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Scientific Aspects of the Unemployment Problem.

EVEN more perhaps than Dr. Miall's "History of Chemical Chemistry", the programme of the recent jubilee meetings of the Society of Chemical Industry illustrates the remarkable extent to which, during the last fifty years, the science of chemistry has penetrated and transformed almost every section of industry, if not indeed of the public services. Examples are to be found in the scientific papers presented at the meetings, which covered not only chemical industry generally and such special sections of it as the dyestuff industry, but also a discussion on fuel subjects which embraced questions of fundamental importance to society in general as well to industry. Striking evidence of the widespread impact of science upon industry is to be found in the technical visits paid by members of the Society. These covered such diverse industries as wallpaper manufacture, the research laboratories of the General Electric Co., Ltd.—which provide an outstanding example of an industry created and continually expanded by the application of scientific research—dry cleaning, fine chemicals and drugs, gas, coke and tar, brewing, agriculture, foodstuffs, fuel research, the protection of metals against corrosion; while visits to the National Physical Laboratory and the Chemical Research Laboratory demonstrated the vital importance of scientific research in national life.

It is against such a background that the true bearing of Sir Harry McGowan's presidential address to the Society of Chemical Industry, discussing the reaction of scientific and technical progress on the finance and economy of the modern State, is perceived. Scientific discoveries and their application in industry have dislocated the major balance between industrial and agricultural production and have threatened the whole social, financial, and political structure of our civilisation. Sir Harry McGowan uttered no idle warning when he hinted at the possibility of our common civilisation perishing through our inability to control the forces which applied science primarily has created. Under the influence of science, not only industry but also accepted views of trade and competition are changing their value, and policies such as free trade or protection acquire a new significance.

Sir Harry McGowan urged that the policy of industrial co-operation which has developed notably in chemical industry under such forces should be extended into the more difficult field of international co-operation—as indeed has already been done in

some few branches of industry, though with what success it is difficult as yet to say. As an aid to such control or development, Sir Harry McGowan visualised a Minister of State devoted to the task of promoting the co-ordinated reorganisation of all our industries, and beyond this an international chemical council to provide chemical industry with a world-wide range. The effective rationalisation thus secured would stabilise development and co-ordinate or expedite research.

To turn from the picture of industrial and international co-operation thus eloquently painted to the efforts of Parliament during the past session to cope with unemployment and the general industrial situation is to realise how far from commensurate with the rapidity of technological or scientific advance in the last fifty years is the influence which representatives of science or of scientific industry are able to exert on the direction of public affairs. Examples of this have already been the subject of comment in these columns. Thus, the Royal Commission on Transport in its final report made certain recommendations regarding both road and rail transport which were intended to assist the general economic development of the nation. Neither in respect of the electrification of suburban services nor in the diversion of heavy goods traffic from road to rail have any adequate steps been taken to give effect to the recommendations of the Commission, although both these recommendations should encourage employment and the recovery of the railways from their difficult position. In the absence of a more scientific policy, it is still common for a heavy goods lorry to do damage to a road in a few hours amounting to several times the combined value of the lorry and its load.

A similar hiatus between knowledge and action exists in the fuel question. A really scientific consideration of the coal and fuel industries would alleviate considerably the difficulties in which the coal industry finds itself. Lack of courage, however, remains the characteristic Government attitude in 1931 as in 1926, and not even the growing seriousness of atmospheric pollution or the intensity of the unemployment situation has driven Parliament to examine the utilisation of our coal resources in the form of smokeless fuel or oil fuel as a possible economic policy worthy of development. The fuel problem and the competition between raw coal, gas, and electricity is still allowed to develop along haphazard lines, without any attempt to plan and enact a scientific and economic national policy. To this position no contrast could be more startling than the discussion on fuel subjects at the recent jubilee meetings of the Society of Chemical Industry, which was planned to elucidate definite answers to such questions as the probable effect upon the amount of coal raised, of the increasing use of oil, of the future development of the gas and electrical industries, of a large development of low temperature carbonisation, or of a general improvement of the standard of living. Only upon the considered answers to such questions can an adequate fuel policy be based, yet here again it is science and industry and not Parliament which is conducting the inquiry. The conference indeed took a sombre view of the prospects of any increased demand for coal, Dr. Lessing considering that a decrease in consumption is more probable; and even in the development of the hydrogenation process, prospects of an increased output of raw coal are not bright. Although international agreements might secure more lucrative prices, they are unlikely to affect the tonnage of coal raised. Lieut.-Commander Kenworthy's suggestion that scientific workers, economists, and business men should set up a representative body to examine the economic side of the coal problem was itself a confession that Parliament is not the instrument which will put coal mining on its feet. Essentially the plea was an admission that the fuel problem demands scientific treatment as an organic unit by the best brains of the country, unfettered by political ties.

When we pass to the direct contribution of the recent parliamentary session to the relief of unemployment, our present system of government shows to no greater advantage. For a sanctioned expenditure of up to £173,000,000 on emergency work for the relief of unemployment, work has been found for an additional 200,000 only, not allowing for any possible effects of discontinuing the safeguarding on gloves, lace, and cutlery. Such is the outcome not merely of this large expenditure of money but also of Parliament's endeavours to induce reorganisation of the coal, cotton, and iron and steel industries, Acts on housing, land drainage, and transport, and the expenditure of large sums on electrification, road improvement, and afforestation. There can indeed be no fairer comment on the situation than the recommendation of the Macmillan report that we should attack the task of capital development in England in a much more systematic and far-sighted manner than hitherto. An era of conscious and deliberate management must succeed the era of undirected natural evolution.

It is, of course, alleged by some that science itself causes unemployment, and that the increased production made possible by the mechanisation of industry under the influence of science is mainly responsible for our present difficulties. Superficial support may be found for such a view, but apart from the unescapable fact that industries such as the wireless industry—in which there is no unemployment—the electrical industry in all its branches, the automobile industry, the chemical industries, and aviation, which provide employment for millions of workers for whom otherwise there could be no industrial occupation, are the direct outcome of creative science and its application, the evidence of such industrial leaders as Mr. Henry Ford indicates that industrial leadership and continuous improvement in efficiency lead to industrial expansion and increased employment. The idea that there is only a limited amount of employment in the world has been revived in the present crisis, but remains a fallacy. The temporary unemployment due to displacement of workers during the genuine rationalisation of an industry, the permanent displacement of certain workers through the rise of a new industry such as the rayon industry, and the decline of the older textile industries, even though the final volume of employment is increased, tend to obscure the real issues, and the confusion is heightened by the failure of the industrialist either to foresee the problems and difficulties involved or to secure a minimum disturbance during the transition period.

The possibilities in the application of scientific method to the unemployment problem are indicated not only by the Macmillan report, which visualises a comprehensive re-building and re-planning policy for our larger towns and industrial centres, the re-planning and re-fitting of stable industries, and the electrification of railway systems, but also by the International Labour Office in its proposals for practical action on unemployment in Europe, which were recently submitted to the Commission of Inquiry for European Union. Without elaborating a definite scheme, the memorandum outlines such ideas as a definitely planned international road system to meet the probable requirements of rapidly increasing motor traffic and to provide connexions between the special roads for motor traffic which are at present being constructed everywhere independently in the most advanced countries of Europe; the co-ordination of regional systems of navigable waterways; the international distribution of electric power; and the concerted and uniform substitution on all European continental railways of a suitable system of automatic coupling in place of the present screw couplings, which are annually responsible for many fatal accidents. Schemes of this type planned in advance as a definite programme would enable public works to be postponed from a boom period and carried out in a time of depression. They should thus be of direct value in reducing the incidence of unemployment as well as in encouraging the spirit of European co-operation on which the Macmillan report laid such stress.

Any such schemes of development will now have to be considered in the light of the report of the May Committee on National Expenditure, which is under consideration by the Cabinet. As we have already pointed out, this committee included no one familiar with scientific progress and development, and research departments have clearly been singled out for drastic economies. It is evident that the members of the committee still hold to the fallacy that research is a luxury because its results cannot always and immediately be translated into pounds sterling on an annual report or balance sheet.

The real difficulty to-day is that science has not even yet come to take its right place in the direction of both industry and national affairs. Broadly speaking, those industries in which science is associated with commercial and financial interests in direct administrative control are the industries which have proved most able to meet the present industrial depression. The comparative impotency of Parliament in the present industrial situation is largely due to its lack of inherent scientific and technical knowledge, as well as to the absence of such knowledge in those holding high administrative appointments in the Civil Service. No severer handicap has been imposed on Great Britain in the present crisis than the exclusion, often deliberate, of technical and scientific men of administrative ability from responsible administrative posts in industry or in Government service. Not until this defect is remedied in Parliament, as in Government service and industries generally, can we expect to see not merely effective and scientific reorganisation of our industries from the point of view of the nation as a whole, but also the initiation of the task of wise international co-operation in a spirit of unselfishness and world service. Such reorganisation and international co-operation will open increasing opportunities for creative science, to which alone in the changing face of industry the worker can look for continued and adequate employment.

The Psychological Problem of Joan of Arc.

The Trial of Jeanne d'Arc. A complete translation of the Text of the Original Documents, with an Introduction, by W. P. Barrett. (Broadway Medieval Library.) Pp. viii + 352 + 12 plates. (London: George Routledge and Sons, Ltd., 1931.) 15*s.* net.

THERE can have been few historical events which have seemed more inexplicable than those which made up the life of Joan of Arc. A peasant girl of eighteen profoundly affected the destinies of nations. Such things seem impossible; yet they occurred. The problem of Joan will perhaps never be completely solved. It may never be possible to show that her history was simply an unusual configuration of events, motives, and personal characteristics which were each in themselves neither unique nor startling. But Mr. Barrett's excellent translation of the documents relating to her trial enables even the layman to attempt such an analysis.

Some of the leaders of the French, who followed Joan, may have been sceptical of her supernatural powers and have used her only on account of her influence with the people. Some of the ecclesiastics, who burnt her, may have been genuinely concerned only in upholding the authority of the Church and in defending it against the dangerous and uncertain guide of individual conscience. But rational explanations of Joan's effect upon her time in terms of political motives and ecclesiastical theory can only solve half the problem. They leave the part played by superstition and hysteria wholly unexplained.

Goddesses or saints on one hand and demons or witches on the other are both, anthropologically and psychologically, aspects of the same idea. It is possible, as Miss Murray has argued, that Joan incarnated the goddess of a Dianic cult which had survived among the peasantry from neolithic times. But whether or not such a cult had actually survived, Joan was psychologically a demon to one party and a goddess to the other. Now, modern psychology has shown that these two ideas are projections of two aspects of the concept of the mother, one evil and terrifying, the other good and supremely helpful, which survive in the unconscious from earliest infancy. From this fact these ideas derive their force.

To her enemies Joan was not only a political nuisance and a heretic; she was also a witch, something infernally dangerous which must at all costs be destroyed. To her friends she was not only the creator of nationalism; she was a saint, perhaps even a goddess, who could not fail. There is a type of defensive nationalism, especially prevalent among the Latin races, which is clearly an expression of the Œdipus complex. To the unconscious, France became the persecuted mother, and the English and the Burgundians the violators from whom she was to be delivered. Joan, the Maid, gave this fantasy to the people. As a saint or goddess she was also a symbol of the ideal mother, and therefore must have become identified with France. The fact that she was a virgin was important, as Voltaire observed, for, curiously enough, the unconscious generally likes to think of its mother as a virgin—one who has been threatened by the father but who has not yet yielded to him. If she had been known to have given herself to any one man she would have lost her power over the rest. For the same reason the mother goddesses of antiquity were often unmarried—that is, they were either wholly chaste or universally promiscuous.

If Joan was the bad mother to the unconscious of her enemies and the good mother to the unconscious of her friends, to her own unconscious it seems probable that she was not a woman at all, but a rebellious son. The fantasy of nationalism is the fantasy of the son who, desirous of believing that his mother loves him only, imagines that she is the unwilling victim of his father from whom he will set her free. National leaders have been undoubtedly often inspired by such an unconscious fantasy; and when a woman displays the same symptom the suspicion at once arises that she may have unconsciously believed herself to be a man. Joan's transvestism was so persistent that it brought her to the stake. Therefore it can scarcely be rationalised as a protection against the soldiery among whom she lived. The loss of her male clothes or of her virginity might have destroyed the unconscious delusion of masculinity from which she probably derived much of her power.

Joan's voices appear to have been the projection of her own unconscious wishes. They told her to wear men's clothes and to deliver France. In them she implicitly believed, and so gained that confidence in her mission which inspired faith in her friends and fear in her enemies. Lastly, she had an intelligence of a high order, which must have helped to remove the doubts from those who might otherwise have thought her mad.

There have been many women with the Œdipus complexes of men which have been expressed in patriotic fantasies. There have been others who

had voices which gave them an unnatural confidence, and yet others who have been intelligent. The combination of these three qualities in one person at a time when the political and mental life of the world enabled them to be effective were probably among the most important factors which went to make up the history of Joan of Arc.

Anthropology in Nigeria.

(1) *A Sudanese Kingdom: an Ethnographical Study of the Jukun-speaking Peoples of Nigeria.* By C. K. Meek. Pp. xxxiv + 548 + 64 plates. (London: Kegan Paul and Co., Ltd., 1931.) 25*s.* net.

(2) *Tribal Studies in Northern Nigeria.* By C. K. Meek. Vol. 1. Pp. x + 582 + 60 plates. (London: Kegan Paul and Co., Ltd., 1931.) 25*s.* net.

(1) THIS work on the Jukun of Northern Nigeria has been eagerly awaited by all those who were aware of Mr. Meek's study of this interesting people. Though these "studies were confined to a period of less than five months", no doubt he has been able to confirm and enlarge his knowledge from many sources in the last decade, during which he has had access to all the anthropological information collected throughout Nigeria. He has made excellent use of his opportunities, and the book may be regarded as authoritative and containing his considered opinion on the customs of the Jukun; in view of the haste with which the African, even in the Northern Provinces, is now shedding his old beliefs, it is unlikely that further researches will throw much additional light on them.

In an introduction of 21 pages, Mr. H. R. Palmer, formerly Lieutenant-Governor of the Northern Provinces of Nigeria and now Governor of the Gambia, discusses the affinities and history of the tribe. He would appear to place too much reliance on etymological similarities and on traditions and tales, some of which are probably of fairly recent Mohammedan provenance. Mr. Meek's treatment is more conservative, but, despite all, the origin of the Jukun is far from certain, though some facts give colour to their claim of a migration—at any rate, so far as the leading families are concerned—from Yemen, or Yeman, which to them includes all north-east Africa.

The Jukun kingdom was known as Kororofa, or Kwararafa, and was at the height of its power in the fifteenth to the seventeenth centuries, during which it is said to have captured Kano and Zaria, and to have penetrated into Bornu, Katsina, and even Gobir. Its capital, of the same name, was situated south of the Benue River, some three hundred miles south-south-east of Kano, and was abandoned a century ago, about the same time as the greater number of the towns were destroyed by the Fulani and Chamba. The tribe is now very small, numbering only some 25,000, living in scattered communities, mostly south of the Benue.

It is difficult to understand how this people, which to-day shows not the slightest warlike tendencies, could ever have formed a great confederacy, but no doubt their prestige was, to a large extent, due to moral and religious considerations, to the influence of their divine king. It is claimed that their power extended to the sea, but no evidence is given for this, and the far greater Aro theocracy, with its five million adherents, stood in their way.

Mr. Meek states that Calabar, the port to which the Aro exported most of their own—and probably the Jukun—slaves, "was known locally as Atakpa or 'King of the Akpa' or Apa. For the Ekoi of these regions bore the same title as the Jukun farther north". Akpa, however, is the name applied hereabouts to a large river, and it is unlikely that it has any connexion with the Jukun 'Apa', while the branch of the Ekoi settled here is called Kwa. Mr. Palmer (p. xix) and Mr. Meek (p. 16) are also incorrect in thinking that Dama "is a tribal name in the southern provinces"; according to the peoples of Ogoja province it was given to some of them by Hausa and others from the north.

The Jukun language is classified as belonging to the Sudanese group, which is enlarged to include semi-Bantu; out of 115 words, however, no less than 57 per cent are common to Bantu and Sudanese. Though little reliance can be placed on language to show the affinities of a people, this fact, together with their physical appearance as shown in the photographs, strengthens the belief that the mass of the people are of a Nigritic type; unfortunately the author took no somatic measurements.

The Jukun are still in the midst of changing from mother-right to father-right; there is no strict clan organisation and few traces of exogamy. The taboos as regards the use of personal names are stringently observed; even wives, who were wedded as virgins, may not thus address their husbands, though women who have previously been married can do so. The most interesting part of the book is that dealing with the divine king, who appears to be now regarded as an incarnation of the whole pantheon. His chief function is to secure plentiful harvests for his people, as he is the

principal intermediary with the gods and ancestors on whom their growth depends; if he is out of favour with these, he is secretly killed. Apparently the normal reign of a Jukun king was about seven years, though a vigorous and popular man might live far longer.

Mr. Meek identifies both the Dindi (or soul) and the "spiritual guardian"—which seems to resemble what I have called the Over-Soul among the southern tribes—with the Egyptian *Ka*, but, even allowing for the considerable variation in the beliefs about this latter at different periods, there is a much larger content in the Nigerian idea, part of it unique. Heaven (*Kindo*) is regarded as "The House of Truth", and the earth-goddess Ama, who rules there, as a just and righteous deity.

The most interesting of the burial rites is the "releasing of the white grave cloth from the mouth", the purpose of which seems to be very similar to the Egyptian "opening of the mouth", so that the dead man may be able to speak in Kindo and inquire the cause of his death, which he will later declare to his living relatives at the ceremony of the Aku-Akwa, when the soul is formally requested to take up his abode in the bush and house shrines respectively.

According to the author, "A main cause for the firmness of the belief in the continuous existence of the dead is due to the conception of the necessity of the punishment of witches and sorcerers". The causality, however, is not apparent; the two beliefs, in survival and witchcraft, run in all probability side by side, as in most peoples, African and other.

A large—and, even in the reviewer's opinion, an excessive—portion of the book is taken up with comparisons of beliefs and practices in other countries, which will offend those scientists at home who consider that the field-worker should confine himself strictly to the people whom he is studying. Mr. Meek's assertions as to the close connexion of Jukun customs with those of ancient Egypt seem to be fully warranted. He is to be highly congratulated on the book, which is also well produced and illustrated, though some of the photographs might have been more appositely placed; few misprints have been noticed, but surely on p. 63 "the influence of the father's relatives is tending to decrease" should read "increase". The index is not so full as could be desired, which is the more regrettable, since the facts dealing with a single idea or custom are not always kept together.

(2) The second book under review, "Tribal Studies in Northern Nigeria", vol. 1, contains ethnographical notes on a large number of little-known peoples, dealing chiefly with their social organisation and languages. It is well for this information to be printed and made available for officials and scientists; fuller knowledge can be filled in as acquired. Perhaps the most interesting feature described is the sexual communism which is customary in some areas.

The Eket sacred lake, mentioned on p. 166, lies to the south-west, not to the north, of Calabar; this statement is referred to "The Golden Bough", where it is mentioned that the lake is near Eket in North Calabar. The illustrations are not so good as those in the Jukun book. An index will presumably be provided in the last volume.

P. AMAURY TALBOT.

Mathematics for Actuaries and Others.

(1) *An Elementary Treatise on Actuarial Mathematics.* By Harry Freeman. (Published for the Institute of Actuaries.) Pp. xiii + 399. (Cambridge: At the University Press, 1931.) 25*s.* net.

(2) *Some Recent Researches in the Theory of Statistics and Actuarial Science.* By Prof. J. F. Steffensen. (Published for the Institute of Actuaries.) Pp. vi + 52. (Cambridge: At the University Press, 1930.) 5*s.* net.

(3) *Probabilités et statistiques.* Par Dr. R. de Montessus de Ballore. (Leçons professées à l'Office National Météorologique de France.) Pp. ix + 211. (Paris: Hermann et Cie, 1931.) 60 francs.

(1) MATHEMATICS has been indebted to actuaries in the past for many valuable contributions in the fields of interpolation, finite differences, and statistical method. We have here an excellent treatise, by an actuary, on those branches of mathematics which are needed by the actuarial student. The author has held in mind the standard required to pass the examinations of the Institute of Actuaries, but has interpreted this standard in a broad way, with the result that we have chapters on elementary trigonometry, on functions and limits, and on differential and integral calculus, as well as those more especially required by the actuarial student, as are the chapters on differences, interpolation, approximate integration, and probability. The result is a model textbook. Proofs are clearly explained, and followed up by many illustrative examples, while the chapters end with a large number of well-chosen examples for solution by the student.

Apart from the needs of the student, we may anticipate that the research worker who has mainly

relied in the past on Whittaker and Robinson's "Calculus of Observations" for the study of numerical mathematics will be able to supplement his reading with profit in the future from the text-book under review. The theory of statistics has not been dealt with, which seems a rather important omission, unless it is thought that this subject should preferably have a text-book to itself one of these days. It is not only on interpolation that many of our actuarial mathematicians have made important contributions to knowledge; papers frequently occur in the actuarial literature on points of statistical theory. The grounding that is furnished to the student on the subject of probability by the author, who is careful to avoid being dogmatic, should, however, be of great value to those who are going on to more advanced studies, as well as furnishing a ready tool for immediate use in life assurance calculations.

In the chapters on interpolation, importance is attached to the use of higher differences than the first, and to the study of the remainder term; and in this section reference is made to the fundamental work of Steffensen, made familiar to students in Great Britain through the English translation of his work on interpolation.

(2) Prof. Steffensen was invited in 1930 by the University of London to deliver a course of lectures, and he chose as his subject "Some Recent Researches in the Theory of Statistics and Actuarial Science". These lectures have now been published for the Institute of Actuaries by the Cambridge University Press. This is not a text-book in the accepted sense so much as a collection of notes, and it suffers a little from the heterogeneous character of the material with which the lecturer chose to deal. He has something to say on the place of mathematics in statistical and actuarial theory, and for the rest the book is a critical mathematical commentary on certain points of theory.

It is unusual to find an author setting out boldly to expose "errors due to neglect of the principle that theoretical assumptions should not contain contradictions". Interest in his section on "presumptive values of frequency constants" is shown by the way the matter was taken up and discussed by Dr. G. J. Lidstone in a recent issue of the *Journal of the Institute of Actuaries*. We feel that Prof. Steffensen has not been particularly illuminating in explaining the contradictions here, if indeed there are any. Other matters dealt with in the lectures are certain propositions in inequalities, and the theoretical foundations of various types of frequency functions.

