NATURE

SATURDAY, NOVEMBER 19, 1932

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Editorial and Publishing Offices:

MACMILLAN & CO., LTD.

ST. MARTIN'S STREET, LONDON, W.C.2

Telephone Number: WHITEHALL 8831

Telegraphic Address: PHUSIS, LESQUARE, LONDON

No. 3290, Vol. 130]

Pylons and Pipelines

THE conspicuous network of high tension cables which is being spread criss-cross about the countryside may serve to remind us of the far greater ramifications of gas pipes and cables underground. Indeed, the streets of the cities of the world are as busy transporting material below the surface as above it, whilst in some lands, notably in America, pipelines carrying natural gas run across the countryside for great distances.

To-day there is increasing competition between gas, electricity and raw coal as sources of heat: all three use the product of the mine as their starting point. In the gas industry selected coals are carbonised so as to give a maximum yield of gas and a solid fuel—coke. In the electrical industry, low grade coal is burnt in highly efficient boiler plants and the steam produced converted in turbines into electrical energy. The domestic user of forty million tons of coal per annum burns specially large or lump coal mined for the purpose, the smalls, so-called slack, being burnt under industrial boilers. By means of pipes and cables, gas and electricity are carried directly into every room of the consumer's house; he only has to turn a tap or pull a switch to obtain service from them: the advantage over coal is overwhelming. It is not necessary for him to keep stocks of either: there are no ashes to be removed by hand: they produce neither dirt within the house nor smoke without. On the other hand, coal has to be transported by train to the local depot, by cart to the house cellar, by hand in buckets to the room, and it is applied again by hand to the fire at irregular intervals. Gas fire and electric stove burn regularly and at constant efficiency: the coal fire burns with very variable efficiency.

For water heating, central heating, and similar purposes coal is replaced by coke, a product of the gas industry which, now that it is made under close supervision and delivered as a high-class material, low in ash and moisture content and regular as to size, has proved to be admirably adapted for the purpose: stoves fired with it require a minimum of attention. Such heating can also be done with gas or electricity, working under thermostatic control, the economics of the operation depending on their price.

A serious competitor of the three methods of heating based on coal is imported oil, firing by which is likewise automatic in its operation. Both for industrial boilers and for public and private

central heating, oil fuel is continually making headway.

The use of raw coal is in fact unscientific and 'unmodern' : it also brings with it all the evils of the smoke nuisance, dirty and dismal cities, and consequent ill-health. Many would abolish it by legislation, yet somehow the coal fire survives, partly for psychological reasons, partly because of the capital cost of replacing it, and partly also because, to the man who burns it in anything like an efficient grate, it is still the cheapest source of heat.

Gas and electricity are still too dear in most parts of Great Britain, not because of any lack of technical efficiency, leading to high production costs in either industry, but to the high cost of all that is comprised under distribution charges. Although both industries are making progress, and must continue to do so as they are continually modernised, the price factor is still the determining one in their more general utilisation. Users economise with them and do not use them as freely as their value merits. With more reasonably priced fuel there would be far less parsimony and better health. By his invention of the steam turbine the late Sir Charles Parsons halved the cost of generating electricity : the cumulative inventions of this century in the gas industry have probably had nearly the same effect.

In the coal trade likewise the distribution costs are far too high : in no other basic commodity does the price at the source bear so small a proportion to the price delivered to the householder. Some day perhaps house to house deliveries by one firm only in a given street on a particular day will become obligatory, as it should be with the essential food services. We add enormously to the cost of living by neglecting such elementary economies.

The coal industry could do much to help the situation. Never was any policy more short-sighted than the decision taken when statutory coal prices were fixed, to mulct the gas and electricity companies in extra charges because they were able to pay the same. It is senseless to seek to establish permanence for a price from gas companies which is higher than that got from other users of precisely the same brand of coal. It would be far more to the interest of the mines to give minimum rates to these industries, with the certainty that at lower prices they could greatly increase their sales and hence their consumption of coal.

The fight between home coal and imported oil is becoming very acute : it is certain, for example, that another coal strike would nearly eliminate coal from factory boilers. The coal industry must realise that the day of raw coal, either on land or at sea, is passing and coal must largely be burnt in such a manner that the energy in it reaches the former customer in a more up-to-date form. The whole technique of mining requires re-examination from this point of view : it should generally be possible to mine a coal of the best size for a particular use, and not add to the mining costs by specially bringing large coal to the surface.

A dangerous competitor of the coal industry for the generation of electricity is water-power, though fortunately for the mines this is as yet but little developed in Britain. It has been calculated that in Europe the progressive expansion of water-power is annually displacing 5 million tons of coal, whereby annually 5000 miners become superfluous.

Fortunately again for the coal industry, we have practically no natural gas in Britain—this now substitutes 78 million tons of coal in the United States. Of the 100,000 miles of pipelines in that country 65,000 miles are used to convey natural gas, individual lines being upwards of 1000 miles in length.

There has developed very rapidly in the United States a use for the propane and butane fractions which can be scrubbed out of natural gas and are sold liquefied, either in cylinders or in pressure tank cars. Propane is used in individual farms and houses where towns gas is not available. The sales of the liquefied gas have increased at a very rapid rate : they were 18 million gallons in 1930 and 28 million gallons in 1931, and the number of customers served with propane was 117,000 in 1930, as compared with 55,000 in 1929 and 20,000 in 1928. The use of the butane fraction has developed along the lines of establishing central stations in communities too small to support a gas works. Butane is mixed with air, and the resulting mixture distributed and metered to residents in the settlement in the same way as towns gas. In this way the remote countryside has all the advantages of gas enjoyed by the dweller in the city and at a comparable price.

The development of the use of gas in cylinders has brought to the front again the question of gas as a motor fuel : in Britain important experiments are in progress to this end. On the test bench, the maximum power output of a standard low compression engine when running on towns gas as

compared with petrol is 88 per cent, and by either increasing the compression ratio or enriching the gas with benzol, it will be possible to raise the maximum power when running with gas almost to that obtainable with petrol. A test vehicle is being run on the road with special steel cylinders of light construction, containing gas at a pressure of 3000 lb. per square inch : these are well within the range of metallurgical technology, and their construction can no doubt be cheapened when the occasion arises. Even more progress in trying out gas has been made in France with satisfactory results.

Should these experiments be successful a new era in motoring would arise in Britain, with an equally great repercussion on the gas industry. The organisation of a chain of compressing and filling stations would not present any insuperable difficulties. In particular, the makers of gas of high calorific power would come into their own, as this would afford additional mileage without refilling, though probably some agreed standard gas would have to be furnished throughout the country, so as to avoid the necessity of adjusting the proportion of gas to air supply on engines of motor vehicles. Undoubtedly also, engines burning gas could be so designed as to give complete combustion, thus avoiding the large proportion of carbon monoxide which is at present produced from petrol.

The running of motor vehicles on gas made from British coal would have a profound effect on the gas industry, which with the increased make would be able to lower its price for gas to the householder. The railways, too, would once more have a large quantity of coal to transport. Surely the effort to solve this problem is worth making by all parties, including the mines. If, as at present, they continue to hold gas and electricity up to ransom, they are eventually doomed.

Equally useful to the mines would be the solution of the motor car fuel problem on quite other lines, for example, the discovery of a dry cell of large capacity which could be quickly recharged at local filling stations. Such an invention is by no means beyond the bounds of possibility.

Dr. A. E. Dunstan, in his brilliant summary of fluid fuels to-day and to-morrow delivered before the Society of Chemical Industry, considers that the coal era will be succeeded first by an oil era, then by a gas era, and finally by an electricity era, coal of course being the primary basis for the two latter. To-day coal is still responsible for seventy per cent of the power produced in the world. Great Britain has coal but no oil ; the use of oil to-day is outstripping that of coal. It will continue to increase as the Diesel engine is perfected, unless more coal is burned in the modern way.

We, at all events, must rush through the oil era and reach that of gas without delay. Let our pylons and pipelines be significant of the will to do this, otherwise tank farms will replace winding shafts on the landscape.

Large Molecules

Die hochmolekularen organischen Verbindungen—Kautschuk und Cellulose. Von Prof. Dr. Hermann Staudinger. Pp. xv + 540. (Berlin : Julius Springer, 1932.) 52 gold marks.

PROF. STAUDINGER'S book on "Large Organic Molecules" is based upon a series of sixty-nine papers on "Highly-polymerised Compounds" and thirty-nine papers on "Isoprene and Caoutchouc" which have been issued during the period 1920–26 from Zurich, and during the period 1926–32 from Freiburg, as a record of researches carried out under the inspiration and control of the author. No attempt has been made to cover the whole field, and in particular the large molecules of the proteins have not been considered. Nevertheless a very clear general idea emerges from the detailed experiments of which a summary is now given. The author is in fact a real organic chemist, who believes in real bonds, and is prepared to extend indefinitely the conception of homopolar molecules, in which *all the atoms are held together by normal covalences.* This idea follows logically from his observations on the progressive polymerisation of compounds such as :

(i) Polyoxymethylene,

$$CH_2O \longrightarrow -CH_2-O-(CH_2-O)_x-CH_2-O-$$

(ii) Polystyrol,

$$\begin{matrix} C_6H_5 \\ | \\ CH{=}CH_2 \end{matrix} \longrightarrow \begin{matrix} C_6H_5 & C_6H_5 & C_6H_5 \\ | & | & | \\ -CH-CH_2-(CH-CH_2)_x-CH-CH_2- \end{matrix}$$

(iii) Polyvinylalcohol,

$$\begin{matrix} OH \\ | \\ CH{=}CH_2 \end{matrix} \longrightarrow \begin{matrix} OH & OH & OH \\ | & | & | \\ -CH-CH_2-(CH-CH_2)_x-CH-CH_2- \end{matrix}$$

(iv) Sodium polyacrylate,

$$\begin{matrix} COO'Na^{\cdot} \\ | \\ CH{=}CH_2 \end{matrix} \longrightarrow \begin{matrix} COO'Na^{\cdot} & COO'Na^{\cdot} & COO'Na^{\cdot} \\ | & | & | \\ -CH-CH_2-(CH-CH_2)_x-CH-CH_2- \end{matrix}$$

In all these cases the early stages of polymerisation obviously depend on the formation of covalent molecules, and it would be illogical to set any limit on the length to which the chains of carbon atoms may be extended when the conditions are favourable.

With this background of experimental facts in his mind, the author has looked round for similar structures amongst natural products and claims to have found them in carbohydrates, such as cellulose, and especially in caoutchouc. Thus he supposes that the molecule of caoutchouc, of the composition $(C_5H_8)_{1000}$, contains 13,000 atoms, all united by normal covalencies, and has a molecular weight of 68,000. On the other hand, he has prepared a polystyrol $(C_8H_8)_{6000}$, with about 100,000 atoms in the molecule and a molecular weight of 600,000.

These highly polymerised products form a separate group of organic compounds, since the length of the chain necessarily varies in individual molecules and only a statistical average can be determined, whereas in other synthetic products large molecular weights may be obtained by processes which give rise to identical molecules throughout, as in the more complex dyestuffs or drugs. The average length of the 'thread' can, however, be estimated by a variety of methods. The most important of these depends on finding a formula to express the relationship between the length of the thread and the viscosity of a solution of given concentration.

In the case of roughly spherical molecules the 'specific-viscosity' does not depend to any large extent on the size of the molecules, but for thread-like molecules the specific viscosity increases proportionally with the molecular weight, since the ability of the fibres to impede the movement of the fluid increases with the length of the fibres, and would be correspondingly reduced if the fibres were broken up into shorter lengths. The precise form of the relation between viscosity and length of thread is perhaps open to dispute, but the method has proved invaluable in providing a method of estimating (by extrapolation) the length of threads which are too long to be measured by other methods.

The most trustworthy of these other methods depends on attaching some other radical to the ends of the chain. This radical is then estimated quantitatively (as in recent work on the methylation of cellulose and starch) and the proportion of end-group can be used to deduce the length of the chain. This method can only be used in the case of the smaller threads, but when combined with measurements of viscosity it provides data which can be used for extrapolation to greater lengths.

The existence of aggregates, held together by secondary valencies or van der Waals' forces, is freely admitted in the case of soaps and many other substances of moderate molecular weight, which owe their colloidal properties to the formation of micellar aggregates ; but no such aggregation is needed to produce colloidal properties in 'eucolloids' containing from 10^3 to 10^5 atoms of carbon in each molecule. The author therefore believes that the thread-like molecules of cellulose or rubber, although aggregated into bundles in the solid state, may be separated completely into individual threads by dispersion in a suitable medium.

This deduction is fully justified by the contrast between the strength of the carbon to carbon bond, either in the diamond or in an organic compound, and the feebleness of the forces by which molecules are held together in the volatile fusible crystals of a typical organic compound. The only question in dispute is therefore the possibility that under some conditions this separation may still be incomplete.

In this respect Prof. Staudinger has put forward a common-sense view, which will be widely welcomed, especially by chemists who have retained their reverence for structural formulæ and their faith in the quadrivalency of carbon. It is indeed an agreeable sign of the times that organic chemistry in the hands of Staudinger, and inorganic chemistry in the hands of Prof. W. L. Bragg, have provided simultaneously such attractive examples of large molecules, constructed in strict accord with the most orthodox theories of chemical structure ; and the reviewer can recall few lectures to which he has listened with greater pleasure than that of Bragg to the Mineralogical Society on the "Structure of the Silicates" and Staudinger's lecture to the Solvay Institute on "Large Molecules", when the floor was littered with glucose molecules, in the form of half-inch lengths of match-stick, which he had broken off from his rods and bundles of cellulose molecules.

