THE last few years have witnessed a remarkable revival in polar exploration. Few of the expeditions have been on a large scale, most of them being confined to one or more summer seasons in the Arctic or Antarctic, but they have generally been noted for intensive investigation of particular problems. The time is thus opportune for the British Polar Exhibition, which is to be held in the Central Hall, Westminster, on July 2–15 next. The exhibition will illustrate the deeds of British explorers from the sixteenth to the twentieth century. One section will contain a loan collection of relics, historical documents, old charts, pictures, maps, paintings, flags, and ship models. Another section will deal with modern polar work, including the research into whales and whaling now being conducted in Antarctic waters. A third section will illustrate equipment, food, and appliances. In this section various firms have promised help. Two evening lectures will be given on south polar and north polar exploration respectively. A polar booklet is being prepared for sale by Dr. H. R. Mill. Any profits that accrue from the exhibition will be distributed to societies or institutions engaged in geographical research. A small committee is undertaking the arrangements, and Lieut.-Com. L. C. Bernacchi, Carlton Chambers, 8 Regent Street, London, S.W.1, is the organising director. There is little doubt that the exhibition should evoke much interest and have considerable educational value in demonstrating the aims of polar exploration.

A MOVEMENT for the encouragement of gliding in Great Britain has at last been initiated by the establishment of the British Gliding Association, with Air Vice-Marshal Sir Sefton Brancker as its first president. Generous gifts, both of money and of apparatus, have been received from numerous well-wishers of this branch of aeronautics. Meanwhile, clubs are being started in different parts of the country, and gliding looks as if it may become a popular and at the same time scientifically valuable sport. We are, indeed,

gradually becoming air-minded. In Germany, where this movement, owing to restrictions on the use of the power unit in machines, is undoubtedly more advanced, the Government assists by subsidy on account of the aerodynamic information that has become available by this new activity. The lecture on "Ten Years Soaring and Gliding in Germany", by Prof. Walter Georgii, delivered before the Royal Aeronautical Society and recently noticed in these columns, has done much to provide the necessary precise technical details for successful development here, and has undoubtedly been largely responsible for the new impetus to the movement. The British Gliding Association, with its offices at 44A Dover Street, London, W.1, has produced the first number of its new journal, which contains much valuable information on the subject.

PARTNERSHIP between science and industry formed the theme of Mr. J. Arthur Reavell's presidential address to the Institution of Chemical Engineers delivered on April 4. Scientific investigation, he said, has enabled the wool industry to turn out a product of higher finish and to utilise low-grade wool and waste; in agriculture it has led to increased yields and improved quality; while in the steel industry the discovery of resistant alloys has led to great economies. These are examples of the way in which science has aided industry, but there is still considerable delay in translating the findings of the laboratory into industrial practice. To avoid this time lag, Mr. Reavell pleaded for the representation of the scientific side of industry on boards of directors. It is essential in modern industry, he said, that there should be scientific men on the boards of companies in whom their non-scientific colleagues have sufficient confidence to enable decisions on technical questions to be taken with less delay. Industry is not entirely to blame in this matter, for, in the past, scientific workers have largely neglected the financial side of industry. This attitude must be changed, for science is now, and must be increasingly in the future, a fundamental part of industry. At the close of the address, the following medals were presented: Moulton Medal, awarded for the best paper of the year of a mature character, to Mr. H. Hellings, Dr. S. Pexton, and Dr. Chaplin; Junior Moulton Medal, awarded for the best paper by a graduate or student of the Institution presented to the graduates' and students' section, to Mr. Harold Smith; Osborne Reynolds Medal, for meritorious service for the advancement of the Institution during the year, to Prof. J. W. Hinchley, honorary secretary of the Institution. It is of interest to note that the Moulton awards are made for the first time.

THE Final Report of the Departmental Committee on Ethyl Petrol has been published by H.M. Stationery Office (1*s*. net). The report embodies the results of investigations extending over eighteen months on the prevalence of the occurrence of lead in normal urine; in the settled dust of the streets and in garages; on the quantities of lead found in the crank-case oil and cylinder deposits of motor vehicles run on ethyl petrol; and on the possible danger to health arising from the spillage of ethyl petrol in confined spaces and from the exhaust gas of motor vehicles run on ethyl petrol. The results of these investigations agree with those of the experiments carried out in the United States of America, and show that the use of ethyl petrol as a motor fuel would not increase the proportion of particulate lead in the air of the streets to such an extent as to constitute a risk to the health of the community. The results of the investigations show also that the risk of injury to health from the spillage of ethyl petrol and from the absorption of lead tetraethyl through the skin is so small as to be negligible.

THE recent appointment by the Prime Minister of a committee to report on the desirability of establishing one or more national parks in Great Britain gives particular interest in an article in *Geography* for March in which Dr. Vaughan Cornish takes a general survey of the coasts of Great Britain from this point of view. He suggests first that the choice of a coast park should not lie in Scotland, on account of the short winter days, or in eastern England, with its low winter temperatures. The south coast has obvious advantages in climate and accessibility, but owing to the development of seaside resorts, it is scarcely possible to find a stretch of wild cliff scenery long enough to serve the purpose of a park. His suggestions, finally, are that the most suitable sites are in the two peninsulas of Pembroke and Cornwall. In Pembroke he points to the stretch of wild coast line between Strumble Head and Caldy Island, and in Cornwall to the cliff scenery between Cambeak and Trevose Head on the north coast and the granite cliffs of the Land's End. In the chosen areas, a mild winter climate and relatively long days would enhance the value of the scenery and render the parks more valuable.

THE best method of eliminating the flue dust emitted from power station and factory chimneys is one which is being actively investigated by engineers at the present time. When coal is burned upon a grate, the solids which pass into suspension are produced by the mechanical action of the draught raising the finer particles of the solid fuel. With pulverised fuel, on the other hand, the fuel is burned when in the gases of the furnace. In this case a greater percentage of solid matter reaches the chimney. It was hoped that, as the dust is exceedingly fine, it would be carried great distances before it reached the ground. Experience has proved that this is not the case. In a paper read before the Association of Mining Electrical Engineers by J. W. Gibson, and published in their *Journal* for January and February 1930, a good introduction is given to chimney dust problems. Several methods have been used in practice to eliminate the dust. One of the earliest methods was to reduce the velocity of the flue gases so that the dust has time to fall out of suspension. Another method is to use an electric precipitator, and for light dust concentrations this method is probably the best. The method of spraying the smoke with water, technically known as washing, is being actively investigated at the present

time. The quantity of water required is large, and if the coal contain sulphur the water gets acidulated and recirculation increases the acid concentration. The water circuit, therefore, has to be designed so that it can resist corrosion. In few cases would it be permissible to permit the effluent water to flow into a stream and the commercial solution of the problem of neutralising the acid is not easy. Another promising method is to cause the effluent gases to rotate so that the dust is thrown out by centrifugal action. Successful attempts have been made abroad to reduce the ash content of the fuel before it passes into the combustion chamber. By combining several of these methods,successful results could be obtained.

AT the present time the amount of nitrate obtained by the fixation of atmospheric nitrogen in the form of ammonia is equal to about half the total world consumption. It is highly probable that artificial nitrate will replace natural nitrogen products. In the *Brown Boveri Review* for December, a description is given of electrical machines which are particularly suitable for use in ammonia works and have been developed to meet the severe service conditions in this industry. The production of ammonia by the high pressure process is divided into three distinct operations. The first consists in isolating and purifying the gases nitrogen and hydrogen. The second consists in combining those gases in the presence of a catalytic agent. This has to be done at the most suitable temperature and pressure for the reaction. In the third operation the ammonia is concentrated and combined with some agent to form the required commercial product. Usual products are ammonium sulphate, calcium nitrate, and potassium nitrate. In the first operation the nitrogen is usually obtained from liquid air by fractional distillation at very low temperatures. Compressors and pumps are required for this process. They are usually driven by 200 kilowatt motors contained in flame-proof enclosures. The production of hydrogen by electrolysis of water requires a very heavy current consumption, 25,000 kilowatts sometimes being used. If only three-phase current is available, it has to be converted into direct current. This is usually done by rotating machinery. Brown Boveri and Co., however, manufacture mercury arc rectifiers for this purpose having a capacity of 3000 kilowatts. For the second process they also make a steam turbine driven turbo-blower which circulates gases at a pressure of 260 kgm. per sq. cm.

WE have received from the director a number of the recent issues of the *Publications of the Hull Museum*, dealing, for the most part, with local antiquities. Of these, No. 163, "Hull Museum Treasures" is a reprint of articles by Mr. T. Sheppard, the director, which have appeared in the *Hull Daily Mail* during the past year. Week by week some specially noteworthy object in the Museum has been exhibited in a case apart and has been figured and described in the local newspaper. This is a method admirably calculated to stimulate local interest in the collections which may be commended to curators of other local museums. Of more general interest to archæologists are two *Publications*, Nos. 162 and 166. Of these, the latter contains the speech made by Sir Frederic G. Kenyon in October last in declaring open the Mortimer Collection of Prehistoric Antiquities, while the former is the catalogue of the collection. The Mortimer collection of prehistoric objects, from the barrows of East Yorkshire, was made by the two brothers R. and J. R. Mortimer, corn merchants, of Driffield, in the last century. Being first in the field, they were fortunate in being able to induce farm labourers to scour the country in search of relics. Prizes were offered for the greatest quantity of implements found, one of these being a free trip to the Leeds Exhibition of 1868. Later, the brothers devoted themselves to opening up the barrows of East Yorkshire. They brought together a remarkable collection of prehistoric, Roman, and Saxon antiquities which was described by J. R. Mortimer in his "Forty Years' Researches in British and Anglo-Saxon Burial Mounds."

AFTER Mr. J. R. Mortimer's death, Driffield failed to retain the collection as he had hoped it would, and finally it was purchased for Hull by Col. G. H. Clarke at the very low price of £1000. The collection is now exhibited in the Old Art Gallery in the City Hall as "The Mortimer Collection, the Gift of Col. Clarke". British archæologists owe a deep debt of gratitude to Col. Clarke and to the trustees of the Mortimer estate for having kept this important and indeed unique collection in England, as it might well have gone to the United States at a much higher price. The catalogue describes the collection, item by item, under the heading of each site, the mound or grave in each case being stated. It is well illustrated; but it lacks a map of the area, and a plan of each site is much to be desired. If the catalogue attains a second edition, as a work so valuable to archæologists deserves, these defects might be remedied.

A COPY reached us recently of a paper on "A National Script for India", read in May last before the East India Association, London, by Dr. A Latifi, Ambala, Punjab. Dr. Latifi makes it quite clear that, in view of the extreme complication of the Arabic and Devanagri scripts, Roman is virtually the only competitor in the field. What he does not establish so unquestionably is that Roman must undergo considerable adaptation before it meets Indian requirements. His main argument is that Roman script, in its unmodified form, leads to such inconvenient orthographies as ACHCHHĀ. This, he suggests, would be rendered far better by a script which distinguished between the two A sounds, had a single symbol for the sound CHH, and used the Arabic *teshdid* as a mark of repetition. In such a script, the word ACHCHHĀ would become ʌɛ̃ɔA. The emendation is certainly more concise, but is it really a simplification? The proposed new symbol is not an easy one to write, nor it is easy to see why Hindustani has more need for group sound-symbols than have the European languages, which have so far managed to do very well without them. If repetition of syllables is a feature peculiar to Hindustani, then there is a certain case for introducing the Arabic contraction, but to

differentiate the script any further seems only to be increasing the difficulties of communication between Indians and Europeans. There is a quite natural temptation on the part of reformers to bestow on India the benefits of reforms which Europe in her linguistic conservatism rejects. But it must be remembered that a familiar alphabet immensely facilitates the learning of a new language, and one may well question very seriously whether it is worth sacrificing this advantage for the sake of a slightly more perfect notational system.