(3) In "Probabilités et statistiques" we have a book of a different character. In his study of probability the author follows the traditional lines of Laplace, and his object is to reach the binomial distribution, of which he then gives the general theory. He applies this function to fit by means of moments a great variety of frequency distributions. The method has considerable success, but there are cases—as, for example, the distribution of barometric heights at Southampton—where the method proposed by the author is no more successful than were earlier efforts to fit Pearsonian curves. We wish that the author had used a sound test of goodness of fit in demonstrating the success (or non-success) of his formula; as it is, we are left in some doubt as to how his method compares with, for example, Pearson's Type I. distribution, to which there are strong resemblances. The work is largely the outcome of the author's own researches, and will be studied with profit by mathematical statisticians.

JOHN WISHART.

Palæolithic Man in Egypt.

Prehistoric Survey of Egypt and Western Asia. Vol. 1: *Paleolithic Man and the Nile-Faiyum Divide; a Study of the Region during Pliocene and Pleistocene Times.* By K. S. Sandford and W. J. Arkell. (The University of Chicago Oriental Institute Publications, Vol. 10.) Pp. xv + 77 + 11 plates. (Chicago: University of Chicago Press; London: Cambridge University Press, 1930.) 22*s.* 6*d.* net.

THE Oriental Institute of the University of Chicago a few years ago began a prehistoric survey of Egypt and Western Asia under the direction of Dr. J. H. Breasted. It devoted attention first to the valley of the Nile and the Faiyum depression in the Egyptian desert, where the stone implements of prehistoric man have long been noticed lying on the surface. It assigned to two geologists, Dr. K. S. Sandford and Dr. W. J. Arkell, of Oxford, the task of discovering and mapping the deposits in which the various implements actually occurred. It has now published, as its first volume, a valuable, well-illustrated report on the results.

Drs. Sandford and Arkell are to be congratulated on having added a most important contribution to our knowledge of the history of the Nile valley in Lower Egypt during Pliocene and Pleistocene times, and so made it possible to understand the circumstances in which man first appeared in that region of Africa.

There are no traces of man in Lower Egypt during the Pliocene period, when the northern part of the Nile valley formed an arm of the sea and the Faiyum depression did not exist. The earliest stone implements are of the Chellean type and occur with characteristic Acheulean implements in an extensively preserved river-terrace in the Nile valley at from 70 ft. to 85 ft. above the present level of the river. The Chellean implements are more or less water-worn, while those of Acheulean type are as sharp-edged as if freshly made, so the former seem to have been derived from some still older deposit. Next, there are Mousterian implements of a rather late form found abundantly in a terrace about 25 feet above the existing Nile alluvium. The later terraces in the Nile valley, presumably containing the implements of Upper Palæolithic and Neolithic man, are actually buried by this alluvium and thus inaccessible to study.

Drs. Sandford and Arkell have fortunately overcome this difficulty by discovering that the terrace with Mousterian implements passes from the Nile valley through the Hawara channel into the Faiyum depression. It sinks a little towards the Faiyum, and seems to prove that in Mousterian times the depression was completely filled with a great lake which received water from the Nile. The whole country was then fertile and it was not until later Palæolithic times that desert conditions began, and they may not have reached their present state until the Neolithic period. In these later times the Faiyum lake began to shrink, leaving a succession of beaches as terraces marking the several shores as it gradually diminished to its present extent. The beaches, of course, away from the Hawara channel, are not obscured by later alluvial deposits, and so can be searched for any implements they may contain. A beach about 20 feet below the Mousterian level yields late Palæolithic stone implements of a peculiar local group which Vignard has named the Sebilian. Then follow beaches with Neolithic implements which have already been well studied and described by Miss G. Caton-Thompson and Miss E. W. Gardner.

The evidence on which the various conclusions are based is recorded in a series of remarkably concise chapters, which are illustrated by diagrammatic sections of the deposits and effective sketches of the different types of implements. Actual photographs of the country are also given in the plates. Dr. Breasted contributes a useful foreword, and the authors themselves add a summary which, with the aid of a coloured geological map, makes the whole work readily understood. A. S. W.

Short Reviews.

The Dynamic Universe. By James Mackaye. Pp. x + 308. (London : Charles Scribner's Sons, 1931.) 10*s.* 6*d.* net.

THE complex structure of modern physics has caused many obscurities and inaccuracies to creep into the formulation of its epistemological presuppositions. Even the cosmological value of the principles and equations of relativity is difficult to extricate clearly from the mass of speculations, dimensional and non-dimensional, to which they have given rise. In undertaking a clarification of the confused conditions of theoretical physics, Prof. Mackaye has performed a very useful task; and this he does by providing critical answers to a number of pertinent questions such as the following : What is the cause of gravitation ? Is matter a form of radiation ? What is the cause of the Lorentz contraction ? Why are not material bodies retarded in their motion through space ? Has the theory of relativity superseded the law of causation ? Is the acceleration of material bodies relative exclusively to other material bodies ?

The variety of these questions shows the range and purpose of the author's inquiry. Yet, besides separating physics and metaphysics and explaining the one by the other, Prof. Mackaye has the ambition of presenting a cosmic theory dealing with the structure, and cause of change of motion, of material bodies. This attempt is based mainly on the radiation theory, which the author claims to fulfil the aspirations both of science and philosophy by reason of its unifying character. Although very suggestive, this portion of the book is less convincing, especially as the radiation theory in its present stage is a " rather blind groping for the truth ". One might question also the author's final remark that " the explanation of nature's laws are physical, not metaphysical", in view of the fact that any explanation has to assume a number of constructive elements which are beyond the actual range of the particular theory seeking an explanation. The author, however, is himself fully aware of these difficulties, and the cautious presentation of his thesis should cause much useful thinking to philosophers and physicists alike.

T. GREENWOOD.

Rapid Methods for the Chemical Analysis of Special Steels, Steel-Making Alloys, their Ores, Graphites, and Bearing Metals. By Charles Morris Johnson. Fourth edition. Pp. xix + 729. (New York : John Wiley and Sons, Inc. ; London : Chapman and Hall, Ltd., 1930.) 37*s.* 6*d.* net.

IN the fourth edition of this book, we are presented with detailed descriptions of the methods of analysis of steel, steel works materials, etc. Instead of re-setting the third edition, the author has incorporated new and improved methods in eighteen appendices occupying 176 pages rather more closely printed than the rest of the book. The only other material alteration made is in the chapter devoted to the determination of tungsten in low tungsten steel and the analysis of slags con-

taining chromium, tungsten, and vanadium; this has been rewritten and re-set. Otherwise, the third edition is given unchanged.

The book is essentially a laboratory handbook; the methods are described in very great detail, necessitating, therefore, considerable repetition and reference to methods which are not given in full until later in the book, the pages for reference not always being given. Considerable space is occupied by descriptions of apparatus designed by the author, such as electric furnaces, rheostats, and carbon dioxide absorption 'bulbs', which can be made in the laboratory. The methods are described as rapid methods; but it is rather surprising to find that more use is not made of the electrolytic process for the determination of copper, as this method, although not 'rapid' in itself, can be carried out while the determination of the other constituents in, for example, a bearing metal is taking place.

The last three appendices are devoted to details in the preparation of steel for microscopical examination and the results to be observed in normal and abnormal specimens. In a work of this description, such details must be of necessity rather scanty, but, coupled with references to original papers, they serve as a useful introduction to the subject.

Articulated Locomotives. By Prof. Lionel Wiener. Pp. xv + 628. (London: Constable and Co., Ltd., 1930.) 42*s*. net.

AN articulated locomotive is a locomotive in which one or more of the driven axles are able to take up positions where they do not remain parallel to the others and may take angular positions in curves. Such locomotives, once rarely seen, are now found on many railways. The causes for this are the need for more powerful locomotives, the need for using heavy locomotives on lines with permanent way of insufficient strength, and the demand for locomotives of sufficient flexibility to negotiate curves of small radius. Well-known forms of articulated locomotives include the Fairlie, the Mallet, and the Garratt.

One landmark in locomotive history was the Semmering Contest in 1857, for it was then that most systems of locomotive articulation first appeared. Since then makers in all countries have produced articulated locomotives, and of these a great deal of information is given in the book under notice. One of Prof. Wiener's objects was to establish a clear system of classification of types. In addition to the descriptions, sketches, and illustrations of the engines, the book contains alphabetical lists of locomotives, railways and builders, and a chronological sequence of inventions connected with articulated locomotives.

Mechanics of the Gyroscope. By Prof. Richard F. Deimel. (Engineering Science Series.) Pp. x + 192. (New York: The Macmillan Co., 1929.) 17*s*. net.

THIS book is intended primarily for engineering students, but will be found of use also by students of applied mathematics and physics who are interested in the practical applications of the gyroscope. As regards scope and standard it occupies a position between the exhaustive treatises of Gray and of Klein and Sommerfeld on one hand, and Crabtree's elementary book on "Spinning Tops and Gyroscopic Motion" on the other. About thirty pages of the book are devoted to a rapid survey of dynamical principles, though this would scarcely seem to be necessary in view of the existence of a sufficiency of good text-books on this part of the subject. Then follow chapters on rotation under no forces (the free gyro), and on the spinning top and its motion on a plane and under constraint.

The book concludes with a discussion of applications to various types of gyro-compass and stabilisers used in ships and mono-rail cars. This discussion occupies about a third of the available space, and deals very fully with such topics as the stability of the gyroscopic apparatus and the methods used for controlling its oscillations and diminishing the errors to which it is liable. The free use of illustrations and tables taken from actual practice has enabled the author to produce a most interesting and instructive introduction to the theory and practice of gyroscopic motion.

Positivismus und reale Aussenwelt: Vortrag, gehalten am 12. November 1930 im Harnack-Haus der Kaiser Wilhelm-Gesellschaft für Förderung der Wissenschaften. Von Max Planck. Pp. iii + 35. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1931.) 1·80 gold marks.

THIS is a striking addition to the much-discussed pronouncements of physicists on the philosophical bearings of their new theories. Prof. Planck reveals himself as an idealist, having many beliefs in common with Sir Arthur Eddington and Sir James Jeans. His exposition of scientific method, and his views on the principle of causality and on the problem of free-will are a penetrating analysis of certain fundamental questions which are still a puzzle to the philosopher. Though Prof. Planck's message is hopeful, it is doubtful whether it should be taken as the final explanation of modern physics. T. G.

The World Mapped: being a Short History of Attempts to Map the World from Antiquity to the Twentieth Century. By Dr. I. J. Curnow. Pp. vi + 104 + 10 plates. (London: Sifton Praed and Co., Ltd., 1930.) 5*s*.

THIS is little more than an essay on an important and vast subject, nor indeed does its author make any further claim. It succeeds, however, in giving an outline of the subject, in which the principal developments are traced and illustrated by reproductions of early maps. The map-makers of antiquity have most notice, and perhaps the monks of the Dark Ages, and their fantastic maps merit a little less attention than they receive in Miss Curnow's allotment of space. This restricts a little the treatment of more enlightened ages. As a whole, however, the work is useful and may be recommended. It contains a short bibliography.

Matter and Radiation.*

By Prof. F. G. DONNAN, C.B.E., F.R.S.

THE title of this lecture might suggest a discussion of the greater part of physical and chemical science. It is proposed, however, to confine the following remarks to a consideration of certain views and theories concerning the reciprocal inter-conversion of matter and radiant energy.

Some twenty-five years ago Jeans proposed, as an explanation of the enormous energy radiated by the stars, the startling hypothesis that matter might, under certain conditions, suffer a process of 'annihilation', whereby a proton and an electron might coalesce, and, disappearing as matter in the ordinary sense of the word, be converted into energy of radiation. The basis of Jeans's hypothesis was given by the special relativity theory of Einstein, which showed that matter and energy can be mutually related. Thus the energy corresponding to a mass m grams of matter was found by Einstein to be equal to mc^2 ergs, where c is the velocity of light in centimetres per second. Similarly, if E be the energy in ergs of a given quantity of radiation, its mass in grams is given by the expression E/c^2. We may express Jeans's idea by means of the equation $P+E=$Radiation, where $P=$proton and $E=$electron. Now the mass of $P+E$ is equal to the mass of a hydrogen atom, and this is equal to the reciprocal of the Avogadro number N, the value of which is known to be $6{\cdot}06\times10^{23}$. Hence it is possible to calculate the energy of the radiation produced in the above reaction.

The development by Einstein of Planck's quantum theory enabled Jeans to carry this calculation one step further. If we suppose that the coalescence of P and E produces one quantum of monochromatic radiation (one 'photon'), we know that the energy of this quantum is given by the expression $h\nu$ where h is Planck's constant of action and ν the frequency of the monochromatic radiation. We can now write Jeans's hypothesis in the form of an equation, namely, $mc^2=h\nu$, and this equation enables us to calculate the value of ν, since

$$m=\frac{1}{6{\cdot}06\times10^{23}},\quad c=3\times10^{10},\quad \text{and}\quad h=6{\cdot}5\times10^{-27}.$$

This calculation gives as a result $\nu=2{\cdot}2\times10^{23}$, the corresponding wave-length being $\lambda=1{\cdot}3\times10^{-13}$ cm.

Twenty-five years ago no radiation of this high frequency was known to science. Recent investigations on the so-called cosmic rays, which reach us from all parts of the heavens, have shown, however, that this radiant energy of cosmic origin contains frequencies equal to and greater than the frequency calculated above. Such results indicate, therefore, that some such hypothesis as that of Jeans is very probable, and that in the depths of space phenomena are occurring which are capable of producing photons of extremely high frequencies.

In the subsequent development of his theory of stellar radiation, Jeans has propounded the interesting hypothesis that in the interior of stars and nebulæ there exist very large and complex atoms which are much more massive than any known to us in the earth. In these 'super-radioactive' atoms Jeans supposes that electrons circulating near the atomic nuclei occasionally fall into the nuclei and, combining with the protons, produce the energy of stellar radiation as a resultant of the 'annihilation' of matter, that is, of electrons and protons. These actions are regarded by Jeans as independent of temperature and characteristic of the complexity and instability of the massive atoms. I do not intend to follow here the later hypothesis of Jeans, and propose to deal with the reaction $P+E=$Radiation as a *chemical* reaction occurring between *free* electrons and protons. This reaction, if it be possible, is certainly the simplest and most fundamental of all chemical reactions and therefore worthy of the closest study.

We may observe two things about such a reaction. It evidently does not occur under any except very unusual conditions, as otherwise the material universe could not endure for very long. We may suppose that some very intense source of 'activation' is necessary, such as an extremely high temperature or possibly very high velocities of collision due to extremely high electric fields. The reaction is a very strongly exothermic one, so that the reverse reaction would be likely to occur only at excessively high temperatures. Given a system consisting of free protons and electrons, a proton-electron 'gas', we may therefore imagine the reversible equilibrium

$$P+E \rightleftarrows \text{Radiation}$$

as occurring in a closed space at a given temperature, and endeavour to obtain some idea of the temperatures which would be necessary. Only photons of frequency equal to or greater than $2{\cdot}2\times10^{23}$ could transform into a proton-electron pair. If the temperature were such that the *hohlraum* radiation were rich in frequencies of this high order, we might expect the possibility of such an equilibrium, assuming that this temperature was high enough to 'activate' the forward reaction. Given such assumptions, there are two very simple ways of calculating a possible temperature. The well-known formula $\lambda_m T=0{\cdot}3$ gives the wave-length λ_m of the radiant energy of maximum density in a closed space at a temperature of T degrees on the Kelvin thermodynamic scale. The frequency ν corresponding to λ_m being given by the equation $c=\nu\lambda_m$, we obtain the result $T=\frac{0{\cdot}3\nu}{c}$. If we now identify ν with $2{\cdot}2\times10^{23}$, it follows that

$$T=\frac{0{\cdot}3\times2{\cdot}2\times10^{23}}{3\times10^{10}}=2{\cdot}2\times10^{12}\ ^\circ\text{K}.$$

Thus in a closed space at a temperature of the order of 10^{12} K, that is, one billion degrees, it would be

* Digest of a lecture delivered to the Research Department of the Metropolitan Vickers Electrical Company on June 12.

possible for the reversible equilibrium $P+E \rightleftarrows$ Radiation to exist. Under these conditions matter, in the form of protons and electrons, would be constantly dissolving into radiant energy, and simultaneously radiant energy would be constantly giving birth to protons and electrons.

Another approximate way of calculating the necessary high temperature is the following. We start with the well-known equation for the variation with the temperature of the equilibrium constant K of an ideal gas reaction, namely, $\frac{d \log K}{dT} = \frac{Q}{RT^2}$ where Q is the heat of the reaction. If Q does not vary with temperature, the integrated form of this equation is $\log K = \frac{-Q}{RT} + \text{constant}$, which we may write in the form $K = k_1 e^{-Q/RT}$, where k_1 is another constant. In this form of the equation, Q and R refer to gram molecules. If we divide both these quantities by the Avogadro number N (that is, the number of molecules in a gram molecule) we can state the equation in a form referred to molecular magnitudes: $K = k_1 e^{-q/kT}$, where $q = Q/N$ and $k = R/N$ (called the Boltzmann constant).

Now if q is an extremely large quantity, it is necessary that T should have a very great value if K is to possess an appreciable magnitude. We observe, for example, that $K = k_1/e$ if $q = kT$. Now although it is not possible in the present case to define the equilibrium constant K in the usual way, let us, nevertheless, apply the foregoing reasoning, and write therefore $q = mc^2 = kT$, or $T = mc^2/k$. Since $m = 1/N$ and $k = R/N$, this gives the result $T = c^2/R$. Recollecting that $c^2 = 9 \times 10^{20}$ and $R = 8{\cdot}4 \times 10^8$ ergs, we get $T = 10^{12}$ °K, which is approximately the same result as before.

We might have used the Planck radiation equation in these approximate calculations. We shall employ it now, however, for a somewhat different purpose. This equation gives the distribution of radiant energy E as a function of the wave-length, and we may write it for our present purpose in the form:

$$E_\nu = \text{const.} \frac{\nu^2}{e^{h\nu/kT} - 1}.$$

In the present case

$$\frac{h\nu}{kT} = \frac{mc^2}{kT} = \frac{c^2}{RT} = \frac{10^{12}}{T},$$

so that we have

$$E_\nu = \frac{\nu^2}{e^{10^{12}/T} - 1}.$$

For two different temperatures T_1 and T_2 and the same ν

$$\frac{(E_\nu)_{T_1}}{(E_\nu)_{T_2}} = \frac{e^{10^{12}/T_2} - 1}{e^{10^{12}/T_1} - 1}.$$

If we put $T_2 = 10^{12}$, $T_1 = 10^{10}$, we get

$$\frac{(E_\nu)_{T=10^{10}}}{(E_\nu)_{T=10^{12}}} = \frac{e-1}{e^{100}-1} = \frac{1{\cdot}7}{e^{100}}.$$

Hence, in comparison with the energy density of radiation of frequency $\nu = 2{\cdot}2 \times 10^{23}$ at $T = 10^{12}$, the energy density of this radiation at $T = 10^{10}$ will be negligibly small. It follows, therefore, that the reverse reaction Radiation $\rightarrow P+E$ would be practically non-existent at $T = 10^{10}$, though very marked at $T = 10^{12}$. Thus if the temperature 10^{10} were high enough to activate strongly the forward reaction $P+E \rightarrow$ Radiation, matter (in the form of protons and electrons) would dissolve into radiation practically completely.

Quite recently, E. A. Milne has given an important theoretical treatment of the reversible thermodynamic equilibrium $P+E \rightleftarrows$ Radiation, employing for this purpose the quantum statistics of Fermi and Dirac. If n is the number of protons, or the equivalent number of electrons, present per cubic centimetre at statistical equilibrium, then Milne's result may be expressed in the form:

$$n = \frac{2^{\frac{1}{2}}}{h^3}[2\pi kT(m_e/m_p)^{\frac{1}{2}}]^{\frac{3}{2}} e^{-\frac{1}{2}\frac{mc^2}{kT}}$$

where h = Planck constant, k = Boltzmann constant, m_e = mass of one electron, m_p = mass of one proton, $m = m_e + m_p$. Employing the known values of the constants and changing to 10 as exponent base, Milne's equation reduces to:

$$n = 0{\cdot}96 \times 10^{18} T^{\frac{3}{2}} \times 10^{-\frac{2{\cdot}35 \times 10^{12}}{T}}.$$

The following short table gives a few of the results calculated by Milne by means of this equation.

T	n (No. of Protons per c.c.)	ρ_m (Grams per c.c.)	ρ_R (Grams per c.c.)
10^{10}	10^{-202}	$1{\cdot}65 \times 10^{-226}$	$0{\cdot}85 \times 10^{5}$
10^{11}	10^{11}	$1{\cdot}65 \times 10^{-13}$	$0{\cdot}85 \times 10^{9}$
10^{12}	10^{65}	$1{\cdot}34 \times 10^{10}$	$0{\cdot}85 \times 10^{13}$

In this table, ρ_m = density of matter and ρ_R = density of radiant energy. ρ_R is calculated from the equation $\rho_R = \frac{aT^4}{c^2}$, where a = Stefan's constant.

It will be seen that our former rough calculations are in qualitative agreement with Milne's results. Imagine hydrogen gas gradually heated up in an enclosed space. Then we have the following picture. As the temperature rises the molecules will be ionised and finally completely dissociated into atoms. With sufficient further rise of temperature the atoms will become ionised, and when this process is practically complete we shall have our proton-electron gas. We must now imagine that at some very high temperature the reaction $P+E \rightarrow$ Radiation sets in. Milne's results show that at $T = 10^{10}$ this reaction will be practically complete. As the temperature rises still higher the reverse reaction, the 'birth' of matter from radiation, begins to be appreciable, and we see that at $T = 10^{12}$ the equilibrium density of matter becomes equal to $1{\cdot}34 \times 10^{10}$ grams per c.c. The state of affairs at $T = 10^{12}$ corresponds in fact to enormous densities for both matter and radiation.

We can never expect in our laboratories to attain to temperatures of this order of magnitude. Our only hope in this matter, as in so many other related problems of physico-chemical science, lies in the technical progress of electrical science. Only

through the attainment and control of enormous voltages are we likely to obtain results equivalent to the very high temperatures discussed previously. Let us calculate, for example, the energy value of mc^2 in terms of electron-volts. We must write (where V = voltage and e = electron charge)

$$eV = mc^2 = \frac{c^2}{N} = \frac{9 \times 10^{20}}{6 \times 10^{23}} = 1{\cdot}5 \times 10^{-3}.$$

Now $e = 4{\cdot}8 \times 10^{-10}$ e.s.u. Hence $V = 0{\cdot}3 \times 10^7$ e.s.u. Since one electrostatic unit of voltage equals 300 volts, $V = 300 \times 0{\cdot}3 \times 10^7 = 9 \times 10^8$ or nine hundred million volts.