The present volume will be read with interest as a full account of the story which was then told in such delightful outline.

T. M. L.

Sulphur Bacteria

Sulphur Bacteria: a Monograph. By Prof. D. Ellis. Pp. ix + 261. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1932.) 21*s.* net.

THE sulphur bacteria belong to that remarkable group of autotrophic organisms, the members of which have adopted eccentric modes of metabolism in which unusual sources of energy are tapped. In their case it is the partial oxidation of sulphuretted hydrogen, or perhaps rather of the HS' ion, with formation of free sulphur. At the same time, carbonic acid is reduced and made available as a source of carbon compounds. Nitrogen can be assimilated from ammonium salts. These materials and some mineral salts are all that is required for the continued growth and well-being of the organisms. The group is confined to organisms which have sulphur globules in their cells. The further oxidation of this sulphur to sulphate, which undoubtedly occurs, has not been proved to be connected with the vital activity of the cells. Sometimes the sulphur is excreted and undergoes oxidation outside the cell.

A feature of great interest in the group is the occurrence of coloured organisms (rhodo-thiobacteria) and much discussion has taken place as to the nature and function of the colouring matter. The prevailing opinion appears to be that by its aid the organisms are enabled to utilise the energy of light in the assimilation of carbon from carbon dioxide. The sulphur metabolism of these coloured organisms seems, however, to be the same as that of the leuco-thiobacteria, so that they have two strings to their metabolic bow.

Considerable practical difficulties arise in the study of the group; especially, perhaps, that pure cultures are difficult to obtain and have not yet in all cases been attained and that the organisms are highly pleomorphic.

The author pays great attention to the classification of this large and important group and adopts an original scheme based primarily on a division into the two groups of colourless and coloured sulphur bacteria. These yield between them eleven families, distinguished by differences in morphology and modes of reproduction and ciliation; these again are divided into 23 genera. A full and well-illustrated description is given of the known organisms, and numerous special points of interest are discussed in separate chapters: such as the intimate structure of the cell, irritability, the mechanism of ciliary motion, etc.

Finally, a very complete account is given of the work on the colouring matter of these organisms. This was first investigated by Ray Lankester in 1873, but the composition and relations of the two colouring matters which are present have not yet been settled.

The sulphur bacteria play an important part in Nature in the sulphur cycle, in which the combined sulphur of the amino-acids of the protein molecule is brought, through the stages of sulphuretted hydrogen and free sulphur, into the condition of a soluble sulphate assimilable by plants, to be reintroduced by them into the protein molecule.

All interested in this fascinating subject will find in Prof. Ellis's book a clear and well documented account of all that is known about it. A. H.

World Civilisations

The History of World Civilisation: from Prehistoric Times to the Middle Ages. By Prof. H. Schneider. Vol. 1. Pp. xiv + 360. Vol. 2. Pp. vi + 361–908. (London: George Routledge and Sons, Ltd., 1931.) 42*s.* net.

THIS important and well-known book has been translated from the German, quite competently, though with a good many slips in proof correcting. It naturally suggests the still more famous book of Spengler, which it resembles in the wide sweep of its survey, the facility of its comparisons and the insistence on the rise and fall of civilisations. It is, however, a much weightier book for several reasons. In the first place, it is based on a thorough and scholarly study of the materials; Dr. Schneider's knowledge of the early history of all the civilisations he treats—Egyptian, Babylonian, Greek, Roman, Indian and Chinese—is amazing. In the second place, he is not obsessed by the fallacy which commended Spengler's work as a sensation but undermined its real value, namely, that we are in presence of the decadence of our own civilisation. In the third place, Dr. Schneider is a professor of philosophy and hence by his profession and habitual ways of thinking is always trying to see his subject as a whole.

Now, as human civilisation is one great connected process, this is a prerequisite of the highest importance. At the same time it has led the author

into many doubtful positions—one in particular—which have been noticed with marked disapproval by the specialists and are likely to prejudice the public against the high value of the work as a whole, unless they are pointed out and guarded against at starting.

This one most insistent theory is that of the origin of all civilisations from a northern land and northern peoples, who, accustomed to see the sun disappear entirely in the winter and be born again in the spring, conceived a solar religion which Dr. Schneider traces in the mythology of all. The good and supreme Being is in conflict with a treacherous and malign power which for a time subdues him, and then by various devices he is brought back to life and beneficence again. This so-called 'Cimmerian hypothesis' is not of course generally accepted, but it would be a grave mistake to rule out of consideration any light that it may throw on the dark places of primitive man, and the suggestions which Dr. Schneider is able to make on this basis are often surprisingly enlightening.

The other side, on which the book is most likely to arrest the general reader, is the constant tendency to see analogies in the upward course of the various civilisations described. Egyptians are compared with Babylonians at every turn, and Jews with Greeks and Romans. When we reach the final sections of the book, in which India and China are dealt with much more summarily than the more western peoples, this method is predominant. The assumption always is that each civilisation follows a similar course to that of others, in main outline, with differences due to the various endowment and circumstances of each. Assuming the similarity, the contrasting points stand out more clearly and become more significant of the character of the people to whom they are due. Thus the great gods of India, Indra Agni and Varuna, correspond in a general way to those of the Greek mythology as seen in the "Iliad", but in India they are less clearly visualised and less differentiated. As that power was feebler among the Indians, plastic art achieved nothing like the Zeus of Phidias or the Hermes of Praxiteles.

The section on China is specially interesting from this point of view. Treating the Chinese as most like the Greeks, but crediting them with a mainly independent evolution, Schneider finds that Lao Tzu corresponds more or less to Xenophanes and Confucius to Pythagoras. Both teachers approached very closely to the Greeks though they did not quite attain their level. "Lao Tzu's monism was scientifically on a lower plane than Parmenides and Heraclitus and the criticism of Confucius did not culminate in a Socratic method of bringing valuable knowledge to birth." The reader will notice how the method, which may sometimes strike him as fanciful, has the supreme merit of making the whole story alive and fascinating, and if he wishes to criticise or supplement, so much the better.

The book as a whole is a masterly performance and the sequel will be awaited with great interest. The present two volumes bring us down only to the threshold of the Middle Ages. Chu Hsi, who died in 1200, is the last great man touched on in the Chinese section, and treated somewhat cavalierly. The fact that these volumes stop at that point partly explains what will appear to a careful reader the most serious weakness of the book. Exact science, the ordering of their world by what they had ascertained of the laws of Nature, does not receive sufficient attention. There is too much of their theological beliefs, too little of what they were learning and practising all the time about the world they lived in. Let us hope that this will receive due acknowledgment when science was reborn in greater strength after A.D. 1200.

F. S. MARVIN.

The Insect Menace

The Insect Menace. By L. O. Howard. Pp. xv + 347 + 32 plates. (London: D. Appleton and Co., 1931.) 12*s.* 6*d.* net.

DESPITE the fact that human health and happiness rest on biological foundations, it is surprising how slight has been the incorporation of biological knowledge in current public opinion. For this condition of affairs the biologist himself has not been without blame, in that he has failed to realise that none but the trained specialist can hope to understand the jargon of technical terminology, in which his researches are written. Since the general public provides much of the sinews, which make biological research possible, it seems only fair that its members should be provided from time to time with a readily intelligible account of the progress that the biologist is making in solving problems of human import. In no biological field does the stream of research flow so rapidly as in that of entomology, and in this book the author, who successfully directed the affairs of the United

States Bureau of Entomology for many years, sets himself the task of educating the lay mind in the methods by which the entomologist is coping with the depredations of insect pests.

In the initial chapters Dr. Howard explains why insects with their vast range of structural adaptations, extending over a period of forty million years, have achieved such a marked degree of ascendancy over practically all other living organisms save man. It is further shown that the achievement of economic status as pests by insects has been mainly determined by human agency, which has also fostered their spread from region to region and country to country by reason of the facilities offered by modern systems of rapid transport.

If one has any doubts of the extent of the damage caused by insects, the formidable figures —even approximate as they are—furnished by statisticians will go far to remove them. For example, during the year 1919 it was estimated that insect ravages were responsible for a reduction of four hundred million pounds in the value of the crops of the United States alone. It almost staggers the imagination to think of the extent of the losses reckoned in terms of the crops of the whole world. It is readily comprehensible how these losses must and do affect the prices of many staple commodities such as cotton, sugar, maize and wheat as well as the conditions of the labour market in different parts of the world. Then again there is still to be considered that toll of human health and efficiency, to say nothing of domesticated animals, which is exacted by the pathogenic micro-organisms, that are transmitted by insects, blood-sucking and non-blood-sucking, in both tropical and temperate countries.

In view of all the facts, there is cause for congratulation that to-day there are more than seventy countries which have come to realise the importance of applied entomology, and are now providing staffs of trained entomologists, who either act in an advisory capacity or carry on research on specific problems. It is recognised that human resource and ingenuity are being taxed to the utmost to cope with the insect menace. Methods of attack vary with the individual insect species. Now it may be biological, as in the case of the cottony-cushion scale of California and the Levuana caterpillar of Fiji. Again it may be mechanical and chemical, as in the case of the cotton-boll weevil; or again it may be legislative, involving stringent measures of quarantine and eradication, as in the case of the Mediterranean fruit-fly. That solutions of what at one time seemed hopeless problems have been achieved is shown by the present negligible status in the United States of the Rocky Mountain locust, the cotton-boll weevil and the Mediterranean fruit-fly. Elimination of the breeding grounds in the North-West by settlement and cultivation has obliterated the swarms of the first of these; in regard to the second it has been shown that cotton can be successfully grown despite the weevil, if the plants are dusted with arsenate of lime; and the dreaded fruit-fly introduced into Florida in 1929 was speedily eradicated by the destruction of all infested fruit and restriction of shipments of fruit from infested to non-infested areas.

In conclusion, we would say that Dr. Howard has admirably achieved the purpose with which he set out. The educated layman will find no difficulty in following his arguments, and we can guarantee that the reader's interest will be sustained from cover to cover. The book should enjoy a wide circulation among those who are anxious to extend their knowledge of Nature's ways.

A. E. CAMERON.

Short Reviews

A Scheme of Egyptian Chronology: with Notes thereon including Notes on Cretan and other Chronologies. By Duncan Macnaughton. Pp. xii + 406 + 19 plates. (London: Luzac and Co., 1932.) 25*s*.

THE author here follows up certain suggestions in reference to Egyptian chronology which were put forward in his "Scheme of Babylonian Chronology", but were not worked out. Further study has now shown him the possibilities of a number of clues to the dating of the early Egyptian dynasties. His theory, broadly, is that the 'births' of the gods in the Palermo Stone refer to the commencement of planetary cycles, which could probably only occur in historic times at a certain period, reinforced by his interpretation of the evidence of the list of Eratosthenes, and other calendrical and astronomical evidence.

The author himself regards his results as of varying value, some being classed as highly probable and others as only "mere possibilities". The result as regards the crucial dates are certainly high in comparison with more conservative systems. Thus Dynasty I is put at 5776 B.C. as against the 4360 B.C. of Petrie or the 3315 of Meyer. The author is scrupulously fair in the full statement of his data, and even those who do not agree with him, will find his book a useful compendium of the facts relating to the controversial questions of Egyptian chronology.

The Scenery of England: a Study of Harmonious Grouping in Town and Country. By Dr. Vaughan Cornish. Pp. 125 + 8 plates. (London: The Council for the Preservation of Rural England, 1932.) 3*s.* 6*d.* net.

DR. CORNISH here presents to us the beauty of England in a succession of charming word-pictures from his rich store of personal impressions of the many types of landscape which the country affords, including the Lakes, the Peak, the Fens, the Cotswolds, Dartmoor, the New Forest, the Dorset coast, Wiltshire downs and many other parts. This, in a book of so modest a compass, should be a more effective method of rousing public interest in the work of the Council for the Preservation of Rural England than a more categorical description of the country, county by county, or district by district. Dr. Cornish throughout lays stress on the importance of making buildings harmonise with the landscape, and he concludes with appendixes on the aims and objects of the Council and powers and duties of affiliated local authorities.

The Council's attitude towards modern developments is thoroughly sane and well-balanced, emphasising the complementary relationship between town and country and the necessity for planning England as a whole, never suggesting that it would be either possible or desirable to hamper the healthy growth of cities. The face of England as regards extent of area is still predominantly rural by a wide margin, and it would no doubt be to the advantage of the nation that it should remain so. Hence it seems to us that the efforts and deliberations of the Council should always be made with an eye to the possibility that the population will continue to increase indefinitely.

If the present huge population of England were ever to double itself and remain concentrated in a few unwieldy 'conurbations', it is difficult to see what could be done to prevent a large fraction of the area of the country from wearing a heavy suburban cloak, even though the remaining rural districts might still be solitary and the remoter mountain regions practically uninhabited wilderness as at present. L. C. W. B.

The Call of the Bush: Wanderings of a Nature Man on the Murray River. By Harold Priest. Pp. 240 + 16 plates. (London: T. Werner Laurie, Ltd., 1932.) 12*s.* 6*d.* net.

THIS is the record of a long tramp along the course of the Murray River, the author shifting for himself and 'living on the country' as he went, though he ultimately joined up with a couple of cattlemen and accompanied them for a time. His observations on the great river and the various human and animal types which frequent it are varied and they are interestingly told, but the book would have been even better than it is had there been more detailed natural history and less reflective 'padding'. One interesting observation is on the coloration of the ticks infesting the common Australian monitor (miscalled 'guana' or 'goanna'), which are black when adhering to the black areas of the reptile's skin, and yellow when on the pale ground, and this, as the author says, suggests that this adaptive hue, which renders them very difficult to see, means that they have had to protect themselves against removal by other agencies as well as their hosts. Another interesting fact recorded is that domestic cats kept in the wilds bring their kittens fishes as well as other animals, indicating that the animals' well-known fondness for these has its foundation in a natural preying habit.