REFERRING to the letter on "Curling" by Mr. W. H. Macaulay and General G. E. Smith in NATURE of Mar. 15, p. 408, Mr. Wm. Taylor, of Messrs. Taylor, Taylor, and Hobson, Ltd., Stoughton Street Works, Leicester, writes suggesting that 'borrow' is due to the difference of friction on the two sides of the cup, in one case the sum and in the other case the difference, of rotational and translatory motions being involved. This, however, could not produce any sensible effect in the first 40 yards of the run of a stone; it would have an effect only quite close to the end. Mr. Taylor also suggests that the friction at the back edge of the cup cannot be greater than that at the front edge; the standard law of friction on ice, however, is that it decreases with increased pressure, the thawing due to pressure providing a lubricant. The greater friction behind than in front is probably partly due to the rim of the cup being sharper inside than outside.

VOLUME 21 of the Collected Researches of the National Physical Laboratory contains 448 pages devoted to 21 papers on magnetic and electrical subjects which have been written by the staff during the last five years and have in nearly all cases been published in the proceedings of scientific societies or in the scientific or technical periodicals during that period. Seven of these deal with the design and accurate testing of standard inductances or of standard resistances which are to be as free as possible of induction. Many of these problems arise in connexion with telephony, and radio waves and their propagation furnish the subject of nine other papers which deal with the polarisation and attenuation of the waves, the determination of the direction from which they come and the errors which night causes in the determination. The wireless valve and the piezo-electric quartz resonator each get a paper devoted to them, while problems of power distribution receive attention in papers on the losses in magnetic sheet material and in dielectrics respectively. Terrestrial magnetism receives consideration in a paper on a coil method of determining the vertical component, and precision is imparted to the definition of the capacitance of a condenser by an investigation of the effect of its surroundings. In short, the volume represents advances to which the staff may look back with considerable pride.

THE Huxley Memorial Lecture for 1930 of the Imperial College of Science and Technology, South Kensington, will be delivered by Prof. Graham Wallas, on "Physical and Social Science", on Monday, May 5, at 5.30 P.M.

AT the annual general meeting of the Physical Society, held on Mar. 28, the following officers were elected for the year 1930–31:—*President*: Prof. A. S. Eddington; *Hon. Secretaries*: Dr. Ezer Griffiths and Dr. Allan Ferguson; *Hon. Foreign Secretary*: Prof. O. W. Richardson; *Hon. Treasurer*: Mr. R. S. Whipple; *Hon. Librarian*: Mr. J. H. Brinkworth.

BRIGADIER-GENERAL SIR HAROLD HARTLEY, fellow and tutor of Balliol College, Oxford, and Mr. Allen Mawer, Provost of University College, London, have been elected members of the Athenæum Club under the provisions of Rule II. of the Club, which empowers the annual election by the Committee of a certain number of persons of distinguished eminence in science, literature, the arts, or for public service.

THE following appointments in the Colonial Agricultural and Forestry Services have recently been made: Mr. C. K. Latham, Mr. A. S. Richardson, and Mr. A. J. Wakefield, district agricultural officers, to be senior agricultural officers, Tanganyika Territory; Mr. R. B. Allnutt, to be district agricultural officer, Tanganyika Territory; Mr. J. R. P. Gent, deputy conservator of forests, Gold Coast, to be deputy conservator of forests, Nigeria.

A MEMORIAL service for the late George Alexander Gibson, professor of mathematics in the University of Glasgow from 1909 until 1927, was held in the University Chapel on Friday, April 4. Prof. Gibson, whom failing health compelled to retire from his academic duties after a long and strenuous period of service in the Royal Technical College and the University, was greatly respected as an able and conscientious teacher, while he also rendered important services as an administrator in earlier days in the work of reorganisation at the Technical College and later on as a member of the University Court.

THE Royal Geographical Society will celebrate its centenary in October this year. According to the provisional programme recently issued, the celebrations will begin on Oct. 21 with the opening of the Society's new lecture hall and other new buildings at Kensington Gore by his Majesty the King or one of the Royal Princes appointed by him. Other events will include addresses on the history of the Society, on the history of exploration during the last century, and on certain other aspects of geography. There will be a reception on Oct. 22 and a centenary dinner on Oct. 23. A detailed programme will be issued to fellows later.

AN important auction sale of botanical books and books of travel will take place on Monday and Tuesday next, April 14 and 15, when Messrs. Christie, Manson, and Woods will offer at 8 King Street, St. James's, S.W.1, the library formed by Samuel Rudge, and his nephew, Edward Rudge, author of "Plantarum Guianæ Rariorum, 1805–7", containing many rare works.

IN the "Report on the Health of the Army for the Year 1928" (London: H.M. Stationery Office. Price, 5*s*. net), recently issued, Lieut.-General Fawcus states that the year under review was the healthiest since the War, the admission ratio having fallen to

426·2 per 1000 of the strength, or 11·5 per 1000 below that of 1913. The invaliding and constantly sick ratios also show a reduction, although both are somewhat higher than in 1913. Among the men, the four chief causes of admission to hospital are venereal diseases (7213), malaria (6550), inflammation of tonsils (6110), and inflammation of areolar tissues (5465). The enteric fevers contributed only 42 cases, a remarkable record.

VOL. 1, consisting of six numbers, and No. 1 of vol. 2 of the *Technical Instrument Bulletin*, a journal devoted to optical and allied instruments as applied to industry and research, and issued in collaboration with the Emil Busch Optical Co., have now appeared. Several of the articles have dealt with photography and photographic apparatus; among others may be mentioned contributions on choice of magnification in microscopy by Prof. Hauser, on optical instruments for testing works materials by H. Ehlert, on instantaneous photography of living micro-organisms by A. G. Frewin, on the meaning of apperture by Dr. Hans Schulz, on microscopical examination of glass by Dr. L. Springer, and on the magnifying spectacle by O. Heinemann. Copies of the journal will be sent on application to the editor, A. G. Frewin Diamond House, Hatton Garden, E.C.1.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—Two technical assistants, chemists, at the Royal Arsenal, Woolwich—The Chief Superintendent of Ordnance Factories, Royal Arsenal, Woolwich, S.E. 18 (April 14). An organiser of agricultural education for the Administrative County of West Suffolk—The Secretary of the West Suffolk Agricultural Committee, Shire Hall, Bury St. Edmunds (April 19). A demonstrator in biology at Guy's Hospital Medical School—The Dean, Guy's Hospital Medical School, London Bridge, S.E.1 (April 22). A research assistant in the mechanical engineering department of the University of Sheffield—The Registrar, The University, Sheffield (April 23). A temporary sanitary inspector for the Royal Borough of Kensington—The Medical Officer of Health, Town Hall, Kensington, W.8 (April 26). A lecturer in engineering at the Sunderland Technical College—The Chief Education Officer, 15 John Street, Sunderland (May 5). An assistant indexer for work in connexion with the forthcoming collective index at the Bureau of Chemical Abstracts—The Secretary, Bureau of Chemical Abstracts, Central House, Finsbury Square, E.C.2 (May 9). Lecturers in pure mathematics and in geography at the L.C.C. Shoreditch Technical Institute—The Education Officer (H2/1), The County Hall, Westminster Bridge, S.E.1 (May 10). A lecturer in the Department of Phonetics at the School of Oriental Studies—The Director, School of Oriental Studies, Finsbury Circus, E.C.2 (May 15). Part-time lecturers in Siamese and Tibetan, respectively, at the School of Oriental Studies—The Director, School of Oriental Studies, Finsbury Circus, E.C.1 (June 14). A science master, chief subject chemistry, at Bishop's Stortford College—The Head Master, Bishop's Stortford College, Herts. A public analyst for the purposes of the Food and Drugs (Adulteration) Act, 1928, for the county of Southampton—The Clerk of the County Council, The Castle, Winchester.

Our Astronomical Column.

A New Trojan Minor Planet.—*Circular* 294 of the Astronomisches Recheninstitut contains an announcement by Dr. G. Stracke that he has discovered a seventh Trojan planet. It was found by K. Reinmuth, assistant at Königstuhl Observatory, on Jan. 27, and observed by him again on Feb. 19 and 24; Dr. Stracke deduced the orbit from these three places,and finds the mean daily motion to be 297·852″, almost exactly that of Jupiter. Both i and ϕ are moderate, being 3° 9′ and 8° 42′ respectively, so the oscillations from the equilateral position will not be so large as in some cases. It makes a fifth member of the group of Trojans the longitude of which is 60° greater than that of Jupiter, while there are only two on the other side of Jupiter.

The New Planet.—A circular from the Lowell Observatory, dated Mar. 13, combined with several numbers of the *Daily Science News Bulletin*, issued by Science Service of Washington, D.C., give details of the discovery. The Lawrence Lowell photographic telescope was devoted to the search for the body, the existence of which was predicted by the late Prof. Percival Lovell. The work was placed in the hands of Mr. Clyde W. Tombaugh, a young assistant who joined the Observatory staff in January 1929. He systematically surveyed the ecliptic zone, and had nearly half completed the circle when on Jan. 21 last he detected the new orb in the vicinity of Delta Geminorum. The discovery was confirmed by plates taken on Jan. 23 and Jan. 29, and since Feb. 19 the planet has been regularly followed. Examination in the 24-inch refractor failed to show a definite disc; comparison of the visual with the photographic magnitudes shows that its light is yellower than that of Uranus or Neptune.

Circular No. 7D of the Société Astronomique de France reports that M. F. Baldet observed the planet visually with the 33-inch refractor at Meudon on Mar. 20, 27, and 28; he satisfied himself that the angular diameter did not exceed 0·2″, which corresponds to 4000 miles at a distance of 45 units. He makes the erroneous statement that a body of diameter 1500 kilometres and albedo 0·15 would appear of magnitude 15 at distance 45. This error of taking the light as varying as the inverse square of the distance, instead of the inverse fourth power, since the distances from both sun and earth have to be considered, has been common.

The *Illustrated London News* of April 5 contains excellent reproductions of five photographs of the planet, taken at Flagstaff, Yerkes, Neubabelsberg, Merate (Milan), and Oxford (Radcliffe). The Flagstaff photograph is undated, but was probably taken early on Mar. 2 (U.T.). Measures on the photograph give the following position for the planet for the equinox of 1930·0: R.A. $7^h\ 16^m\ 13^s{\cdot}72$, N.Decl. 22° 5′ 18·3″. It was then 17^s east of δ Geminorum, which it passed about Mar. 8. It is now again approaching the star, but owing to its northward motion it will clear it on the north side on its return journey. The inclination of its orbit to the ecliptic appears to be about 14°, which helps to explain why it was not picked up sooner, as twenty years ago it was several degrees south of the ecliptic.

Research Items.

Gipsy Exorcism.—In Pt. 3, Vol. 8 of the *Journal of the Gipsy-lore Society*, Ser. 3, Mr. Engelbert Wittich describes some of the fraudulent tricks practised by German gipsies, and includes among them two forms of exorcism—*digno dorgaben* ('little exorcism') and *baro dorgaben* ('big exorcism'). By 'little exorcism' is meant the curing of illness, but 'big exorcism' is the expulsion or exorcism of an evil spirit which is bringing misfortune to the house. The practice of 'little exorcism' for illness is usually left to a female gipsy. The patient is given three chestnuts, of which one has previously been bored with a red hot needle. These 'magic' chestnuts are said to have been obtained from a 'holy tree' in India, and must be worn by the patient next the skin for three days and three nights. If at the end of that time they are split open in the presence of the gipsy, and one of them is found to have a black stain in the middle, this is a bad sign portending death. This fate can only be averted by the payment of a sum of money which the gipsy spends on obtaining magic herbs and potions. 'Big exorcism' comes into operation on the indication of the presence of an evil spirit by a snake's skin, the heart of a bat still fresh, or a hedgehog's foot with the bones arranged to resemble a child's hand, being found when the householder is digging in his garden. The evil spirit must be made *gamlo* (kindly). Holy water must be obtained at considerable expense from a holy spring in India, known only to a limited number of the gipsy's people. The whole place is then sprinkled with the water, and digging is undertaken in the garden to see if the spirit is appeased. If, as is usual, another sign of misfortune appears, the *baro rom* or 'big man', that is, the wizard, or the *baro tschuwl*, the 'great woman' or witch, is called in. He comes with great solemnity, accompanied by some sign, the cattle become restless, spirit candles burn with a blue flame in the garden, etc. After an incantation—"Bind the straw, hang the straw, give the horses water"—the gipsy finds in one of a plate of hard boiled eggs over which he has repeated his incantation three times a curiously coiled horse hair, a presage of evil. The ancestors of the victim have incurred the wrath of Heaven by a serious crime. A large sum of money is buried in the garden with three hens' heads. This ultimately is found to have been changed into a root curiously formed, which must be carefully tended for years until prosperity returns.