It does not follow, of course, that voltages of this enormous value would be necessary, since we only require electrical potential gradients sufficient to impart to protons and electrons the energies required for 'activation', that is, the energies required to overcome the repulsive forces which exist at very small distances. We might say, at a guess, that controllable voltages of the order of a hundred million volts would be likely to initiate an entirely new era in physico-chemical science. The future progress of this fundamental science lies, therefore, in the hands of the scientific electrical engineer. It is to be earnestly hoped that these advances will be made in England, the land where the electron and proton were discovered by Thomson and Rutherford, and the land where one hundred years ago Faraday discovered how to set electrons in ordered motion by moving magnetic fields.

If we turn back now to our enclosure in chemical and radiant equilibrium at a temperature of 10^{12} degrees, we know that there exists in such an enclosure a sufficient density of photons of frequencies equal to $2{\cdot}2 \times 10^{23}$ and upwards, that is, of photons which can transform into proton-electron pairs. Suppose that from such an enclosure there could escape a dense stream of radiant energy of frequencies lying between, say, $2{\cdot}2 \times 10^{23}$ and 10^{24}. Imagine a sufficiently dense stream of this type of radiation to escape into *cold* interstellar space, and perhaps there to encounter another similar stream. What might happen? Is it not extremely probable that matter would be generated? The reverse reaction radiant energy$\rightarrow P + E$ does not *necessarily* demand a very high temperature. It would be enough if there existed a sufficient density of photons of frequency equal to or greater than $2{\cdot}2 \times 10^{23}$. Such a reaction would be, indeed, the most fundamental synthetic photochemical reaction. Now photons of such frequencies are known to be reaching our planet from all directions in space. It seems quite possible, therefore, that matter may be in process of generation in cold interstellar space, whereas temperatures such as 10^{12} could only be expected to occur in the hot cores of stars, as Milne has suggested.

Jeans and Eddington tend to emphasise the 'running-down' of the universe, the steady dissolution of matter into radiation. It seems likely, however, that, although the total effect may be such a running-down, there exist places in the universe where a 'running-up' may occur, even though this running-up be of a temporary nature. The universe is probably in a state of fluctuation. It is certainly large enough to permit very considerable local fluctuations, and such fluctuations are by no means incompatible with that general running-down process which the second law of thermodynamics seems to demand. It may be true that the universe, as a whole, is passing from a less probable to a more probable state, from a state of greater to a state of lesser organisation. This general drift, however, is quite compatible with intense local fluctuations in the opposite direction. The re-conversion of radiation into matter may be one of these.

Southern Whaling.*

IN "Southern Whaling" Sir Sidney Harmer reviews the present position of the whaling industry and summarises our knowledge, obtained largely as the result of commercial operations, of the biology of the great whales. The statistics, gathered with scrupulous care, show clearly the great concentration of modern commercial operations in the southern hemisphere, where on the average three-quarters of the annual world-catch of whales is obtained. Since hunting began in that region at the beginning of the present century, quite half of the world's catch has been made in the Antarctic, while African waters have contributed another quarter. Modern whaling operations, therefore, are conducted principally round the great ice barrier which surrounds the south pole.

Analysis of the species captured by the commercial vessels shows the great preponderance of finner whales in the catches, 90 per cent of which consists of the four species—Blue, Fin, Humpback, and Sei. Of these, the Blue and the Fin contribute on the average three-quarters of the total captures, so that the industry is largely dependent on the available stock of these two species. The annual world-catch of all species of whales has risen from 11,000 in 1919 to about 30,000 in 1929 and is still increasing, and the percentage of Antarctic Blue and Fin whales in the total world-catch has risen correspondingly from 63 to 85.

Recent researches into the life-histories of Blue and Fin whales have established that the period of gestation of these species is about a year, and that the young are born at the most every alternate year. Propagation, therefore, is slow. It has been noted that the percentage of sexually mature females in the catches is decreasing, while evidence has also been brought forward which points to a steady decline in the average length of whales captured in Antarctic waters in recent times. In connexion with the latter feature, it is to be remembered that, in whale hunting, the larger

* "Southern Whaling." By Sir Sidney Harmer. *Proceedings of the Linnean Society of London*, Session 142, 1929–30.

animals are deliberately selected. Now a decrease in the average length of a species inhabiting a self-contained area and subjected to intensive fishing operations is regarded as symptomatic of over-fishing, but in the case of Antarctic whales other factors—for example, seasonal movements, inter-area recruitment, and the possibility of variation in the routes of migration, about which little or nothing is known—have also to be considered, so that further research into these factors is necessary before it can be definitely stated that there is a serious decline in the stocks of whales over the whole Antarctic area. There appears to be justification, however, for the fear that the whale stock is being exploited detrimentally, and Sir Sidney Harmer expresses the opinion that the industry in Antarctic waters is rapidly approaching the peak, if indeed that point has not already been reached. New developments in pelagic whaling have vitiated methods of conservation of the whale stock hitherto adopted, so that conservation by international agreement or legislation would seem to be an urgent necessity both in the interests of the whales and of the industry.

The great rise in the whaling industry within recent years began with this new phase of pelagic whaling, that is, whaling without licenses outwith territorial limits, with parent ships of large size fully equipped with the latest appliances for the production of oil and guano. Unlike the earlier floating factories, these ships are self-contained and the whole carcase of the whale is hauled on board over a slipway, now most efficiently fitted at the stern. The parent ships are attended by several 'catchers', and harbours are not absolutely essential, as re-fuelling and re-storing can be done at sea from the 'carriers', while unloading of oil and guano can also be effected. This has been made possible by the use of whale carcases as 'fenders', while wireless, wireless direction-finding, and wireless telephony enable 'carrier' and mother-ship to establish contact without difficulty. The cruising radius of these large ships, in contrast to shore stations, is enormous, and it is not surprising that hunting for whales has been effected right round the fringe of pack ice which streams off the great ice barrier surrounding the south polar regions.

Sir Sidney Harmer is of the opinion that there is some relation between the distribution of whales and seasonal temperatures, and lays particular stress on a correlation between the September mean air-temperatures (for example, at South Georgia) and the order in which the Blue and Fin whales reach their maxima during the immediately succeeding whaling season in the same locality. Mossman [1] also states, "It is certain that the varying temperature of the South Atlantic caused by the fluctuating quantity of polar ice induces changes in the volume, direction and temperature of the great ocean currents". Temperature in itself is not considered a limiting factor in migrations, but it is taken as giving some indication of the melting of the ice which, with the interaction of the ocean currents, results in the growth of the plankton on which whales feed. Researches into the food of whales have so far elucidated that both Blue and Fin whales are plankton feeders and subsist in the Antarctic almost entirely on Euphausians; but, as Sir Sidney Harmer remarks, "The prevalence of these Crustaceans at any time does not produce an identical behaviour in the several species of whales", but that, "each species has its own times and seasons".

The question of the migrations of whales is one of prime importance, but the problem still awaits solution. There are undoubtedly breeding and feeding migrations, and the supposition that in the southern hemisphere a southward migration is for feeding and a northward for breeding is probably correct. Nothing, however, seems to be known of the migration routes or of the extent of the northward retiral.

The monthly statistics of the whales captured in the dependencies of the Falklands show clearly that the Blue and Fin whales reach their maxima during the summer months in the Antarctic and during the southern winter off the African coast. The composition of the stock fluctuates considerably in any one season (say at South Georgia), so that it is obvious that there are several lines of convergence on this particular area. Normally, at all sub-antarctic and antarctic localities, large and fat individuals are caught at the beginning of the season. Later, thin whales predominate, while towards the end of the season fat individuals may be again in evidence. It is presumed, therefore, that the lean whales have come from poor feeding grounds, probably in the warmer sub-tropical waters, and that the fat whales have experienced good feeding grounds nearer the polar ice or within the ice zone. A certain percentage of whales remains in sub-antarctic areas during the southern winter, and those captured have been found to be sexually mature or almost mature, but, naturally, operations during this period cannot be carried out except on a very limited scale, so that the relative frequency of whales in sub-antarctic waters during this period cannot be estimated.

Sir Sidney Harmer has submitted the figures as gathered by him from various sources to statistical treatment and has given a few tentative interpretations. No complete explanation is possible from the available data as to seasonal movements, but the suggestion is put forward that the central point of the main concentration of the Fin whale is farther north than that of the Blue whale, which latter is assumed to be (and probably is) an ice-loving species. The statistics show clearly that there are definite years when the Blue whales are in excess in the captures and others when Fin whales are more abundant, and that these phases seem to be correlated with the fluctuating ice conditions. The adoption, therefore, of the September mean temperature as a means of establishing correlation has been actuated by these occurrences. Blue whale years seem to correspond with low temperatures and heavy ice conditions, and Fin whale years with the reverse. With regard

to breeding seasons, all available knowledge, chiefly from a study of fœtuses, is again reviewed, and the interpretation, with which there is general agreement, is that pairing and parturition take place outside the usual hunting grounds and seasons.

Since the publication of Sir Sidney Harmer's paper on "Southern Whaling", there has appeared "International Whaling Statistics" for the ten-year period 1919–1929, which has been published at Oslo by the Norwegian Government on the recommendation of the International Council for the Exploration of the Sea. This contains the figures from the whaling industry throughout the world, and is the first of a series which will constitute a complete study of the whaling industry for the last twenty years. The figures employed in Sir Sidney Harmer's paper show sometimes considerable differences from those of the "International Statistics", though, taken as a whole, this does not affect the general trend of the argument. Attention may be directed, however, to one particular series of figures. In Table 6 of Sir Sidney Harmer's paper, the tabulated data represent the whales captured during the season 1928–29 by all countries, and not, as stated, by Norwegian companies only. An interesting feature in the presentation of the data in "International Statistics" is the average production of oil per whale. The oil production is here given in the form of Blue whale equivalents on the following basis: one Blue whale = 2 Fin whales = $2\frac{1}{2}$ Humpbacks = 6 Sei whales. Previously a production of 75 to 80 barrels of oil per whale was considered a good average, but nowadays this has risen with the improved methods of extraction to more than a hundred. The more complete utilisation of the whale carcases by pelagic whalers is all to the good, but has added to the investigator's difficulties in that recent oil production figures are not comparable with those for earlier years, while the effect on oil production of any variations in condition or of decrease in the average size of the whales is also masked. The efficiency of modern 'plant' has also resulted in an improvement in the quality of the oil produced, and it is now possible to put the higher grades of oil direct on the market in a more or less colourless and odourless condition.

An interesting effect of the intensive whaling operations in the Antarctic is that exploration has incidentally received a new impetus, as it did in the early days of sealing, for example, of Weddell, Biscoe, and Enderby, and new discoveries of land are likely to be achieved. Scientifically, also, the exploration of new areas will extend our knowledge of the distribution and frequency of these finner whales.

[1] Mossman, R. C. "The Climate and Meteorology of Antarctic and Sub-Antarctic Regions." *Journal of the Scottish Meteorological Society*, 3rd Series, vol. 18, No. 35, 1918.

Obituary.

Prof. Archibald Barr, F.R.S.

BY the death of emeritus Prof. Archibald Barr, on Aug. 5, in Glasgow, the engineering profession loses one of its ablest representatives in Great Britain.

Prof. Barr was born in Paisley in 1855. He was educated at Paisley Grammar School and the University of Glasgow, where he graduated in engineering science in 1876. Thereafter he spent eight years as assistant to Prof. James Thomson in the University of Glasgow, when he was called to the chair of mechanical engineering in the Yorkshire College (now the University of Leeds), where he spent five years and equipped and organised the engineering laboratory, making it one of the most up-to-date in the country at that time. In 1889 he was recalled to Glasgow as regius professor of civil engineering and mechanics in the University, in succession to the earlier holders of the chair—Lewis Gordon, Macquorn Rankine, and James Thomson.

Dr. Barr might then have settled down to the comparative ease of an academic life, but he found at Glasgow inadequate lecture rooms and a poorly equipped laboratory in the basement, and he had the vision to see that the science teaching of the future must develop along experimental lines; he therefore threw himself with characteristic energy and purpose into the work of arousing interest and collecting funds with which to build and equip an engineering college worthy of Glasgow as one of the most important centres of engineering activity in Great Britain. The result was the James Watt Engineering Laboratories, opened in 1900. Here he continued, until 1913, to lecture, to supervise laboratory instruction and research, and to inspire an ever-growing staff and body of students with the determination to understand the fundamental principles of engineering science and to apply these to the manifold problems that confront the engineer in the daily practice of his profession. In 1889, when he went to Glasgow, there were thirty-six engineering students at the University; when he resigned the chair in 1913, this number had increased to more than two hundred.

Dr. Barr did not confine his activities to the University, but undertook consulting work in the testing of engine and boiler plants, and contributed to the papers and discussions of the leading engineering and scientific societies in Glasgow and London. He served at different times as president of the Institution of Engineers and Shipbuilders in Scotland, the Royal Philosophical Society of Glasgow, and the Scottish Aeronautical Society; he supervised the first motor car reliability trials held in Scotland, in 1901; was convener of the engineering section of the Glasgow International Exhibition in 1901, and chairman of the committee which organised the first aviation meeting held in Scotland, at Lanark in 1910; while from 1921 until his death he was chairman of the governors of the Royal Scottish National Institution, at Larbert, for the care of mentally defectives.

The year after Prof. Barr's appointment to the

chair of engineering at Yorkshire College, Dr. William Stroud went to the college as professor of physics. These two young men became close friends, and the partnership proved most fruitful of results. Prof. Barr brought to it his gifts of mechanical invention and organising ability; Prof. Stroud, his flashlight penetration to the scientific core of a problem. In 1888 they decided to carry out a research on the mechanical equivalent of heat, but immediately thereafter they chanced upon an advertisement by the British War Office calling for a range-finder to measure ranges for gunfire, and in three weeks' time the essential features of the modern instrument had taken experimental form. For some years they worked at the development of the instrument, Prof. Barr making many of the parts with his own hands, and himself adjusting them from a platform on the roof of his house in Glasgow. In 1892 the first naval range-finder was built and tried on board H.M.S. *Arethusa*, and at once demonstrated its value to the Service; from that time the demand for such instruments steadily increased. In 1895 a small workshop was opened in an old stable, and later, another old building was occupied in the same neighbourhood. In 1904 the first part of the present factory building of Barr and Stroud, Ltd., was opened at Anniesland, on the western outskirts of Glasgow, with about a hundred workmen. It grew by 1914 to a factory with 900 men, supplying naval and military instruments to the British Government and nearly every foreign Power; while during the War, the main building was extended and two new buildings added to provide room for more than 2000 workers.

Prof. Barr took the keenest interest in all the problems of manufacture and factory development, visiting the United States in 1896 to learn something of their machine methods, and installing the first American milling machine to come to Scotland, two years later. He initiated the scheme of welfare work in the factory, sick benefit, recreation clubs, dining hall, and the use of the premium system in encouraging output.

The extended use of the range-finder on board ship made it imperative to control the fire of the guns; in 1905, Prof. Barr invented a step-by-step motor for signalling electrically from range-finder to gun, and from that date onwards many instruments were designed and patented which have gradually developed into the intricate fire-control system of the modern warship. An electrically operated torsion-meter for measuring the power developed by large prime movers was developed in 1912.

The War inevitably involved the firm of Barr and Stroud in greatly increased production of its usual work, and in this activity Prof. Barr took his share, but he also developed a number of instruments for military and naval use—the torpedo depth recorder, the rangetaker-tester, a bomb-dropping sight for aircraft, the submarine periscope—and took a keen interest in the manufacture of optical glass by improved methods. After the War, the attention of his firm was necessarily turned towards civilian work, and he perfected Dr. E. E. Fournier d'Albe's optophone for enabling the blind to read ordinary type, and a series of instruments for producing contour maps from photographs taken from an aeroplane, by which means survey work in new and unexplored countries has been very greatly simplified.

Prof. Barr was elected a fellow of the Royal Society in 1923, was a member of the Institutions of Civil and of Mechanical Engineers and the Institute of Metals, and was made doctor of laws of the University of Glasgow in 1914.

Prof. Barr will be remembered by his many students for his clear, direct, convincing explanations of the fundamental principles underlying any problem. He was not content to teach engineering as a mere branch of applied science, but aimed to develop in his students the power of thinking out for themselves the laws of science on which the particular work of the moment was based. He was a ready and lucid speaker, and drew upon a fund of humour and wide human sympathies which enabled him to command the interest and constant attention of his classes and to get into close touch with his students individually outside the lecture room. From boyhood he showed inventive talent, and all his life his mind was occupied with the solution of a long series of mechanical problems; while to the development of his patents on a manufacturing scale he applied an integrity which would not brook the least lapse from workmanship of the highest class. He brought to the management of his business a well-balanced judgment, a rapidity of thought that enabled him to come to a sound conclusion quickly, a clearness of mind by which he distinguished the commercial and financial aspects of a problem from the practical and scientific, and a sympathy with his fellow-workers and employees which has found expression in a workshop and organisation where every facility for the well-being of those engaged in the work is provided. His death will be deeply felt by the members of his family, his daughter and two sons (his wife died three years ago, and his second son was killed in France in 1915), by his business associates, and by a wide circle of friends and past students.

WE regret to record the death of Mrs. Howes, widow of the late Prof. G. B. Howes, who succeeded Huxley at the Royal College of Science. Mrs Howes died in Kenya Colony, at the home of her daughter, Mrs. Rae, on July 4, aged seventy-nine years. Forty years ago she made the home of her husband a resort for the younger school of biologists, and did much to forward the cause of modern biology.

WE regret to announce the following deaths:

Prof. W. E. Dixon, F.R.S., University lecturer in pharmacology at Cambridge and formerly professor of pharmacology in King's College, London, on Aug. 16.

Prof. J. W. Hinchley, professor of chemical engineering in the Imperial College of Science and Technology and secretary of the Institution of Chemical Engineers, on Aug. 13, aged sixty years.

News and Views.

THE results of the explosions made by the German Greenland Expedition to determine the thickness of the Greenland ice-cap have been awaited with much interest, owing to their widespread geographical and geological bearing. Two theories have been advanced as to the structure of Greenland. According to one theory, it is a high plateau capped with ice, and the rapid flow of the Greenland glaciers is due to their steep gradient. According to the rival view, Greenland, like Ireland, is a saucer-shaped land, consisting of a rim of mountains with the central hollow filled by ice, which flows outward over the surrounding highlands. Carvill Lewis adduced Greenland in support of the assumed covering of the Irish Sea by a dome of ice which then flowed over the Welsh mountains to the height of 1300 ft. Croll claimed that the Greenland ice was as thick as its height above sea-level, in support of his view that the ice at the south pole is 24 miles thick. Croll's estimates of the thickness of the Greenland ice-cap were declared impossible, in accordance with Lord Kelvin's calculations as to the maximum possible thickness of ice.

THE German Greenland Expedition under the late Prof. Wegener has now tested the thickness of the ice by artificial earthquakes, and the results have been announced by a telegram published in the *Times* on Aug. 13. The largest single charge fired was 74 kgm. of dynamite: 25 explosions were made, and the resulting waves observed. The control station was on lat. 72° N., midway between the eastern and western coasts, and therefore at the geographical centre of Greenland. The height there is 9800 ft. above sea-level. From the time taken for the return of the explosion-wave reflected from the base of the ice-sheet, it is calculated that the ice is 8800 ft. thick. The rock floor, according to this result, is only 1000 ft. above sea-level. The ice 38 miles inland, at the height of 6000 ft. above sea-level, is from 2300 ft. to 3000 ft. thick, so that the rock floor is there about 2000 ft. higher than in the interior. These experiments tend to support Croll's view that Greenland is saucer-shaped, and that the internal ice-cap is much thicker than has been claimed as physically possible. To what degree the explosion-wave results are trustworthy will be considered when the details of the experiments and calculations are available; but the ice is obviously much thicker than was expected on the conception that Greenland, like Labrador, is a high plateau with a marginal mountain range.

THE subjects to be dealt with by Section G (Engineering) of the British Association during the London meeting have been broadly chosen from three separate points of view. That the meeting marks the centenary of the Association is shown by the presidential address by Sir J. Alfred Ewing, which is, at the same time, the Bramwell Trust Lecture. In this Sir Alfred will deal with the position of prime movers in 1931. Prof. Elihu Thomson will speak on "Pioneering in Electrical Engineering Fifty Years Ago", and Sir Robert Hadfield will describe "Faraday's Work in Ferrous Metallurgy". To reflect the activities of the Association in all parts of the British Commonwealth, papers are to be given by: General C. H. Mitchell (Canada), "Engineers' Contributions to Canada's Development"; Mr. A. L. Egan (South Africa), "Methods of Improving the Kata Conditions of Atmospheric Air in Deep-level Mines". Lastly, since the Association is meeting for the first time in London, the special engineering interests of that city are to receive attention. London is, practically speaking, the centre of many activities in the sphere of aeronautics. The research work in this sphere at the National Physical Laboratory and at the Royal Aircraft Establishment, South Farnborough, will be touched upon by Mr. E. F. Relf and Mr. R. McKinnon Wood, who will respectively describe the new wind tunnels at these two establishments. Col. the Master of Sempill will give a paper on "Motorless Flight". These three papers are correlated with demonstrations: the wind tunnels by the visit to the National Physical Laboratory, and "Motorless Flight" by the gliding demonstrations to be given at Feltham Air Park on Sunday, Sept. 27.

FURTHER subjects to be discussed in Section G of the British Association which are connected more or less closely with London are: "Acoustical Problems of Broadcasting Studios", by Mr. Noel Ashbridge, of the British Broadcasting Corporation, and "London Tunnelling Problems", by Mr. H. H. Dalrymple-Hay. These papers, too, are combined with appropriate visits and demonstrations. Apart from these three special aspects, other important subjects of a general nature are included in the programme. Dr. W. Rosenhain will speak on "Metals and Alloys in relation to Engineering Progress", and Prof. F. C. Lea will present a paper on "The Effect of Temperature on some of the Physical Properties of Metals", these dealing with the metallurgical side. Sir David Milne-Watson, on "The New Gas Industry", will refer to some aspects of the important national question of fuel utilisation. Mechanical and manufacturing engineering are represented by Prof. E. G. Coker's paper on "Force Fits and Shrinkage Fits"; civil engineering by Prof. C. F. Jenkin, who will describe his "Earth Pressure Investigations"; while Prof. Julius Hartmann (Copenhagen) with his paper on "Jet Rectifiers" will deal with an important aspect of modern electrical engineering.