Pila (the Apple-Snail). By Dr. Baini Prashad. (The Indian Zoological Memoirs on Indian Animal Types, edited by Dr. K. N. Bahl, No. 4.) Pp. xi + 83. (Lucknow: Methodist Publishing House, 1932.) 2 rupees.

THIS laboratory manual on the snail now studied in most eastern universities as a type of gastropod mollusc is itself a model of what such a book ought to be. It is well illustrated, and contains not only a description of the anatomy of the subject and practical directions for its dissection, but also a synopsis of the eight Indian species of the genus *Pila*, and some interesting bionomical notes. From these it is plain that the apple-snail is the most versatile of the gastropods—or indeed, of all Mollusca. Usually a denizen of fresh-water, it can, in the case at least of *P. globosa*, tolerate that which is brackish; usually vegetarian, it may eat dead animal matter. It has both aquatic and aerial respiration at its command; it can swim as well as crawl in water, and yet can travel overland and even climb trees, while it lays its eggs on land, and specimens left dry in a cupboard rivalled the celebrated desert-snail of the British Museum by being found alive after five years.

The Animals came to Drink. By Cherry Kearton. Pp. 189 + 31 plates. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1932.) 6*s.* net.

IN the introductory note the author states that he would "be thankful if this book could act as a counterblast to the many animal stories, so constantly appearing, which are based on utterly false or distorted natural history", and his desire will certainly be fulfilled if this volume achieves the popularity it deserves. The reader's attention is held from start to finish and the genuine ring of truth is established as, in the form of a story, the writer recalls his own long experience of African wild life. The narrative centres round the wanderings of an *impalla;* the insistent demand for water results in the description of many incidents which show the author's patience and keenness of observation. The volume is well illustrated.

Water Pollution Research

By DR. A. PARKER

THE growth of industry and of the population during the last century, especially in the north of England, gave rise to several undesirable conditions, including gross contamination of rivers, which in some cases became little better than open sewers. A plentiful supply of water of good quality for domestic and agricultural purposes is one of the major factors in public health, and large quantities of comparatively pure water are required for many industrial processes. Available sources, both surface and underground, of unpolluted water are gradually being depleted and there is no doubt that many rivers which are at present polluted will have to be utilised in the future as sources of supply, after treatment, for both domestic and industrial purposes. Further, the problems of river pollution are of importance in that they affect not only the health and recreations of the population but also the interests of farmers, landowners and fishermen. It is not surprising, therefore, that attention has frequently been directed to the need for satisfactory methods of preventing or reducing pollution.

It was recognised by the Royal Commission on Sewage Disposal, whose comprehensive inquiry during the years 1898–1915 produced results of great value, that satisfactory methods of disposal of polluting liquids from industrial operations were in many cases either unknown or impracticable, and that the problems involved could not be solved without further knowledge. One of the recommendations of the Commission was the establishment of a central authority the duties of which should include the investigation of problems in the purification of polluting discharges and the collection and correlation of the results of investigations by others. Since 1915, the importance of the subject has been stressed on several occasions. In February 1927, public opinion was focused on the matter by a deputation, representative of the British Waterworks Association, the Salmon and Trout Association and other authorities, which was received by the late Lord Balfour, then Lord President of the Council. In consequence of the views expressed by these and other independent authorities and by several Government departments, the Water Pollution Research Board was set up in June 1927 by the Department of Scientific and Industrial Research. This Board was appointed to submit schemes for research on the prevention of the pollution of rivers and other sources of water supply and on any relevant matters affecting the purity of water supplies, and to supervise approved investigations.

Since its appointment, the Board has initiated investigations of the problem of disposal of effluents from beet sugar factories, the base-exchange process of water softening, the causes of the corrosive and plumbo-solvent action of certain waters on mains and service pipes, and of bacteriological and physico-chemical problems associated with processes of purification of sewage. In addition, a comprehensive scientific survey of the River Tees was begun early in 1929. The research staff has also assisted other investigators by directing attention to appropriate scientific and technical literature and by indicating the most promising methods of attacking the problems to be solved. In this connexion, informative summaries of current literature relating to water supplies, sewage, trade waste waters, river pollution and kindred subjects are systematically prepared and published monthly.

Of the investigations already mentioned, that dealing with effluents from beet sugar factories and the survey of the River Tees have reached the most advanced stages. It is proposed, therefore, briefly to describe these two investigations and the more important results obtained. Incidentally, as an illustration of the greater interest now being taken in the problems of water supply and river pollution, it should be mentioned that a session of Section B (Chemistry) at the recent meeting at York of the British Association was devoted to a discussion of the survey of the River Tees. In addition, Sections D (Zoology) and K (Botany) held a joint discussion on biological balance in fresh water, while the organisation required for recording water level and river flow in the British Isles was discussed in Section A (Mathematical Science and Physics).

When the Water Pollution Research Board began its activities, the beet sugar industry had only recently developed on an extensive scale in Great Britain, but already several serious cases of the pollution of rivers by the waste waters had occurred. Preliminary work soon indicated that it might be advisable to suggest modifications in the factory processes so as to reduce the quantities or alter the composition of the effluents rather than to consider only methods of purification. It was important, therefore, that the investigation should be proceeded with as rapidly as possible, before other factories were erected.

On arrival at the factory, the beets are conveyed by water carriage along flumes to washers in which they are washed to remove adhering soil and debris. In a factory of average size, 1,000–1,500 tons of beet are dealt with each day and the total quantity of fluming and washing water varies from 2·5 to 3·5 million gallons. After washing, the beets are cut into small slices or cossettes from which the sugar is extracted with hot juice or water, usually in a battery of diffusers; the diffusers are cleaned periodically by washing with water. The spent cossettes are then pressed to reduce their moisture content. Water

removed from the spent cossettes, together with the washings from the diffusers, is generally known as process water and amounts to 300,000–500,000 gallons per day. Purification of the solution of sugar is effected by several processes and the purified juice is evaporated to crystallise the sugar. A large quantity of cooling water is required during the concentration of the juice, and from 75 to 80 per cent of the water in the juice is removed and condensed in the process. The total quantity of water from the condensers is of the order of 3 million gallons per 1,000 tons of beet treated; this water is often used again in the flumes for carrying the beets to the washers. From this brief description of the factory processes, it will be noted that the principal effluents for disposal are fluming and washing water, 2·5–3·5 million gallons per 1,000 tons of beet, and process water, 300,000–500,000 gallons per 1,000 tons of beet. The fluming and washing water carries soil and beet debris and contains small amounts of dissolved organic and inorganic substances. It is definitely polluting in character, but though larger in quantity it is not so objectionable as process water. This latter effluent contains 0·2–0·4 per cent of sugar, ferments rapidly on storage and takes up large quantities of oxygen from any river into which it may be discharged.

As a result of the investigation during 1927–30, the Water Pollution Research Board definitely concluded that by suitable modifications in the factory processes, the whole, or at least the major quantities, of the fluming and washing water and of the process water could be re-used, leaving little or no effluent for disposal. Certain factories have for several seasons re-used the fluming and washing water after simple treatment by screening and sedimentation to remove solid matter, and the re-use of this water has proved to be entirely satisfactory. At some factories the cossettes are extracted by a continuous process of diffusion in which the water removed from the spent cossettes is returned to the diffuser. In this process there is very little waste water for disposal. Even with the intermittent process in a battery of diffusers, large scale trials in the factory have shown that after preliminary treatment with lime or by other simple methods, the process water can in large measure be re-used in place of fresh water. If the fluming and washing water is re-used, then the effluent from the condensers requires consideration. This effluent is not very polluting in character, but it is advisable that it be cooled before discharge to a river, or it may be cooled and re-used.

Although it had been shown that the waste waters from a beet sugar factory could be largely re-used, it was realised that it might be necessary on occasion to discharge a proportion of the waste waters or that some factories might prefer to purify the wastes sufficiently to allow of their discharge into a river rather than to re-use them. After preliminary experiments in the laboratory, it was decided that, as a method of purification, the process of biological oxidation on percolating filters showed promise of success. This process, which is similar to that in operation at many sewage works, was tried therefore in laboratory and large-scale experiments. In addition to the chemical examination of the effluents before and after treatment, the fauna and flora of the filters have been systematically studied, and it has been shown that, under certain conditions, beet sugar factory effluents can be sufficiently purified by biological filtration to allow of their discharge, except into the smallest streams, without causing serious pollution. It has been demonstrated, therefore, that gross contamination of rivers by effluents from beet sugar factories can be avoided and there is no doubt that during the past two or three years this type of pollution has been much reduced.

The survey of the River Tees was undertaken with the object of obtaining more precise information than was hitherto available on the effects of different kinds of effluents, both sewage and industrial, on a river, and with the object of assessing the power of a river to recover from the effects of polluting discharges. This survey provides a good example of what can be achieved from carefully planned co-operation between specialists in different branches of science, for it has included hydrographical, chemical, bacteriological, botanical and zoological observations and experiments. In addition, records of rainfall have been collected for correlation with measurements of river flow.

From the hydrographical measurements, it has been shown that the water in the estuary at depths below one fathom has a tendency to move up river over each tidal cycle of ebb and flood. The water in the top layer, however, has a strong net movement down river, and the volume moving down river in this layer is greater than the net volume moving up river in the lower layers. A circulatory system is thus set up and is superimposed on the to-and-fro movement of the tides. It has been concluded, therefore, that polluting matter is not readily conveyed to the sea unless it is in the surface layer when it reaches the estuary.

Large quantities of crude sewage and of industrial effluents are discharged into the estuary of the Tees, especially in the section from Stockton to Cargo Fleet. The principal industrial effluents are those derived from coke ovens which contain tar acids, naphthalene, cyanide, etc., and spent pickle liquor, which is an acid solution of iron produced during the cleansing of iron and steel. Oxidation of the sewage and effluents occurs in the estuary at the expense of dissolved oxygen. The Tees was formerly a noted salmon river, but for many years large numbers of fish have been killed in the estuary, especially salmon and sea trout smolts during their migration in the spring to the sea. Various observations and experiments

included in the survey have proved that in 1930 and 1931 the death of migrating smolts was not due to the deficiency of dissolved oxygen but to cyanides, which were frequently found in lethal concentrations. Other poisonous substances, including tar acids, were not found in toxic concentrations and it has been concluded that in the absence of cyanides, migrating smolts would not have been killed in 1930 and 1931. This conclusion marks a distinct step forward, for although several explanations had previously been offered, it had never before been suggested that cyanides were responsible for the death of fish in the River Tees. Another interesting result of the survey is that experiments in the laboratory and on a semi-technical scale have demonstrated that cyanides in coke oven effluents can readily be converted into relatively non-toxic ferrocyanide by treatment of the effluents with spent pickle liquor and lime.

In the non-tidal reach of the Tees, there is only one point at which any large quantity of polluting matter enters and this pollution is derived from sewage. Further downstream, for a distance of about 15 miles, there is no polluting discharge of any importance. A study has been made, therefore, of the effects of sewage pollution on the biology of the river and of the factors which influence the rate of self-purification of a river from pollution by sewage. It appears that temperature is the most important factor, so that the rate of self-purification is much greater in summer than in winter. In determining the relative rates of self-purification under various conditions, it has been necessary to calculate the total quantities of different constituents of the river water from the results of chemical analysis and measurements of volumes of water and river flows. The occurrence of certain plants and animals has been correlated with the conditions of the water as determined by chemical analysis and several new and little-known algæ have been discovered. In addition, useful additions to knowledge have been made with regard to the food of fish.

Cod in Danish Waters

COD are present in all Danish North Sea waters and extend northward through the brackish Baltic Sea into the still more brackish Gulf of Bothnia almost (but not quite) to its northern extremity. Elaborate researches upon the cod in all these waters have been carried out by a Danish investigator, Dr. E. M. Poulsen, the results of which have been published recently in a comprehensive report.*

In Section I of the report data regarding the bathymetric distribution of the fish in Danish waters are given. In the North Sea, cod are most abundant in depths of less than 100 metres. Between 100 and 200 metres they are relatively scarce, while at depths of more than 200 metres they are seldom caught. What few cod there are present in these deeper layers are almost entirely old and large fish. In the Baltic, around Bornholm, cod are most numerous from 40 down to 100 metres, at which depths the water is less brackish than in the overlying layers. In the Kattegat, on the other hand, the fish favour depths of from 40 to 60 metres.

Observations on the spawning periods of the cod in these different regions produced very interesting results. In the Kattegat, spawning begins in February, reaches a maximum in March, and finishes about the end of April. In the Belt Sea spawning may extend into the first half of May, while still farther north, in the Bornholm Deep, spawning continues from April until August with June as the main spawning month. Contemporaneous hydrographical data reveal that the cod spawn in water the temperature of which lies between 3° C. and 7° C. The displacement of the spawning season from early spring far into the summer, on proceeding from the Kattegat into the Baltic, corresponds with the different times at which the bottom waters reach this temperature.