Rapid Changes in Mammals caused by Climate.—It is seldom that the process of change of characters comes under observation, but the history of the acclimatisation of four different species of marsupials seems to offer a case in point. About 1870, the late Sir George Gray introduced several species of wallabies from Australia to Kawau Island, near Auckland, New Zealand. A. S. La Souef now records that the intervening sixty years have impressed themselves in quite a definite way upon the fur of the wallabies (*Australian Zoologist*, vol. 6, p. 111; 1930). In three species the same change is noted, that the fur is softer, more silky, and longer, and that while the colouring is darker the markings are more pronounced. In only one of four species of wallabies examined was there no alteration from the normal Australian type. The likelihood that the change is a result of environment is strengthened by the similarity of change shown by opossums which also have been introduced into New Zealand. In these also the fur is found to be longer, more silky, and less dense, and the alteration in character is so marked that, according to the author, one has no difficulty in distinguishing New Zealand opossum pelts from among thousands that may be offered in a sale-room.

Food-storing by Californian Woodpeckers.—The well-known studies of the acorn-storing habit of the California woodpecker (*Balanosphyra formiscivora*), to which Prof. W. E. Ritter has devoted many years, have been pushed to a new stage by the author (*Quart. Rev. Biol.*, vol. 4, p. 453; 1929) in his attempt to estimate the functional or evolutionary value of the habit to the birds themselves. By various means he has tried to test the survival value of acorn-storing, and his strong conclusion is that, although the habit shows sharp limitations to its adaptiveness, it nevertheless is distinctly to the advantage of the California woodpecker. For example, a rough census of the numbers of this species in various districts shows that it exceeds its nearest competitors, the flicker and the Lewis woodpecker, in a proportion varying from three to one to five to one. These others do not store food, and Ritter argues that food-storing, by making the California woodpecker less dependent on local environmental conditions during severe weather, has reduced the rate of mortality and increased the numbers of birds. Close study of the storing habit shows that it is no general activity but conforms minutely to varying external conditions, in fitting storage holes for acorns of different sizes, in selecting nuts of convenient size for handling, and in several other respects, all of which are intrinsic evidences of the adaptiveness of the activities. On the other hand, maladaptations are manifest in the occasional storing of objects which cannot be used as food, in the storing of food where it cannot be recovered, and in the making of storing holes which are never used at all.

Nematode Infection of a Young Dolphin.—In an interesting address to the Quekett Microscopical Club, published in the Club's journal of December last, on the life-histories of some nematodes, Dr. H. A. Baylis refers to the group of related genera and species of nematode worms which occur only in whales, porpoises, and dolphins and are usually found in the bronchi, the air-containing cavities in the head, or in the blood vessels. Each species of worm seems to be strictly confined to one or two kinds of host, and in some species of Cetacea practically every individual appears to be infected. Dr. Baylis records a heavy infection of adult worms in a dolphin so young that its stomach was still full of its mother's milk, and points out that if the larvæ of the worm were discharged into the sea they would be unlikely to reach the proper host again. He therefore suggests that pre-natal infestation occurs, the worms being regularly handed on from mother to offspring. As the worms are viviparous this would be possible, for larvæ would probably always be available so long as adult worms were present.

Nitrogen Fixation by Bacteria.—The question as to whether or not the nodule bacteria of leguminous plants can fix atmospheric nitrogen independently of their host has always been a vexed one, the results previously obtained by a large number of workers being decidedly conflicting. It is, therefore, of particular interest that three papers have recently appeared on this subject within a few weeks of each other by independent workers, all of which are unanimous in their conclusion that no fixation of nitrogen occurs apart from the host plant. F. E.

Allison (*Jour. Agr. Res.*, **39**, p. 893), working with 31 strains of legume-nodule bacteria, grown in a large number of media, under a variety of conditions, has obtained consistently negative results. His conclusions were based on nearly a thousand analyses determined by the Kjeldahl method. E. W. Hopkins (*Soil Science*, **28**, p. 433) gives a useful tabulated summary of all previous investigations, results and working conditions. He also obtained no evidence of nitrogen fixation from any of the five hundred analyses carried out with the Davisson-Parsons method. M. E. Löhnis (*Soil Science*, **29**, p. 37) has also obtained a negative answer to the question, employing in some experiments the Gunning-Arnold and in others the ter Meulen micro-method for the nitrogen determinations. It would seem particularly convincing that all three workers have secured similar results although each used entirely different methods.

Ionised Layers in the Upper Atmosphere.—A report on part of the work of the Peterborough Radio Research Station of the Department of Scientific and Industrial Research has been published by Prof. E. V. Appleton in the March number of the *Proceedings of the Royal Society*. In this paper, attention has been mainly directed to variations in the equivalent height of the layers of ions responsible for the reflection of the waves used in wireless transmission, as studied by the interference fringes formed at Peterborough between waves coming directly from Teddington, Bournemouth, or Birmingham, and those coming by way of the upper air. It seems now to be highly probable that the reflecting stratum is really multiple ; the secondary maxima and minima which sometimes accompany and occasionally replace completely the main fringes have properties which are difficult to reconcile with the view that they always arise through multiple reflection between a single layer and the ground, but are readily accounted for in terms of a second layer at a height of approximately twice that of the main 100 km. layer. The properties of at least the 100 km. layer are, however, in common with most atmospheric phenomena, somewhat erratic, for occasionally it will remain at about the same height during the observations, instead of rising as it usually does to some 125 km. at the hour before sunrise. The theory that a solar radiation is responsible for the production of the ions fits in well with most of the observations, but much still remains to be found out about the details of its action, and the nature of the ions. Two further papers are to appear, on simultaneous reception at different stations, and the results obtained with waves shorter than those made use of for the work described in the present paper.

Electric Power Stations in Japan.—In a paper read at the World Power Conference in Japan, an abstract of which appeared in *Engineering* of Jan. 31, S. Fukumaka discussed the joint operation of steam and hydroelectric power stations in Japan. Since 1922 electricity supply has increased very rapidly and increasing use has been made of water power. The steam stations are now mainly used to supplement the water power plants at times when the load is very heavy. This reduces the cost of the energy supplied to a minimum and conserves fuel. Fukumaka divides the power from hydraulic plants into two parts. The first is the power capacity based on the minimum flow throughout the year, and this power, which he calls primary, is continually utilised. The second part consists of the excess power that can be generated during the rainy season. This part can be considered primary if it can be supplemented when necessary by steam plant. In order to obtain the best results, the economical problems need modification for each case. The total electrical supply in Japan now exceeds three million kilowatts. The peak of the seasonable load, however, occurs in winter when the water power available is least. The steam plant which has to be installed to meet this shortage must be cheap. It must be capable of meeting large fluctuations and the time necessary for starting it must be small. In addition, the operating staff must be small and the stand-by charges a minimum. These requirements are influencing the design of all the new stations, with the result that the use of pulverised fuel is becoming general.

Extinction of Methane Flames by Water Vapour.—Some interesting experiments on the effect of water vapour on the limits of inflammability of methane in air, which supplement those made in 1926 with carbon dioxide, nitrogen, argon, and helium, are described in the February number of the *Journal of the Chemical Society* by Coward and Gleadall. The extinctive action of five of the six diluent gases runs in the order of their molecular heat capacities. Helium has an exceptionally high extinctive effect, ascribed to its abnormally high thermal conductivity. Other factors have very little influence: carbon tetrachloride, although it undergoes extensive reaction in the flame of a methane–air mixture, falls into line with the other diluent gases.

Passive Copper.—The results of some measurements of the adhesion of ' passive ' copper are given by M. Nottage in a paper in the March number of the *Proceedings of the Royal Society*. The copper was made passive by first boiling in absolute alcohol, and then plunging whilst still hot into dilute nitric acid. Experiments with ordinary copper and steel showed that passive copper adhered very strongly to a similar surface, the value of the adhesion with palmitic acid lubrication being 21,000 gm. per sq. cm., whereas ordinary copper has an adhesion of 14,200 gm. per sq. cm. against itself. The passive copper had a uniform reddish tinge, quite unlike the patchy appearance of the usual tarnished surface, and was presumed to be coated with a very thin layer of cuprous oxide, which possessed considerable permanency, persisting for example on rubbing with fine magnesia powder on silk, and on exposure to impure damp air. The results of the adhesion determinations are taken to indicate that the surface film produces a decided increase in the intensity of the attraction field.

Oxidation of Acetaldehyde.—Although it is known that, in the oxidation of benzaldehyde by oxygen, peroxides are formed, there was no information as to the course of the oxidation of acetaldehyde, Liebig in 1835 having observed that it absorbs oxygen at the ordinary temperature, giving, according to him, acetic acid. In the February number of the *Journal of the Chemical Society*, Bowen and Tietz have shown that a peroxide of acetaldehyde is quantitatively formed, that it is a moderately stable substance, and that it is produced thermally as well as photochemically when liquid acetaldehyde is shaken with ozygen. There are two possible peroxides, namely, peracetic acid, $CH_3 . CO . O . OH$ and diacetyl peroxide, $CH_3 . CO . O . O . CO . CH_3$, both of which have been prepared in other ways. The photochemical reaction is essentially the same throughout the ultra-violet absorption band of acetaldehyde, and the rate is proportional to the square root of the light intensity. The formation of diacetyl peroxide occurs in the gaseous, liquid or dissolved states, but it is probably produced by secondary reaction of peracetic acid, which is assumed to be the first product in a chain reaction.

The Viscosity of Liquids.

AMONG the properties of liquids the viscosity is probably the one the investigation of which has suffered most from lack of any accepted theory, however crude and approximate, to guide it. A great body of more or less careful observations exist, but it has furnished remarkably little information as to the nature of the liquid state. The new technique of X-rays, the Raman effect, and the depolarisation of light may do much to elucidate the structure of liquids, but the older and grosser property of viscosity must be at least as pertinent. Recently, a letter of mine published in NATURE of Mar. 1 upon the subject of liquid viscosity called forth a number of letters, and seemed to make it advisable to say a little more of a theory which, little elaborated as it is, offers a picture which may prove helpful. The conception of a transitory and fluctuating 'crystallisation' of a liquid seems to fit in with other observations. I am far from being satisfied with the theory as it stands: my hopes go no further than that the facts cited in my present letter may suggest to some that there is a germ of truth in the point of view put forward. At any rate, I intend to make some measurements myself of the temperature coefficient of liquid viscosity, in the hope that they may throw some light on the old problem as to the force exerted on a single molecule by the molecules in its immediate neighbourhood, within the Lorentz sphere.

THE letter of Prof. Andrade in NATURE of Mar. 1 raises the interesting question as to the reason for the decrease in viscosity of a liquid with rise of temperature. This seems to be closely connected with the similar decrease in the frictional resistance due to the motion of solid bodies through liquids. I have been lately carrying out some experiments on this latter subject as follows.