A CORRESPONDENT, writing from Loughborough on Aug. 6, mentions having seen a fully-grown cuckoo about his house for several days; on the above date it was perched on some railings along with about twenty sparrows, and being fed by a wagtail. Such an appearance of the yearling cuckoo is quite to be looked for at this time of year, but the fact that it has been deemed worthy of notice is worth recording, as it shows that the great difference in habits between the young cuckoo and the adult is not generally known. The old bird is notoriously secretive in its ways—so much so that it is literally only 'a wandering voice'

to 99 per cent of those who know of its existence. But the yearling exposes itself quite freely, is easily approached, and may be seen almost anywhere; in two summers a specimen was seen perched on the top of the Small Waders' aviary which used to be behind the Lion House in the Zoological Gardens. As the build of the cuckoo—long-winged and short-legged—is that generally characteristic of birds which hunt in the open, the behaviour of the yearling is more in accordance with what one would expect from its structure than is that of the adult. Evidently, however, during the bird's progress towards maturity and its travels to and sojourn in the south, it finds it expedient to conceal itself, and retains the habit; possibly the chief elimination the species suffers is by the persecution of birds of prey, which compels individuals to this change of customs, as the cuckoo appears not to suffer from starvation in spring or to be compelled to board ships when on passage—common misfortunes with others of our migrants. The wagtail above alluded to had, no doubt, reared the cuckoo, and the sparrows would have been attracted by their curiosity at a strange bird, often popularly mistaken for animosity, which they rarely display.

A REPORT by Miss D. A. E. Garrod on work on the British School of Archæology in Palestine during the past season appears in *Man* for August. Miss Garrod herself has been engaged in excavating the Mugharet-el-Wad, the largest of the Wady-el-Mughara group of caves, close to the rock basins which were uncovered in the previous season. A series of mesolithic burials has been found with circlets of beads of bone and shell still in place on the skeletons. The better preserved one, which has been removed in one piece, will go to the Palestine museum as an exhibit. On the skull are the remains of a cap strung with dentalia shells, while the lower jaw is full of bone pendant beads. The skeleton lay in a contracted position with one arm across the body. Of the other excavations, Mugharet-el-School is being carried out by Mr. Ted McCown. He has found an interesting Mousterian industry, and at the end of last May brought to light the skull and lower jaw of a young child, three to four years old (see NATURE, June 6, p. 865). The end of a child's humerus was revealed in the hard block of Mousterian breccia. This has now been sent whole to Sir Arthur Keith, in the hope that it may be found to contain the whole skeleton. At Mugharet-el-Tabou is a purely Mousterian deposit of great depth. Its great interest at the moment consists in the fact that it contains well-preserved fauna associated with the Mousterian—at present little known for this region. At Mugharet-el-Kabara, Mr. Turville Petre is excavating Zichron Jakob, a cave ten miles from Wady-el-Mughara. A mesolithic horizon has produced bone sickle handles with carved animal heads at the top, many bone harpoons, and various pieces of carved bone and stone, some of which, it is hoped, may be on exhibition later in London.

THE farming industry in Germany is far from flourishing at the present time. Instead of this preventing the development of new industrial material, it seems, judging from the large number of new agricultural devices shown at the recent show in Hanover, to be acting as a spur to further improvements. In the *Electrician* for July 31, R. Borlase Matthews describes some of the novel machines shown at this agricultural exhibition. Manufacturers are providing machines likely to reduce the costs of production, and the farmer is doing everything to increase the cultivated area and farm the land more intensively, so as to lower the total cost per unit produced. The number of new implements shown was nearly two hundred, and there were 5300 machinery exhibits, numbers which far surpass anything seen at shows in Great Britain. Electrically operated apparatus was very much in evidence, large scale demonstrations being given of equipment suitable for dairying, poultry-keeping, etc. An ingenious device known as the 'rain-cannon' is used for watering fields. It consists of a jet mounted on a cylindrical pressure tank. The upper portion of the tank is filled with air, which is compressed by the water until there is equilibrium. When this is attained, a valve situated in the nozzle opens an orifice. Owing to the sudden release, the air pressure ejects the water in a powerful jet to a considerable distance and at the same time moves it round slightly. This method is a great improvement on the old sprinkler and pipe-line methods. A small rain-cannon requiring only a pressure of two or three atmospheres to work it was a very popular exhibit. Pneumatic transport methods for transporting hay from the barns are coming into use owing to their convenience. A device was shown which supplied concentrated feed to the horses in stables twice a day. It was entirely automatic, requiring charging only once a week.

IN the *University of Colorado Studies* for April 1931 there is an interesting paper by Prof. Kenneth Field on the effects produced by interconnexion of electric light and power supply companies. The tendency in America is for the small companies to unite and form large companies. For example, twenty large companies control more than fifty per cent of the total supply. Just as with the 'grid' in Great Britain, the economies arise from the decrease in the consumption of fuel per unit power generated, the more economical maintenance that can be attained, and what may be described as the substitution of capital for labour. In large steam stations, evaporators for distilling water can be used to prevent scale-forming materials from entering the boilers, and this reduces the maintenance costs. Mechanical stokers, coal and ash handling machinery, coal bunkers, etc., considerably reduce the manual labour required. When water is available for condensing purposes, steam generating stations are located at the coal pits, and thus the cost of transport is lowered. Savings in reserve capacity are facilitated by making temporary service from distant plants possible. During a recent drought in North Carolina, industries in that State which were dependent upon electric light and power were kept in operation by energy received through interconnexion with the Southern Company, operating in South Carolina. This company had no surplus power, but obtained from

the Georgia Company the equivalent of the power which it passed on for use in North Carolina. In turn the Georgia Company received from the Alabama Company the equivalent of the energy it gave to the Southern Company. In effect, therefore, the North Carolina industries were kept going by electricity generated in the State of Alabama. The power was not actually transmitted, but the effect produced was the same as if it were.

A NEW scientific journal which marks an important stage in the geological survey of China has appeared under the name of the *Soil Bulletin*, published for the University of Nanking and the China Council of the Institute of Pacific Relations by the Geological Survey of China. Two numbers have appeared to date, the first in December 1930 and the second in March 1931; and both make contributions of interest to a subject which has received little scientific attention. Soils have distinctive morphological characters, and their classification on the basis of their own features, rather than from the point of view of their origin, is more likely to be of value to the agriculturist. A preliminary reconnaissance of a portion of the soils of China was carried out by Prof. C. F. Shaw in 1930, and this revealed the presence of nine soil regions. Of these, three are large areas of primary soils and six are composed exclusively of secondary soils. It was found that the geological origin of the soil material was subordinate to climate in determining the broad general soil regions, but within the regions it was of much importance. Mode of formation has had a dominant rôle in determining the characteristics of those regions which are composed mostly of alluvial sediments, though both climate and geological origin have naturally also had much influence.

AT the Congrès International du Bois et de la Sylviculture, which was held in Paris on July 1–5, an International Association of Wood Anatomists was formally constituted. This was the outcome of an informal meeting of wood anatomists which was held at Cambridge on the occasion of the fifth International Botanical Congress, in August 1930. At that time it was not found possible to do more than appoint a committee to consider the question of organisation and to report to the next conference, which was provisionally fixed for July 1931, in Paris. The Committee's report included a draft constitution, which was finally adopted at an open meeting held on July 4 last. The Committee was then empowered to enrol members and to carry on the affairs of the Association until such time as the statutory Council shall have been appointed. The secretary to the Committee is Prof. S. J. Record, Yale University School of Forestry, New Haven, Connecticut, United States, and the British representatives on the Committee are Mr. E. H. B. Boulton, Department of Forestry, University of Cambridge; Dr. L. Chalk, Imperial Forestry Institute, Oxford; Mr. B. J. Rendle, Forest Products Research Laboratory, Princes Risborough, and Mr. M. B. Welch, Technological Museum, Sydney, Australia.

IN 1911 an International Hygiene Exhibition was held at Dresden, and in 1930 a second International Exhibition was the appropriate occasion for the opening of a permanent museum of hygiene in that town. Since the first exhibition, almost revolutionary changes have taken place throughout the whole field, so that the 1930 exhibition presented quite a different picture from its predecessor. Its sections included the hospital, physical culture, occupational hygiene, psychic life and hygiene, woman and child, care of health, nourishment, clothing-hygiene, and sanitary and dwelling conditions. The aim of the Museum, organised as a registered association, is to convert the greatest possible number of people to a systematic and continuous care of their health, not merely by imparting instruction, but also by influencing them to think hygienically for themselves. Various sections are devoted to press and publication propaganda, teaching apparatus, lantern-slides, travelling exhibitions, health service, and so on. An illustrated article in the *Museums Journal* for July gives in some detail an account of this important institution.

AN explanatory circular (1208) has been issued by the Ministry of Health respecting the *Memorandum* (153/M.C.W.) on birth control issued in March. It is emphasised that local authorities have no general power to establish birth control clinics as such. Under the Maternity and Child Welfare Act, 1918, facilities for birth control advice at a centre are limited to married women already in attendance as expectant or nursing mothers in whom further pregnancy would be detrimental to health. Under the Public Health Acts, gynæcological clinics may be established and contraceptive advice may there be given to married women in attendance for a similar reason. It is considered undesirable that a gynæcological clinic should be established at a maternity and child welfare centre; such a clinic should be provided in separate premises or at a hospital. Contraceptive advice should not be regarded as falling within the scope of the normal duties of the medical officers of a local authority, who should be free to undertake or to decline it.

THE further issue in the Ministry of Agriculture's new series of bulletins includes one (No. 13) on "Home-grown Feeding Stuffs" by Dr. H. E. Woodman, the object of which is to indicate how the farmer's own produce may best be used in the rearing of stock. From a comparison of the relative cost of some home-grown and purchased feeding stuffs, it is evident that it may pay the farmer better to retain his own potatoes and corn for home consumption rather than to sell them and have to purchase maize meal. A general description follows of the composition, feeding value, and uses of a large variety of common home-grown foods, such as cereals, hays, forage crops, silage, potatoes, and sugar beet by-products, and rations suitable for different types of stock are supplied. In conclusion, a comparative table is drawn up showing the composition and feeding values of various winter forage crops and pasture

grass, from which it is evident that kales in particular should prove satisfactory substitutes for pasturage. Copies of the bulletin may be purchased direct from the Ministry of Agriculture, 10 Whitehall Place, S.W.1, price 8*d*. post free.

The Indian Journal of Veterinary Science and Animal Husbandry is the title of a new quarterly journal the first part of which has recently been published for the Imperial Council of Agricultural Research, New Delhi, India. The annual subscription, including Indian postage, is Rs. 5, or 8*s*. 3*d*., which should be sent to the secretary of the Imperial Council. The aim of the journal is to encourage practical investigations of economic value, and actual notes of practical experiences and clinical observations, rather than abstruse articles on research, are what are required, though reviews and abstracts of current work will be included. This first part contains an article by H. Cooper on anti-rinderpest inoculations, and other papers and abstracts on diseases and infections of cattle and other animals.

IT is announced that Lord Ilchester and Prof. J. Stanley Gardiner have been elected trustees of the British Museum in succession to Lord Ullswater and Lord Chalmers, who have retired.

AFTER consultation with the Lord President of the Council and the president of the Royal Society, the recently formed Agricultural Research Council has appointed Sir William Dampier to be secretary of the Council. Mr. E. H. E. Havelock, of the Development Commission, has been appointed assistant secretary.

THE nineteenth annual meeting of the Indian Science Congress will be held in Bangalore on Jan. 2–8, 1932, under the presidency of Rai Bahadur Lala Shiv Ram Kashyap. The following have been elected sectional presidents; agriculture, Mr. G. N. Rangaswamy Ayyangar; mathematics and physics, Prof. Ganesh Prasad; chemistry, Prof. P. R. Ray; zoology, Prof. D. R. Bhattacharyya; botany, Dr. Haraprasad Chaudhuri; geology, Mr. Percy Evans; medical and veterinary research, Lt.-Col. A. D. Stewart; anthropology, Mr. J. P. Mills; psychology, Prof. N. S. N. Sastry. Further information can be obtained from the General Secretary, 35 Ballygunge Circular Road, Calcutta.

THE Association of Special Libraries and Information Bureaux will hold its annual conference at Lady Margaret Hall, Oxford, on Sept. 18-21, under the presidency of Mr. H. T. Tizard. Some problems of professionalism will form the subject of a lecture by Prof. A. M. Carr Saunders, and Mr. B. M. Headicar will discuss practical methods of arrangement, indexing, and routine in the business library and information bureau. Other subjects included in the programme are "International Abstracting and Indexing" by Sir Frederick Nathan, "Films as a Medium of Information in Education" by Mr. F. A. Hoare, and "Agricultural Economic Information" by Mr. J. P. Maxton. On Sept. 20, Sir Francis Goodenough will give a short address on the Report of the Board of Education Committee on education for salesmanship.

A GREAT earthquake was recorded in the observatories of Great Britain on the evening of Aug. 10. At Kew, the first impulses occurred at 9 h. 28 m. 21 s. p.m., G.M.T. The records indicate that the origin was about 4000 miles north-east by east of Kew, or near the Altai Mountains in Mongolia, and this position is confirmed by reports that it was about 2100 miles from Bombay. An earthquake on Aug. 16 which shook the city of El Paso and was widely felt in Texas and New Mexico was recorded as a small disturbance at Kew Observatory. The first impulses at Kew occurred at 11 h. 52 m. 4 s. G.M.T., and the records indicated that the epicentre was about 5300 miles away. Among other recent earthquakes, one of the most interesting occurred on July 18, in the Mississippi valley (*Daily Science News Bulletin*, Science Service, Washington, D.C., July 20). Its centre was close to New Madrid, the scene of the great earthquakes of Dec. 16, 1811, and Jan. 23 and Feb. 7, 1812.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant lecturer in mechanical engineering at the Technical College, Bradford—The Principal, Technical College, Bradford (Aug. 25). A principal of the Neath Mining and Technical Institute, and an assistant at the Caerphilly Mining and Technical Institute and Junior Technical Day School, with good honours degree in science—The Director of Education, County Hall, Cardiff (Aug. 25). A laboratory steward at the Technical College, Coatbridge—The Director of Education, Lanarkshire House, 191 Ingram Street, Glasgow (Aug. 26). A county librarian under the Durham County Education Authority—The Director of Education, Shire Hall, Durham (Aug. 27). Chemical laboratory assistants at the Royal Arsenal—The War Department Chemist, B.47, Royal Arsenal, Woolwich, S.E.18 (Aug. 29). An assistant librarian in the University of Birmingham—The Secretary, University, Birmingham (Sept. 5). A demonstrator of biology at St. Bartholomew's Hospital Medical College—The Dean of the Medical College, St. Bartholomew's Hospital, E.C.1 (Sept. 10). An assistant at the College of Estate Management for lecturing on town planning and road-making—The Secretary, College of Estate Management, 35 Lincoln's Inn Fields, W.C.2 (Sept. 14). A Milroy lecturer at the Royal College of Physicians for 1933—The Registrar, Royal College of Physicians, Pall Mall East, S.W.1 (Sept. 21). A handicraft instructor under the Lincolnshire (Holland) Education Committee—The Director of Education, High Street, Spalding. An assistant in the development section of the British Non-Ferrous Metals Research Association—The Director, British Non-Ferrous Metals Research Association, Regnart Buildings, Euston Street, N.W.1. An engineering draughtsman under the Air Ministry—The Secretary (S.1), Air Ministry, Kingsway, W.C.2.

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.*]

Magnetic Experiments on the Cosmic Rays.

BOTHE and Kolhörster [1] were the first to show that the cosmic rays manifest themselves to us as highly penetrating corpuscular rays. Direct experimental data on the nature as well as on the energy of these rays are still lacking; they might be obtained by experiments on the magnetic deflection if a sufficiently large and intense magnetic field could be reached.

I have attempted to overcome the difficulty of producing such a field by making use of the magnetic induction in a mass of magnetised iron.[2] Some preliminary experiments using the method of triple coincidences between the impulses of three Geiger-Müller tube-counters to define and analyse the beam of corpuscular rays, only show that these rays are not deflected in iron to an extent comparable to the deflection which electrons of 10^8 *e*-volt would be subjected to. The experiment was repeated later by Mott-Smith,[3] with the same method but with greater precision; the results were again negative and the energy of the corpuscular radiation, presumed to be electronic, was given as 2×10^9 *e*-volt as an approximate minimum value.

A fresh and more extensive series of measurements of the deflection of the corpuscular rays in magnetised iron have been recently undertaken by me, using an improved and more sensitive arrangement (which has already been briefly described[4]) on a principle suggested by Prof. Puccianti.

Figs. 1 and 2 represent the apparatus used in a first experiment in plan and in vertical section. The core of the magnet consists of two iron plates *A* and *B*, 2·8 cm. × 13 cm. × 38 cm., four millimetres apart; the two armatures *C* and *D* close the magnetic circuit. The wire carrying the magnetising current is wound round the plates in a single layer of seven turns per

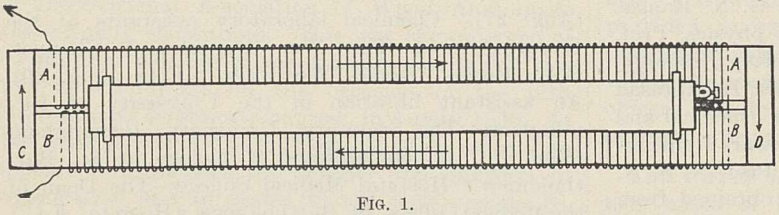

FIG. 1.

centimetre; with a current of five amperes the induction field inside the iron (measured with a ballistic galvanometer) is 16,200 gauss; the induction lines are closed without emerging from the core, and pass through it, as indicated by the arrows, clockwise or counter-clockwise according to the direction of the magnetising current. Above and below the magnet are two tube counters, each of 2·5 cm. internal diameter and of an effective length of 25 cm.; their axes are horizontal and parallel to the direction of magnetisation.

The experiment was carried out by counting the coincidences between the impulses of the two counters, alternately reversing the direction of the magnetising current. Since the two plates are inversely magnetised, the corpuscles are deflected in contrary directions, according as they pass through the first or the second plate. It is consequently easily seen that the corpuscles which have passed through the first counter (if negatively charged) are concentrated in the second or are repelled from it according as the induction lines are counter-clockwise or clockwise. An increase in the frequency of the coincidences in the former case and a diminution in the latter is therefore to be expected. If the corpuscles are positively charged, the conditions are reversed.

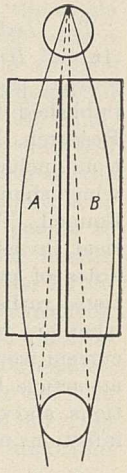

FIG. 2.

Perhaps the performance of the apparatus will be better understood by explaining that the effect of magnetising the plates is to alter the angular aperture of the beam subtended by the lower counter from any point of the upper (see Fig. 2). The effect which may be expected from a beam of corpuscles all of the same energy can be represented approximately (provided R is not too small and the loss of energy in the iron is neglected) by the formula: $\frac{\Delta N}{N_0} = \frac{140}{R}$, where R is the radius of curvature of the path of the corpuscles which penetrate the plate perpendicularly to the induction lines, N_0 is the frequency of the coincidences when the field is zero, ΔN is the difference between the frequency of the coincidences with the field in alternate directions. For electrons or protons of 10^{10} *e*-volt the above formula gives, for example, $\frac{\Delta N}{N_0} = 0{\cdot}068$.

The result of the measurements was as follows:

Field clockwise:
In $197^h\ 34^m$ . . . 21·534 coincidences.
Field counter-clockwise:
In $197^h\ 34^m$ . . . 20·756 coincidences.

$$\Delta N = 778 \pm 200 \quad \frac{\Delta N}{N_0} = \frac{778 \pm 200}{\frac{1}{2}(21{\cdot}534 + 20{\cdot}756)} = 0{\cdot}037 \pm 0{\cdot}01.$$

(The chance coincidences, amounting to 1205 for each series of measurements, have been deducted from the above figures.) The difference is therefore 3·7 times greater than the mean error, and it may be considered as being very probably true. It will be noted that its sign is that proper to a beam of positive particles.

In order to test whether this effect was actually due to the deflection of the penetrating corpuscular rays, which pass through the iron, the experiment was repeated with a magnet similar to the former, but of greater size. If the above assumption is correct, an effect three times larger was to be expected. The result of the measurement was as follows:

Field clockwise:
In $108^h\ 9^m$ . . . 5·261 coincidences.
Field counter-clockwise:
In $108^h\ 9^m$ . . . 5·157 coincidences.

$$\Delta N = 104 \pm 105 \quad \frac{\Delta N}{N_0} = \frac{104 \pm 105}{\frac{1}{2}(5261 + 5157)} = 0{\cdot}02 \pm 0{\cdot}02.$$

It is seen that the difference is within the limit of the experimental error (twice as great as in the former experiment) and does certainly not reach the expected value. The little effect found in both experiments may be due to the deflection of positive secondary particles of lower energy, generated inside the iron. Safely, however, one can only say that the primary

corpuscular rays are not deflected, by passing through the iron to such a great extent, as electrons or protons of 10 or 20 milliards e-volt would be, provided the effective magnetic field is identical with the induction field. (In the latter experiment, for example, it was from electrons of 10^{10} e-volt that an effect of 20 per cent was to be expected.)

A fuller description of the experiments, with a more exhaustive discussion of the results obtained, will be published later.

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Arcetri, Italy, July 10.

[1] W. Bothe und W. Kolhörster, *Zeit. f. Phys.*, **56**, 751; 1929.
[2] B. Rossi, *Rend. Lincei*, **11**, 478; 1930.
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Nuclear Moments of the Isotopes of Lead: Relative Values of the $g(I)$ Factors of Pb(207) and Tl.

As a continuation of the programme that was initiated with the analysis of the hyperfine structure of Tl II,[1] the hyperfine structure of Pb III was investigated. The important Pb III lines [2] in the visible region were examined by means of a concave and an echelon grating. The structure and intensities of the patterns were interpreted consistently by attributing $I = 0$ to the two even isotopes Pb(206) and Pb(208), and $I = \frac{1}{2}$ to the odd isotope Pb(207). This interpretation is in agreement with Kopfermann's [3] deductions based on the structure of Pb I and II lines and with Schüler and Keyston's [4] inference based on intensity measurements of the lead line λ4058.

The observed H.F.S. of Pb(207) III is similar in regard to relative separations to that of Tl II. The magnitudes of the separations in Pb(207) III, however, are much smaller than those of Tl II. The separation of the $6s7s\ ^3S_1$ of Pb(207) III is only 2·25 cm.$^{-1}$ as compared with the 4·97 cm.$^{-1}$ separation of the corresponding state of Tl II.

From these separations of the $^3S_1$ states of the two spectra, the values of the interaction constants of the $6s$ electrons of the $6s7s$ configurations of Pb(207) III and Tl II can be evaluated.[5] A comparison of these values shows that the $g(I)$ factor of the Tl nucleus is about four times that of the Pb(207) nucleus.