Cod larvæ occur throughout the whole of the area investigated, but are most numerous in the North Sea, the South West Kattegat, the Sound, Belts, and Western Baltic, and are relatively very much scarcer in the Skagerak, the North East Kattegat, and in the Baltic proper. The larvæ are peculiarly abundant in front of certain marine ridges which intercept the in-going North Sea currents in the Little Belt, at the Gedser Reef, and at Dragden in the Sound. Hydrographical investigations show that the ingoing salt-water currents are largely blocked at these ridges. Larvæ from the North Sea brought in by the currents are therefore largely intercepted by them and accumulate in great numbers on their seaward sides.

During the period 1917–1927 good and bad survival years for the fry are stated to have alternated regularly, the years 1917, 1919, 1921, 1923, 1925, and 1927 having been good survival years, while the intervening years were bad. The years 1928 and 1929 are described somewhat vaguely as being neither good nor bad but "to some extent normal".

The most interesting and important part of the report is that in which the author records his attempts to determine the causes underlying these annual fluctuations in the abundance of cod fry in these waters. At the outset a certain amount of evidence is put forward which suggests that fluctuations in the number of eggs produced from year to year are not to any appreciable extent correlated with fluctuations in the number of larvæ later produced.

* Erik M. Poulsen. "Biological Investigations upon the Cod in Danish Waters". Meddelelser fra Kommissionen for Danmarks Fiskeri-og Havundersøgelser. Serie: Fiskeri. Bind IX., Nr. 1., pp. 1-148. C. A. Reitzels Forlag, København, 1931.

A distinct correlation is found to exist, however, between the temperature of the bottom waters in March–April–May and the quantity of larvæ which can be caught by standard methods in these months, a relatively high temperature being coincident with a good larval yield and vice versa. The reason for this correlation is claimed to be that temperature conditions are directly responsible for the abundance or otherwise of the planktonic food organisms upon which the fry depend for their survival. The radius of action of a tiny cod larva is very small. If it does not find abundant and easily available food as soon as its yolk is used up it dies.

Dr. Poulsen has also found an apparently significant relation between the temperature of the surface water in January and February and the number of larvæ obtainable in the spring months following. The reason for this, he believes, undoubtedly is that when the surface water in mild winters is comparatively warm the winter minimum of planktonic organisms does not sink so far as in more severe winters. (In this connexion it is interesting to recall that in 1927 Johansen found that the number of plaice fry in the Belt Sea was correlated with the number of days in which the water was covered with ice, and the temperature of the surface water in January and February.)

A definite relation is also established between the salinity of the bottom waters in November and December and the number of fry present in the following spring both in the Belt Sea and to a lesser extent in the Kattegat. This correlation, it is pointed out, cannot be due to any direct influence. Spawning does not begin until January at the earliest and larvæ do not appear until about the end of February. The following tentative explanation is therefore put forward. In the autumn an annual migration of large and sexually mature cod is known to take place from outside into the Belt Sea. This migration is dependent upon an autumn inflow of salt water from the North Sea. The larger the inflow, the greater the number of cod which come in with it. Particularly large numbers of eggs are then spawned and a large brood of larvæ results. At the same time, a large inflow of North Sea water produces a condition of high salinity in the Belt Sea and in the Kattegat.

This explanation implies that fluctuations in the numbers of eggs laid produce corresponding fluctuations in the resulting larval broods. This hypothesis may hold good in the Belt Sea but the author himself, in another part of his report, points out that it does not appear to be true as a general rule. It is to be hoped, therefore, that Dr. Poulsen will continue these researches and that this report will in due course be followed by another containing new and illuminating information on these interesting and important points in the life history of the cod in Danish waters.

G. A. S.

Low Altitude Auroræ

AN unusually low aurora was witnessed on March 8 of this year at the Auroral Observatory, Tromsø, Norway. The height was determined photographically by the Director, L. Harang, working with Dr. W. Bauer (of the Photophysical Laboratory, the Danzig Technical High School), who have made a brief joint report of their work in *Gerlands Beiträge zur Geophysik* (Bd. 37, pp. 109–115, 1932). At the suggestion of E. Brüche, Berlin, two film cameras were in use at the two base stations (43 km. apart) from which simultaneous parallactic photographs were made; this was in order that, by taking short exposures of a few seconds, a continuous record of the development and changes of auroræ might be obtained. On the two evenings of March 8 and 9, 1932, about 500 pairs of photographs of bows, bands, draperies and rays were taken, during intense displays of the northern lights. A series of 20 pairs of these pictures, covering a period of only 75 seconds, on the night of March 8, disclosed a particularly interesting phenomenon.

At 20.45 G.M.T. an intense yellow-green auroral bow with a deep-red lower edge appeared in the north, at an elevation above the horizon of about 13°; it was found to be 290 km. distant, at an altitude of 77 km. Within 40 seconds it drew southwards by 20 km., and penetrated the atmosphere further, to 75 km., while its eastern portion dissolved, so that the bow ceased to be in the field of the camera. Suddenly, during a few seconds, another bow developed, 20 km. behind the first, that is, at the distance where the latter originally appeared; the second bow, however, was lower, its measured height being only 65 km. After 15 seconds its height quickly increased to 80 km., and it receded to 350 km. distance, while the red colour vanished from the lower edge. This bow also then drew slowly southwards, while its right end rose to 100 km.; this disclosed a third faint bow, lying at 90 km. height and 70 km. behind the second one, the gradual southward motion of which it followed. The time during which the second bow was below 75 km. was less than 20 seconds.

The outstanding character of this observation is well illustrated by the diagram here reproduced (Fig. 1), from the paper referred to. In column *A* are shown all the measured heights of the yellow-green auroral bows observed at Tromsø during the period February to October 1929. In the middle column *B* are shown the heights of the red-edged yellow-green bows observed there on March 8, and in column *C* the heights of other yellow-green bows observed on the same evening. The diagram shows that the heights usually exceed 90 km., but, rather rarely, come down nearly to 80 km., as Prof. C. Størmer found. The quite exceptional nature of the lower red-edged

bow of March 8, extending down to 65 km. (or possibly even less) is evident.

We are still ignorant of the precise mode in which the auroral light is produced, but it seems likely to be due to the entry into the atmosphere of charged particles from outside; the sign of the charge, and the speed of the particles, are unknown. Their penetrating power can be conveniently stated (as for α- and β-particles in the laboratory) in terms of the equivalent thickness of air at normal density which they traverse. This cannot be accurately inferred from the measured heights of the lowermost edges of auroræ, because of uncertainties as to the composition and temperature of the air at great heights; but there can be little doubt that particles which come down to 65 km. traverse at least five times as much air as those that come down to 80 km. Thus the newly observed aurora suggests that, at times, particles enter the atmosphere with a penetrating power five times as great as that of those (themselves unusually penetrating) that come down to 80 km. If this interpretation be correct, the extension in the range of our knowledge of these particles is no small one.

Another reflection is prompted by the extremely fleeting nature of this low aurora. Throughout their many years of auroral photography, Størmer, Vegard and Krogness have never measured so low an aurora; of course a great many auroræ the heights of which have not been determined have appeared during this period, and much of their work has been done at stations south of Tromsø. Apart from the red edge, which is not unique, the low bows now measured were not specially outstanding, and there was no obvious indication of their unusually low altitude. May not many such low bows, perhaps equally fleeting, have passed without recognition of their exceptional character? And may there not occasionally be still lower ones to be discovered by some fortunate or patient observer? The answer seems likely to be 'yes'.

Further, every reduction in the auroral heights substantiated by parallactic measurements increases the credibility of the reports of auroræ extending down to the ground. The gap between a height of 65 km. and the ground is a very large one, it is true, but already we have seen the lowermost measured height reduced from 100 km. or 95 km., as in Størmer's early work, to 80 km. in his later work, and, by McLennan's Canadian observations, to 75 km.; and now, by Harang and Bauer, this is brought down to 65 km.—a total reduction of 30 km. The capacity of auroræ to produce low height records—like that of the weather to surpass its own records of long standing—may be much greater than has been supposed.

In this connexion it may be appropriate, finally, to mention that a new collection of reports bearing on the audibility of auroræ, and on low altitude (ground level) auroræ, has been made by Dr. C. S. Beals, of the Dominion Astrophysical Observatory, Victoria, B.C. The reports come from the northern Canadian auroral belt, and are closely similar in tenor to those collected by Mr. J. Halvor Johnson, which I described in an article in NATURE of March 7, 1931. Dr. C. A. Chant, editor of the *Journal of the Royal Astronomical Society of Canada*, had also collected such evidence, during the years 1907–29. Dr. Beals, after discussing the evidence in his paper (which is to appear in January in the *Quarterly Journal of the Royal Meteorological Society*), regards it as reasonably establishing the occurrence, on very rare occasions, both of auroral sounds and of ground-level auroræ. S. CHAPMAN.

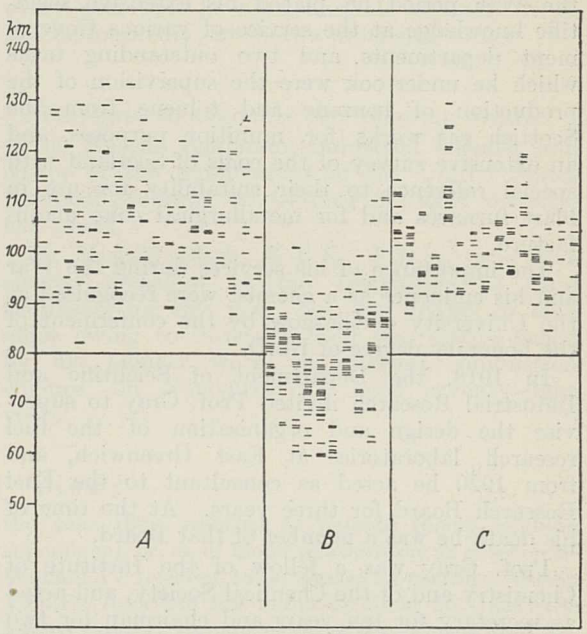

Fig. 1. Heights of auroral bows: *A*, February-October, 1929; *B* and *C*, March 8, 1932. From *Gerlands Beiträge zur Geophysik*, Bd. 37, Heft 1, 1932.

Obituary

PROF. T. GRAY

IT was with profound regret that the many friends of Prof. Thomas Gray learned of his death at Elie, Fife, on September 26. With his passing the Royal Technical College, Glasgow, has lost one of its most distinguished members.

Born at Mid-Calder in 1869, Prof. Gray received his early education at George Watson's College, Edinburgh, and entered the Andersonian College at Glasgow as a student of Prof. Dittmar in 1885. At nineteen years of age, he proceeded to the University of Jena, returning a year later to become assistant to Prof. Dittmar and afterwards to Prof. Henderson. Graduating B.Sc. in the University of London in 1890, his career as a lecturer commenced three years later at the Royal Tech-

nical College and in the same year he was appointed lecturer in chemistry at Queen Margaret College.

The summers of 1899 and 1900 were spent at Jena, where he obtained the degree of Ph.D., and in 1901 he graduated D.Sc., of the University of Glasgow. He also prosecuted his studies at Heidelberg and at the Zurich Polytechnic under Prof. Lunge.

In 1903, on the retirement of Prof. Mills, Dr. Gray succeeded to the 'Young' chair of technical chemistry at the Royal Technical College, and in 1919 was appointed director of the School of Chemistry. He instituted, in the College, the first classes giving public instruction in fuels; and to acquire first-hand knowledge of methods of manufacture and of plant construction, he spent many of his summer vacations in chemical works. During the War period he placed his extensive scientific knowledge at the service of various Government departments, and two outstanding tasks which he undertook were the supervision of the production of benzene and toluene from the Scottish gas works for munition purposes, and an extensive survey of the coals of Scotland with special reference to their suitability for use in blast furnaces and for metallurgical coke manufacture.

The importance of his services during the War and his eminence as a chemist were recognised at the University of Glasgow by the conferment of the honorary degree of LL.D.

In 1918, the Department of Scientific and Industrial Research invited Prof. Gray to supervise the design and organisation of the fuel research laboratories at East Greenwich, and from 1920 he acted as consultant to the Fuel Research Board for three years. At the time of his death he was a member of that Board.

Prof. Gray was a fellow of the Institute of Chemistry and of the Chemical Society, and acted as secretary for ten years and chairman for two years, of the Glasgow Section of the Society of Chemical Industry. Among the committees on which he served, were the Education Committee of the Institution of Gas Engineers, the Scottish Coal Survey Committee, and the Committee on Sampling and Analysis of Coal of the Fuel Research Board, of which he was chairman. His services as an examiner in chemistry were retained by the boards of various institutions, among which were the Faculty of Physicians and Surgeons of Glasgow and the Royal College of Physicians and Surgeons of Edinburgh. He was retained by the British Electric Lamp Manufacturers' Association as a consultant, and his services were much in demand as an expert witness in law cases dealing with chemical patents. Many of his scientific papers were published by the Chemical Society and the Society of Chemical Industry and in the *Berichte*.

In analytical work, Prof. Gray carried accuracy to extremes; and in research his cleverness as a glass blower, and his ingenuity in designing apparatus from the simplest material, were remarkable. An ideal teacher, he was held in high esteem by student and colleague alike. He had a quiet and attractive personality, and to have been included in his circle of friends was to have experienced an ever-increasing admiration for a very fine gentleman. W. J. SKILLING.

M. Salomon Reinach

By the death of Salomon Reinach, which took place at Boulogne-sur-Seine on November 4, France has lost one of her most distinguished and widely-known sons, who for more than a generation held a foremost place in the world of scholarship and archæology.