Two rings of thin sheet-brass were cut off a drawn brass telescope tube about 2 inches in diameter. One ring was 1 inch deep and the other 0·25 inch deep. These rings could be suspended one at a time by four very fine wires with their axes vertical from the bottom of a cylindric inertia mass, which last was hung by a single steel torsion wire. The arrangement was such that the thin rings could be set oscillating in a liquid successively, with the rings totally immersed in it, but the inertia mass not immersed. The object of using rings of different depths was to eliminate any energy loss due to wave or eddy current making due to the fine suspending wires or edges of the rings. The measurement consisted in displacing the suspended mass through a certain angle, say 120°, and then noting the time required for this angle of maximum displacement to be reduced to 60° for the two rings. This gives by difference a measure of the frictional resistance per unit of surface. If the frictional resistance were exactly proportional to the velocity then the differential equation for the motion would be

$$I\frac{d^2\theta}{dt^2}+R\frac{d\theta}{dt}+C\theta=0,$$

where I is the moment of inertia of the oscillating mass and C the coefficient of restoration and θ the angle of displacement. If t' is the time required to decrease the initial amplitude of displacement to half its value, then it is easy to show that $R=1{\cdot}38I/t'$.

On making the measurements in tap water at various temperatures the following results were found:

15° C.	$R=19{\cdot}75$	60° C.	$R'=10{\cdot}1$
30°	15·2	70°	10·7
50°	12·1	80°	10·6

It is seen that a rise of temperature of the water from 15° C. to 80° C. reduces the frictional coefficient R to about half its value.

This method is sufficiently sensitive to show the difference between fresh water and sea water at the same temperature.

If we ask the reasons for it the following suggest themselves. The cause of friction between a solid and a liquid may be regarded as of the same nature as the reason for the coherence of molecules together to form either a solid or a liquid. In view of the assumed electric structure of atoms, this coherence must be regarded as due to electrical attractions between atoms or molecules. Rise of temperature ionises or dissociates molecules into ions or atoms and promotes mobility of these with respect to the mass of the liquid. Hence follows a reduction of the force required to shear a liquid surface along a solid.

Experiments made with paraffin oil (Royal Daylight) showed that, although this liquid seems more limpid than water, the coefficient of frictional resistance with the brass rings was considerably greater. The oil is, however, a good dielectric and therefore not ionised so much as tap water at the same temperature. The practical result is that if the sea had an average temperature of 80° C. instead of about 15° C., ships would require less power to drive them through the water than at present. I am continuing these experiments as time permits.

AMBROSE FLEMING.

Manor Road, Sidmouth,
Mar. 1.

I HAVE read with great interest Prof. Andrade's letter in NATURE of Mar. 1, dealing with the temperature variation of the viscosity of liquids. The theoretical side of this question has admittedly been curiously neglected with perhaps one or two exceptions, of which one of the earliest was Maxwell. Considering, however, how generally the idea of a time of relaxation has entered into modern molecular theory, particularly in relation to liquids, it is more than probable that Maxwell's original conception of the viscosity process will receive an elaborated physical interpretation.

In view of this fact I should like to mention a formula connecting the viscosity and temperature in liquids which I have had occasion to examine in a paper which has been communicated elsewhere, and which may be built up from Maxwell's fundamental definition of liquid viscosity. This formula

$$\eta=\frac{Ae^{\beta T}}{T-b}$$

holds for a number of liquids over a wide temperature range, which liquids include both normal and associating liquids. The accompanying table shows two examples. The formula has admittedly three constants but is similar to that of Prof. Andrade in that it contains an exponential function. From general molecular theory and in view of the direct relation between viscosity and vapour pressure, it is probable that an exponential form of equation

for viscosity and temperature will prove to be the most satisfactory. In this connexion a comparison of the derivations of J. S. Dunn's equation (*Trans.*

Temp.	Water, $A=1{\cdot}522$. $\beta=-0{\cdot}003822$. $b=243$		Octane, $A=1{\cdot}128$. $\beta=-0{\cdot}002399$. $b=190$.	
	η obs.	η calc.	η obs.	η calc.
0° C.	0·01792	0·01787	0·007060	0·007060
10	01308	01289	006159	006152
20	01005	00996	005419	005423
30	00801	00797	004828	004826
40	00656	00657	004328	004328
50	00549	00554	003907	003908
60	00469	00474	003551	003548
70	00406	00410	003241	003238
80	00357	00359	002971	002967
90	00317	00317	002730	002730
100	00284	00281	002520	002519
110	—	—	002335	002332
120	—	—	002160	002165

The values for η obs. for water are those of Bingham and Jackson, for octane those of Thorpe and Rodger.

Farad. Soc., **22**, pp. 401-405; 1926) $1/\eta = Ae^{-Q/RT}$ based on kinetic theory considerations and $\eta = Ae^{b/T}$ put forward by Prof. Andrade should be of great interest.

E. W. MADGE.

46 Crowther Road,
Stockland Green,
Erdington, Birmingham.

A SATISFACTORY explanation of the decrease of liquid viscosity with temperature has long been required, and Prof. Andrade's theoretical treatment of the subject will be awaited with interest. His simple formula connecting viscosity and temperature appears to give good agreement for certain liquids, but I should like to point out that it does not give such good agreement when applied to measurements on some mineral oils, as does a formula due to Slotte. The measurements were taken several years ago and in attempting to find an empirical relationship between the viscosity and the temperature, I obtained, quite independently, a formula which was identical

Temp.	η calc. (Andr.).	η obs.	η calc. (Slotte).
20	12·36	15·20	15·46
25	9·03	10·15	10·19
30	6·67	7·04	6·99
35	4·97	4·97	4·93
40	3·75	3·58	3·58
45	2·85	2·67	2·66
50	2·18	2·00	2·01
55	1·685	1·550	1·558
60	1·313	1·232	1·217
65	1·028	0·965	0·966
70	0·813	0·780	0·777
75	0·646	0·633	0·636
80	0·517	0·517	0·522
85	0·417	0·432	0·435
90	0·337	0·362	0·363
95	0·275	0·306	0·305

with that due to Slotte and adopted by Thorpe and Rodger as best representing their experimental results. This formula is usually written in the form

$$\eta = \frac{c}{t+a}n$$

where η is the viscosity, t the temperature in °C., and C, a and n constants depending on the liquid used. The constants A and b in Prof. Andrade's formula (NATURE, Mar. 1, p. 309) have been calculated for a somewhat viscous oil from the viscosity values at 35° C. and 80° C., and the agreement between the observed results and those calculated from the two formulæ shown in the accompanying table.

One naturally expects to be able to obtain closer agreement between observed and calculated results with a formula containing three constants than with one containing two, but in this connexion a further interesting fact was observed. It was found that the value of C obtained from eight oils of widely varying viscosities could be expressed with considerable accuracy by the formula

$$C = ad^n$$

where a and d are constants which are independent of the nature of the oil and the approximate values of which were $1{\cdot}5 \times 10^{-3}$ and 400 respectively. Thus Slotte's formula also becomes one in which there are only two constants the values of which are dependent on the nature of the liquid. On examining the values of C and n obtained for other liquids it was found that, with the exception of the alcohols, they were connected by a similar relationship, the values of a and d differing but slightly from those obtained for the mineral oils. This empirical relationship was not published, and it was thought that the results might be of some interest when considering the theoretical aspects of the problem.

D. H. BLACK.

International Telephone and Telegraph
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The Hyde, Hendon.

IN a recent issue of NATURE (Mar. 1, p. 309) Prof. Andrade publishes the following formula, $\eta = Ae^{b/T}$, for the coefficient of viscosity of liquids as a function of the temperature T, which he shows to be in excellent agreement with the experimental data. Now I wish to point out that a practically equivalent formula, namely, $\eta = CTe^{U/kT}$, was given by me more than four years ago in a paper on the heat motion of solid and liquid bodies (*Zeit. f. Phys.*, **35**, p. 664-667; 1926). Since this has obviously remained unnoticed, it may be well to state briefly the fundamental conception on the heat motion of liquids upon which the above formula is based.

The 'crawling' of the particles of the liquid is considered as a combination of oscillations about a (temporary) position of equilibrium and of a jerky displacement of this position from time to time. The average number of oscillations performed about the same equilibrium position is equal to $e^{U/kT}$, where u is the energy required to tear the particle out of it. An elementary displacement of the equilibrium position is consequently achieved in a time $\tau = \tau_0 e^{U/kT}$, τ_0 being the period of the oscillations, which corresponds to a 'crawling' velocity $v = \frac{\delta}{\tau} = \frac{\delta}{\tau_0}e^{-U/kT}$, where δ, the average range of this displacement, is of the order of the mean distance between neighbouring particles, and to a diffusion coefficient $D = \frac{1}{3}\delta v = \frac{\delta^2}{3\tau_0}e^{-U/kT}$. Now the latter is connected with the friction coefficient f (= ratio of force to the mean velocity which is due to it) by Einstein's formula $Df = kT$. If, on the other hand, we regard the particle as a small sphere of radius $a \cong \delta$ then we have by Stokes's formula $f = 6\pi a\eta$. Hence $\eta = \frac{\tau_0 kT}{2\pi a\delta^2}e^{U/kT}$ which is the above formula with $C = \frac{\tau_0 k}{2\pi a\delta^2}$.

Putting here $\tau_0 \cong 10^{-13}$ sec. and $a \cong \delta \cong 10^{-8}$ cm.: one gets for C or Andrade's coefficient $A = CT$ values of the correct order of magnitude.

J. FRENKEL.

Physico-Technical Röntgen Institute,
Leningrad, Mar. 8.

I AM naturally gratified at the interest which my brief letter on liquid viscosity, published in NATURE of Mar. 1, seems to have aroused. In view of the correspondence which has ensued I should like first to indicate briefly the theoretical considerations, mentioned in passing in my former letter, which lead me to the formula $\eta = Ae^{b/T}$; secondly, to refer to the general directions in which I look for experimental confirmation; and thirdly, to discuss some of the points raised by the correspondence.

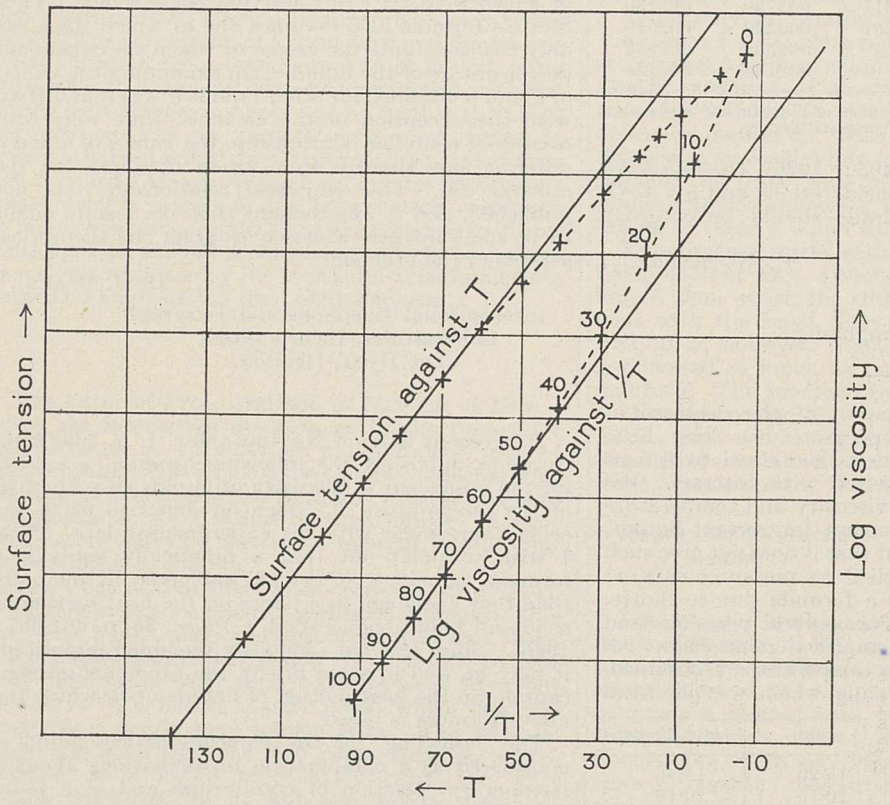

FIG. 1.