This result is especially significant. Up to the present the observed I values have been explained consistently on the assumption that only spinning protons contribute to the resultant moment of the nucleus.[6] The simple assumption that each proton contributes $\frac{1}{2}h/2\pi$ to the resultant was sufficient to explain the known facts. On this simple theory, the resultant moments of the nuclei of Tl and Pb(207), for both of which $I = \frac{1}{2}$, would be due to one unneutralised spinning proton. The $g(I)$ factors of the two nuclei, then, would be expected to be the same, since there is no evidence to indicate why different spinning protons with the same mechanical moments should have widely different magnetic moments. Contrary to this expectation, experiment shows that the $g(I)$ of the Tl nucleus is about four times that of the Pb(207) nucleus. The obvious conclusion is that the moment of at least one of the nuclei is composite and not due simply to a spinning proton. This conclusion invalidates the simple rule that each proton contributes $\pm\frac{1}{2}h/2\pi$ to the resultant, and necessitates endowing some of the protons in at least one of the nuclei with some property in addition to spin.

Our knowledge of extra-nuclear electronic structure suggests orbital motion. This model is not extreme, since the dimensions of a proton relative to a complete nucleus are of the same order as the dimensions of an electron to the atom. Such a model has the possibilities of explaining not only resultant I values, but also the nuclear $g(I)$ factors, even if the latter are negative.

J. C. MCLENNAN.
M. F. CRAWFORD.
L. B. LEPPARD.

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[7] Page and Watson, *Phys. Rev.*, vol. 35, p. 1584; 1930.

Diamagnetism of Liquid Mixtures.

WITH regard to the discussion in NATURE by Trew and Spencer [1] and Ranganadham [2] on the diamagnetism of liquid mixtures, I should like to communicate the following data based on measurements carried out by me.

I find that the deviations from the susceptibility for the mixture calculated from the proportions of the components for acetone-chloroform is only 2 per cent. I find no trace of paramagnetism. Trew and Spencer believe that the paramagnetism they find for this mixture is probably attributable to the formation of dimethyltrichloromethyl carbinol (in German, Trichlorbutylalkohol tertiär), which their measurements show to be *paramagnetic*. I find this substance to be *diamagnetic* ($\chi = -0{\cdot}65 \times 10^{-6}$, and with water of crystallisation present $\chi = -0{\cdot}67 \times 10^{-6}$). Further, for this substance I have obtained values of $\chi = -0{\cdot}64_5$ and $\chi = -0{\cdot}66 \times 10^{-6}$ respectively from calculation following Pascal's rule. Again, the density of this substance according to Trew and Spencer is 0·66, whereas I find it to be 1·5, and these authors state that the substance is pale yellow, while all chemical references agree that it is white, a fact which I have observed myself. I find in agreement with previous work that the melting-point is 96·5° C. (97° C. ?) and 76° C. in the case where water of crystallisation is present. Two samples of dimethyltrichloromethyl carbinol where investigated, one from Kahlbaum, the other made by Frl. Karin Meyer; the two showed identical properties.

The capillary ascension method of Quincke was employed using field strengths of 8200, 3850, 1800, and 1300 gauss; the last of these gave only qualitative results since the sensibility at this field strength was not sufficiently great. In view of the present results, the possibility of explaining Trew and Spencer's measurements (at 640 gauss) by an anomalous dependence on the field strength is thus probably excluded. For the dimethyltrichloromethyl carbinol a Weiss (bifilar) balance method was employed to determine the susceptibility using a field of 8500 gauss.

It should also be noticed that the density curve for acetone and chloroform, given by Trew and Spencer in their original paper, shows that dimethyltrichloromethyl carbinol could not have been present in this mixture, for if it had been, a large density anomaly would have appeared.

The use of Pascal's theoretical values, by means of which Trew and Spencer have attempted to support their results, appears to me to be misleading. For example, the single exception in agreement between theory and measurements quoted by Trew and Spencer, namely, acetone, is precisely the substance for which the large deviations are found to occur. Further, a closer inspection of Pascal's results shows that the deviations between calculated values and experimental observations of other authors are system-

atic, that is, the greater the halogen (Cl, Br) content of a compound the greater these deviations become.[3] My results, $\chi = -0{\cdot}58 \times 10^{-6}$ for acetone and $\chi = -0{\cdot}485 \times 10^{-6}$ for chloroform, are within the limit of error of previous measurements recorded by other authors.

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July 26.

[1] *Proc. Roy. Soc.*, **131**, 1931, p. 209, and NATURE, **128**, 1931, p. 152.
[2] NATURE, **127**, 1931, p. 975.
[3] Pascal, *Ann. de Chim. et Phys.*, **19**, p. 67; 1910.

Function of Water Vapour in the Dissociation of a Salt Hydrate.

IN measuring the influence of the gaseous product upon the velocity of dissociations of the type

$$\text{Solid}_1 \longrightarrow \text{Solid}_2 + \text{Gas},$$

we have found an interesting effect with the reaction:

$$MnC_2O_4.2H_2O \longrightarrow MnC_2O_4 + H_2O,$$

which goes on slowly in a vacuum at 76°, at which temperature the dissociation pressure is approximately 135 mm.

The reaction rate under otherwise constant conditions is sensitive to quite small concentrations of water vapour. Plotted against a linear scale of water vapour pressures, the quotient

$$\frac{\text{Rate in vacuum}}{\text{Rate at } p\text{H}_2\text{O}}$$

(shown in the diagram as 'rate') at first falls sharply; this appears to be the normal behaviour of salt hydrates. But with increasing water vapour pressures the rate passes through a minimum at about 10^{-1} mm. (that is $<10^{-3}$ of the dissociation pressure) and then rises, to pass through a maximum of the same order as the rate in vacuum; thereafter it falls again along a more gentle curve eventually to zero at the dissociation pressure. So far as we know at present, this minimum and maximum is a unique case.

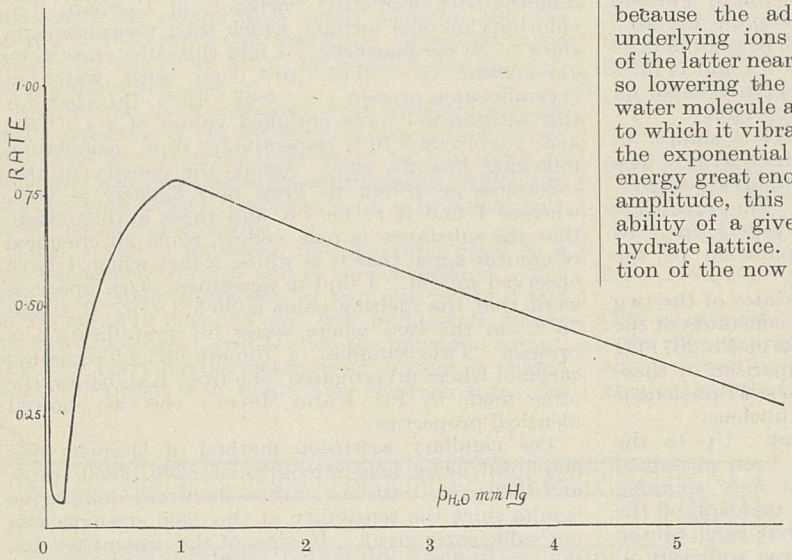

FIG. 1.

In rough outline the following picture might provide a qualitative explanation of the effect: the reaction is experimentally of the usual 'interface' type, that is, dependent upon the presence of the anhydrous phase. It possesses a large temperature coefficient, so that the rate-governing process is subject to a considerable activation, presumably in vibrational degrees of freedom. In our view, two stages are involved:

$$\text{Salt hydrate} \rightleftarrows (\text{Anhydrous salt} + H_2O \text{ adsorbed in interface}) \rightleftarrows \text{Anhydrous salt} + H_2O \text{ (gas)}.$$

Water molecules in the hydrate lattice adjoining the anhydrous phase require a smaller vibrational energy to enable them to break out of the lattice because of the attraction exerted by the ions on the opposite side of the reaction zone; hence the reluctance of the reaction to take place in the absence of the second solid phase.

Water vapour in the gas phase establishes an adsorption equilibrium in the interface zone between the two solids rapidly in comparison with the slow chemical reaction. The net rate of decomposition is now decreased (*a*) because it is the difference between two opposing rates, (*b*) because a fraction of the interface is blocked for decomposition by the adsorbed molecules already present.

As the two-dimensional density of adsorbed molecules increases (with the arbitrarily maintained partial pressure) a stage will be reached in which the gaps in the adsorption layer are more or less surrounded by other adsorbed molecules. We suppose that these gaps may be much more effective in promoting the reaction than the corresponding area not so surrounded, because the adsorbed molecules polarised by the underlying ions virtually carry the attractive field of the latter nearer to the hydrate side of the interface, so lowering the force constant between the hydrate water molecule and the rest of its lattice, with respect to which it vibrates in the reaction zone. Because of the exponential factor governing the chance of an energy great enough to give the molecule an assigned amplitude, this may increase enormously the probability of a given molecule breaking loose from the hydrate lattice. At the same time, the mutual attraction of the now rather numerous adsorbed molecules polarised by oppositely charged ions will decrease the probability of a given molecule contributing to the reverse reaction by passing from the adsorbed layer back to the lattice. The combined effect is to cause the net rate to rise again, and clearly it must pass through a maximum and fall again more slowly as the gaps available for the forward reaction become filled up and the number of molecules in a position to contribute to the reverse reaction is still further increased. Ultimately the two opposing rates become equal at the dissociation pressure.

The initial rapid fall with very small fractions of the dissociation pressure explains the well-known difficulty of approaching the equilibrium in many salt hydrate systems experimentally.

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Magnetism of Colloidal Gold.

IN three previous notes in NATURE[1] it has been pointed out that the diamagnetism of graphite, antimony, and bismuth decreases with particle size. This was most striking in graphite and less in antimony and bismuth. In a later communication on the same subject[2] I adopted two methods of

colloidalisation of bismuth—Bredig's method and mechanical colloidalisation. In Bredig's method I obtained an abnormally low value, due to the powder containing a mixture of oxide and the metal, as was pointed out by me. In the case of bismuth, S. S. Bhatnagar [3] contends that he obtains a large amount of oxide by mechanically colloidalising bismuth, and part of the decrease of diamagnetism that I obtained by that method is also due to oxidation.

We have recently investigated carefully prepared gold sols avoiding all possibilities of oxidation. The sol was prepared by the method of Zsigmondy for the preparation of gold sols, by reducing dilute solutions of gold chloride ($HAuCl_4$) by formaldehyde. The particle sizes are 10-40 $\mu\mu$ as mentioned by him. The sol was always kept in an atmosphere of hydrogen and never allowed to come in contact with the atmosphere. It was coagulated, washed, and dried in a high vacuum desiccator. From a large quantity of the sol about 20 mgm. were obtained as precipitate.

Its susceptibility was then determined in a high sensitivity Curie balance, the substance being sealed in a thin capsule and a correction being applied for the susceptibility of the latter. The specific susceptibility, χ, obtained was $0{\cdot}0804 \times 10^{-6}$, the value for gold in the massive state being $0{\cdot}15 \times 10^{-6}$ (I.C.T.).

As Gerlach has explained [4] the phenomena observed by Honda [5] on the decrease of diamagnetic susceptibility of copper and silver on cold working as due to the small percentages of the amorphous substance dispersed in the main body of the elements, it is possible that in a sol a very small percentage is in an amorphous state. An alternative suggestion is that a small percentage is in a crystalline structure different from cubical (copper, silver, and gold are cubical in structure), as the sols of gold and silver are known to exhibit magnetic double refraction. The well-known X-ray spectrograms of colloidal gold and that of crystals by Debye and Scherrer, however, show that both give similar line spectra, but in the former case the lines are more diffuse. While more work is necessary to decide completely between these explanations, it is certain that diamagnetism in gold and possibly also in many other substances depends on crystalline and block structure.

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BALWANT SINGH.
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Lahore, June 29.

[1] Sir C. V. Raman, NATURE, **123**, 945; 1929. V. I. Vaidhianathan, NATURE, **124**, 762; 1929, and **125**, 672; 1930.
[2] *Ind. Jour. Phys.* **5**, 559; 1930.
[3] *Ind. Chem. Soc. Jour.* **7**, 975; 1930.
[4] NATURE, **127**, 556; 1931.
[5] NATURE, **126**, 990; 1930.

Structure of the Trifluorides of Aluminium, Iron, Cobalt, Rhodium, and Palladium.

UNTIL recently very little was known about the structure of these trifluorides.[1,2] An examination by the powder method was made of aluminium and iron trifluorides, forming a part of an investigation on the structure of the trihalogen salts of aluminium, iron, and chromium. The diagrams so obtained proved that the trifluorides mentioned in the title are all isomorphous, as was already known of the four latter compounds.

The hexagonal elementary cell contains three molecules:

AlF_3 :	$a = 4{\cdot}93$ A.,	$c = 6{\cdot}25$ A.,	$c/a = 1{\cdot}265$
FeF_3 :	$a = 5{\cdot}20$ A.,	$c = 6{\cdot}66$ A.,	$c/a = 1{\cdot}28$ [2]
CoF_3 :	$a = 5{\cdot}06$ A.,	$c = 6{\cdot}63$ A.,	$c/a = 1{\cdot}31$ [2]
RhF_3 :	$a = 4{\cdot}88$ A.,	$c = 6{\cdot}81$ A.,	$c/a = 1{\cdot}39$ [2]
PdF_3 :	$a = 5{\cdot}05$ A.,	$c = 7{\cdot}08$ A.,	$c/a = 1{\cdot}40$ [2]

Contrary to Ebert,[2] I found that these structures are not purely rhombohedral, for with chromium $K\alpha$ rays it was possible to discern undoubtedly 200 near 003 (111 rhombohedral). The space group proved to be D_3^1 with metal on

one onefold position : 000, and on
one twofold position : $\frac{1}{3}\,\frac{2}{3}\,u_1$; $\frac{2}{3}\,\frac{1}{3}\,\bar{u}_1$; with $u_1 = \frac{2}{3}$.

The fluorine ions on :

(1) one threefold position :

$$u_2\,u_2\,\tfrac{1}{2}\ ;\ 0\,\bar{u}_2\,\tfrac{1}{2}\ ;\ \bar{u}_2\,0\,\tfrac{1}{2}\ ;\ \text{with } u_2 = \tfrac{2}{3},$$

(2) one sixfold position :

$$xyz\ ;\ y-x,\ \bar{x},\ z\ ;\ \bar{y},\ x-y,\ z\ ;$$
$$yx\bar{z}\ ;\ \bar{x},\ y-x,\ \bar{z}\ ;\ x-y,\ \bar{y},\ \bar{z},$$

with $x = \frac{1}{6}$, $y = \frac{5}{6}$, $z = \frac{1}{6}$.

These five parameters will differ very little from the above rational values. The intensities calculated with these parameters are in good agreement with those observed.

In the case of aluminium trifluoride, u_1 is perhaps 0·70 rather than $\frac{2}{3}$.

The structure consists of alternating planes of metal and fluorine ions, the latter being close-packed around the first.

The distance between two fluorine ions is somewhat smaller than that calculated with a radius of 1·33 A., namely : $AlF_3 = 2{\cdot}46$ A., $FeF_3 = 2{\cdot}60$ A., $CoF_3 = 2{\cdot}53$ A., $RhF_3 = 2{\cdot}44$ A., $PdF_3 = 2{\cdot}52$ A. This is in remarkable agreement with the observation in some trifluorides of the rare earths by Oftedahl,[3] who found 2·47 A. in lanthanum trifluoride.

The metal ions are arranged on a nearly cubic rhombohedron, the fluorine ions (2) are on the middle of the six polar edges; only the fluorine ions (1) are not on the middle of the other edges.

A full report will be given in the *Z. für Kristallographie*. A communication on the various structure types for compounds of the type MF_3 will also follow. I am indebted to Dr. H. J. Verweel for a part of the experimental work.

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[1] A. Ferrari and A. Schurillo, *Gazz. Chim.*, **59**, 927; 1929.
[2] F. Ebert, *Z. Anorg. Chem.*, **196**, 395; 1931.
[3] I. Oftedahl, *Zeit. Phys. Chem.*, B, **5**, 272; 1929.

Effects of Inadequate Feeding on Insect Metamorphosis.

SOME years ago H. S. Pruthi pointed out [1,2] that moulting in insects is not the result of growth, but is "primarily concerned with metabolism". He found that intermittent starvation of the larvæ of *Tenebrio molitor* extended the duration of the larval period and increased the number of moults, the size and weight before pupation of the older larvæ being the same as in the younger ones. Partially starved larvæ of *Pieris brassicæ* also showed an increased number of moults, the size and weight before pupation being the same as in normally fed caterpillars used for control experiments. Pruthi therefore concluded that if "moulting is simply to allow growth, there is absolutely no necessity for extra moults", and expressed the opinion, based on observations detailed in his paper,[1] that if larvæ are starved before the commencement of the metamorphic processes pupation is delayed, while if they are starved after maturity pupation is accelerated. On the other hand, as he himself shows, several workers contradict the theory that inadequate feeding, quantitatively or qualitatively, delays metamorphosis.

My own limited experience supports those who take this view. In the case of *Orgyia turbata* Butler (Corbett and Dover[3]), on which observations were made by the Government Entomologist, F.M.S. and S.S., and his staff, it was found that a heavy mortality occurred among caterpillars fed on *Crotolaria* (a plant to which they were not accustomed), but that those which survived completed the larval period sooner and with less moults than those fed on *Mimosa*, the favourite food-plant of the earlier instars. It seems, therefore, that diminished metabolic activity, consequent on an unpalatable food-supply, accelerates the completion of the larval period, probably because there is a lesser accumulation of waste nitrogenous and carbonaceous matter, the elimination of which, as suggested by Eisig and Sharp [4], is assisted by ecdyses. Moreover, "a quick life-cycle would increase the possibility of the larvæ surviving the disadvantages occasioned by unhealthy food". These opinions are of interest, not only because they partially contradict the views of Pruthi and others (while supporting the fundamental hypothesis that moulting is more intimately connected with general metabolism rather than with growth), but also because they suggest that "an insect which has once gained a foothold on a plant which is commonly supposed to be unpalatable may be more numerous than on more favoured food-plants", at least during the initial stages of adaptation.

How can the difference between the above observations and those of Pruthi be explained? The answer probably lies in the fact that in all his partial starvation experiments starvation was intermittent, while in the case of *Orgyia turbata* fed on *Crotolaria* the food-supply was apparently unpalatable, and was not partaken of so freely as was *Mimosa*: there was a reduction in the quantity of food taken, but there were no periods of starvation followed by normal feeding. The interpretation of Pruthi's results, therefore, appears to be that a comparatively lengthy period of starvation, followed by an equal period of normal feeding, disturbed the metabolic rhythm to the extent of retarding growth. The increased number of moults observed in his intermittently starved larvæ can be explained by Eisig and Sharp's theory, for the nature of the feeding permitted to them must have resulted in an excessive accumulation of waste products which ecdyses helped to eliminate. If these explanations are accepted, it will be seen that Pruthi's results are brought more into line with the proposition that, in many cases, an unpalatable and reduced food-supply accelerates the completion of the larval period. The problem is, however, a controversial one, and is of both biologic and economic interest. Further investigations should therefore be of value.

CEDRIC DOVER.

[1] Pruthi, *Brit. Jour. Exp. Biol.*, **8**, 1; 1925.
[2] Pruthi, NATURE, Dec. 26; 1925.
[3] Corbett and Dover, *Malayan Agric. Journ.*, **15**, 7; 1927.
[4] Sharp, "Camb. Nat. Hist.", Insects, **1**, p. 163; 1901.

Excitation of the Green Auroral Line.

THIS note will be of special interest when compared with my paper on the light of the night sky, published in a recent number of the *Physical Review*, and with my report before the Pasadena meeting of the American Physical Society, in which I reported the first effectively complete reproduction of the aurora spectrum. On many of the spectra which were photographed during the progress of the above-mentioned experiments, it was thought that there were definite, though weak, indications of the presence of the green auroral line. The failure of the green line to appear with considerable intensity in these experiments was never considered to be serious, since there was ample evidence for the occurrence of collisions between excited nitrogen molecules and metastable oxygen atoms in the states which are involved in the emission of the green line. Since the state on which the green line originates is metastable, it is not at all surprising that the line was either absent or missing in these experiments.

In my most recent experiments, on raising the pressure from 10^{-3} mm. to about 5 mm. by admitting oxygen to the tube in which the auroral spectrum was reproduced at the lower pressure, it was found that, so far as the excitation of oxygen was concerned, the tube behaved very much as it did at the lower pressure. Now at 10^{-3} mm. it was often possible to obtain a large decomposition of oxygen molecules into atoms, without the appearance, however, of the arc spectrum of oxygen. The presence of atoms in great numbers was indicated by the incandescence of small bits of oxide (as in atomic hydrogen) and also by strong heating of small patches of the tube wall. Now the production of oxygen atoms, under conditions where no arc lines (other than the green line) are produced, arises both in the aurora and in the night sky. Because of the marked resemblance between the low-pressure tube and the high-pressure tube, a photograph was taken of the spectrum of the high-pressure tube and a fairly strong excitation of the green line was observed. Other plates showed that when the arc lines of oxygen increased in intensity the green line decreased in intensity, which indicates that the process by which the green line is excited in these experiments is one which does not excite the arc spectrum. Such a process is discussed in some detail in my paper on the light of the night sky.

It is believed that the process of excitation of the green lines is the same in both the high-pressure and the low-pressure tubes, but that at high pressures the green line is emitted because collisions with the wall or with nitrogen molecules are less probable in view of the diluting effect of the added oxygen. It is also possible that the lifetime of the metastable oxygen atom which emits the green line is less at high pressures than at very low pressures in view of the close proximity of excited atoms and molecules.

It is important to note that the green line was excited in the present experiments without the use of rare gases. Practically all other laboratory reproductions of the green line have been made with the help of rare gases. Fuller discussion of the present work will show that the present excitation of the green line and the rest of the auroral spectrum is probably the one that occurs in Nature, and furthermore, it is a phenomenon in which only oxygen and nitrogen are involved. For that reason the present experiments should have a direct bearing on the problem of the origin of auroral displays.

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July 18.

The Slow Combustion of Methane and Ethane.

THE observations referred to by Prof. W. A. Bone in NATURE of Aug. 1 (p. 188) with regard to the source of alcohols in the combustion products of paraffin hydrocarbons were based on experimental evidence accumulated in Great Britain and other countries from the point of view of the peroxide mechanism of combustion; compare, for example, in the case of methane, the work of Wartenburg and Sieg,[1] who concluded that methane first forms the moloxide $CH_4(O_2)$. It is interesting to note that the earlier supporters of the peroxide theory of oxidation had discovered the presence of alcohols in the oxidation

products of hydrocarbons, but it was considered that these alcohols had been derived directly from the peroxides or from the esters [2] and not at all from a primary hydroxylation process.