Salomon Reinach was born at St.-Germain on August 29, 1858, and, with his two brothers, also destined to attain high distinction in the world of learning, was educated at the Lycée Condorcet. He afterwards attended the École Normale and took the degrees of doctor of law and doctor of letters at the University of Paris. From that time onward his life was devoted to archæological studies, but in no narrow sense. In his view of the past he saw life whole. The breadth of his knowledge of antiquity was equalled by his understanding of it; and it should be no matter for surprise that he attained a universal reputation as an authority in classical scholarship and the history of philosophy, religion and art as well as in archæology.

In 1879 Reinach at the age of twenty-one years became a member of the French School of Archæology in Athens and later acted as the secretary of the Archæological Commission in Tunis. In 1885 he was appointed to the staff of the National Museums and in the same year published his "Traite d'Epigraphie Grecque", a Latin grammar and a handbook of field archæology. These had already been preceded by a manual of classical philology, issued between 1882 and 1884. By the time he was appointed curator of the Museum of St.-Germain and professor at the Louvre School in 1902, his monumental catalogue of the prehistoric collections of that Museum, which has recently been revised and re-issued, had won for him an established position as an authority in prehistoric archæology. Archæological studies took him to Greece, North Africa, southern Russia, Asia Minor, the whole fringe of the Mediterranean and the Danube. In western Europe his expert knowledge extended from palæolithic man to Gauls and Romans; and his acquaintance with the European museums and their contents was probably unique.

Reinach's literary output in the fields of classical scholarship, philosophy, comparative religion, art and archæology was very large. In 1902 he became the director of the *Révue Archéologique*. Throughout his life a stream of papers, monographs, books and articles came from his pen. It was characteristic of his humanistic attitude that he should also contribute to contemporary history and controversy—in this field he wrote *inter alia* a history

of the War and one of the Russian revolution, while the concluding chapters of the latest edition of his "Orpheus" is a masterly review of post-War tendencies in religious and political thought from his special point of view, that of the philosopher and historian who sees current events broadly, not as an ephemeral manifestation of human activity, but as part of a panoramic whole in which the springs of action are deep-rooted in the principles which govern the growth of humanity and the development of civilisation. He admitted himself something of a disciple of Voltaire, and his "Orpheus", a study of the history of religion in which religions are treated as natural phenomena, aroused some antagonism by his attitude towards Christianity. His writing, in truth, was not always uncoloured by emotion, and it was this, perhaps, which sometimes rendered his judgment open to question, as in his endorsement of the authenticity of the 'antiquities' from Glozel. Yet it is a remarkable tribute to the authority and enduring quality of his work that several of his books ran through more than one edition and of the "Orpheus" there were no less than thirty-eight French editions, the translation of the last appearing in England in 1931.

DR. C. B. MARSON

DR. C. B. MARSON, recently appointed head of the Chemical Department of the Hull Municipal Technical College, died suddenly on October 26.

Dr. Marson was apprenticed to Capt. J. A. Foster, public analyst of Hull, and during most of the War was attached to the French army at Verdun. After that he was on the chemical staff of the British Thomson-Houston Company, Rugby. He resigned that post in order to enter on a course in the Department of Coal Gas and Fuel Industries at the University of Leeds, which was terminated by his taking the B.Sc. degree with first-class honours in fuel and metallurgy, and later the Ph.D. degree. Since that time he has been in succession Gas Research Fellow at the University of Leeds, chemist on the staff of the Joint Research Committee of the Institution of Gas Engineers and the University of Leeds, and chief chemist of the Northern Coke Research Committee, stationed at Armstrong College, Newcastle-on-Tyne, until he took up his post at Hull a few weeks ago.

Dr. Marson was conspicuously successful in every post that he filled, and his untimely death has undoubtedly cut short a promising career.

H. J. H.

WE regret to announce the following deaths:

Dr. Marcus Benjamin, industrial chemist and editor of the publications of the United States National Museum, on October 22, aged seventy-five years.

Sir Dugald Clerk, K.B.E., F.R.S., who was elected president of the Institution of Civil Engineers for this year, but was unable to take office owing to ill-health, and was distinguished by his pioneer work on internal combustion engines, on November 12, aged seventy-eight years.

News and Views

H.R.H. the Duke of York, F.R.S.

HIS ROYAL HIGHNESS THE DUKE OF YORK attended the ordinary meeting of the Royal Society on November 10, signed the roll, and was formally admitted a fellow by the president, Sir Frederick Gowland Hopkins. The Duke had been elected on June 16 last. As is generally known, the opening page in the charter book, denoting the Society's inauguration, bears the signatures "Charles-Founder", "James [Duke of York, afterwards James II.] Fellow", and "Rupert"; the latter was the cousin of the reigning monarch. But another signature—"George", is there, and posterity may well conjecture how his name comes to be subscribed in alignment with that of "Rupert", and not beneath it. There was never a George Rupert; the name was that of George of Denmark, who married the Princess Anne. Elected (or brought into) the Society on its anniversary day, in 1704, and not long after Newton became president, it was the latter who waited on the Prince that day (with others), to obtain his signature, and adherence. Queen Anne herself never signed the charter book.

The Royal Family and the Royal Society

THE election of royal personages, subsequent to the year 1820, whether as patrons (being reigning sovereigns), or, as of blood relationship, is of interest. William IV (elected 1831) signed as patron. Queen Victoria inscribed her name on June 20, 1838, the Prince Consort signing below after election in 1840. King Edward VII signed when Prince of Wales, and again as patron (1901). In the former instance he had been elected in 1863, being proposed by Maj.-Gen. Sabine, the president. It would seem that it was not until March 2, 1882, whilst William Spottiswoode was president, that the Prince attended and inscribed his name. Also, in that year, his brother, the Duke of Edinburgh, was elected. Another brother, the Duke of Connaught, was elected on November 8, 1906, on the proposal of Lord Rayleigh, president, attending for admission in December following. His Royal Highness is, happily, still on the roll. His Majesty King George V was elected a fellow on June 8, 1893, when Duke of York, on the proposal of Lord Kelvin and Sir Michael Foster; on becoming Prince of Wales he then inscribed, and again in 1910 as monarch and patron. More recent times have witnessed the election and admission of Prince Arthur of Connaught (1914), His Royal Highness the Prince of Wales (1919, on the proposal of Sir J. J. Thomson, president); lastly, the Duke of York.

A Nobel Prize for Dr. Irving Langmuir

THE influence of the contributions to modern chemical thought of Dr. Irving Langmuir, who has been awarded the Nobel Prize for chemistry for 1932, is probably more widespread and generally appreciated than those of many of his predecessors. It was as if a new chapter had been commenced in the book of knowledge of the state and behaviour of molecules at interfaces, which forms the very bases of the science of colloids and is of fundamental importance in such diverse ramifications of the physical sciences as heterogeneous catalysis and thermionic emission, when Langmuir published his well-known papers in 1917. As occasionally happens, mathematical treatment may obscure the reality of physical and chemical processes, and that useful tool may prove an obstruction rather than an aid to further advance. It is no exaggeration to say that a new flood of light was thrown on the whole subject of the adsorption of, and reactions of, gases at solid surfaces, as well as the mechanism involved in changes in the surface tension of liquids. There are no better examples of the effects of welding our essentially chemical point of view, in which molecules are regarded as perfectly defined objects of definite form, with a physical appreciation of the general applicability of the Boltzmann distribution law and of the action of local fields of force extending over relatively short distances. This same breadth of treatment is also noted in the more recent and what some may regard as more physical aspects of his work. Thanks to Langmuir, thermionics is now an important branch of physical chemistry.

IT is only natural that investigations of such a fundamental character should have economic consequences, and Langmuir's work has led to many important industrial results, of which the gas-filled lamp is probably most widely appreciated. What was once "Dr. Whitney's experiment" in the General Electric Company has now become the life blood of all important industries, and it is a pity to note that apparently one large European firm is no longer encouraging fundamental research; probably the right men are not available. No small part of Langmuir's contributions to chemistry lies in his enthusiasm and the clarity of his presentation. The Lewis atom became as it were a household word when the concepts were developed, applied and expounded by Langmuir, and one almost had a vision of molecules of fatty acid floating across a water surface when listening to him. Those that know Langmuir as a friend are always impressed both by his kindness and his great breadth of interests. Whether it is ice-skating in winter, observing the formation of ripples and surface currents in summer on Lake George, or noting the brilliance of spiders' eyes when illuminated by a flash-lamp, there is always something of interest, something arresting and something which would convince many a classical scholar of the great advantages of science as an educational medium.

Retirement of Prof. E. B. Poulton, F.R.S.

WHEN, now forty years ago, Prof. E. B. Poulton succeeded Prof. Westwood, its first holder, in the Hope professorship of zoology at Oxford, great anticipations were entertained of the results to follow from the appointment of one who had already distinguished himself as an able investigator and experimenter in the field of evolutionary study. These expectations have been abundantly fulfilled; and it is not too much to say that under Prof. Poulton's untiring exertions, the Hope Department in the University of Oxford has become known throughout the scientific world as a chief centre for the maintenance and development of those views of organic evolution which owe their origin to the epoch-making work of Charles Darwin and Alfred Russel Wallace. Under his energetic administration, the great entomological collection, bequeathed by Mr. Hope and tended in its early days by the first Hope professor, has been immensely increased, and has been made available in an unexampled manner for the illustration of problems of first-rate biological importance. By his influence in stimulating and directing the efforts of observers and collectors in many parts of the world, Prof. Poulton has been able to accumulate a vast amount of material of the highest value for scientific workers at home, to whom he has never failed to afford the utmost help and encouragement. His own labours in the field of bionomics have been far-reaching and fruitful, and have caused him to be known everywhere as the most prominent living upholder of the doctrine of natural selection as propounded by Darwin in the "Origin of Species". His approaching retirement is felt, not only by entomologists, but also by the whole University of Oxford, as a serious loss; and it is much to be hoped that a successor may be found who will recognise and make it his business to carry on the great traditions of the Hope Department. It is a matter of congratulation that Prof. Poulton, when he relinquishes the engrossing task of administration, will be free to continue, on an even larger scale, those researches and expositions which have had so remarkable an influence on the progress of scientific entomology.

Dr. R. A. Millikan

IT is stated by Science Service, of Washington, D.C., that a Roosevelt Medal for achievement in science has been presented to Dr. Robert Andrews Millikan, director of the Norman Bridge Laboratory of Physics and chairman of the executive council of the California Institute of Technology. The presentation was made by James R. Garfield, Secretary of the Interior in the Roosevelt Cabinet. The medal is one of a series of awards established in 1923 by the Roosevelt Memorial Association. Usually three are given each year in three out of twelve fields of activity associated with Col. Roosevelt's career, but only one award has been made in 1932. Dr. Millikan has become widely known because of his achievements in physical research and was awarded the Nobel Prize for physics in 1923. Outstanding among his

accomplishments are the measuring of the charge on the electron and the study of cosmic radiation. Former recipients of the Roosevelt medal for work of a scientific nature include: Prof. Henry Fairfield Osborn, president of the American Museum of Natural History; Dr. Frank M. Chapman, curator of ornithology for the Museum; Dr. Herbert Putnam, librarian of Congress; and Richard E. Byrd, explorer.

Cambridge Philosophical Society

A BRILLIANT company assembled in the hall of Pembroke College, Cambridge, on Saturday, November 12, to celebrate by a dinner the centenary of the grant of a Royal Charter to the Cambridge Philosophical Society. Dr. A. Hutchinson, the Master of the College and president of the Society, was in the chair, and the occasion was honoured by the presence of H.R.H. Prince George. Among other distinguished people present were Mr. Stanley Baldwin, Chancellor of the University, the presidents of the Royal Society and of the British Association, and presidents or directors of many other leading scientific societies and institutions. The toast of the Society was proposed by Prince George and replied to by Dr. Hutchinson. The Master of Trinity proposed the toast of the guests, and responses were made by Mr. Baldwin and Sir William Bragg.

IN his reply to the toast of the Society, Dr. Hutchinson gave an interesting account of its origin and early work, and he was able to show that throughout its existence members of the Royal Family have honoured it by their favour and patronage. H.R.H. the Duke of Gloucester, a nephew of King George III and Chancellor of the University, accepted the office of patron on November 19, 1819, and made a handsome donation to the funds of the Society. Two years later H.R.H. Augustus Frederick, Duke of Sussex and a younger son of King George IV, became a vice-patron of the Society; afterwards he accepted the office of president of the Royal Society. When the Charter was granted by King William IV in 1832 he specifically confirmed his two kinsmen in their offices. The Prince Consort was patron of the Society when he was Chancellor of the University; and Dr. Hutchinson in the course of his speech said that he had been empowered by the Council of the Society to propose that the office of patron be revived, and that the present Chancellor, Mr. Baldwin, be invited to accept it. In his speech later in the evening, Mr. Baldwin stated that he regarded the office as one of high honour and accepted the invitation with pleasure.