The method by which I arrive at the formula is by taking two layers of molecules, parallel to the direction of motion of the liquid and considering the transfer of momentum between them. In the case of a gas, Maxwell showed how the viscosity can be derived by considering this momentum as being communicated by molecules transferring themselves bodily through a distance large compared to their own sizes, from one layer to the other. But both the non-fulfilment of the conditions postulated in Maxwell's treatment, and the fact that while gas viscosity goes up with temperature liquid viscosity goes down, show that some radically different picture is needed for liquids. I suppose that momentum is transferred from layer to layer by a temporary union of molecules in contiguous layers, the duration of this union not exceeding the very brief time required for the molecules to acquire a common velocity of translation. The union takes place under the action of the residual field of the molecules, which suffices to bind them permanently in the solid state, but is overcome by the energy of motion in the liquid state. General considerations suffice to show that the greater the temperature agitation the smaller the probability that the residual field of fixed average strength will result in temporary union for a given molecule. The viscosity of a liquid, therefore, decreases with rise in temperature until finally the energy of motion overcomes the molecular field and the liquid boils. The general picture is one of the liquid 'crystallising' temporarily in minute patches: at the temperature of solidification the crystallisation becomes general and permanent, at the boiling point it must be very small.

To obtain the quantitative law more precise assumptions are necessary. We can suppose that the temporary combination represents the position of minimum potential energy of the molecule with respect to the local field. Just as in Langevin's theory of magnetism the tendency of the molecules to set, with respect to an *external* field, in the position of minimum potential energy, with axes parallel to the field, is opposed by the thermal agitation, so here too the tendency of two molecules to combine is opposed by the thermal agitation. The simplest application of Boltzmann's formula leads to the viscosity formula given in my former letter. In this formula the constant b is, of course, of the form $-E/k$, where E is the energy, numerically negative, of juxtaposition, k the Boltzmann constant. The constant A contains as factors $M^{3/2}\rho^{-1/3}$, where M is the molecular weight, ρ the density. The formula virtually assumes that the number of impacts is independent of the temperature, the effect of the increased velocity being opposed by certain factors, such as the expansion. It is probable that A depends slightly on the temperature, and I am now trying to elaborate this point, but comparison with the recorded data shows that A may be taken as a constant to a first approximation.

It is my belief that the constant b, expressing in some way the strength of the intermolecular field, will prove of great importance for the theory of liquids, and will take its place alongside the surface tension. The constant b can be accurately determined from the variation of viscosity with temperature, the constant A less so, it being very insensitive, like the constant A in O. W. Richardson's thermionic formula.

One way in which to check the reasonableness of the hypothesis on which the theory is based is to calculate the number of momentary combinations which it requires to give the observed viscosity. Just above the

melting point I suppose that practically every collision leads to a sharing of momentum, so that the number obtained should be of the order of the total number of collisions. In the case of mercury this number comes out to be $3{\cdot}7 \times 10^{12}$ per sec., which is reasonable, being of the same order as the vibration frequency of the solid. I have also obtained a rough value for the internal pressures of one or two organic liquids, which come out to be of the right order, but the assumptions made in this case are of a tentative nature, and I am now devoting further attention to this problem.

I distinguish between true association, as occurring in liquids ordinarily called associated, and the brief union needed for the sharing of momentum which I postulate for all liquids. True association, in which molecules are bound together in clusters of two or more for a time large compared to the intervals between collisions, leads, with the mechanism postulated, to an increase of viscosity. The application of the formula to many associated liquids leads to some very interesting results. It is found to hold accurately at higher temperatures, but as the temperature falls the actual viscosity becomes increasingly greater, compared to that predicted by the formula. This I take to mean that at the higher temperatures the liquids are either not associated at all, or else that such association as may exist is of a stable kind, unaffected by the temperature. In the case of water the formula $\eta = Ae^{b/T}$ expresses the viscosity within 0·5 per cent from 100° to 60°, when the deviation begins to set in and rapidly increases. It is striking that the surface tension of water is a linear function of the absolute temperature above 60°, but that below 60° the deviation from linearity rapidly increases, as shown by Fig. 1, in which surface tension plotted against T, and the logarithm of viscosity plotted against $1/T$, are exhibited in the same diagram. As an inverse temperature scale would make it troublesome to trace the point at which the viscosity law changes, the actual temperature values of the different points are indicated on the curve itself. Water and many other associating liquids can be fitted by the formula $\eta = A'e^{b'/T-\theta}$ as an approximation, the formula having no detailed theoretical basis, but being derived by an obvious analogy from other branches of physics. For water the fit is within about 1 per cent throughout the range. It seems more reasonable, however, to use a formula of the type $\eta = A(1+\alpha e^{-\beta T})e^{b/T}$, the term $1+\alpha e^{-\beta T}$ expressing the decrease of association with temperature. This formula, it is true, has four constants, but four constants are commonly used in empirical formulæ designed to fit water.[1] It gives the viscosity over the range $T = 263{\cdot}7$ (supercooling of 9° C.) to $T = 363$ within 0·25 per cent (the viscosity at 100° seems experimentally doubtful). The variations in the viscosity of water, as measured by different observers of high repute, markedly exceed this at many temperatures. There is no indication of a systematic deviation. For fitting the formula I have taken the mean of the results of Hosking, and of Bingham and White, as given in Landolt-Bornstein, 1923 edition, for which the greatest variation at any one temperature is 0·9 per cent, while at most temperatures the agreement is good. For supercooled water the values of White and Twining, quoted in Landolt-Bornstein, are taken.

The accompanying table exhibits the fit.

If b measures the strength of the molecular field, as defined by the conditions specified, it should be connected on one hand with the boiling point, and on the other hand with the dielectric polarisation due to deformation of the molecule. In all homologous series for which measurements are accessible to me, b increases regularly with the boiling point and with the polarisation. This is an aspect of the subject at which I am now working with some promise of result. Among other results obtained by considering the variation of b throughout homologous series, I may mention that, plotted against numbers of carbon atoms for the fatty acids, b lies on one curve for the odd numbers of carbons, and another for the even numbers. The data are very scanty, but this conclusion seems justified, and extends to the liquid state conclusions based on the behaviour of the solid state to X-rays.

VISCOSITY OF WATER.

$\eta_{calc.} = 4{\cdot}328e^{1554/T}(1+e^{12{\cdot}097-{\cdot}0477T}) \times 10^{-5}$

Temperature °C.	$\eta_{obs.} \times 10^5$.	$\eta_{calc.} \times 10^5$.	$\frac{\eta_{obs.}-\eta_{calc.}}{100\ \eta}$ (Percentage error.)
−9·3	2545	2539	+·2
−8·48	2454	2456	−·1
−7·23	2337	2338	−·05
−6·2	2246	2246	0
−4·7	2118	2122	−·2
−2·1	1927	1930	−·2
0	1795	1792	+·2
5	1523	1521	+·1
10	1306	1308	−·15
15	1140	1139	+·1
20	1003	1003	0
25	894	892	+·2
30	800	800	0
35	723	722	+·15
40	657	657	0
45	600	600	0
50	550	551	−·2
55	508	508	0
60	471	471	0
65	436	437	−·2
70	407	407	0
75	380	381	−·3
80	356	356	0
85	335	335	0
90	315	315	0
95	(297)	296	−·3
100	(281)	280	−·35

In the experimental values for 95° and 100° Hosking's values, which are markedly higher than those of other observers, are omitted. The values given are averages for Slotte, Thorpe and Rodger, and Bingham and White. Accurate determinations in the neighbourhood of the boiling point are badly needed.

The variation of viscosity with pressure is another part of the subject which is yielding promising results. The general nature of the increase is clearly represented by the theory, $\log \eta$ being a linear function of P as a first approximation, but even in cases such as water something of a more quantitative nature has already been obtained. The viscosity of solutions is another field to which the general formula is being applied.

One of the greatest troubles which I have met with in trying to check the theory is the lack of precise data. Organic chemists tell me that it is doubtful, for example, if the fatty acids used for the recorded determinations were pure. Again, the variations between the results obtained by different observers with certain of the most ordinary substances, for example, ethyl ether or mercury, are very large: for ether they amount to as much as 9 per cent in the neighbourhood of 20° C., and for mercury to 3 per cent at temperatures above 140° C. (see Erk, "Unsere Kenntnis der Zähigkeit von Quecksilber," *Zeitschrift für Physik*, **47**, 886; 1928). The range of measurements

[1] The purely empirical four-constant formula which Bingham and Jackson (Bureau of Standards, No. 298) give for fitting water from 0° to 100° shows an error of 1·4 per cent when extrapolated to −9° C.

is, in general, extraordinarily limited compared to, say, that available for surface tension : there are, in general, no measurements above the boiling point at atmospheric pressure, and for low boiling liquids scarcely any at all below 0° C., which is in many cases, for example, pentane, the most important part of the range. I am planning a series of investigations to be carried out in this laboratory, in the hope of adding to the reliable data for viscosity, more especially the temperature variation required to give b.

Turning to the letters which have been sent to NATURE since my first letter was printed, the letter from my old friend Dr. S. E. Sheppard, published on Mar. 29, gives what is practically my formula and states one of my first results, namely, that for a large number of liquids the formula represents the observed data, within experimental error, over a wide range of temperature. The complete independence of our work—our letters were written within a few days of one another, his in America, mine in England—may serve to emphasise the point that I wish to stress, namely, that this formula has a fundamental significance, and the constant b—Sheppard's k—has an intimate relation to the various properties connected with the internal energy of liquids. The other points of interest which Sheppard raises are not the same as mine. Sheppard has not made it quite clear how he obtains his a for associating liquids, for $\eta = Ae^{b/T}$ will not fit, for example, water. Presumably, he has found the value of b by fitting one or two of the low temperature values. I note that he has found that the formula has been already given by Senor J. de Guzman in the *Anales de la Sociedad Española de Fisica y Quimica*, 1913. Prof. Kendall has pointed out to me that he mentions it, in the form $\log \eta^{1/3} = a/T + b$, in a footnote to a paper in the *Journal of the American Chemical Society*, **39**, 1799 ; 1917. I have also, since deriving it, found that J. S. Dunn has given it in a short paper in the *Transactions of the Faraday Society*, **22**, 401; 1926, as quoted in Mr. E. W. Madge's letter. Mr. Dunn's paper had escaped my attention just as it has that of Dr. Sheppard and his collaborators. No particular attention ever seems to have been paid to the formula before, and it is not quoted in the standard books, for example, Hatschek's " Viscosity of Liquids ". It is always distressing to find that one has been anticipated, in whatever degree, but it certainly does not seem to have been previously realised that the formula $\eta = Ae^{b/T}$ is fundamentally characteristic of normal liquids.

As regards Mr. E. W. Madge's formula, $\eta = \frac{A}{T-b}e^{\beta T}$, it does not seem to fit octane sensibly better than my formula with two constants, and it does not fit water so well as the formula $\eta = Ae^{b/T-\theta}$, with the same number of constants, which I quote earlier in this letter, variations as large as 1·5 per cent occurring in Mr. Madge's table, as against 0·9 per cent over the same range with my simpler three-constant formula. If Mr. Madge had computed the value for supercooled water at −9·3° C., he would have found a discrepancy of nearly 5 per cent, as against 1·3 per cent given by $\eta = Ae^{b/T-\theta}$!

Dr. Frenkel's formula is scarcely, as he claims, " practically equivalent " to mine, for it is $ATe^{b/T}$, instead of $Ae^{b/T}$, and the multiplication by T renders it unable to fit the variation of viscosity with temperature, interesting as is its derivation.

I am afraid I can attach but little importance to the fact, cited by Dr. Black, that the formula does not fit commercial mineral oils, of no definite composition, in view of my success, confirmed by Dr. Sheppard, in fitting a great variety of pure chemical substances. I have investigated the type of variation from the formula shown by Dr. Black's oils, and it is of a nature quite different from that shown by pure substances which do not fit, namely, such as associate strongly. So far as I can learn, oils of this type often change their viscosity permanently on heating.

Sir Ambrose Fleming's very interesting letter deals with the points which lie somewhat off the main current of my argument.

I feel that some apology for the length of this letter is needed, but, even in this space, I have only been able to refer in the briefest possible manner to points connected with the subject which I have under immediate investigation.