The particular view that oxygen first enters the –CH group with its labile hydrogen, to form an alkyl hydrogen peroxide, was arrived at in 1926, after a consideration of the results obtained in a research on the slow oxidation of a large number of fuel vapours in air.[3] Attempts to isolate organic peroxides were unsuccessful,[4] but now, after five years, it has been discovered by Dumanois, Mondain-Monval, and Quanquin that alkyl hydrogen peroxides are present, not only in the combustion tube, but also in the petrol engine.[5]

An intensive study of the oxidation of ethane and methane in air with and without the addition of inhibitors, carried out by myself (an account of which has been submitted for publication), has provided further evidence in favour of the Engler-Bach peroxidation theory of combustion. The experiment of endeavouring to isolate the moloxide or the activated methyl hydrogen peroxide from methane has not been attempted, since it is considered that at the temperatures of the experiment, namely, above 600° C., any organic peroxide would have an extremely short life, and if any organic peroxide were isolated, then, as Staudinger points out, it would not be the primary one, but a derivative or degraded form of it. The peroxidation theory of combustion is not essentially based on the isolation and identification of organic peroxides, but rather on the characteristic behaviour of inhibitors and surfaces and on the phenomena of autoxidation and autocatalysis.

It would be interesting to know how Prof. Bone would explain by the hydroxylation theory the autoxidation of benzene vapour to phenol or of aniline vapour to tars at low temperatures, facts recorded in the literature of hydrocarbon combustion.[6]

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[1] *Ber.* **53**, 2192; 1920. A short bibliography of the subject of the oxidation of fuel vapours is given in *R. and M.* (Air Ministry), 1374; 1930.
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[3] Callendar and others, *Engineering*, *R. and M.* (Air Ministry), 1062; 1926.
[4] Mardles, *J.C.S.*, 872; 1928.
[5] *Comptes rendus*, **19**, 158; 1931. *Ann. des Comb. Liquides*, **5**, 915; 1930.
[6] Mardles, *J.C.S.*, 872; 1928. Gill, Mardles, and Tett, *Trans. Far. Soc.*, **24**, 574; 1928. Brunner, *Helvetica Chemica Acta*, **13**, 197; 1930.

Œstrus-Producing Hormones.

RECENTLY, Doisy and his co-workers (1931) have reported the isolation from the urine of pregnancy of a crystalline substance possessing œstrus-producing activity, which is distinct from the active substance theelin, previously described by them. The latter substance, to which they gave the formula $C_{18}H_{21}(OH)_2$, was shortly afterwards isolated by one of us (Butenandt, 1929) [1] and by Dingemanse and co-workers [2] (1930). It was shown afterwards (Butenandt, 1930) that this substance is represented by the formula $C_{18}H_{22}O_2$, and that it behaves either as a hydroxy ketone or as a dihydroxy alcohol.

There is no doubt that the second substance isolated by Doisy and his co-workers,[3] to which they give the formula $C_{18}H_{21}(OH)_3$, is identical with that fully described earlier by one of us (Marrian, 1930)[4]. Although Prof. Doisy refers to the triol previously isolated, there is no suggestion in his papers that it had been characterised as a trihydroxy substance of the formula $C_{18}H_{21}(OH)_3$. His view that the substance described by one of us is a mixture of both active substances is apparently based solely on a difference between the *uncorrected* melting points. The evidence of the analytical data, which clearly shows this supposition to be untenable, is ignored.

A year ago when the presence in urine of two distinct œstrin-producing substances was clear to us, we were considerably puzzled over the relationship between them. The suggestion was tentatively advanced (Marrian, 1930) that the substance $C_{18}H_{22}O_2$ on treatment with hot alkali took up the elements of water to form $C_{18}H_{24}O_3$. This supposition was afterwards shown to be incorrect (Butenandt, 1930), since the former substance proved to be unchanged by such treatment. At the same time it was shown that both substances occur together in urine, and that by distillation in a high vacuum with potassium bisulphate, $C_{18}H_{24}O_3$ could be converted into $C_{18}H_{22}O_2$. Prof. Doisy has made no adequate reference to this work, and has advanced the earlier view, which has been shown to be untenable.

G. F. MARRIAN.
A. BUTENANDT.

London and Göttingen,
July 23.

[1] Butenandt, *Naturwiss.*, **17**, 879; 1929. *Deutsch. Med. Woch.*, **55**, 2171; 1929. *Zeit. für physiol. Chem.*, **191**, 140; 1930. *Abh. d. Ges. d. Wissensch. zu Gottingen*; 1931. *Math. phys.* Kl. iii. Folge, Heft 2.
[2] Dingemanse *et al.*, *Deutsch. Med. Woch.*, **56**, 301; 1930.
[3] Doisy *et al.*, *Proc. Soc. Exp. Biol. Med.*, **28**, 88; 1930. *J. Biol. Chem.*, **91**, 641, 647, 653, 655; 1931.
[4] Marrian, *Chem. and Ind.*, June 20; 1930. *Biochem. Jour.*, **24**, 1021; 1930.

Segregation of Floral Characters in the Wild Oxlip.

DR. C. J. BOND [1] finds that in hybrids between the primrose (*Primula vulgaris*) and the cowslip (*Primula veris*) the earliest flowers were formed singly on long peduncles of the primrose type, while the later ones were arranged in the umbelliferous type as in the cowslip. He asks whether these two types of inflorescence are also found in the true oxlip (*Primula elatior*).

I have cultivated this latter plant, originally obtained from Cambridgeshire, for many years, and have never seen any of the plants producing flowers singly on peduncles as in the primrose. They were always produced on a common erect scape. In Switzerland, too, where I found them last May, this was the sole method of flower-bearing. This fact, therefore, would support the more generally held opinion that *Primula elatior* Jacq. is a true species and quite distinct from the hybrid between the primrose and cowslip, from which it differs in other characters also.

In hybrids of my own raising, between the primrose and the true oxlip (*Primula elatior*), I have, however, often noticed the phenomenon described by Dr. Bond for hybrids between primrose and cowslip. I have also seen the two types of flower-bearing in hybrids which I have raised from *Primula elatior* crossed with *Primula Juliae*. In this case also the single pedunculate flowers preceded those borne on a common scape, which was usually comparatively short. It would appear, therefore, that in crossing some species of *Primula*, one of which produces its flowers singly and the other bearing numerous flowers on a common scape, neither type of inflorescence is completely dominant, but that both types may occur in succession. As this condition occurs also in the cultivated form known as Mrs. McGillivray, it would point to this plant being a hybrid, probably with *Primula Juliae* as one of the parents.

F. E. WEISS.

Pittance Farm, near Cranleigh,
Surrey, July 27.

[1] NATURE, May 9, p. 708.

Research Items.

The Roman Neanderthal Skull.—A description of the Neanderthal skull found at Saccopastore, near Rome, as first announced to the Société romaine d'Anthropologie on June 1, 1929, is given by Prof. Sergio Sergi in *L'Anthropologie*, t. 41, Nos. 3-4. It is one of the best preserved of the Neanderthal skulls, and the condition of the base affords an exceptional opportunity of appreciating its characteristics. The cranial capacity is 1200 c.c., which makes it the smallest known of the Neanderthal skulls. This fact, combined with its refinement in character, suggests that it is the skull of a female, and, judging from the state of the sutures and dentition, it is that of a young woman. The position of the foramen, which is farther forward than in the Chapelle-aux-Saints skull, in which, however, the position may be due to faulty orientation and reconstruction, indicates that the head was carried as erect as in modern man. The cephalic index is approximately 78·4. The horizontal contours of the Saccopastore and La Chapelle skulls, taken in the plane of the lambda, coincide in a surprising manner. The horizontal perimeter is, at the maximum, 520 mm., La Quina being 515 mm. Near the lambda is a complex system of wormian bones, a common phenomenon in Neanderthal skulls. The significance of this feature has hitherto been overlooked; but it points to instability in the occipital region over the inion, which is here in course of evolution. In norma lateralis the whole peribregmatic region shows flattening, the frontal inclination (74°) and occipital (70·5°) being comparable to that of the Gibraltar skull. In a posterior segment the skull shows a certain degree of roundness, contrasting with the bun-like projection of the occiput in La Chapelle and La Quina. The face and its features are very large. In its general dimensions and its morphology the skull is nearest to the Gibraltar skull. The associated fauna point to a dating at the Riss-Würm Interglacial.

Milk Diets for Rats.—We have received the first number of the fourth volume of *The Journal of Nutrition* (Messrs. Baillière, Tindall, and Cox). This journal, which is produced in the United States, was started in 1929, and has established itself as a scientific periodical dealing with many different aspects of the nutrition of animals and human beings. Among the original contributions are papers by J. Waddell, H. Steenbock, and E. B. Hart on the effects of milk diets on rats. On whole cow's milk supplemented with copper the animals suffered from anæmia, and growth and reproduction were subnormal although third-generation animals were secured. When iron was also added to the diet, no anæmia occurred, but growth and reproduction were still subnormal. The females matured late and the reproductive cycles were prolonged. Small amounts of manganese or iron improved the ovulation rhythm. No evidence of lack of vitamin E was observed. The males suffered from testicular degeneration, which also was not due to deficiency of vitamin E. It was also found that addition of iron to an ordinary stock ration prevented the animals from utilising the vitamin E in the diet or possibly destroyed its vitamin E content. D. L. Hussemann and R. A. Hetler found that vitamin B_2 is probably more essential for successful lactation in the rat than vitamin B_1, although both are required.

Incubation of the Mexican Jacana.—The share taken by the respective parents in the incubation of the eggs of shore-birds still requires much investigation. Alden H. Miller contributes new facts concerning the breeding activities of the Mexican jacana (*Jacana spinosa*) observed at Lake Olomega, Central America (*Condor*, vol. 33, p. 32; 1931). Scrutiny of the marsh at a distance of 50-75 yards revealed the presence of nests, which were betrayed when the adult birds quietly ran or sneaked away. In every case it was the male bird which was flushed from the nest, and although in some instances the females were near by, they were little disturbed by an intruder at the nest, in contradistinction to the males. It is the author's impression that females were more often seen about nests containing fresh or slightly incubated eggs than about eggs heavily incubated or where there were young. He decides that the male jacana performs most if not all of the incubation, and that it also cares for the young. Females take relatively little interest in eggs and young, although they are decidedly active in courtship. Another interesting observation was that the demonstrations indulged in by the incubating birds were much less frantic than the demonstrations of birds accompanied by young, and that 'broken wing' antics were seen only in cases where the eggs were hatching or where young were following the male parent.

Nitrogenous Excretion in Invertebrates.—Prof. H. Delaunay contributes to *Biological Reviews* (Camb. Phil. Soc., vol. 6, July 1931) a useful summary of recent work on excretion in invertebrates. He directs attention to the three main types of excretory organs —(*a*) those which open to the exterior, for example, nephridia, malpighian tubes of insects; (*b*) those in which excretory substance accumulates, for example, the branchial heart of cephalopods; (*c*) the atrocytic organs or cells which shed into the fluid in some cavity the solid or liquid which they produce, for example, the chloragogen cells of oligochætes, the pericardial cells of insects. An account follows of recent observations on excretion, beginning with the Protozoa. In *Paramecium* and *Spirostomum* nitrogen is excreted as urea, but in *Didinium* in ammoniacal form. In *Spirostomum*, the fluid withdrawn by means of a micropipette from the contractile vacuoles contains so small an amount of urea that it would appear that these vacuoles serve simply to expel the excess of water from the cytoplasm, and that the nitrogenous waste passes out by osmosis from the entire surface of the organism. In leeches, ammoniacal nitrogen forms the major part of the excretion, and this appears to be true also for earthworms. The absence of uric acid in the concretions and extracts of nephridia appears to be general (but Willem has stated that in the concretions in the excretory organs of *Arenicola* urate of sodium is present). On the contrary, uric acid preponderates in the excretory material of insects. The author reviews the conditions in cœlenterates, sponges, echinoderms, molluscs, crustacea, insects, and araneids, and then passes to a comparative study of the different nitrogenous excretory products.

Methylene Blue Stain for Yeast Cells.—The hitherto unsuspected factors producing anomalous results in the staining of yeast cells with methylene blue have already been indicated in NATURE (**126**, 491; 1930), and the necessity for revision of the technique is

further demonstrated by the work of Fink and Weinfurtner, recorded in the *Wochenschrift für Brauerei* (**48**, 159; 1931). Portions of a 0·4 per cent suspension in distilled water of fresh pressed yeast were added to five times the volume of solutions of certain sugars. It was shown by plate-culture experiments that, after 30 minutes, most of the cells were still alive, although the methylene blue test indicated that only 10 per cent had survived compared with 95 per cent in a blank experiment. It is clear that in order to take the stain so readily the permeability of the walls of the yeast cell must have undergone a considerable increase in excess of that which normally occurs when yeast is suspended in distilled water. This increase is attributed to the sugar used, cane sugar, dextrose, lævulose, and galactose being approximately equal in effect, whilst maltose produces a smaller increase in permeability. The increase seems to be related to the fact that the sugars are non-electrolytes, since addition of potassium chloride in 0·1 *N* strength inhibited it completely: that is, the original impermeability of the walls was restored, the living cells being less susceptible to the stain than the dead cells. Revision of technique, therefore, will have to allow not only for the *p*H value of the medium, but also for the fact that in the absence of electrolytes and in the presence of sugars methylene blue will readily enter the cell and afterwards inhibit its growth.

Germination of Damaged Seeds.—How much a seed can be damaged without seriously affecting the resulting plant has been a matter of controversy since the inception of seed testing, and the question has been recently investigated by the British Association of Commercial Seed Analysts. New seed of species of *Brassica* may be damaged in a variety of ways; the testa may be lost or cracked, or the seed may be partially sprouted or attacked by weevils, and yet show a germination of seventy-five to a hundred per cent. Yearling seed, however, gave less satisfactory results. In the case of timothy, although badly damaged seed was of little value, that which was only slightly eaten showed a fifty-six per cent germination, and it seems possible that a satisfactory line of demarcation may be drawn between good and useless seed. As regards leguminous seeds, lucerne is the least susceptible to damage, more than eighty per cent germination being recorded, except in those cases where fracture had occurred at the junction of the cotyledons and radicle. Trefoil, alsike, and white clover, with seeds damaged in a similar manner, gave distinctly lower germination. The most striking results, however, were obtained with maple peas, even severely damaged seeds giving a seventy-eight per cent germination, of which fifty-six yielded mature plants. Soil tests carried out with new swede seeds, the testas of which were either entirely or partially missing, showed even up to ninety-seven per cent germination, failure only occurring where injury to the radicle was excessive. It would seem, therefore, that some revision in the use of the term 'impurities' in the case of such seeds is necessary.

Granites of Eastern Australia.—A valuable summary of the ages, distribution, and petrological characters of the granites of eastern Australia has been published by Prof. E. W. Skeats in the *Proc. Roy. Soc. Victoria*, **43**, 1931, pp. 101-118. Pre-Cambrian granites appear to be limited to the western part of the area, thus lending support to the hypothesis that the growth of Australia has been, on the whole, from west to east. Cambrian intrusions are found in west Tasmania and central Victoria; those of the Lower Devonian are widespread from Tasmania to south New South Wales; those of the Upper Devonian range from Victoria to central New South Wales; Lower Carboniferous granites occur in Victoria and Queensland; and Permo-Carboniferous and Triassic (or post-Triassic) examples are found in north New South Wales and Queensland. The loci of granitic intrusion thus seem to have migrated northwards during the periods mentioned. Judged by the association of *lit-par-lit* intrusions with fluxion gneisses and highly folded and metamorphosed sediments, there were only two important periods of mountain-building, the first in the Pre-Cambrian and the second at a time doubtfully referred to the Lower Devonian. Most of the remaining granites are thought to have been intruded under conditions of tension.

Air Pollution at Pittsburgh.—A paper, from the *Pittsburgh Record* June–July 1931, by H. B. Meller, head of the Air Pollution Investigation of the Mellon Institute of Industrial Research, gives the results of a year's study of 'sootfall' in Pittsburgh, 1929–30, and comparisons with previous studies, 1912–13 and 1923–24. Within the period, Pittsburgh had increased its population from 534,000 in 1910 to 680,000 in 1930, with some 20 per cent increase of area. 'Sootfall' represents the deposit caught in 'containers' exposed in different parts of the city, eighteen in 1930, eleven on the previous occasions. They were changed monthly, and, in the last study, an additional set daily. The catch for the year ranged from 2319 tons per square mile at Woods Run to 553 at Mt. Washington. If the catchment is on the same lines as in the corresponding study in Great Britain, Mt. Washington would be rated as a *C* station and Woods Run as a treble *D*. The scheme of analysis is, however, not quite identical. In Pittsburgh deposits are classified into: combustible 36 per cent, ash 47, and iron oxide 17. British records count insoluble (tar, carbon or soot, and ash) 60 to 40 per cent and soluble (loss on ignition and ash) 40 to 60 per cent according to site, in town or country, and no special account is taken of iron oxide. Tar counts in Great Britain at about 1 per cent; at Pittsburgh 1·3 per cent at a railroad signal bridge and 5·1 per cent at a car-parking garage. In the conclusions, the triple problem is summarised as the elimination of smoke, dust, and sulphur; for the first two the solution is in sight, for the last "there is now no satisfactory process".

An Application of Thyratrons.—It is often necessary in radioactive work to count voltage pulses, such as those which are produced by amplifying the disturbances produced by single α-particles. Several circuits involving thyratrons which can be used for this purpose are described by Dr. Wynn-Williams in the July number of the *Proceedings of the Royal Society*. The thryatron is a grid-controlled arc tube, and has the property that a heavy anode current cannot flow so long as there are not merely thin positive ion sheaths on the grid wires. Essentially it is an inertialess relay system, with the relay action for starting controlled by the potential of the grid. Other means, such as interruption of the anode current mechanically, have to be employed to extinguish the arc current, and in earlier devices for counting with thyratrons, the speed of counting had been limited by the inertia of the extinguishing device. This difficulty is largely obviated on the circuits described in the present paper by using a number of thyratrons, so disposed that the lighting of the arc in one automatically puts another into a condition in which it is sensitive, and so gives the first a longer time to be reset by the mechanical quenching device without the recording system as a whole failing to record some of the pulses, if they follow one another

rapidly. It has been found possible to record impulses separated by so little as 1/500 sec., and a system has been described, but not tested, in which the 'dial' recording numerically the total number of pulses is itself a system of thyratrons, containing no mechanical parts whatever.

Nitrogen Contents of Barley and its Wort.—The difficult task of summarising and interpreting the unfinished experiments of the late Prof. Schryver and of correlating the results of subsequent workers, including himself, has been ably accomplished by L. R. Bishop in a recent paper in the *Journal of the Institute of Brewing* (**37**, 345; 1931). The accumulated data provide some interesting generalisations. In particular, the soluble nitrogen compounds of a wort produced by mashing an English malt account for from 30 to 40 per cent of the total nitrogen present in the original dry barley, fluctuations in this proportion corresponding with variations in the conditions of malting and mashing. The temperature of mashing is of particular importance, and the methods recently devised for the determination of the various forms in which nitrogen may occur have enabled a distinction to be drawn between ammonia-, amide-, and amino-nitrogen, which remain almost constant in amount, and peptide-nitrogen, which is produced in maximum quantities by mashing at 50° C. It is interesting to note that the results confirm and amplify those obtained by H. T. Brown in 1909 in connexion with the relation of mashing-temperature and total permanently-soluble wort nitrogen. The wort carbohydrates also were shown to follow similar regular variations, the 'apparent maltose' giving a sharp maximum at 60° C., and dextrins and other constituents a less marked maximum at 70° C. These conclusions have a practical as well as a theoretical interest, since it is hoped that investigations at present in hand will show exactly which types of nitrogen compound best fulfil the feeding requirements of the yeast. When this link is supplied, a big step will have been taken towards deciding the optimum nitrogen content of the barley and predicting the best malting and mashing conditions.

Astronomical Topics.

New Bright Comet, 1931 *c*.—Mr. P. M. Ryves, who is a fellow of the Royal Astronomical Society and a member of the British Astronomical Association, residing at Zaragoza, Spain, telegraphed to the U.A.I. Bureau at Copenhagen that he had discovered a comet of magnitude 5·5 approaching the sun. The following positions of Aug. 10 and 12 (which are probably only approximate) were obtained by him; that of Aug. 14 was obtained by Prof. G. van Biesbroeck at Yerkes Observatory, after receiving the announcement of the discovery:

	U.T.	R.A. 1931·0	N. Decl. 1931·0	Mag.
Aug.	$10^d\ 3^h\ 30^m$	$7^h\ 43^m\ 0^s$	23° 48′ 0″	—
,,	12 4 0	7 52 0	23 19 0	5·5
,,	14 9 29·1	8 4 32·53	22 45 46	4.0

The comet is visible in the morning twilight; an attempt was made to deduce an orbit from the above material, but the first two positions are probably not sufficiently exact for the purpose. The perihelion distance is likely to be small, and the comet may become visible in daylight, like the great comet of 1882 and Skjellerup's comet of 1927. Comets near the sun are difficult to observe, since the sky is too bright to see comparison stars. Positions obtained by reading the circles of equatorials are better than nothing.

Comets.—*Harvard Card*, No. 159, contains a suggestion from Mr. L. E. Cunningham that the comet recently detected by Herr Reinmuth on plates exposed on Mar. 4 and 5, 1902, is probably identical with comet 1925 II (Schwassmann-Wachmann 1). This is the remarkable comet the orbit of which lies wholly between those of Jupiter and Saturn. The daily motion accords exactly, while there is a discordance of 11^m in R.A., $1\frac{1}{2}°$ in Decl. These discordances are not unduly large, considering that the elements used were not definitive, and that the motion has been carried back twenty-five years, without applying perturbations. The comet would have been near aphelion in 1902, and as Reinmuth gave the magnitude as 12·0 it must then have been passing through one of its bright outbursts, of which two have been observed in the last two years. If the identity is confirmed, the early observation will be of great use in improving the elements of the comet.

Prof. M. Kamienski (assisted by E. Rybka) continues in *Pub. Warsaw Observatory*, vol. 6, his exhaustive researches on the motion of comet Wolf I. He deals here with the apparition of 1918–19. The observations are numerous and extend from July 11, 1918, to April 1, 1919. The comet was unexpectedly bright, reaching mag. $9\frac{1}{2}$ in November. The observations agree very closely with his previous calculation for the first five months, then the observed R.A. falls behind the calculated one, the amount reaching 19″ in the final group. Prof. Kamienski hopes to remove these discordances by a recalculation of the planetary perturbations from 1884 to 1919.

Stellar Rotation.—Dr. E. A. Kreiken contributes a paper on this subject to the May number of *Mon. Not. Roy. Ast. Soc.* The stars discussed are mainly eclipsing variables and spectroscopic binaries. There are strong reasons for believing that in these close pairs tidal action makes the periods of rotation and revolution equal to each other. Theoretical reasons lead Dr. Kreiken to the formula:

$$\log \text{period} = 1{\cdot}5 \log \text{diameter} - 0{\cdot}5 \log \text{mass} + \text{constant}.$$

This formula differs in one point only from a formula derived empirically by Elvey (*Astro. Jour.*, **71**, 4; 1930). Elvey omitted the term depending on mass. The constant term is evaluated from stars of different classes; the value −0·28 is found from eclipsing variables, −0·04 from spectroscopic binaries with small eccentricity. It gradually rises as the eccentricity increases, and reaches +1·58 for spectroscopic binaries with eccentricity greater than 0·60. This accords well with theory, since period and eccentricity are presumed to increase as the stars grow older.