Gaseous Combustion at High Pressure

AT the meeting of the Royal Society on November 10 when the Duke of York was admitted to the fellowship of the Society, Prof. W. A. Bone gave an account of Parts 14, 15 and 16 of his researches on gaseous combustion at high pressure. These record an exploration of the phenomena of explosion of hydrogen–air and carbon monoxide–air mixtures into regions of pressure much higher than those hitherto examined and the apparatus specially designed for the purpose was described. Hydrogen–air mixtures explode quite normally with initial pressures up to 500 atmospheres but at 750 atmospheres detonation occurs with violence sufficient to damage the apparatus. Carbon monoxide–air mixtures have been successfully exploded at initial pressures up to 1,000 atmospheres. As previously observed, the nitrogen is activated, absorbing during the early stages energy which is released during the later stages so as to retard the cooling of the products. This activated nitrogen reacts with excess oxygen, if present at the high temperature of explosion, giving oxides of nitrogen, the formation of which is favoured by increase of pressure. Nitric oxide dissociates readily during the process of cooling, so experiments were made in which the cooling is accelerated by causing the gas to expand suddenly at a predetermined instant after firing. Exploding mixtures of ($2CO + 3O_2 + 2N_2$) at an initial pressure of 70 atmospheres, the yield of nitric oxide is 5·4 per cent, and results at 88 atmospheres indicate a probable maximum of about six per cent. Such yields exceed those previously recorded but are probably insufficient to serve as a basis for the commercial fixation of nitrogen by explosive combustion. Experiments were shown to demonstrate how a rise of pressure increases the luminosity of carbon monoxide–air flames and leads to the formation of oxides of nitrogen.

Heavy Oil Aeroplane Engine

THE Air Ministry has issued some particulars of the first British heavy oil aeroplane engine. The Rolls-Royce 'Condor' compression ignition engine has successfully passed an Air Ministry test of 50 hours, and flight tests are now being undertaken in a Hawker 'Horsley' aeroplane. The engine has been developed from the 'Condor' petrol aeroplane engine, which has been strengthened where necessary to take the increased forces due to the raising of the compression ratio from $6\frac{1}{2}$ to $12\frac{1}{2}$. The maximum explosion pressure within the cylinders is 800 lb. per square inch. At the normal speed of 1,900 revolutions per minute, the engine develops 500 brake horse power. The increase in weight over that of the petrol engine is less than ten per cent, the engine weight being 1,504 lb. or 3 lb. per brake horse power, a weight-power ratio which represents a very large reduction over that of the Beardmore 'Tornado' engines installed in the airship *R 101*. As a petrol engine, the Rolls-Royce 'Condor' has a weight-power ratio of approximately 2 lb. per brake horse power. Assuming that the fuel consumption of the heavy oil engine is twenty-five per cent less than that of the petrol engine, there should be a saving in the total weight of engine and fuel for a lengthy flight such as the present types of aeroplanes are capable of making. In addition, the experimental flight tests are intended to investigate the extent to which the size of the radiator and the weight of cooling water can be reduced as compared with standard petrol engines.

Plant Morphology

MR. H. HAMSHAW THOMAS'S paper entitled "The Old Morphology and the New", read before the Linnean Society on November 10, created considerable interest. In recent years, Mr. Thomas said, a great gulf has arisen between the classical concepts of plant morphology and the new ideas which have been suggested by a study of the modern pteridophytes and of the older Palæozoic floras. A century of botanical investigation has not strengthened the foundations of the old morphology, but its modern exponents on the Continent have been led to regard much of what is termed morphology as irrelevant, and they reject all considerations of phylogeny, as well as the studies on the anatomy and cytology of plants. On the other hand, the foundations of the old system have been seriously shaken. Goethe, in a passage which has been generally overlooked, recognised the validity of some of the considerations of the new morphology, the name applied to the concepts put forward by Lignier, Bower, Tansley, and others. According to this view the body of the higher plants is derived from a thallus with forking branches bearing terminal sporangia; large leaves were derived from branch systems which may or may not have continued to bear sporangia. Thus the reproductive structures of the seed plants are to be considered as modified branches or branch systems rather than as modified foliar structures. The application of these ideas to the flowering plants may lead to considerable changes in our ideas of primitive characters. It is suggested that the flowering plants may be derived from the Palæozoic pteridosperms, and this leads to some new suggestions as to the morphology of modern floral structures.

Science and the Community

IN an address to the annual conjoint meeting of the Manchester Chemical Societies on November 10, Prof. A. Findlay, under the title "Science and the Community", strongly deprecated extravagant claims advanced as to the part science has to play in the administration of the State. Much disservice has been done to the cause of science by those who fail to recognise that scientific facts are often only one aspect or factor involved in a problem. Science is only one of the great human values, and attempts to antagonise the spirit of science and the quest of beauty, moral values and ethics are a misfortune to the whole community. Prof. Findlay suggested that, so far as industry is concerned, the battle for the recognition of science is already won, but his opinion that science has already received full recognition in the affairs of State was strongly challenged in the subsequent discussion. Prof. Findlay referred to the excessive specialisation of the average graduate in science and emphasised the need for a wider training and for the imparting of general culture and particularly the sense of values which the philosophy of science inculcates. In this, as in his plea for the recognition of the scientific spirit as one of the great expressions of the human spirit, making a contribution to spiritual welfare of mankind fully as important as that of art and literature and religion, Prof. Findlay presented an admirably balanced picture of the position of science in human culture which was greatly appreciated even by those who most strongly criticised either his assumptions as to the position of science in industry and the State, or the intractability of the human factors in social problems to the probings of the scientific mind.

Mexican Archæological Sites

THE Mexican Supreme Court has ruled, according to a Science Service (Washington, D.C.) message from Mexico City, that the country's archæological sites are under the jurisdiction of the Federal Government, and not that of the individual States. This settles an important issue, as has already been indicated in these columns (NATURE, Oct. 29, p. 656). Upheld by the recent decision, Federal Government archæologists arranged to proceed at once to make excavations at Monte Alban, where the spectacular discovery of a treasure tomb was reported last January. The expedition is under the leadership of Alfonso Caso, the discoverer of the Monte Alban tombs, and he will be assisted by a staff of four archæologists and six students. As little appears to have been known in Great Britain of the case upon which the Supreme Court has now pronounced until the matter was *sub judice*, a brief account of the point at issue and the origin of the dispute between the Federal Government and the States may not be out of place.

HITHERTO the Federal Government alone, with the exception of the State of Mexico, has shown any interest in the protection and investigation of the antiquities of early Mexican civilisation, the State governments being either indifferent, or without the resources necessary for such an undertaking. When, however, the remarkable treasures discovered in the Monte Alban tombs were placed on exhibition in March last, the enormous intrinsic value of the treasure and the wide-spread interest it aroused, which, it may be said, was responsible for the raising of a considerable sum of money from the public in the form of entrance fees, moved the State of Oaxaca, in which Monte Alban is situated, to lay claim to the treasure and to assert its rights over the antiquities within its borders. This at once raised the whole question of Federal and State jurisdiction in relation to antiquities, upon which the Supreme Court has now given its ruling. The decision has been awaited with anxiety, and there can be no doubt that the ruling is in the best interests of the study of Mexican archæology in present circumstances. The individual States have not the experience or the interest in their antiquities requisite for dealing with questions arising out of the granting of concessions for archæological exploration—a matter of importance in view of the widely-extended and invaluable activities of numerous expeditions from the United States now operating in Mexico; they have neither resources, nor personnel

for exploration, nor means for the proper display of archæological finds for scientific study as the Federal Government has; while it is generally thought among Mexican archæologists that, had the decision gone in favour of the States, as was expected, they would not have been able to afford their monuments adequate protection from damage, illicit exploitation and other dangers.

The West Indian Hurricane

THE reports of the hurricane that devastated a large part of Cuba on November 9 after destroying most of the banana crop in Jamaica and causing serious damage and loss of life in Little Cayman and Cayman Brac, show that this was the most destructive of the four storms that have caused much loss of life in the West Indies during the hurricane season that—since it is only once in about ten years that the season extends beyond October—should now be ending. The latest estimates give the loss of life in Cuba alone, due mainly to the sea wave on the south coast raised presumably by the southerly hurricane immediately to the east of the storm centre, as more than two thousand. The death roll was therefore much heavier than for the hurricanes which visited the neighbourhood of Galveston on August 13 last, and the Bahamas on September 5, and even for the very violent hurricane of September 26-27 in Puerto Rico. The most recent storm was abnormal in its track as well as in the late date of its occurrence. From information given in the *Times* of November 11, 12, and 14, it would appear that the centre was moving northwards or a little east of north when it passed to the west of Jamaica, and towards north-east when it crossed Cuba. Many storms pass the neighbourhood of Jamaica or the seas to the south of that island, but they are nearly always moving west or north-west, and, if they recurve to north-east, do so far away and in a much higher latitude. The hurricane season of 1932 will long be remembered, although when the total number of hurricanes in this season can be determined it will probably be found that, in the past fifty years, 1886 and 1887 with eleven storms in each case, still hold first place, while 1916, with a total of eight, remains outstanding in more recent years.

Optical Apparatus at the Science Museum

A SPECIAL exhibition dealing with optical phenomena and optical instruments will be opened at the Science Museum on November 19, and will remain on view until the middle of February, 1933. A special feature of the exhibition will be a number of demonstrations and experiments operable by visitors. These will illustrate reflection, refraction, dispersion, interference, diffraction, and polarisation of light as well as the working of simple optical instruments such as the telescope and microscope. They should be of particular interest to students, especially to those who have not the facilities for performing such experiments themselves. Other demonstrations will include a large projection microscope designed for the examination of metals in large pieces, a rangefinder specially adapted to take short ranges in the Museum, a home cinematograph projector using standard size film, a large ophthalmoscope for examination of the human eye and a modern epidiascope. The historical development of various optical instruments will be illustrated by examples selected from the Museum collections, and current practice in optical instrument manufacture will be further represented by a selection of modern instruments lent by various firms especially for the exhibition.

Exhibition of British Coastal Craft

A TEMPORARY exhibition illustrating the fishing boats and coastal craft of Great Britain will be opened in the Entrance Hall of the Science Museum on November 19 and will remain on view until the middle of February, 1933. Some thirty models which have been selected mainly from the large collection of small craft exhibited in Gallery 61 of the Museum, will be shown, in addition to a collection of about sixty photographic transparencies, some of boats for which no models are available in actual use, and others of detailed plans of the more important types. The arrangement will be geographical and will thus show in their proper relations the yoles and sexerns of the Shetlands and Orkneys, the fifies and baldies of the east coast of Scotland, and the cobbles of Yorkshire, together with the eighteenth century herring-busses and the early nineteenth century three-masted luggers which fished in the North Sea. East Anglia will be represented by the distinctive sailing drifters of Yarmouth, the trawlers of Lowestoft and also by the wherries and older keels of the Broads. There will also be the many craft peculiar to the Thames estuary, the barges, lighters and bawleys, besides the older wherries and peter-boats. From the south coast there will be examples of smacks from Ramsgate and Brixham, the eighteenth century hog-boats of Brighton and the luggers which have succeeded them; also the luggers of Penzance and of Fowey. Very little has yet been written about the west coast local shipping, but several typical examples will be included.

Shyok Glaciers and Indus Floods

UNDER the above title, Mr. J. M. Lacey in an article in the *Engineer* for October 14 gives an account of the formation of the great ice dams which form across the Upper Shyok River in Kashmir, and of the floods in the Indus valley which result from the release of the large volumes of water pent up behind the dams. The Upper Shyok has its source in the Rima Glacier in the Karakoram region, and in its downward course passes the three important glaciers, Chong Kumdan, 9 miles long, falling 3,000 ft.; the Kichik Kumdan, 7 miles long, falling 3,500 ft.; and the Aktash, 5 miles long, falling 2,000 ft. In the event of heavy accumulation of snow on the eastern range, these glaciers advance rapidly into the Shyok gorge. On occasions they flow right across the river until they strike the precipitous cliffs on the opposite side, and sometimes turn down the bed

of the river for hundreds of yards. The first recorded damming of the Shyok occurred in 1779, the water breaking through and causing a flood the following year. Since then the river has been dammed many times but experts find great difficulty in forming any conclusion regarding the periodicity of the advance and retreat of the glaciers. One observer, Major Mason, however, considers that after 1932 there will be no danger of a block for another thirty years.

Medical Uses of Radium

THE Medical Research Council has issued under the above title a summary of reports from research centres for 1931 on the radium treatment of cancer (Special Report Series, No. 174. London: H.M. Stationery Office. 1*s.* 3*d.* net). The main lines of radium therapy employed at present are described, and the results of the treatment of cancer of certain organs—tongue and mouth, breast, uterus, rectum, and others—are detailed. While the immediate results of the treatment are generally beneficial, the ultimate results are disappointing, few cases surviving after three or four years. But it must be remembered that most of the cases are advanced ones and inoperable. For these almost the only hope lies in radium therapy, and occasionally a striking result is obtained. Various methods of applying radium are being tested at the various centres, and we may hope in the future that improved methods will yield better results. A statistical analysis of all the cases treated at the Middlesex Hospital since 1925 is given in an appendix.

New Nature Reserve in Cheshire

AN addition of value has been made to the possessions of the Royal Society for the Protection of Birds in the Eastwood Nature Reserve, Stalybridge (*Bird Notes and News*, Autumn Number). The reserve, originally extending to about eight acres, was bequeathed by the Right Hon. John F. Cheetham, together with £5,000 for its upkeep. To this has been added an adjacent four acres, with £500, by a niece of the donor, Mrs. Wimbush of Taunton. The reserve is a beautiful ravine within the public park given by Mr. Cheetham to Stalybridge, and his wish that it should be kept in a natural state as regards fauna and flora will insure the continuance of a sample of wild Nature in the heart of an industrial area. Already there is abundance of wild plants and unexpected variety of birds, and judicious treatment of the reserve should add to the attractiveness of both.

Announcements

SIR ARTHUR KEITH, who is recovering from a serious illness, has been given six months' leave of absence by the Council of the Royal College of Surgeons of England. During his absence, the duties of conservator of the Museum of the College will be taken over by Mr. R. H. Burne, physiological curator to the Museum.