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Catalytic Reactions at High Pressures.

THE technical synthesis of ammonia by high pressure catalysis has given a great impetus to the development of high pressure reactions. At the present time reaction pressures are confined to a few hundred atmospheres, at which pressures the technical problems in so far as material and construction are concerned may be fairly claimed to be solved. Work in the high pressure laboratory at Amsterdam envisages operating pressures above ten thousand atmospheres and a few determinations of physical constants have already been made at pressures as high as 35,000 atmospheres. At these pressures, again, especially at high temperatures, new problems of material, construction, and design will confront the engineer hoping to industrialise a process operating under these conditions. Technical interest in catalysis at high pressures is at present focused on the numerous reactions involving the use of water gas as raw material and on hydrogenation of coal, including products derived from coal. Many others involving processes of amination and oxidation are doubtless capable of development.

Whilst the difficulties involved in the hydrogenation of coal are partly economic in character and lie partly in the variability of the raw material, these factors are not so important in many of the reactions involving water gas, and in that field it is clear that a whole series of careful physical chemical investigations are necessary before the state of affairs may be considered to be at all satisfactory.

In developing the synthesis of ammonia, preliminary work involved the determination of the data necessary to establish the conditions of equilibrium of the system

$$N_2 + 3H_2 \rightleftarrows 2NH_3$$

over a wide range of pressure and of temperature. This phase of the problem was in part simplified by the absence of other reactions in the combination of the two gases and by a knowledge, with fairly accurate data available, of the specific heats of hydrogen and nitrogen and approximate values for the heat of formation of ammonia, its specific heat and compressibility. More accurate data have only recently been obtained, but the approximate data available before development of the industrial processes were sufficiently accurate.

In the case of reactions involving water gas, the state of affairs is much more complex because there is a whole series of reactions which are possible with the gases carbon monoxide and hydrogen. The initial

reactions which are important may be formulated as follows :

$$(1)\ CO + H_2 \rightleftarrows HCHO$$

$$(2)\ CO + 2H_2 \rightleftarrows CH_3OH$$

$$(3)\ CO + 3H_2 \rightleftarrows CH_4 + H_2O$$

By aldol condensation together with stages of hydrogenation a whole sequence of higher aldehydes and alcohols may be obtained from (1), with the possible exception of ethyl alcohol.

Accurate data on the heats of these reactions, on the specific heats and on the compressibilities of most of the products, are at present not available and in consequence the equilibrium under high pressures and over a range of temperatures for any one of these reactions cannot as yet be said to be determined with any degree of accuracy. The work at the Imperial College on the experimental determination of the methanol equilibrium, reaction (2), appears to be the most complete at the present time. Having obtained preliminary if not exact information on the conditions of equilibrium, the next stage involves the choice of a suitable catalyst, and here we note that apart from chemical reactivity the catalyst employed must possess the additional property of being highly selective in its action. Whilst it is known from investigations that a copper catalyst favours reaction (1), a zinc oxide catalyst containing certain promoters, for example, chromium oxide, favours (2), and an active nickel catalyst is most suitable for the formation of methane, and that the rate of aldol condensation resulting in the formation of higher alcohols can readily be augmented by the addition of small qualities of alkali, the mechanism of the catalytic processes themselves which must contain the secret of the selectivity of these catalysts is unknown.

Although the use of iron as a catalyst in the synthesis of ammonia has been known for nearly thirty years, it is only recently that any definite ideas as to what constitutes an active catalyst for this reaction have been developed. These may be said to have originated in an examination of the activity of catalysts prepared by two different ways ; as minute agglomerates and crystals formed as a result of condensation from the vapour phase, and by the breaking up of large crystals by processes of ' activation ' and prevention of the regrowth of the grain size by the addition of suitable materials.

Developments along similar lines involving measurements both on the heats of adsorption as well as reaction rates in both forward and reverse directions may assist in the building up of a satisfactory interpretation of catalytic action. From the discussion which was held at the Royal Society on Mar. 20 on catalytic chemical reactions under high pressures, it was clearly evident that work both scientific and industrial in this important field is advancing rapidly in England, and in addition that the organic chemistry of the simpler aliphatic compounds was a field which requires immediate exploration by both physicists and physical chemists.

ERIC K. RIDEAL.

Historic Natural Events.

April 14, 1912. S.S. *Titanic* sunk by Iceberg in Atlantic.—During the months of April and May 1912, there was an abnormally large amount of ice off the Newfoundland Banks. In April no fewer than 395 icebergs were counted south of lat. 48° N., compared with an average number of 83, and in May 345 compared with an average of 130. The icebergs spread far to the south of their usual limits, and on April 14, the White Star liner *Titanic* struck one in lat. 41° 46′ N., long. 50° 14′ W., and sank with great loss of life. As a result of this disaster, the first International Conference for Safety of Life at Sea was held in London in 1913, at which it was decided to establish and maintain a regular patrol of the iceberg area.

April 15, 1077. End of ' Canossa ' Winter.—The winter of 1076–77 was so rigorous in England, France, and central Europe that the oldest inhabitants did not remember a similar one. The " Harleian Miscellany " records that " in the tenth year of his [William the Conqueror's] reign, the cold of winter was exceeding memorable, both for sharpness and for continuance, for the earth remained hard from the beginning of November until the midst of April then ensuing ". In Europe the snow lasted from Nov. 1 to Mar. 26, and the Rhine was crossed on the ice so late as April. In central France hard frosts continued for four and a half months and the vines perished. The passes across the Apennines were completely blocked by snow and ice. It was from Jan. 25 to 28, 1077, that the Emperor Henry IV. of Germany stood shivering, bareheaded and barefooted, and clad in a hair shirt, before Pope Gregory VII. in the courtyard of the Castle of Canossa in northern Italy, before the Pope removed the ban of excommunication imposed for his harsh treatment of the Saxon princes.

April 15, 1927. Mississippi Floods.—The floods in the Mississippi valley in February–July 1927, because of their magnitude, protracted duration, and economic destructiveness, formed one of the greatest calamities of modern times. Their beginnings may be traced back to the abnormal rains of September 1926 over the greater part of the Mississippi drainage area. There were further heavy rains in October and November, and in December there were general floods in the southern streams tributary to the Ohio River. The early months of 1927 also had a rainfall above the normal in most parts of the basin, but the most serious flooding did not begin until April 15, 1927, when a crevasse began to form in the levee guarding the river at Dorena, Mo., 30 miles below Cairo, Ill. From that date the floods spread with terrible rapidity, and crevasses were formed in the levees. The total area of lands overflowed was 28,573 square miles, and the damage was estimated as more than 284 million dollars. The loss of life was 214 ; this (as well as the material loss) would have been far higher but for the warnings issued by the U.S. Weather Bureau.

April 18, 1850. Tornado at Dublin.—A violent thunderstorm developed at 3.30 P.M., with hailstones as large as pigeon's eggs. At 4 P.M. a tornado passed over, with hurricane winds from south-east, which abruptly changed to north-west. A great deal of damage was done ; in some districts practically every pane of glass was blown in, chimneys were overthrown, and roofs carried off, while many trees were uprooted. These fell to north-west and south-east in about equal proportions, adjacent trees sometimes lying in opposite directions. The Cattle Show was in progress, and the cattle broke loose, leading to fearful confusion.

April 18, 1906. Earthquake in California.—The Californian earthquake on this day caused much damage in San Francisco, less by the shock than by the fires that followed it. The most remarkable feature of this earthquake was the great length (not less than 270 miles) of an old fault known as the San Andreas rift along which the displacement occurred, reaching from Cape Mendocino on the north to near Monterey on the south. Subsequent surveys of the district showed that the crust on both sides of the fault had moved, that on the south-west side to the north-west and on the other side to the south-east.

April 19, 1849. Snowstorm.—There was heavy snow in south-east England on April 16–20, and on April 19 the Westerham coach was buried and left all night in a snow drift on Titsey Hill.

Societies and Academies.

PARIS.

Academy of Sciences, Mar. 3.—**Emile Borel**: Probabilities universally negligible.—**L. Lecornu**: The loss of heat in explosion motors.—**A. Cotton** and **G. Dupouy**: The magnetic fields given by the large Bellevue electro-magnet. Diagrams are given of the results of the exploration of the magnetic fields produced under varying conditions of radius of the pole pieces, and distance between them. For very small pole pieces and at a distance apart of 2 mm., the field is near 70,000 gauss.—**Charles Moureu, Charles Dufraisse**, and **Nicolas Drisch**: Researches on the mechanism of the formation of rubrene: a new synthesis. The starting point of this synthesis is the ketone $(C_6H_5)_2C=CH-CO-C_6H_5$. Treatment with phosphorus pentachloride and the resulting chlorine derivative allowed to react with potassium acetate gives a substance capable of conversion into rubrene by simple heating. The yield is 30 per cent of the original ketone, and the new synthesis has nothing in common with the older methods of preparation.—**J. Costantin**: Mountain plants and Lamarckism. A discussion of the resistance to disease in the sugar cane acquired by growth at high altitudes and its transmission.—**E. L. Bouvier**: Some observations on the Saturnioid butterflies of the family of the Ceratocampidæ.—**V. Grignard** and **Th. N. Iliesco**: The condensation of isobutanal. A résumé of work published in detail elsewhere.—**Raffaele Nasini** was elected a *Correspondant* for the Section of Chemistry.—**Bertrand Gambier**: Some properties of circles.—**A. Buhl**: The cartography, in E_3, of triple integrals with fields deformed in E_4.—**A. Marchaud**: A characteristic topological property of Jordan curves without a double point.—**Georges Durand**: Ordinary points and singular points of envelopes of spheres.—**Henri Poncin**: A mixed problem in a circular ring.—**Julius Wolff**: The angular derivative in conformal representation.—**J. Haag**: The theory of the rachet pins.—**A. Gruvel** and **W. Besnard**: Description and presentation of a new oceanographic apparatus. The instrument is designed to collect a specimen of water, to measure the temperature at a predetermined depth, and to measure the depth at which these operations are carried out.—**Georges Déjardin**: The second spectrum of xenon in the interval 9000 A.–6000 A. The lines given were obtained by using the oscillating discharge in a tube without electrodes.—**V. Ambarzumian** and **D. Iwanenko**: Unobservable electrons and the β-rays. An outline of a theory of β-rays analogous with the theory of light quanta proposed by Dirac.—**Estanave**: A new contribution to integral photography.—**F. Bourion** and **E. Rouyer**: The cryoscopic study of paraldehyde in aqueous solution, and in solutions of potassium chloride.—**Alfred Molnar**: Researches on the cold hardening of lead, tin, and cadmium at different temperatures.—**Marcel Guillot**: The carrying down of polonium, a chloropoloniate, by ammonium chloroplumbate. The precipitation of crystals of $(NH_4)_2PbCl_6$ from a solution containing polonium results in partition of the polonium between the liquid and crystal phases. Since, under the same conditions of acidity, the precipitation of lead chloride from a solution containing polonium leaves the whole of the latter in solution, it is concluded that the phenomenon is probably not due to adsorption but to the formation of a polonium compound $(NH_4)_2PoCl_6$, isomorphous with the lead chloroplumbate.—**C. Matveyeff**: The cone-in-cone structure observed in the celestine of Wereino (Ural).—**Philippe Fabre**: The laws of electrical excitability by very short discharges in rapid muscles.—**C. Ninni**: The demonstration of the existence of the tubercle ultra-virus by direct inoculation in the lymphatic ganglions.

LENINGRAD.