Dr. Kreiken has not yet used rotation periods derived from the contours of spectral lines; but he hopes to discuss them in the future. He tests his formula on the rotations in the planetary system, but some of his conclusions seem untrustworthy. He assumes that tidal friction in the solar system is inappreciable, and takes the rotation periods of Mercury and Venus as only a few hours. But observations of surface markings make it nearly certain that Mercury rotates in the same time as its revolution, 88 days; while spectroscopic observations make it highly probable that the rotation period of Venus is at least several days. Moreover, following some conclusions of Jeans about the sun's interior, Kreiken takes its rotation period as one sixtieth of 26 days. It does not seem fair to do this for the sun, as the values for the stars presumably are those of their surfaces.

The Significance of the Relationship between Corals and Zooxanthellæ.

By Dr. C. M. YONGE, Marine Biological Laboratory, Plymouth.

BOTH by the publication of his book, "Coral Reefs and Atolls", and by a recent contribution to NATURE,[1] Prof. J. Stanley Gardiner has materially added to the debt which all interested in problems of corals and of coral reefs already owe him. As a result, however, of work on the physiology of corals carried out during the course of the Great Barrier Reef Expedition, I am unable entirely to agree with Prof. Gardiner's conclusions in one important matter. He suggests that corals obtain supplies of carbohydrate from their contained zooxanthellæ, and also that the oxygen produced by the latter as a result of photosynthetic activity is of *vital* importance to the animals. My own conclusions as to the significance of the relationship between corals and zooxanthellæ are somewhat different, and, since this work—the result of the combined labours of Mrs. Yonge, Mr. A. G. Nicholls, and myself—is now largely completed, I am able to put them forward with confidence and no longer tentatively as in previous contributions to NATURE.[2, 3, 4] Moreover, it has proved necessary to publish this work in a series of six large reports,[5, 6, 7, 8, 9, 10] and a short summary of the results obtained is, therefore, not without some justification.

The zooxanthellæ of the Madreporaria are yellowish brown spherical bodies varying in diameter from 6μ to 14μ. Each contains a granular nucleus, one, and occasionally two, pyrenoids around which an amyloid assimilation product accumulates, and vacuolated cytoplasm which contains many oil droplets. The whole is bounded by a stout cellulose wall. They increase rapidly by division into two, but there is no evidence of the formation of spores, nor were they ever found in centrifuged water samples, while all attempts at culturing them outside the body of the animal failed. Unlike the green *Chlamydomonas* present in *Convoluta roscoffensis*, which, as shown by Keeble and Gamble,[11] occur free in the sea and form spores, the zooxanthellæ can live only within the tissues of the coral and are transmitted direct from parent to offspring by way of the planulæ. They are thus definitely degenerate. Within the tissues they occur only in the endoderm, most plentifully in the superficial regions. They are invariably contained within tissue cells, very frequently in wandering cells which convey them from place to place, and their absence from the ectoderm and mesogloea may be due to the mechanical difficulties of transporting such relatively large objects through the dense material of the mesogloea.

Although zooxanthellæ never occur in the ectodermal glandular margin of the mesenterial filaments, they may, especially under certain conditions, be very numerous in the 'absorptive' region which lies at the base of this. Degenerating zooxanthellæ are always most abundant in this region, although they may occur anywhere in the endoderm, but always in small numbers in a healthy coral. Boschma[12, 13, 14] has based his views, that zooxanthellæ are digested by corals, on the presence of these degenerating algæ in the 'absorptive' zone, but clear evidence was obtained that this region, as well as being the sole absorptive area, is also the only site of excretion. It is thus the only region of the coral where interchange between the interior of the tissues and the exterior takes place. Degenerating zooxanthellæ present are in process of *excretion* and not digestion.

The pyrenoid of the zooxanthellæ contains chlorophyll which, in the presence of light, forms the amyloid assimilation product (not apparently true starch), utilising carbon dioxide and producing oxygen. Experiments with corals in sealed jars showed that the hydrogen-ion concentration of the water rises appreciably after nine hours in darkness, owing to the accumulation of carbon dioxide, whereas in the light the hydrogen-ion concentration remains constant, because the carbon dioxide is utilised by the zooxanthellæ. In *Dendrophyllia*, a deep-water coral which has extended its vertical range and is not uncommon on the surface of reefs, there is a similar rise in hydrogen-ion concentration in both light and darkness. In common with all deep and cold water corals, *Dendrophyllia* possesses no zooxanthellæ. The carbohydrate formed as a result of photosynthesis is in part converted into oil and stored in that form, as in diatoms and other algæ. Protein synthesis, which involves the utilisation of nitrogen and also of phosphorus and sulphur, was followed by estimations of the phosphorus exchange between corals and the surrounding water. Whereas *Dendrophyllia* excretes large quantities of phosphorus in the same way as any other animal, the reef-building corals which contain zooxanthellæ do not. On the contrary, they frequently remove phosphorus from the surrounding water, even when this has been greatly increased by the addition of phosphate. The zooxanthellæ are thus capable of utilising much more phosphorus than is normally produced by the katabolic processes of the corals in which they live. The same is probably true of nitrogen and possibly of sulphur.

The abundance of zooxanthellæ is thus dependent upon two factors, light and the presence of nutrient substances, carbon dioxide, nitrogen, phosphorus, and sulphur, the latter in turn depending on the metabolic state of the coral. It proved possible to demonstrate experimentally the effect of these limiting factors. In the case of light, comparison between reef-building corals from the surface of the reef and from depths of 7 or 9 fathoms revealed that the former had approximately double the population of zooxanthellæ, while individual colonies from the reef surface which had grown on the under-side of boulders in the absence of light were found practically devoid of zooxanthellæ. The results of an experiment whereby corals were kept in a light-tight box in the sea for 152 days showed that the animals could survive this treatment without obvious harm, but that practically all the zooxanthellæ had died and been extruded at the end of this period. In all cases they were ejected by way of the 'absorptive' zone. Reef-building corals deprived of zooxanthellæ in this way excreted large quantities of phosphate of about the same order of magnitude as *Dendrophyllia*. Sections of such corals revealed that, in place of the zooxanthellæ, there were great numbers of wandering cells with granular contents, and it would therefore appear that these cells normally contain zooxanthellæ, but in the absence of these they resume their original function of excretion. Such wandering cells are a constant and conspicuous feature in the histology of corals, such as *Dendrophyllia* and *Balanophyllia*, which never contain zooxanthellæ.

The metabolic activities of corals were lowered in three ways: by starvation, by heating, and by deprivation of oxygen. In the case of starvation, a series of experiments were set up in which corals were starved (in filtered sea water) and fed (with freshly caught zooplankton) under parallel conditions. In all cases it was found that starved Madreporaria quickly show a great reduction in the bulk of their tissues, and

that this is shown equally whether zooxanthellæ are present or not. Almost immediately after starvation begins, zooxanthellæ are expelled in large numbers—some, but by no means all, dead, and practically all intact—and this continues until almost all are extruded. There is no evidence whatever of any digestion of the zooxanthellæ by the corals, or of any transference of material, such as the fat which Keeble and Gamble showed was passed from the *Chlamydomonas* to the *Convoluta*, from the plants to the animal. *Chlamydomonas*, however, possesses *no* cellulose wall. It was conclusively proved that Madreporaria obtain no nourishment whatever from their contained zooxanthellæ, and also that the latter are not even necessary for the initial development and early growth of the newly settled larvæ.

Precisely the same results, so far as the zooxanthellæ are concerned, were obtained when corals were heated to 36° C. for two hours or placed for some days in water almost devoid of oxygen. As in the starved animals, the zooxanthellæ were ejected in great numbers by way of the 'absorptive' zone of the mesenterial filaments, and then passed out through the mouth in mucus strings. The same process was observed in Nature during the summer months when corals on the reef surface were subjected to temperatures of above 35° C. over low-water in the day time, and as a result were almost completely denuded of zooxanthellæ, which gradually multiplied again until, at the end of about three months, the usual content of zooxanthellæ was regained. Here again the extruded zooxanthellæ were intact and apparently alive and healthy when extruded.

In every case, as a result of starvation, heating, or deprivation of oxygen, the metabolic activities of the coral were reduced, and, as a result, the amount of nitrogen, phosphorus, sulphur, and carbon dioxide produced by them was greatly reduced. This lack of the necessary inorganic food materials of the zooxanthellæ is clearly the cause of their expulsion, which is effected by the wandering cells which convey them to the 'absorptive' zone where they are expelled. It is difficult to explain what impels the wandering cells to do this, but it may possibly be the abnormal raising of the hydrogen-ion concentration in the tissues. There is certainly, however, a mechanism here whereby the population of zooxanthellæ is maintained at the level which the metabolic state of the coral, that is the amount of available food, permits. When the population falls below this level, it quickly reaches the maximum possible, owing to the very rapid multiplication of the zooxanthellæ.

Unlike the zooxanthellæ, which are apparently unable to live apart from the animals and are definitely degenerate in so far as they have lost the power to form spores, the reef-building corals can, and, where light is absent, invariably do, live without zooxanthellæ, like all deep and cold water corals. To an individual coral colony the association with zooxanthellæ is *not* essential. Nevertheless, the vast majority of reef-building corals and practically all the Cœlenterata on the reefs possess them, and there can be no doubt that they play an important, probably a vital, rôle in the economy of marine life on a coral reef. This work on the physiology of corals has indicated what the significance of the association may be.

Before proceeding to this, however, the question of oxygen production by the zooxanthellæ must first be discussed. In the presence of light, the zooxanthellæ, as a result of photosynthetic activity, produce oxygen. Exact determinations showed that whereas the oxygen content of enclosed volumes of sea-water in which corals were kept for nine hours in the light might be doubled or even trebled, in the dark it fell to one half, or much less, during a similar period. Corals could be kept in an enclosed volume of water for several weeks without suffering from lack of oxygen, owing to the presence of this closed system. A series of experiments, carried out over twenty-seven hours continuously, showed that only over the middle of the day, between the hours of 10 A.M. and 3 P.M. approximately, does oxygen production by the zooxanthellæ exceed oxygen consumption by the coral and the zooxanthellæ. Over twenty-four hours there was always a drop in oxygen content, showing that the production of oxygen by the zooxanthellæ cannot completely supply the wants of the coral. Mr. A. P. Orr found that the oxygen tension in pools on the reef surface at low tide at night fell as low as 17·8 per cent saturation, whereas under similar conditions by day it might rise as high as 230·4 per cent. As soon as the sea covered the reef, however, normal conditions again prevailed.

In spite of these facts, the benefit derived by the corals from this supply of oxygen is almost certainly more apparent than real. It was found that corals can survive exposure to water of less than 10 per cent oxygen saturation for several days, and that they can respire equally well in water less than 50 per cent saturated as in water fully saturated with oxygen. Under normal conditions, except in sheltered lagoons and other regions where coral growth is slight, they would never be exposed to such conditions; for water movements around the exposed areas of reefs where coral growth is invariably most prolific are always great, and the constant mixing of the water ensures a continuous supply of oxygen. Finally, were the zooxanthellæ absent, the great quantities of nutrient salts excreted by the corals and other Cœlenterata which contain zooxanthellæ would permit of a much greater growth of phytoplankton, with a consequent increase of oxygen in the water. The zooxanthellæ are really imprisoned phytoplankton which produce oxgyen within the corals instead of in the sea-water. There is no satisfactory experimental evidence indicating that the oxygen produced by the zooxanthellæ within the corals is essential to these animals or that they would not flourish equally well in its absence.

An examination of the feeding mechanisms of more than forty genera of Madreporaria revealed that corals are carnivores with highly specialised feeding mechanisms for dealing with zooplankton of all sizes. This was abundantly confirmed by a study of their digestive enzymes. Protein alone can be digested extracellularly in the cœlenteron, but only to polypeptides, digestion being completed intracellularly where amino-acids are formed. Fat also can be digested intracellularly, but very slowly; while the only carbohydrate which can be digested, and that very slowly, is that found in animal tissues, namely, glycogen. Extracts of the mesenterial filaments showed no digestive action on zooxanthellæ or on any carbohydrate of plant origin. The Madreporaria are thus amongst the most highly specialised carnivores in the animal kingdom, being capable only of digesting animal matter with its constituent proteins, fats, and glycogen.

It is improbable that the small quantities of glycogen and fat which can be digested suffice for the energy requirements of the corals, in spite of their relatively low needs. It will be necessary, therefore, to break down proteins by deaminisation, with a consequent accumulation in the tissues of the nitrogen, phosphorus, and sulphur split off from the protein molecules in this process. This need for the formation of carbohydrate from protein would explain the remarkably dense population of zooxanthellæ in all healthy reef-builders. If the animal is to function with maximum efficiency it must rid itself of these end products of metabolic activity. The excretory

system consists of wandering cells, and though these rid the body of excrement quickly enough for the needs of an individual coral colony, it may well be quite otherwise in the case of a large population.

Coral reefs only maintain themselves owing to their remarkable powers of growth in the face of innumerable adverse factors, of which the power of the sea and the action of diverse boring organisms are the most potent. It is essential, therefore, that they should function with the utmost efficiency, and their powers of growth could not but be impaired were excretory products to accumulate in the tissues. But they possess in the zooxanthellæ the means whereby all excrement is automatically removed practically the moment it is formed (unlike photosynthesis, protein synthesis in plants proceeds in darkness as well as in light), and which increases as the tissues grow and the excretion of nitrogen, phosphorus, and sulphur increases. Coral reefs as a whole are largely a closed system, obtaining their food certainly from the zooplankton in the sea, but adding to the dissolved nutrient substances only when they die or expel surplus zooxanthellæ. It appears by no means improbable that the Madreporaria have attained their present great importance in the economy of marine life in tropical waters owing to the aid given to them by their contained zooxanthellæ. In their absence the corals would have been unable to overcome the disadvantages inherent in the simplicity of their structure and of their metabolic processes.

The association between corals and zooxanthellæ is, therefore, essential to the plants, certainly not to individual coral colonies, but probably an indispensable factor in the necessarily exceptional powers of growth and repair possessed by the marine communities known as coral reefs.

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New Physics Building at the National Physical Laboratory.

By Dr. G. W. C. KAYE, O.B.E.

BUSHY House at Teddington, which was erected about 1715 by the first Earl of Halifax, a president of the Royal Society and a pupil of Newton, played a not inconsiderable part in the life of the Royal Family of Great Britain. It was, however, destined to fill, after two centuries, an even larger rôle in the life of the nation. In 1900, after many preliminaries, Bushy House was selected as the future home of the National Physical Laboratory, and in 1902 the Laboratory was formally opened by the present King (then Prince of Wales).

Since that date, under the directorship first of Sir Richard Glazebrook and now of Sir Joseph Petavel, a great part of the extensive grounds of Bushy house has been gradually covered by a large collection of buildings devoted to the requirements of the various departments of the Laboratory. During the last few years, these buildings have overflowed on to land acquired for the purpose in the proximity of Bushy Park. But for more than a quarter of a century, physics, the most comprehensive department of the Laboratory, which indeed gives its name to the whole, continued to be inadequately accommodated partly in Bushy House and partly in a number of converted dwelling-houses on the outskirts of the grounds.

Plans for a new physics building were first got out in 1924, and a design prepared by Mr. F. A. Llewellyn, of H.M. Office of Works, was exhibited at the Royal Academy in 1927. The proposed building had a frontage of 295 feet with wings 135 feet in length, forming three sides of a rectangle. The construction

FIG. 1.

of the central portion of the building was begun in January 1929, and the formal opening by Sir F. Gowland Hopkins, president of the Royal Society and chairman of the General Board of the Laboratory, took place on June 23 last.

The site of the building, which abuts on Bushy Park on two sides, enjoys immunity from traffic noises and vibrations. The structure is mainly of

heavy brickwork, which was preferred to a steel-frame building on the score of transmission of noise and tremor. The outer walls are of Crowborough bricks with Daneshill brick and Portland stone dressings.

As will be seen from Fig. 1, the completed portion of the building (of which the frontage is 180 feet) is mainly of three stories, with a central tower. Each storey is wholly on one level. There is a small basement for special purposes. Behind the main block are workshops, industrial laboratories, store-rooms, boilers, etc., all of one storey and semi-isolated from the main building. A large door in the rear of the building is provided with a crane and permits the ready unloading of heavy equipment and stores direct from lorries.

The building is planned on a system of units, all

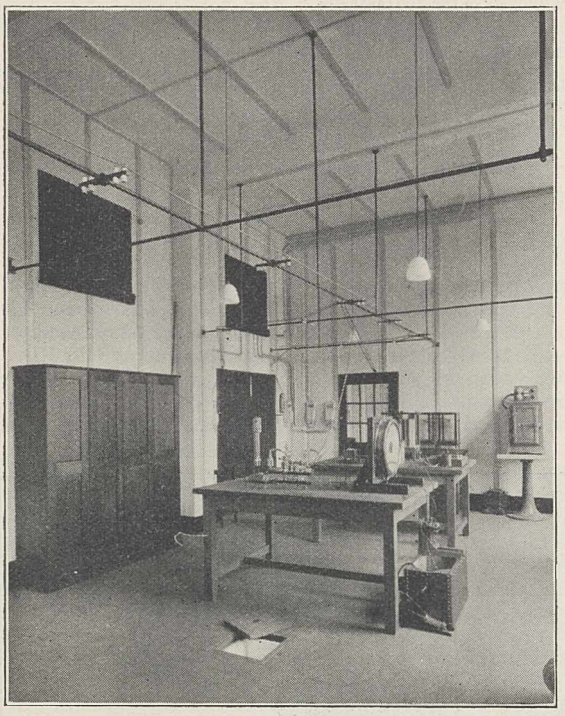

FIG. 2.

partition walls being non-structural, to facilitate rearrangement of rooms should the necessity arise. In general, the rooms measure about 18 ft. from back to front, the length being either 10 ft., 20 ft., or 30 ft. The heights of the rooms are 16 ft., 14 ft., and 12 ft. on the ground, first, and second floors respectively. In all cases the floors are of concrete, covered with thick cork carpet. Vertical wooden battens are provided at about 3 ft. intervals throughout the walls and ceilings to facilitate the erection of equipment and apparatus. Windows can be quickly darkened by lightproof blinds. Joinery throughout the building is of stained and polished British Columbian pine, except in the entrance hall and landings, where teak has been used.

The whole of the service mains (electricity, gas, water, etc.) are located in spacious horizontal ducts over the corridors. These ducts, which permit a man to walk along them, communicate with each other by vertical ducts and with the various rooms by doors at 10 ft. intervals. The distribution of the several services to the experimental tables is completed in each room by the aid of an overhead light steel tubular framework provided with insulators for electric cables, and clips for piping, etc. Thus all the services can be brought immediately above a particular apparatus, the lay-out being much facilitated by the use throughout of movable tables rather than of fixed benches. The freedom so gained is enhanced by the provision of sinks let into the floors and provided with loose wooden covers. The usual sinks are, of course, also provided. Many of these details are shown in Fig. 2, which illustrates one of the laboratories.

The electrical services, which are clearly identified by a colour scheme of labels, include 230-volt A.C. at 50 cycles, 240-volt D.C., 110-volt D.C., and 110 volts from a 400-ampere-hour battery. The mains leading from the ducts in the various rooms are connected to 30-ampere switch fuses on the walls, though in the industrial laboratory provision is made for heavier currents.

A system of small service trolleys (of the dinner-waggon type), which can be readily transported about the building, provides sets of accumulators giving low voltage D.C. for steady current work. Experience has shown that this meets the present-day requirements of the Department more satisfactorily than the usual system of split-voltage battery mains. The trolley system is also extended to sets of high-voltage light-current accumulators, and to heavy, costly, or specialised instruments which are only occasionally required by a particular experimenter.

Access to the different floors and the flat roof (which is designed to permit open-air experimental work) is gained by a staircase and passenger lift in the central tower, which also contains an experimental well 70 ft. deep provided with observation platforms.

As at present arranged, the ground floor of the building is devoted largely to investigations on heat: for example, hygrometry, thermal conductivity of metals, refractories, building materials, etc., specific heats of gases, low-temperature research, work for the Engineering Committee of the Food Investigation Board, including a wind tunnel for measuring the exchange of heat between brine-cooled pipes and air passing outside them. There is also a large 200-kilovolt constant-potential generator for operating X-ray tubes used for purposes of 'dosage' and intensity measurements.

The first floor contains the administrative offices, library, etc., and laboratories devoted to investigations in atomic physics, including work on single metal crystals.

The second floor is given over largely to researches on sound: for example, the measurement of noise, the absolute measurement of sound, the calibration of microphones, and the acoustics of buildings. There are large, heavily lagged enclosures to facilitate such work. On this floor also is housed the photographic section of the Laboratory and the departmental drawing office. The end rooms on this floor can have one side opened wide to the outer air should the necessity arise.

The basement affords accommodation for constant-temperature rooms, a reverberation chamber for measurements of acoustical coefficients of absorption, and equipment for photographing sound pulses and water ripples. There are store-rooms in the basement for housing records and special equipment and material, such as radium. The Laboratory, it will be recalled, is responsible for the custody, distribution, and testing of radium for the National Radium Trust and Radium Commission. Facilities are also provided in the basement for projecting cinematograph films.

The part of the building already constructed will house the Heat and General Physics Section of the Physics Department, with part of the radiology and sound work. It is hoped during the next few years that sanction will be obtained for the erection of the wings, so that the remainder of the Radiology Section and the temperature standardisation work can be transferred from the dwelling-houses and other buildings in which they are at present accommodated. The quadrangle will be completed by the Acoustics Building, the erection of a section of which has recently been approved.

The Pulp-Wood Market in the United States.

UNDER the arresting headline "Russia seizes Canada's Market", the *Monetary Times* of Toronto (Jan. 2, 1931) discusses the position of the pulp-wood market, a position which is not without interest for Europe. In 1924, under the heading "The Mistaken Idea that Canada has a Monopoly in Wood", the Canadian Pulpwood Association in a memorandum to the Royal Commission on Pulpwood wrote: "Contrary to the prevailing idea, it must not be overlooked that if the American is forced to turn away from Canada for raw materials, he will find that we have not by any means a monopoly. For instance, wood from Russia, in large quantities, is already freely quoted, by substantial concerns, for delivery at Atlantic seaports. If the U.S. operator has the Canadian door shut in his face, he will naturally consider it to his interest to encourage forestry conservation and development intensively in the United States to ensure independence as far as possible."