THE New Tank of the William Froude Laboratory at the National Physical Laboratory will be opened by the Right Hon. Stanley Baldwin on November 18 at three o'clock. Several demonstrations will be given at the opening ceremony, including screw propeller tests in the New Tank and rough water experiments in the Alfred Yarrow Tank.

A COURSE of lectures on "The Fear of Death in Primitive Religion" will be delivered by Sir James Frazer at University College, Gower Street, London, W.C.1, on November 25, November 29 and December 1, at 5 P.M. The lectures, although addressed to students of the University, will be open to others interested in the subject. Admission will be free and without ticket.

PROF. M. ISHIMOTO has been appointed director of the Earthquake Research Institute, Tokyo, in succession to Prof. K. Suyehiro, who died on April 9 of this year (see NATURE, **130**, 132, 1932). Prof. Ishimoto is well known as the inventor of a tiltmeter, resembling Zöllner's horizontal pendulum, with which he has made many interesting observations on the tilts of the ground immediately preceding earthquakes.

AT the anniversary meeting of the Mineralogical Society held on November 1 the following officers were elected:—*President:* Sir John Flett; *Vice-Presidents:* Prof. C. Gilbert Cullis, Mr. Arthur Russell; *Treasurer:* Mr. F. N. Ashcroft; *General Secretary:* Mr. W. Campbell Smith; *Foreign Secretary:* Prof. A. Hutchinson; *Editor of the Journal:* Dr. L. J. Spencer.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant lecturer in mathematics, mechanics and physics at the Polytechnic, Regent Street, London, W.1.—The Director of Education (Nov. 21). A joint examiner in mathematics for the Higher School Certificate Examination of the University of Bristol—The Registrar (Nov. 30). Two assistant civil engineers for the Directorate of Works, The War Office—The Under-Secretary of State (C.5.), The War Office, London, S.W.1 (Nov. 23). A public analyst to the Metropolitan Borough of Woolwich—The Town Clerk, Town Hall, Woolwich, S.E.18 (Dec. 2). A waterfowl research assistant at the National Institute of Poultry Husbandry—The Director, National Institute of Poultry Husbandry, Newport, Salop (Dec. 5). A laboratory steward in the Department of Zoology of the University of Bristol—The Registrar (Dec. 6). A secretary, assistant librarian and assistant curator of the Manx Museum—The Curator, Manx Museum, Douglas, Isle of Man (Dec. 7). A research fellow in bacteriology at the Lister Institute of Preventive Medicine—The Secretary, Lister Institute, Chelsea Bridge Road, London, S.W.1 (Dec. 9). An independent lecturer in applied mathematics at the University College of Wales, Aberystwyth—The Secretary (Feb. 1).

Letters to the Editor

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

Ultra-Violet Absorption Spectrum and Chemical Structure of Vitamin B_1

WE have been particularly interested in the report in NATURE[1] by Bowden and Snow regarding the photochemistry of the vitamins, in view of our investigations of the absorption spectra of various vitamin B_1 concentrates, a preliminary report of which was presented at the meeting of the American Chemical Society at Buffalo, September, 1931.[2] At that time we noted that the concentrates examined had absorption maxima at 2600 A., but as the concentrates were admittedly impure, and as some also presented maxima at other wave-lengths, we hesitated to identify any band with vitamin B_1.

In view of the possible presence of contaminating substances in the Jansen-Donath preparation used by Bowden and Snow, we agree with Morton and Heilbron[3] that their definite conclusion, "The correlation of the 2600 band with the activity of vitamin B_1 has thus been fully established" seems scarcely to have been justified by their reported experiment, in which irradiation of the preparation with the 2560 A. line reduced the intensity of the 2600 A. absorption band and destroyed the B_1 activity. Particularly is this true because, as we pointed out in our previous paper, certain biologically inactive purines and pyrimidines (which we have shown to be characterised by an absorption maximum at 2600 A., and to be destroyed by certain regions of the ultra-violet[4]), might be expected to contaminate B_1 concentrates. In view of this difficulty, we believed it advisable, at the time of our earlier report, to carry out parallel spectrographic and biological studies on a number of B_1 preparations before making positive statements about the absorption of the vitamin.

During the course of our later investigations, and prior to the publication of Bowden and Snow's report, Windaus and his co-workers[5] announced a crystalline B_1 preparation, believed by them to be pure B_1, which had, indeed, a pronounced absorption maximum at 2600 A.

Our later experiments include the comparison of the biological activity and ultra-violet absorption spectra of four B_1 concentrates prepared in this Laboratory, of three kindly supplied us by other workers, and of three reported by Guha[6] and by Windaus[5]. Full details of the spectrographic technique and biological assays will appear shortly in the *Bulletin of Basic Science Research*. The absorption curves of all these are presented in Fig. 1. The biological activity of three of these preparations (H_4, and the two Guha preparations) have not been determined by methods permitting comparison of their activities with those of the others.

In agreement with our previous suggestions, it was found that the two relatively inactive concentrates (H_1 and Cerecedo) had very high absorption in the 2600 A. region, presumably because of the presence of inactive purines or pyrimidines. When these were eliminated, a good degree of correlation was found between the activity and the absorption at 2600 A., better than that at any other wave-length in the ultra-violet spectrum. If, for example, the activity and the extinction at 2600 A. of the Windaus preparation are each taken as 100, these values are respectively, for the other four concentrates: Heyroth II, 26·7, 29·8; Seidell (30:85), 24·0, 32·8; Heyroth III, 6·7, 7·0; Seidell (30:182), 4·8, 14·4. This, together with the fact that a maximum at or near 2600 A. was found in all of the concentrates, indicated that vitamin B_1 is characterised by a 2600 A. band.

The type of absorption thus attributed to vitamin B_1 resembles most closely, of the nitrogenous heterocyclic compounds which have thus far been investigated, the absorption of pyrimidine-ring-containing compounds, or of compounds of the type of ergothioneine. The absorption curve of the sulphur-containing Windaus preparation, the most active of those considered, is in fact very similar to that of uracil[4] or other pyrimidines. The molecular extinction coefficient of the Windaus preparation at 2600 A. as calculated from the empirical formula of Windaus is 8225, and as calculated from the formula of van Veen[7] is 8925. That of uracil at the same wave-length is 9500.[4]

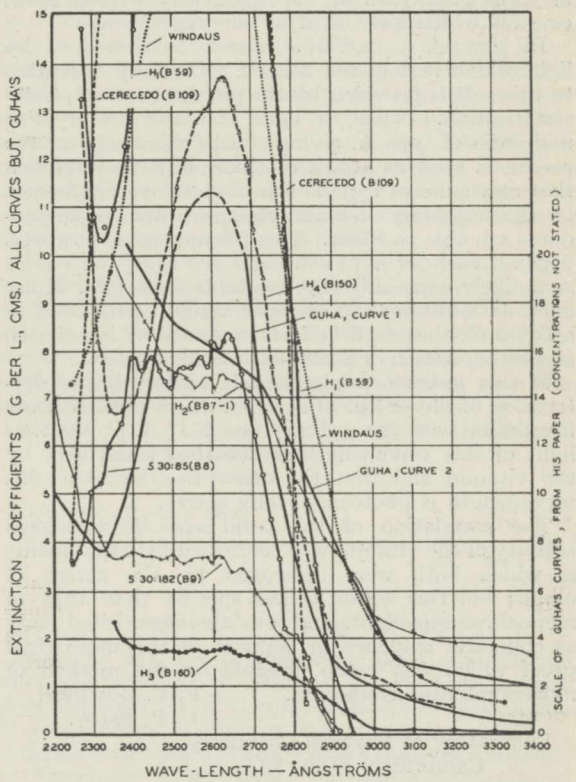

FIG. 1.—Ultra-violet absorption spectra of various vitamin B_1 concentrates.

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Aug. 24.

[1] NATURE, **129**, 720; 1932.
[2] Heyroth and Loofbourow, *Bull. Bus. Sci. Res.*, **3**, 237; 1931.
[3] NATURE, **129**, 866; 1932.
[4] Heyroth and Loofbourow, *J. Amer. Chem. Soc.*, **53**, 3441; 1931.
[5] Windaus, Tschesche, Ruhkopf, Laquer, and Schultz, *Z. physiol. Chem.*, **204**, 123; 1932.
[6] Guha, *Biochem. J.*, **25**, 941; 1931.
[7] van Veen, *Rec. trav. Chim.*, **50**, 200, 208, 610; 1931.

THE experiments of Heyroth and Loofbourow have established a close correlation between the physiological activity of concentrates of vitamin B_1 (after eliminating inactive purines and pyrimidines, which absorb in the same spectral region), and the intensity of the absorption band at 2600 A. They have thus provided a welcome confirmation of the proof which we gave in our letter to NATURE of May 14, that vitamin B_1 is characterised by an absorption covering the mercury line at 2537 A. The detection in their concentrates of inactive substances which absorb light of similar wave-length is of great value as a guide to the conditions under which the intensity of the band may be used as a measure of the concentration of the vitamin; but the identification of the characteristic band by the method of monochromatic irradiation was independent of the presence or absence of these impurities in the apparently homogeneous crystals which were used in our experiments.

In general, a molecule cannot be destroyed by light which it does not absorb. The only exception to this rule is provided by the phenomenon of photosensitisation. Thus, if light is absorbed by alien molecules of type A, giving rise to chemically active products, such as atoms of chlorine, it may happen that molecules of type B can be destroyed indirectly by the secondary chemical changes which these products are able to effect. This phenomenon, however, depends on a series of contingencies which we regard as unlikely, especially with so stable a vitamin. Moreover, an additional coincidence would be required to account for the parallel effects produced by irradiation and by the action of alkali, as described below.

If this indirect mechanism is excluded, the destruction of physiological activity which resulted from irradiation with the mercury line 2537 A. proves that light of this wave-length is absorbed selectively by the vitamin and that the absorption band at this wave-length is photochemically active.

The correlation of this band with the biological activity of the vitamin was confirmed by experiments in which both were destroyed by the action of alkali; but this action is less specific than that of monochromatic light, and was therefore cited only as collateral evidence in support of the more rigid proof which was made possible by the method of monochromatic irradiation.

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C. P. SNOW.

Laboratory of Physical Chemistry,
Cambridge. Oct. 29.

Potency of Vitamin B_1 Preparations

RECENTLY (1932),[1] we have advanced indirect evidence for the belief that crystalline specimens of vitamin B_1 from baker's yeast, prepared by our methods, were more potent than those of Windaus, Tschesche *et al.* (1932).[2] Owing to their courtesy, we have been able to confirm this by direct test. Comparative tests upon pigeons (by curative method) have been made. As birds developed characteristic symptoms, they have been given alternately by mouth, approximately 14γ (0·014 mgm.) of each preparation. (Results by mouth are usually 30 per cent. lower than by injection.) The results were as follows:

Prep.	No. of birds	Dose given.	Average day dose	Standard error of mean	Vitamin B_1 units/mgm.*
G. (Windaus, Tschesche *et al.*)	10	14·2γ	4·31γ	0·63	279
	8	23·28γ	4·58γ	0·41	262
E. (our own)	10	13·8γ	2·56γ	0·35	469

The mean difference in potency $G : E$ is 1 : 1·75; that is, ours proved to be one and three quarter times as potent. Tested by the usual statistical formula, this difference would occur by chance less than once in fifty trials. It is supported by the tests upon larger doses, and also by reckoning the percentage cures with 14γ dose. For G we have 10/13 cured, and for E 10/10. As we have found it possible to fractionate our crystals still further, we have no hesitation in concluding that more potent vitamin B_1 can be prepared than preparation G, and that this cannot be therefore pure vitamin B_1.

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* 12 mgm. Janson acid clay = 1 pigeon dose.

[1] *J. Physiol.*, **76**, 1; 1932.
[2] Windaus, Tschesche, Ruhkopf, Laquer and Schultz, *Z. physiol. Chem.*, **204**, 123; 1932.

A Growth-Stimulating Substance in Fatigued Muscle

MUSCULAR exercise results in development of the muscles concerned, and it influences other parts of the body. A metabolic product of muscular activity is probably responsible for the muscle hypertrophy, and it is possible that such a hormone may circulate in the blood and stimulate other organs. To our knowledge the only experimental study of this question is that of Bělehrádek[1], who fed tadpoles with artificially fatigued frog muscle. The weight of these tadpoles was increased by 28 per cent compared with controls fed on resting frog muscle, and they metamorphosed earlier than the controls. This has been confirmed by Siebert and Petow.[2]

We have extended this work by feeding blow-fly larvæ with frog muscle fatigued by electrical stimulation through the nerve. In 16 out of 18 experiments the larvæ fed on fatigued muscle grew larger than those fed on resting muscle, the average excess weight being 9 per cent. The larvæ fed on fatigued muscle did not metamorphose earlier than the controls, and their oxygen consumption was unchanged; but the rate of heart beat of the former exceeded that of the latter by 14 per cent.

Work is now being continued on the substances responsible for this growth stimulation and on their mode of action.

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Oct. 27.

[1] *Arch. Int. Physiol.*, **22**, 376; 1924.
[2] *Z. klin. Med.*, **102**, 434; 1925.