Academy of Sciences (*Comptes Rendus*, No. 21, 1929).—**V. Ambarzumian**: Methods of determining the number of different atoms in the atmosphere of stars.—**D. I. Eropkin**: Determination of the absorption in the atmosphere of planets. A new method is described which is based on the study of the influence of the atmosphere on the gradual decrease of the brightness of a satellite in the half-shadow and in the shadow of the planet. The method requires that the entire photometric curve of an eclipse should be interpreted, and it can be applied in practice only to the case of planets with bright satellites, for example, the earth and Jupiter.—**V. V. Barovskii**: A description of a new species of the genus *Malthodes* Kies. (Coleoptera, Cantharididæ) of Central Asia. *Malthodes grigorievi* sp. n. is described from Fergana; this is the first representative of the genus in the fauna of Central Asia.—**N. Olenev**: Classification and geographical distribution of Ixodidæ (4). Descriptions of *Ixodes semenovi*, sp. n. from *Accentor collaris* (Scop.) in Turkestan, and of *I. redikorzevi lagurœ* sbsp. n., from *Lagurus lagurus* in the Lower Volga steppes, as well as a discussion of several other species.—**N. P. Annenkova**: A supplement to the polychæt fauna of the Black Sea. (1) *Goniada bobrezkii* sp. n. This is the first representative of the family Goniadidæ known from the Black Sea.

(*Comptes Rendus*, No. 22, 1929).—**D. I. Mushketov** and **P. M. Nikiforov**: A gravimetric and seismic expedition to Central Asia. A preliminary account of the expedition is given. The work with pendulums, gravity variometers, and seismographs was carried out at a number of points in the Fergana depression, and a lack of compensation was quite definitely established; the resulting tendency of the earth's crust to vertical upward displacements is the cause of earthquakes, which are not unusual in that locality. As regards the origin of the Fergana depression, the conclusion was reached that it was formed as a result of squeezing of the earth's crust, the sial-masses having been pressed into a denser layer underlying the crust.—**P. I. Simanin**: Contributions to the Culicid fauna of Fergana. A list of twelve species of mosquitoes is given. The number of setæ on the first joint of the valva is a doubtful specific character in the genus *Anopheles*.—**D. Beliankin**: Titanium oxide in the dinas. In a metallurgical oven, the titanium oxide of a dinas brick migrates towards the unaffected zone. Analogous phenomena can be observed in the natural granites and porphyrites.

PRAGUE.

Czech (Bohemian) Academy of Sciences and Arts (Second Class, Natural Science and Medicine), Dec. 6.—Extraordinary meeting: Prof. J. Matiegka gave a detailed account of his investigation concerning the identification of the remains of Jan Amos Komenský (Comenius) in the Church of Naarden, Holland.—Ordinary meeting—**O. Jírovec**: The fauna of the digestive tract of the termite *Calotermes* species Greek.—**O. Jírovec**: Nuclear division in *Trypanosoma evansi*.—**C. Čechura**: Magnetic declination of Moravia and Silesia in the epoch 1925·5.—**V. Špaček** and **B. Zahálka**: Magnetism of the mountain Říp.—**F. Němejc**: Palæobotanical researches on the quaternary flora of some localities in the vicinity of Růžomberk, Slovakia.—**M. Dillinger**: A study of the maximum of current

occurring in the electrolysis of mercuric cyanide solutions with the dropping mercury kathode. The electroreduction of the non-electrolyte mercuric cyanide in presence of electrolytes proceeds like that of oxygen, the maximal maximum occurring at a certain conductance, which is proportional to the concentration of mercuric cyanide. The mercury cathode shows a considerable polarisation.—**B. Brauner**: Comments to a former report on the analysis of water from the pond Babylon, Bohemian Forest.

ROME.

Royal National Academy of the Lincei, Nov. 17.—**P. Burgatti**: The transformations of Lorentz. A simple method is given for deducing Cayley's theorem, that the coefficients of a linear and orthogonal transformation in a Euclidean S_n are expressible rationally by means of $n(n-1)/2$ independent parameters.—**U. Cisotti**: Types of rigid isolated profiles subjected to dynamic action by means of a local fluid current circulating round them.—**N. Parravano and E. Onorata**: 'Blanc' alumina. Results are given which indicate the existence of what, in Wyckoff's terminology, must be regarded as a semi-crystalline alumina, obtained by the thermal decomposition of hexahydrated aluminium chloride, as well as of another alumina arising from the first at a higher temperature. The former exhibits the double refraction characteristic of non-monometric crystalline substances, whereas the second gives a distinct X-ray interference spectrum pointing to hexagonal or rhombohedric symmetry. The passage from the first to the second is accompanied by increase in density from 2·2 to about 3·5 and is, therefore, attended by approach of the atoms in the space intervening between the atoms of the unit cell. Conversion of the second form into corundum also occurs with rise in the density (from 3·5 to 3·9) and with further approach of the atoms of the unit cell.—**F. Vercelli**: The system of currents in the Straits of Bab-el-Mandeb in the summer.—**E. Bortolotti**: Geodetic co-ordinates along a line (1).—**R. Calapso**: A problem of the zero system osculatory to a congruence W.—**Gr. C. Moisil**: Movable datums in functional space.—**O. Onicescu**: The asymptotic behaviour and the zeros of a class of entire functions.—**G. Supino**: A criterion of choice between elastic solutions with equal resultants.—**G. Viola**: The system of U Cephei. The data collected on this system since 1913, particularly by Bemporad, are considered. The mean light curve indicates asymmetry with respect to the minimum epoch, oscillations both during the phase of totality and at the beginning and end of the eclipse, and inconstancy of the maximum luminosity of the system.—**E. Fermi**: The 4*d* complex of the helium molecule.—**Giambattista Dal Piaz**: New geological observations on the region lying between the Aurino torrent and the river Rienza (Upper Adige) (3).—**A. Ferrari and F. Giorgi**: Crystalline structure of anhydrous iodides of divalent metals (1). Cobalt, ferrous, and manganese iodides. These iodides exhibit structure of the cadmium iodide type. The elementary cells have the following dimensions: cobalt iodide, $a=3\cdot96$ A., $c=6\cdot65$ A., $c:a=1\cdot68$, density, 5·75; ferrous iodide, $a=4\cdot04$ A., $c=6\cdot75$ A., $c:a=1\cdot67$, density, 5·39; manganese iodide, $a=4\cdot16$ A., $c=6\cdot82$ A., $c:a=1\cdot64$, density, 5·01. The dimensions of the unit cell of lead iodide, for which previous authors have given discordant values, are $a=4\cdot53$ A., $c=6\cdot92$ A., $c:a=1\cdot53$.—**L. Maddalena**: Utilisation of an interesting hydric level over the north-east part of the plateau of Sette Comuni.—**G. Gabrieli**: Two iconographic codices of plants in miniature, in the Royal Library at Windsor.

Official Publications Received.

BRITISH.

Report of the Rugby School Natural History Society for the Year 1929. (Sixty-third Issue.) Pp. 43+2 plates. (Rugby.)

Canada. Department of Mines: Geological Survey, Canada. Memoir 155: Horton-Windsor District, Nova Scotia. By W. A. Bell. (No. 2176.) Pp. ii+268 (36 plates). (Ottawa: F. A. Acland.) 50 cents.

Canada. Department of Mines: National Museum of Canada. Bulletin No. 62: Annual Report for 1928. Pp. 38. (Ottawa: F. A. Acland.)

Dominion of Canada. Report of the Department of Mines for the Fiscal Year ending March 31, 1929. (No. 2217.) Pp. vi+58. (Ottawa: F. A. Acland.) 25 cents.

Gold Coast: Survey Department. Records, Vol. 1: Report on Three Chains of Triangulation surveyed in the Southern Part of the Colony during the Years 1924, 1925 and 1926. By Capt. J. Calder Wood. Pp. 116. (London: The Crown Agents for the Colonies; Accra: Survey Department.) 12*s*. 6*d*.

Proceedings of the Royal Society of Edinburgh. Vol. 50, Part 1, No. 4: The Occurrence of Cell Division in the Endodermis. By George Bond. Pp. 38-50. 1*s*. Vol. 50, Part 1, No. 5: The Early Colonization of North-eastern Scotland. By Prof. V. G. Childe. Pp. 51-78+2 plates. 3*s*. Vol. 50, Part 1, No. 6: The Gonadotrope Actions of the Anterior Lobe of the Pituitary. By B. P. Wiesner and F. A. E. Crew. Pp. 79-103+2 plates. 3*s*. Vol. 50, Part 1, No. 7: On the Presence of a Kyogenic Substance in the Mouse Placenta. By Ljuba Mirskaia. Pp. 104-112+1 plate. 1*s*. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Memorandum on British Patent Law Reform by Joint Chemical Committee, submitted to the Board of Trade Patents Committee, 1929. Pp. ii+32. (London: The Association of British Chemical Manufacturers.) 1*s*.

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, Dominica, 1928-29. Pp. iv+34. (Trinidad.) 6*d*.

Navy (Health). Statistical Report of the Health of the Navy for the Year 1928. Pp. 151. (London: H.M. Stationery Office.) 5*s*. net.

Ministry of Agriculture and Fisheries Standing Committee on River Pollution. River Pollution and Fisheries: a Non-Technical Report on the Work during 1926, 1927 and 1928 of the Standing Committee on River Pollution appointed in 1921. Pp. 69. (London: H.M. Stationery Office.) 1*s*. 3*d*. net.

The Research Scheme of the Institute of Brewing. Memorandum, 1930. Pp. 18. (London.)

Department of Scientific and Industrial Research. Building Science Abstracts. Vol. 3 (New Series), No. 2, February. Abstracts Nos. 242-247. Pp. 37-71. (London: H.M. Stationery Office.) 9*d*. net.

Air Ministry: Aeronautical Research Committee. Reports and Memoranda. No. 1265 (E. 33): Engine Performance with Gaseous Fuels. Part 1: Characteristics and Engine Performance of Gaseous Fuels obtained from Oil; Part 2: Engine Performance from Kerosene/Oil Gas Mixtures. By Squadron Leader W. Helmore. (I.C.E. 625: I.C.E. 626: I.C.E. 688: I.C.E. 689.) Pp. 54. 3*s*. net. No. 1279 (Ae. 425): Tests under Conditions of Infinite Aspect Ratio of 4 Aerofoils in a High Speed Wind Tunnel. By T. E. Stanton. (T. 2856.) Pp. 4+1 plate. 4*d*. net. No. 1280 (Ae. 426): On the Distribution of Pressure over a Symmetrical Joukowski Section at High Speeds. By T. E. Stanton. (T. 2849.) Pp. 3+2 plates. 4*d*. net. No. 1283 (Ae. 429): The Effects of Turbulence and Surface Roughness on the Drag of a Circular Cylinder. By A. Fage and J. H. Warsnap. (T. 2844.) Pp. 8+6 plates. 6*d*. net. (London: H.M. Stationery Office.)

Department of Agriculture: Straits Settlements and Federated Malay States. General Series, No. 1: The Culture of Vegetables in Malaya. By B. Bunting and J. N. Milsum. Pp. iv+80+12 plates. (Kuala Lumpur.) 1.50 dollars.

Proceedings of the Royal Irish Academy. Vol. 39, Section A, No. 5: Velocities of Ions in the Cathode Dark Space. By Dr. K. G. Emeleus. Pp. 49-57. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 6*d*.

Tanganyika Territory: Department of Tsetse Research. Co-ordination Report No. 1: 1st September 1928 to 31st August 1929. Pp. 6. 1*s*. Co-ordination Report No. 2: 1st March 1929 to 28th February 1930. Pp. 12. 1*s*. (Dar es Salaam.)

A Check-List of the Sphegidae of the Ethiopian Region. By Dr. G. Arnold. Pp. 21. (Pretoria: The Transvaal Museum.)

FOREIGN.

Det Kongelige Departement for Handel, Sjøfart, Industri, Håndverk og Fiskeri. Norges Svalbard- og Ishavs-Undersøkelser. Skrifter om Svalbard og Ishavet. Nr. 27: Beiträge zur Kenntnis der invertebraten Fauna von Svalbard. Von Sig Thor. Mit Beiträgen von F. Lengersdorf, A. C. Oudemans, C. Fr. Roewer und A. Roman. Pp. x+156+26 Tafeln. 18.00 kr. Nr. 28: Die Altersstellung des Fischhorizontes, des Grippianiveaus und des unteren Saurierhorizontes in Spitsbergen. Von Hans Frebold. Pp. 36+6 Tafeln. 4.00 kr. (Oslo: Jacob Dybwad.)