The memorandum went on to point out that research would be stimulated, that so far as possible existing American hardwoods would be utilised, and that already there had been a remarkable development in the use of the long-leaf southern pine in the kraft industry. In short, that there was a possibility that, in the attempt to take advantage of America's extremity by the threat of pulp-wood export restrictions, Canada might find that she had jeopardised a valuable trade connexion in paper products, encouraged her chief customer to develop her own resources, whilst unconsciously encouraging her trade with other countries.

To-day these predictions are coming true. America has been busily engaged in investigating every source of pulp-wood supply, an absolute necessity to her, owing to her enormous consumption of pulp. One of the new sources of supply has proved to be Russia. This year, Russian shipments of the highest quality of wood, amounting to some 300 cords, are being delivered in the eastern States at the same price as Canadian wood. Further, Canada gave transportation preference to the Russian wood; for the latter, landed at the Canadian ports of Sorel or Three Rivers, was for a time carried to the United States by Canadian railways at lower freight rates than these railways gave to Canadian wood for precisely the same movement.

The other possibility predicted, that America would undertake research with the object of endeavouring to make use of materials of her own not previously utilised for the pulp trade, has also been verified by the already mentioned development of the long-leafed southern pine in the kraft industry; and there is another interesting outcome. Dr. C. H. Herty, former president of the American Chemical Society, recently announced to the Atlanta Chamber of Commerce that he had succeeded in producing high grade newsprint paper from southern slash pine, cooked in the same digester and under the same conditions as spruce. The importance of this research work becomes evident when it is understood that there are vast reserves of this timber in the southern States, and that this variety of southern pine had always been regarded as the least capable of producing regular newsprint.

The above description of the present position in the pulp industry in the New World carries some important lessons for Europe. It displays the close and accurate study made of world-wide forest resources and the thorough knowledge of the pulp-wood industry which exists on the other side of the Atlantic. It also throws a strong light on the attitude taken up and ideas expressed since the War in some quarters in Britain upon the small influence the Russian coniferous forests were capable of exerting on the markets.

University and Educational Intelligence.

LONDON.—The degree of D.Sc. has been conferred on the following: W. Youngman, for a thesis entitled "Further Studies in the Cytology of the Hibisceæ", with two subsidiary contributions; S. E. Hollingworth, for a thesis entitled "The Glaciation and Physiographic Development of the Eden Catchment Basin West of that River, and the Drumlins of Edenside and the Solway Basin", with two subsidiary contributions; Lin. L. Lee (Rothamsted Experimental Station), for a thesis entitled "The Influence of Geology and Climates on Soil Types" (*Jour. S.-E. Agric. Coll.*, June 1931); A. N. Puri (Rothamsted Experimental Station), for a thesis entitled "Studies in Soil Colloids" (*Memoirs of Dept. of Agriculture*, 1930; *Soil Science*, 1930–31); A. J. Maslen (Chelsea Polytechnic), for a thesis entitled "The Structure of *Mesoxylon Platypodium* and *Mesoxyliodes*" (*Annals of Botany*, July 1930); L. R. Underwood (Imperial College—City and Guilds College and East London College), for a thesis entitled "The Combustion of an Oil Jet in an Engine Cylinder".

THE following fellowships for the year 1931–32 have been awarded by the Salters' Institute of Industrial Chemistry and approved by the Court of the Salters' Company: J. L. Sweeten (St. Catherine's College, Cambridge) and Norman Stuart (Imperial College, London). Fellowships have been renewed to: D. L. Hodge (Imperial College, London), D. J. Branscombe (University College, Exeter), J. Hofton (Caius College, Cambridge), and H. G. Simpson (East London College). The Salters' Institute has also awarded one hundred and thirteen grants-in-aid to young men and women employed in chemical works, to facilitate their further studies.

THE Ramsay Memorial Fellowship Trustees have made the following awards of new fellowships for the year 1931–32: Dr. B. K. Blount, a fellowship of £300, tenable for two years, at the University of Oxford; Mr. Ragnar Ericson, a Swedish fellowship of £300, tenable for two years, at the Imperial College, London; Dr. George Karagunis, a Greek fellowship of £400, tenable for one year, at University College, London; Dr. J. Lens, a Netherland fellowship of £300, tenable for two years, at University College, London; Dr. Y. Urushibara, a Japanese fellowship of £400, tenable for two years, at University College, London. The Trustees have renewed the following fellowships for the year 1931–32: Mr. W. R. Angus (British fellow), University College, London, and Dr. James Bell (Glasgow fellow), University College, London.

Birthdays and Research Centres.

Aug. 23, 1869.—Dr. R. T. GUNTHER, curator of the Lewis Evans Collection of Historic Scientific Instruments in the University of Oxford.

I am especially interested in the discovery of ancient scientific instruments and specimens, and in their preservation for illustrating the history of the natural sciences. It has been only too frequently a common experience in the laboratories of our universities that with every change in the directorate a quantity of unique apparatus of great scientific interest has been scrapped. It is with the view of checking the wastage of apparatus of special historic or artistic value that the Lewis Evans Collection has been founded. Incidentally, the benefaction of Dr. Evans has led to the restoration (in part) of the Old Ashmolean, the oldest museum of natural history in Britain, and quite recently to the discovery of some of Edward Lhwyd's type specimens of British fossils, long believed to have been irretrievably lost.

Aug. 23, 1886.—Prof. W. STILES, F.R.S., Mason professor of botany in the University of Birmingham.

In the near future I hope to see considerable development of our knowledge of the physiology of plants and the application of this knowledge to various plant industries, including agriculture, horticulture, and food storage.

My own researches have dealt mainly with problems of cell physiology, particularly with those of absorption of substances by living cells, and the passage and movement of substances from cell to cell in the organism. While continuing work on this subject, I am also engaged on an investigation of the relation between the chemical and physical constitution of substances and their toxic action on plant cells and tissues. Latterly I have turned my attention to the very fundamental questions of respiration and photosynthesis by plants, and am investigating these processes by methods specially developed for the purpose.

Aug. 24, 1880.—Dr. A. D. IMMS, F.R.S., chief entomologist at the Rothamsted Experimental Station, Harpenden, Herts.

My duties involve keeping abreast with many aspects of entomology. At the same time, the writing of a comprehensive text-book on the subject has absorbed much time and energy during the past few years. The modern trend of the subject, as with other branches of zoology, is towards its biological and physiological aspects. An entomologist well trained in physiological technique has a wide field in front of him. On the biological side, more exact methods of study of insects in relation to their environments are likely to yield results of both fundamental and economic significance. At the same time, there is a shortage of scientific taxonomists of broad outlook, specialists in the parasitic groups of Hymenoptera, for example, being especially few and far between. My own investigations deal chiefly with parasitism, its effects upon the hosts concerned, and the differential influence of environmental factors on host and parasite.

Aug. 25, 1844.—Sir THOMAS MUIR, C.M.G., F.R.S., formerly Superintendent-General of Education in Cape Colony.

Firmly believing that in the advancement of science every little addition counts, I continue to work at quite minor problems, leaving them to be suggested by my own casual reading or to be brought to my notice by fellow-students from near or far. Fairly often I am able to pay such a correspondent back in his own coin with interest, and so I derive now and again the pleasant satisfaction of seeing a more vigorous brain dealing effectively with a worthier type of work.

I thus welcome the present occasion as giving me the chance of influencing by suggestion a much wider circle of workers: and I select as a subject urgently requiring attention the determinantal properties of oblong arrays. Naturally the first business would be to search out and tabulate the already known results from those of Bézout in 1779, all the while noting contrasts, analogues, and possible generalisations. Even such preliminary labour would in every case reward the worker: and thoughtful afterstudy would almost certainly give something of value to us all.

Aug. 26, 1863.—Mr. EDWARD HEAWOOD, Librarian to the Royal Geographical Society.

My special studies for many years have been the history of exploration and early maps. At the moment I am chiefly interested in the beginnings of topographical survey and mapping in England and the early history of paper-making and the paper trade. Both these subjects, especially the latter, have so far been more or less neglected. Many early maps, for example the English version of the world-map of 1544 generally known as Sebastian Cabot's, or John Norden's map of Kent of about 1595 (among many others), remain to be discovered, and a systematic search in old libraries might bring some at least to light. Practically no information is available on early paper-making in Great Britain, but the subject is of importance in connexion with the dating of old documents or other bibliographical problems.

Aug. 26, 1873.—Prof. W. A. OSBORNE, professor of physiology and dean of the faculty of medicine in the University of Melbourne.

Two problems of gel behaviour interest me at present. (1) Fresh defibrinated blood diluted with a twofold volume of water is laked and is transparent. Addition now of sodium chloride to restore the original osmotic pressure brings back opacity and reflection of light. (2) The cornea in contact with solutions not iso-osmotic with blood behaves as a gel, allowing rapid diffusion of chlorides but slow diffusion of sulphates either way. When the cornea is in contact with iso-osmotic solutions, diffusion of chlorides is uni-directional and towards the aqueous (confirmatory of F. P. Fischer). The question is whether this valved diffusion is due to living epithelium.

Aug. 27, 1865.—Prof. JAMES H. BREASTED, director of the Oriental Institute, University of Chicago.

I am endeavouring to trace the course of human development from the merely physical man disclosed by the palæontologist to the rise and early advance of civilised societies, the product of social evolution culminating in social idealism.

The scene of this evolution has unquestionably been shown to be the ancient Near East—the region folded like a horseshoe around the eastern end of the Mediterranean. The diverse civilisations which arose there are now known to have been the background and basis of European civilised development. These countries to-day constitute an almost inexhaustible storehouse filled with perishing and still unsalvaged evidence disclosing early human development. There has been no comprehensive and systematic effort to save and study this enormous body of perishing evidence *as a whole*. These facts lay a twofold responsibility on modern science: first, the task of salvaging this evidence by scientifically organised and equipped field expeditions; second, the study and constructive interpretation of this evidence.

These responsibilities adequately met will require not only scientific training and method on the part of the *individual*, but also organised effort and funds surpassing those which have been available in humanistic research hitherto. The organisation which I have hoped might contribute to meet this situation, the Oriental Institute of the University of Chicago, is now twelve years old. It maintains a series of twelve field expeditions operating along a front of more than 2000 miles, from the southern shores of the Black Sea on the north, eastward to south Persia (Persepolis), and thence to north-east Africa and the Upper Nile on the south. Its administrative and scientific headquarters, a new building at the University of Chicago, houses a series of research projects and serves as a focus on which converges the new evidence from the excavations and the salvaging operations of the field expeditions.

The subject matter of these researches both at home and abroad—the rise of man—is a process which in itself constitutes the greatest event in the history of the universe so far as it is known to us. The purpose of these researches is eventually to make possible an understanding of human origins and early human advance, based on fuller evidence than has ever been available before, and in so doing perhaps to discern more fully something of the causes and the nature of that mysterious and persistent buoyancy of the human spirit which, in spite of declining intervals, has made the direction of human movement from the beginning—and for probably several hundred thousand years—a rising line.

Aug. 28, 1858.—Prof. ROLAND THAXTER, emeritus professor of cryptogamic botany and honorary curator of the Farlow Herbarium, in Harvard University.

I am publishing this summer my fifth quarto memoir on the taxonomy of the Laboulbeniales (*Memoirs American Academy of Arts and Sciences*, vol. 16, part 1, pp. 1-435, with 60 plates), illustrating many new and curious generic and specific types, and am planning to begin the preparation of a sixth and final part, to include the genus *Laboulbenia* and various addenda, with a general summary, host-index, etc.

Societies and Academies.

PARIS.

Academy of Sciences, June 22.—The president announced the death of Jacob Eriksson, *Correspondant* for the Section of Rural Economy.—H. Deslandres: Simple relations between the molecular spectrum and the structure of the molecule. A table of the infra-red frequencies of gaseous ammonia and carbon dioxide, and a discussion of the data.—Charles Achard and Augustin Boutaric: Some physical properties of the blood serum in lipoid nephrosis. Quantitative measurements of the light absorption and viscosity, before and after heating the blood serum to varying temperatures, are used for determining the changes in the number of particles in the colloidal suspension. The theoretical basis of the method was described in an earlier communication (*C.R.*, **191**, 1332).—R. Fosse, A. Brunel, and P. E. Thomas: The quantitative analysis of very small quantities of allantoin at high dilutions. The application to human urine. The method is based on the destruction of urea by the diastases of the soja bean in presence of cyanide, followed by hydrolysis by hydrochloric acid. The glyoxylic acid thus produced from the allantoin is estimated by a colorimetric method with phenylhydrazine; full working details are given.—C. Sauvageau: Three new examples of plethysmothallus (*plethysmothalle*) (*Myriotrichia* and *Protasperococcus*).—Paul Delens: Orthoptic congruences and isotropic congruences.—W. Sierpinski: A property of the limits of ensembles.—M. Kourensky: The variation of the arbitrary constants for the integrals of ordinary differential equations of the second order.—Florent Bureau: Holomorph functions in a circle of finite radius and integral functions.—Gabeault: The air resistance to ballistic velocities.—M. Aubert and R. Duchêne: The determination by the photographic method of the resistance of petrols to detonation.—D. Barbier: Function of distribution of the eccentricities and mean anomaly of long period visual double stars, the orbits of which have not yet been calculated.—G. Foëx and Mlle. B. Kessler: The various magnetic states of the nickel ion in solutions of its chloride. Moderate rise of temperature (to 90° C.) does not influence the magnetic state of the nickel ion, but raised to a higher temperature (100° C.) the Weiss magnetons are lowered.—Horia Hulubei and Mlle. Yvette Cauchois: The monochromatic stimulation of Raman spectra in the ultra-violet. Applications. The monochromatic radiation was obtained by filtering the light from a mercury lamp through chlorine gas under pressure. Details of experimental results with water and ethyl alcohol are given.—P. Dupont: Study of the hydrolysis of sulphate of zinc solutions with the aid of the quinhydrone electrode.—M. Haïssinsky: A new reaction of polonium. Polonium forms an insoluble pyrogallate: in this reaction it resembles bismuth and antimony, but differs from tellurium.—Mlle. Germaine Bernheim: The preparation of the cyanamides of the earths and alkaline earths. Study of the reaction

$$C_2N_2 + MO = CN.NM + CO$$

as a function of the temperature, where M is barium, strontium, magnesium, zinc, cadmium, or beryllium.—Pierre Jolibois and Georges Chaudron: A new method for getting calcium triphosphate in a soluble form. The method is based on the conversion of the mineral phosphate into an insoluble lead chlorophosphate, followed by treatment with nitric acid. The process is worked in a cycle, with recovery of lead, and the products are ammonium nitrate and ammonium phosphate containing a little ammonium nitrate, both of which can be used as manures.—Al. Yakimach: Phosphate of trivalent manganese and of aluminium. An account of the preparation and analysis of $(NH_4)H_2Mn(PO_4)_2$, $(NH_4)H_2Al(PO_4)_2$, $KH_2Al(PO_4)_2$, and $Ca[H_2Al(PO_4)_2]_2$.—Malaprade and Schnoutka: The separation and estimation of boric acid and alumina. The alumina is separated as a basic sulphite, the excess of carbon dioxide and sulphur dioxide removed by boiling, and the boric acid in the filtrate estimated by the usual double titration.—André Kling and René Schmutz: The decomposition of solutions of sodium hypochlorite (Javel's liquid).—Georges Darzens: A method of separating the cresols and the properties of pure *m*-cresol. The method is based on the formation of a stable addition compound of *m*-cresol and dry sodium acetate: the *p*-cresol forms an addition compound with oxalic acid.—Picon: Silver camphocarbonate. Chemical organosols of silver.—E. Urion: 1, 2-cyclohexanedione or dihydropyrocatechol. This α-diketone has been isolated from the products of decomposition of divinylglycol by reduced copper at 280° C.—Robert Lantz and Georges Mingasson: Researches on the napthalene bisulphite compounds. The abnormal action of sodium bisulphite on certain derivatives of β-oxynaphthoic acid.—Ch. Courtot and Chaix: Study in the diphenylene sulphide series.—N. Kouriatchy: The layers of serpentines and chromites of Togo.—Paul Cristol: The hæmorachidian equilibrium of the bicarbonates.—

Mlle. Choucroun: The hypothesis of mitogenetic radiation acting on the multiplication of bacteria. An account of experiments tending to negative the hypothesis of a mitogenetic radiation or of any action through the walls of the tube containing the bacteria; if the latter vessel is corked, the action ceases.—Edouard Ducloux and Mlle. Georgette Cordier: The study of certain humoral modifications arising in the course of experimental bovine marginal anaplasmosis.—Denis Bach: The mechanism of the antiseptic action of lactic acid on *Bacterium coli*.—Georges Blanc and J. Caminopetros: The virus of exanthematic fever is hereditary in the tick *Rhipicephalus sanguineus*.

CAPE TOWN.

Royal Society of South Africa, June 17.—Gunnar Nygaard: Freshwater Algæ and phytoplankton from the Transvaal. The phytoplankton was found to be in general a typical pond plankton, with *Microcystis aeruginosa* and *Botyococcus Braunii* sometimes becoming dominant. That of the larger river-dams was often dominated by the diatom *Melosira*, which West found to be the chief form in Lake Nyassa. Both lakes and pans appear to be rather poor in species of Algae, only 98 species and varieties being found in the samples, of which six species and five varieties are new. Two noteworthy finds were *Draparnaldia Ravenelii*, a species not found since 1887, when it was described from North America, and a new Coscinodiscus, *C. incomptus*, a freshwater species of this otherwise typically marine genus.—F. Rich: Phytoplankton from South African pans and vleis. 262 species and varieties were found, among which were nine species and eight new varieties, as well as several new forms. The occurrence of *Pleodorina californica* is interesting, for this genus had not been recorded for South Africa. The marked differences found in the plankton from various bodies of water is noteworthy, suggesting that an interesting correlation of this with the chemical and physical characters of the water could be made by collectors in South Africa.

SYDNEY.

Royal Society of New South Wales, June 3.—Daphne L. Coulston: (1) A new colorimetric method for measuring the hydrogen ion concentration of natural waters. This method consists of comparing the intensity of colour produced when the indicator, para nitro phenol, is added to the solution of unknown hydrogen ion concentration with a standard depth of colour in a Dubosq colorimeter. The results have been checked by comparing buffer solutions of known hydrogen ion concentration with the standard.—(2) The splenectomy of tadpoles. The object of the investigation has been to ascertain whether the absence of the spleen influenced the metamorphosis of the larval frog. Frogs used in the experiments belonged to various species of *Limnodynastes*. The tadpoles were about 7·5 cm. in length, and possessed small hind limbs. Urethene was used as an anæsthetic. Six splenectomised and ten normal tadpoles developed similarly over a period of three to four weeks. No deep regeneration had taken place during one month.—(3) Variations of the hydrogen ion concentration of sea water. Of numerous samples taken off the coast at Cronulla, La Perouse, Bondi, Manly, Collaroy, etc., 60 per cent showed a *p*H of 8·5 and 40 per cent of 8·4. These results were obtained using phenol red as an indicator. As samples were taken in Port Jackson the alkalinity of the water decreased perceptibly within a mile from the Heads. Increase in the tension of carbon dioxide decreased the alkalinity. Sea water is only slightly buffered, since so amall an increase as 8 millimetres tension carbon dioxide sufficed to alter *p*H from 8·5 to 7·0.—(4) On the metabolism of cold-blooded animals. Experiments have been made to determine the carbon dioxide expired and the oxygen absorbed for resting frogs and to relate the figures obtained to the surface area of the frogs. Surface area was determined from plasticene moulds lined with silk. The silk was then separated from the cast, cut into fragments so as to lie flat, and reproduced on sensitised photographic paper. The affected areas were cut out and weighed and from the weight of paper the surface area calculated. A frog weighing 30 gm. has a surface of approximately 100 sq. cm. The metabolism of the frog was obtained by placing it in a wide-mouthed jar of rather more than 1 litre capacity, the jar being closed with a rubber stopper through which inlet and outlet tubing passed. Metabolism diminished during starvation and increased two to three times by a rise in temperature of 10° C. Resting frogs produced about 20 calories per sq. cm. of body surface per day.—H. F. W. Whitworth: The mineralogy and origin of the natural beach sand concentrate of New South Wales. Attention is directed to the fact that whilst, in the past, the heavy mineral concentrates have been worked intermittently for their gold, platinum, and tin values, their future value probably lies in their zirconium and titanium contents. The composition of the sand concentrates is given in detail, both chemical and mineralogical analyses being quoted, with descriptions and sketches of individual minerals. The heavy minerals of which the concentrates are formed have been derived, in all probability, from the Triassic sandstones which overlie the Coal Basin between Newcastle and Bulli.—J. C. Earl and Miss T. M. Reynolds: The celluloses of two water plants. The cellulose of *Eichornia crassipes* and *Ottelia ovalifolia* were isolated and compared by means of their triacetates with the normal cotton type of cellulose. Although the separation from associated substances was difficult to carry out, the cellulose from each of these plants appeared to be of the normal type.

Diary of Societies.

SATURDAY, AUGUST 22.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Annual General Meeting) (at Newcastle-upon-Tyne), at 2.30.—Open for further discussion:—Interim Report of the Support of Workings in Mines Committee, A. Walker.

TUESDAY, AUGUST 25.

LONDON NATURAL HISTORY SOCIETY (at London School of Hygiene and Tropical Medicine), at 6.30.—Informal Meeting—Ornithology.

QUEKETT MICROSCOPICAL CLUB (at 11 Chandos Street, W.1), at 7.

CONFERENCES.

AUGUST 25 TO 29.

CONFERENCE OF THE INTERNATIONAL INSTITUTE OF BIBLIOGRAPHY (at the Hague).

Aug. 25.—Prof. A. Pollard: Presidential Address.

Aug. 26.—E. Morel: Statistique du livre en France et son aspect bibliographique.
Dr. J. Vorstius: Index Bibliographicus.
Sir Frederic Nathan: International Abstracting and Indexing of Scientific and Technical Literature.
J. M. C. Muller: Rapport sur le Repertorium Technicum.
J. Gérard: Création d'une Fédération Française des Offices de Documentation.

Aug. 27.—Dr. R. Sand: La documentation dans le domaine de la médicine.
Dr. E. Huet: L'Organisation de la Documentation Dentaire par la Féd. Dent. Int.
Dr. J. G. Priestley: Bibliography of Physiology and the Application thereto of the Decimal Classification.
Dr. M. Pflücke: Aufgaben und Organisation eines Referatenorgans.
B. du Rétail: Le Centre d'Information Économique de Paris et son Service de Dossiers de Presse.
B. M. Headicar: The Bibliography of Economic and Social Sciences.
E. de Grolier: Le classement standardisé appliqué dans la librairie.

Aug. 28.—Various Papers.

Aug. 29. Excursions.

AUGUST 31 TO SEPTEMBER 4.

INTERNATIONAL CONGRESS OF NEUROLOGY (at Berne).