Proceedings of the United States National Museum. Vol. 76, Art. 22: Mitrospira, a new Ordovician Gasteropod Genus. By Edwin Kirk. (No. 2819.) Pp. 6+3 plates. 5 cents. Vol. 76, Art. 23: A new Fossil Coral from the Cretaceous of Texas. By J. Edward Hoffmeister. (No. 2820.) Pp. 3+2 plates. (Washington, D.C.: Government Printing Office.)

U.S. Department of Commerce: Bureau of Standards. Bureau of Standards Journal of Research. Vol. 4, No. 1, January. Pp. ii+175. (Washington, D.C.: Government Printing Office.)

United States Department of the Interior: Office of Education. Bulletin, 1929, No. 34: Statistics of City School Systems, 1927-1928. Pp. 193. 30 cents. Bulletin, 1929, No. 35: Statistics of Public High Schools, 1927-1928. Pp. 136. 20 cents. (Washington, D.C.: Government Printing Office.)

Japanese Journal of Astronomy and Geophysics: Transactions and Abstracts. Vol. 7, No. 2. Pp. ii+47-81+11-18. (Tokyo: National Research Council of Japan.)

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium. Vol. 26, Part 4: The Piperaceae of Costa Rica. By William Trelease. Pp. v+115-226+vii-xii. (Washington, D.C.: Government Printing Office.) 20 cents.

Smithsonian Institution: United States National Museum. Bulletin 148: Collections of Objects of Religious Ceremonial in the United States National Museum. By Immanuel Moses Casanowicz. Pp. viii+207+75 plates. 90 cents. Bulletin 151: East African Reptiles and Amphibians in the United States National Museum. By Arthur Loveridge. Pp. v+135. 25 cents. (Washington, D.C.: Government Printing Office.)

Publikationer fra det Danske Meteorologiske Institut. Aarbøger. Isforholdene i de Arktiske Have (The State of the Ice in the Arctic Seas) 1929. Prepared by Comdr. C. I. H. Speerschneider. Pp. 20+5 maps. (København: G.E.C. Gad.)

U.S. Department of Agriculture. Farmers' Bulletin No. 1483: Control of Insect Pests in Stored Grain. By E. A. Back and R. T. Cotton. Pp. ii+30. (Washington, D.C.: Government Printing Office.) 10 cents.

The Peking Society of Natural History. Bulletin, Vol. 4, Part 2: Yenching Science Conference Papers. Pp. 102. (Peking: The China Booksellers.) 1.50 dollars.

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 81. Notes on Percoid and related Fishes. By Henry W. Fowler. Pp. 633-657. Young Stages of *Conus adversarius* Conrad. By Burnett Smith. Pp. 659-663. (Philadelphia.)

Transactions of the San Diego Society of Natural History. Vol. 6, No. 1: An Annotated List of the Butterflies of San Diego County. By William S. Wright. Pp. 40. 40 cents. Vol. 6, No. 2: Tertiary Foraminifera from Humboldt County, California; a Preliminary Survey of the Fauna. By Joseph A. Cushman and Roscoe E. and Katherine C. Stewart. Pp. 41-94+8 plates. 60 cents. Vol. 6, No. 3: New and renamed Subspecies of *Crotalus confluentus* Say, with Remarks on related Species. By Laurence M. Klauber. Pp. 95-144+plates 9-12. 50 cents. (San Diego, Calif.)

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 91: The Soils of the Libyan Oases. By Dr. R. R. Le P. Worsley. Pp. 27+5 plates. (Cairo: Government Publications Office.) 5 P.T.

CATALOGUES, ETC.

Patents and Trade Marks: including some Useful Information on Designs and Copyright. By Benj. T. King. Pp. 28. (London: Kings Patent Agency, Ltd.)

Surplus Stock. (List No. 101G.) Pp. 12. Museum Jars, Specimen Tubes and Microscopical Sundries. (Pamphlet No. 208B.) Pp. 12. (London: A. Gallenkamp and Co., Ltd.)

Diary of Societies.

FRIDAY, APRIL 11.

ROYAL ASTRONOMICAL SOCIETY, at 5.—R. O. Redman: The Galactic Rotation Effect in Late Type Stars.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—Prof. P. Debye: The Scattering of X-Rays in Gases in Relation to Molecular Structure (Guthrie Lecture).

BRITISH INSTITUTE OF RADIOLOGY (Medical Meeting), at 5.—Discussion on Radiology in Bone Tumours.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.—D. F. W. Baden-Powell: Notes on Raised Beach Mollusca from the Isle of Portland.—J. R. le B. Tomlin: Note on *Panopea cancellata* Sow.—R. Winckworth: Description of a new *Chiton* from Karachi.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 6.15.—Col. Sir T. F. Purves: Address.

INSTITUTION OF CHEMICAL ENGINEERS (at Municipal College of Technology, Manchester), at 7.—Dr. W. H. Hatfield: The Fabrication of Acid-resisting Steel Plant (Lecture).

SOCIETY OF DYERS AND COLOURISTS (Manchester Section) (at Manchester), at 7.—C. Hollins: Patent Law and the Dyer.

OIL AND COLOUR CHEMISTS' ASSOCIATION (Manchester Section) (Annual Meeting) (at Old Rectory Club, Manchester), at 7.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—W. T. Dunn: Gas in Japan and the Far East.

INSTITUTE OF METALS (Sheffield Local Section) (Annual General Meeting) (at Sheffield University), at 7.30.—F. Russell: Refractories and their Uses.

OIL AND COLOUR CHEMISTS' ASSOCIATION (at 30 Russell Square), at 7.30.—E. Hatschek: Some Properties of Jellies.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (at Chemical Society), at 8.—Discussion on Asphalt as a Chemical Engineering Material.—A. W. Attwooll: The Principles of Manufacture of Mastic Asphalt.—D. McDonald: Experience with Some Applications of Mastic Asphalt in a Chemical Works.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Dr. H. A. Bulman, Dr. L. H. Clark, Dr. S. Russ, and Dr. S. Wright: The Physiological Effects of Penetrating X-Rays upon the Cat and Rabbit.

SOCIETY OF DYERS AND COLOURISTS (Manchester Section) (at Manchester).—Dr. J. L. Hankey: Some Remarks on the Treatment of Aniline Black subsequent to Ageing.

PAPER MAKERS' ASSOCIATION (Technical Section, London Division) (at Connaught Rooms, Great Queen Street).—J. Strachan: The Relationship Existing between the Tensile Strength and the Bursting Strength of Paper.

SATURDAY, APRIL 12.

PHYSIOLOGICAL SOCIETY (in Department of Physiology, University, Louvain), at 10 A.M.—G. Debois: Glycogen Recovery after Mammalian Muscular Activity as an Insulin Function.—C. Heymans and J. J. Bouckaert: Sinus Caroticus Reflexes upon Venous Pressure, Liver Volume, and Heart Volume.—P. Rylandt: Conduction in Mammalian Auricles.—J. Morelle: Calcium Shifting. Experimental Rickets.—J. P. Bouckaert, J. L. Petit, and J. de Blende: Variations in Muscular Viscosity.—J. P. Hoet and H. Ernould: On the Nervous Control of Insulin Secretion.—P. de Nayer: Glycogen Deposition in Rabbit's Muscles.—L. de Borggraef: Ions and Excitability.—E. J. Bigwood: Chemical Properties of Gelatin Jellies.—Thomas: The Nature of Blood Sugar.—T. Lewis: Reaction of the Human Skin to Cold.—Prof. A. V. Hill: The Osmotic Pressure of Muscles.—Dr. W. Cramer: On Inhibition of the Adrenal Gland and Vitamin B Deficiency.—Dr. J. F. Fulton, Dr. E. G. T. Liddell, and D. McI. Rioch: The Influence of Experimental Lesions of the Spinal Cord upon the Knee-jerk and Crossed Extensor Reflexes.—E. W. H. Cruickshank: An Adjustable Automatic Shaker for Gas Analysis.—*Demonstrations*:—F. Malengreau: Micromethod for Estimation of Bismuth in Biological Material.—J. Rutten: Isoelectric Point of Bence-Jones Protein.—J. Morelle: Calcium Shifting. Experimental Rickets.—J. P. Bouckaert: Determination of Muscular Viscosity.—A. K. M. Noyons: Differential Calorimeter.

MONDAY, APRIL 14.

ROYAL SOCIETY OF MEDICINE (United Services Section) (Annual General Meeting), at 4.30.—Surg. Capt. L. M. Morris: Recruiting—A Review of Modern Requirements.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—A. B. Eason and others: Discussion on Telephone Exchange Practice in Germany and Scandinavia.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales—Liverpool—Centre) (at Liverpool University), at 7.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (at Cheltenham).—Lt.-Col. S. E. Monkhouse and L. C. Grant: The Heating of Buildings Electrically by means of Thermal Storage.

INSTITUTE OF BREWING (London Section) (at Charing Cross Hotel).—Discussion on The Brewing, Bottling, and Pasteurisation of Beers.

ROYAL IRISH ACADEMY (Dublin).

TUESDAY, APRIL 15.

ROYAL SOCIETY OF MEDICINE, at 5.30.—General Meeting.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—F. J. Lambert: Animal Life in the Marsh Ditches of the Thames Estuary.—Prof. F. Werner: Indian Mantids or Praying Insects.—W. N. F. Woodland: On the Genus *Polypocephalus* Braun, 1879 (Cestoda).—Major E. E. Austen: On a New Dipterous Parasite (Family Calliphoridæ, Subfamily Calliphorinæ) of the Indian Elephant, with Notes on other Dipterous Parasites of Elephants.

LONDON NATURAL HISTORY SOCIETY (at Winchester House, E.C.), at 6.30.—R. Palmer: Some Aquatic Insects (Bacot Memorial Meeting).

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—Annual General Meeting.

WEDNESDAY, APRIL 16.

ROYAL METEOROLOGICAL SOCIETY, at 5.—Dr. S. K. Banerji: The Electric Field of Overhead Thunderclouds.—Dr. F. J. W. Whipple: The Great Siberian Meteor and the Waves Seismic and Aerial which it Produced.

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.

INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.30.—P. A. Scott: Weymouth: Bincleaves Firing Station; Repairing and Strengthening of Reinforced-Concrete Pier.

INSTITUTION OF ELECTRICAL ENGINEERS (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.—H. S. Carnegie: The Selection of Electric Drive for Heavy Industrial Use.

FOLK-LORE SOCIETY (at University College), at 8.—Dr. R. Flower: The Ring of Sovereignty: a Study in the Transmission of a Theme.

ROYAL MICROSCOPICAL SOCIETY, at 8.—A. Craig-Bennett: An Imbedding Apparatus for Research Workers.—J. Smiles: The Measurement of Spherical Aberration in High Numerical Aperture Objectives by Interferometry.

THURSDAY, APRIL 17.

INSTITUTION OF ELECTRICAL ENGINEERS (Hampshire Sub-Centre) (at Municipal College, Portsmouth), at 7.30.—Dr. C. V. Drysdale: Alternating-Current Potentiometers and their Applications.

INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre—Dublin) (at Trinity College, Dublin), at 7.45.

ANNUAL MEETING.

APRIL 9, 10, AND 11.

INSTITUTION OF NAVAL ARCHITECTS (at Royal Society of Arts).

Friday, April 11, at 11 A.M.—R. Sulzer: Causes and Prevention of Vibration in Motor Ships.

Dr. J. L. Taylor: Vibration of Ships.

Lieut.-Col. F. Dondona: Sea Trials of Italian Flotilla Leaders.

At 3.—G. S. Baker and Miss E. M. Keary: Experiments on the Resistance and Form of Towed Barges.

W. C. S. Wigley: Ship Wave Resistance—Some Further Comparisons of Mathematical Theory and Experiment Result.

CONGRESS.

APRIL 25 to 28.

FLEMISH CONGRESS OF NATURAL SCIENCES AND MEDICINE (at Antwerp).