Limiting Mobilities of Some Monovalent Ions and the Dissociation Constant of Acetic Acid at 25°

VOGEL and Jeffery in a recent letter,[1] with the same heading as the above, have directed attention to the fact that we omitted, in our recent paper,[2] to mention that they have published[3] different figures from ours for the limiting mobilities of ions. Though we should, possibly, have referred to their work in that particular connexion, it was not ignored. The conductance measurements of these authors and the

discrepancies between their work and ours were discussed in a paper from this Laboratory.[4] This paper directs attention to the fact that Jeffery and Vogel used a bridge and cells which, due to parasitic currents, could readily give errors in the results. Their use of a water thermostat leads to additional errors of similar nature, as has been shown by Jones and Josephs.[5] Jeffery and Vogel have published conductance measurements only. To obtain ion conductances transference data are necessary. In their paper they present *two* sets of figures for the limiting ion conductances, leaving the choice to the reader. One set is based on a limiting transference number of potassium in potassium chloride of 0·497 and the other on a value of that constant of 0·490, the latter being the result of recent work in our Laboratory.

As to our results, the limiting conductance of the chloride ion, λ_{0Cl}, from which all the other limiting ion conductances may be computed, is based on measurements of conductance, *and transference numbers*, at a series of concentrations of four different chlorides (KCl, NaCl, LiCl, and HCl), and the same result $\lambda_{0Cl} = 76{\cdot}32$, within a few hundredths of a per cent is obtained from the data on each electrolyte. Previous workers have assumed validity of Kohlrausch's law of independent ion mobilities. We feel that our work has proved it, at least for these chlorides.

Our extrapolations have been made using a method based on the assumption that as the dilution is increased ion conductances will approach the relations derived by Onsager.[6]

Vogel and Jeffery also report an ionisation constant of $1{\cdot}776 \times 10^{-5}$ for acetic acid which, they point out, differs considerably from that published by MacInnes and Shedlovsky[7] who give $1{\cdot}753 \times 10^{-5}$ for that constant. We feel that it is sufficient to direct attention to the recent result of Harned and Ehlers[8] who, as the result of an extensive and careful investigation involving galvanic cells without liquid junctions, obtained the value $1{\cdot}754 \times 10^{-5}$ This check is particularly gratifying, since the methods used in the two researches are quite different.

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The Rockefeller Institute
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New York, N.Y.,
Sept. 28.

[1] NATURE, **130**, 435; 1932.
[2] *J. Amer. Chem. Soc.*, **54**, 2758; 1932.
[3] *J. Chem. Soc.*, 1715; 1931. 400; 1932.
[4] *J. Amer. Chem. Soc.*, **54**, 1411; 1932.
[5] *J. Amer. Chem. Soc.*, **50**, 1065; 1928.
[6] *Physik. Z.*, **27**, 388; 1926. **28**, 277; 1927.
[7] *J. Amer. Chem. Soc.*, **54**, 1429; 1932.
[8] *J. Amer. Chem. Soc.*, **54**, 1350; 1932.

Emission of Positive Ions from Cold Surfaces under the Influence of Strong Electric Fields

BEAMS[1] has brought forward experimental evidence showing that the application of a field of the order of 5×10^6 volts per cm. to a tungsten surface may result in the direct removal of adsorbed positive ions of the alkali metals. Ianitsky[2] had previously described experiments in which such an effect was obtained with fields about a hundred times smaller, the positive ions concerned being those of the permanent gases.

I have recently been led to investigate the fluorescence of the glass in a hot cathode X-ray tube,[3] and found that the most negative part of the glass occasionally showed fluorescent spots, which must therefore have been due to positive ion bombardment. The phenomenon was observed with the filament switched off, the gas pressure less than 2×10^{-6} mm. of Hg, and only 20 k.v. across the tube. A detailed consideration of possible mechanisms of formation of the positive ions eliminated all but one, namely, their removal from an adsorbed layer of impurity on the anode. This confirms the observations of Ianitsky, who however did not observe the positive ions as such but by the resulting change in gas pressure.

Ianitsky suggested that the adsorbed gas layer normally exists in a partially ionised form, so that the phenomenon observed by him and by myself would be fundamentally the same as that observed by Beams. It seems to me more probable, however, that it was fundamentally different, the gas layer being *first* ionised by X-rays or by electrons (which would have inevitably been present in the experiments), and *then* the ions removed by the field. Since some of the ions would be formed at a distance of several atomic radii from the surface, a much smaller field would suffice for their removal than was required in Beams's experiments with degassed surfaces. This agrees with experiment.

It seems, however, likely that the compound effect was present in the experiments Beams carried out on gas layers. If this was so, the observed critical voltage for the effect to occur was either that for the positive ion emission or that for starting the discharge responsible for the ionisation, whichever was the larger of the two.

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[1] *Phys. Rev.*, **41**, 687; 1932.
[2] *J. Phys.*, **1**, 153; 1930.
[3] Described in the October issue of the *Proc. Camb. Phil. Soc.*; 1932.

Origin of Zero-Point Entropy

EUCKEN and his collaborators have pointed out that the failure of Nernst's heat theorem—the so-called third law of thermodynamics—which occurs in some cases, is due to the zero-point entropy[1]. A definite zero-point entropy arises from the existence of 'frozen-in' phases stable at higher temperatures which do not reach the real thermal equilibrium on cooling to the neighbourhood of the absolute zero. Teske and I, for example, have found that solid carbon monoxide near 10°K. exhibits such a state in spite of its crystalline structure[2]. Clayton and Giauque have confirmed this result[3] and explained the discrepancy by the suggestion that the asymmetry of the carbon monoxide molecule gives rise to two positions in the lattice of nearly equal energy. The formation of a fully ordered crystal is thus prevented. No such effect is to be expected in the case of nitrogen, which is a symmetrical molecule. Dr. Teller has directed my attention to the fact that similar behaviour may be shown by nitrous oxide as opposed to the symmetrical carbon dioxide: this has proved to be true.

The following table gives some zero-point entropies calculated from the difference of the direct thermal measurements and the entropy value from band spectroscopic data. If the disarrangement is

complete, the basic probability is 2 instead of 1 as in a perfect crystal and the resulting entropy would be

$$R \ln 2 = 1{\cdot}38 \text{ units as maximum.}$$

Molecule	Zero-point entropy	Author
N = N	$-0{\cdot}07 \pm 0{\cdot}20 \simeq 0$	Eucken, 1929.[1]
O = C = O	$+0{\cdot}32 \pm 0{\cdot}27 \simeq 0$	Eucken, 1929.[1]
C = O	$+1{\cdot}06 \pm 0{\cdot}25$	Clusius and Teske, 1929.[2]
	$+1{\cdot}12 \pm 0{\cdot}10$	Clayton and Giauque.[3]
N = N = O	$+0{\cdot}90 \pm 0{\cdot}32$	Clusius, Vaughen and Hiller, 1930.[4]
N = O	$+0{\cdot}75 \pm 0{\cdot}10$	Johnston and Giauque, 1929.[5]

The values of Giauque and his collaborators are explicitly given by these authors. The other data are calculated from the difference of the vapour pressure constant and the chemical constant. The latter has been found by using the value $59{\cdot}4 \times 10^{-40}$ C.G.S. units for the momentum of inertia for nitrous oxide and $70{\cdot}8 \times 10^{-40}$ C.G.S. units for the same quantity for carbon dioxide.[6]

The symmetrical molecules nitrogen and carbon dioxide show no appreciable effect, while the asymmetric carbon monoxide, nitrous oxide and nitric oxide show a definite discrepancy of the same sign, order of magnitude and presumably the same origin.

In conclusion, Nernst's theorem does not apply to structures composed of asymmetric molecules held in position in the lattice by relatively weak orientational forces. We intend to investigate in this laboratory other asymmetric molecules and the possibility of more complete arrangement at liquid helium temperatures. Otherwise it is to be expected that the residual entropy will diminish with increasing molecular asymmetry.

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Sept. 28.

[1] Eucken and Fried, *Z. Phys.*, **29**, 36; 1924. Eucken. *Phys. Z.*, **30**, 818; 1929. **31**, 361; 1930.
[2] Clusius and Teske, *Z. phys. Chem.* (B), **6**, 135; 1929.
[3] Clayton and Giauque, *J. Amer. Chem. Soc.*, **54**, 2610; 1932.
[4] Clusius, Hiller and Vaughen, *Z. phys. Chem.*, (B), **8**, 427; 1930.
[5] Johnston and Giauque, *J. Amer. Chem. Soc.*, **51**, 3194; 1929.
[6] Plyler and Barker, *Phys. Rev.*, **38**, 1825; 1931. Martin and Barker, *Phys. Rev.*, **41**, 291; 1932.

Eddington's Theory and Physical Constants

EDDINGTON'S[1] equation for the mass of proton or electron

$$10m^2 - 136m + 1 = 0 \qquad (1)$$

holds only for 'very mild' interaction between the elementary charges. It has been extended for interactions at intra-atomic distances and the equation comes out to be

$$10m^2 - 135m + 1 = 0 \qquad (2)$$

The 'free' mass from (1) and 'singly constrained' mass from (2) give two values of e/m in perfect agreement with the deflection and the spectroscopic values respectively. For intra-atomic problems the latter alone is applicable. By using Eddington's[1] relation $ch/2\pi e^2 = 137$ and the precise values for the Rydberg number for hydrogen (H_1) [2], Faraday's constant[2], the velocity of light[2] and the chemical atomic weight of monoprotonic hydrogen, from Bleakney's $H_1 : H_2$ ratio[2,3] the following precision values are obtained.

Chemical atomic weight of monoprotonic hydrogen	$H_1 = 1{\cdot}00774$	$\pm 0{\cdot}00002$
Rydberg number for infinite mass	$R = 109737{\cdot}516$	$\pm 0{\cdot}050$
Specific charge of free electrons	$e/m_0 = 1{\cdot}77001$	$\pm 0{\cdot}00013 \times 10^7$ e.m.u.
Specific charge of singly-bound electrons	$e/m_1 = 1{\cdot}75697$	$\pm 0{\cdot}00013 \times 10^7$ e.m.u.
Electronic charge	$e = 4{\cdot}81209$	$\pm 0{\cdot}00037 \times 10^{-10}$ e.s.u.
Avogadro's number	$N = 6{\cdot}01132$	$\pm 0{\cdot}00089 \times 10^{23}$
Planck's constant	$h = 6{\cdot}64879$	$\pm 0{\cdot}00102 \times 10^{-27}$
Compton shift for free electrons at 90°	$h/m_0c = 0{\cdot}0244557$	$\pm 0{\cdot}0000003 \times 10^{-8}$ cm.
Compton shift for singly-bound electrons at 90°	$h/m_1c = 0{\cdot}0242758$	$\pm 0{\cdot}0000003 \times 10^{-8}$ cm.
Wave-length of molybdenum $K\alpha_1$, line	$= 0{\cdot}709701$	$\pm 0{\cdot}000016 \times 10^{-8}$ cm.
Calcite grating space (Yuching Tu's crystal)	$= 3{\cdot}03749$	$\pm 0{\cdot}00048 \times 10^{-8}$ cm.
Wien's radiation constant	$hc/k = 1{\cdot}44128$	$\pm 0{\cdot}00013$
Stefan's radiation constant	$= 5{\cdot}65050$	$\pm 0{\cdot}00051 \times 10^{-5}$

Perry and Chaffee's[4] and Kirchner's[5] determinations of e/m have been analysed. Systematic errors in the method, procedure and apparatus have been found which account for a correction of more than $+0{\cdot}8$ per cent. So far as the corrections are determinable, calculations from both the data give the value $1{\cdot}770 \times 10^7$ in agreement with the e/m_0 value given above and not $1{\cdot}760 \times 10^7$.

Millikan's[6] value for e has been analysed and found to require a correction, due to the holes in the top plate of his condenser, amounting nearly to $+0{\cdot}8$ per cent. The values got by direct measurement of charge on α-rays by Braddick and Cave[7] and Ward, Wynne Williams and Cave[8] give a value in agreement with the above. Also the discrepancy between grating and crystal values of X-ray wavelengths has been removed by the above, without calling into account the hypothetical mosaic structure suggested by Zwicky[9] against which there is already so much evidence, at least in the X-ray measurements.

The criticisms of Birge[2,10] against $ch/2\pi e^2 = 137$ have been analysed and found to disappear completely on using the corrected values of e and e/m'.

A detailed discussion will be published early.

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Oct. 5.

[1] Eddington, *Proc. Roy. Soc.*, A, **134**, 524; 1932.
[2] Birge, *Phys. Rev.*, Supplement 1, 1; 1929.
[3] Bleakney, *Phys. Rev.*, **41**, 32; 1932.
[4] Perry and Chaffee, *Phys. Rev.*, **36**, 904; 1930.
[5] Kirchner, *Ann. Physik*, **8**, 975; 1931.
[6] Millikan, *Phil. Mag.*, **34**, 1; 1917.
[7] Braddick and Cave, *Proc. Roy. Soc.*, A, **121**, 367; 1928.
[8] Ward, Wynne Williams and Cave, *Proc. Roy. Soc.*, A, **125**, 713; 1929.
[9] Zwicky, *Proc. Nat. Acad. Sci.*, **16**, 211; 1930.
[10] Birge, *Phys. Rev.*, **40**, 228; 1932.

Occurrence of *Lithothamnion* in the South Indian Cretaceous

IN two previous communications[1] one of us reported the discovery of abundant algæ, chiefly *Lithothamnion*, in some of the limestones of Upper Cretaceous age from the Trichinopoly and Pondicherry areas of South India.

In the course of a recent examination of the limestone ridges near Cullygoody (Trichinopoly Cretaceous area) we have collected a number of specimens of a pebbly or conglomeratic rock, which is often found at the base of these limestones. In hand specimens, this rock shows a number of rounded or oval cream-coloured 'pebbles' and presents an appearance very similar to the pebbly character of some of the Niniyur flints and cherts.[2] A micro-

scopic examination of this pebbly rock has also revealed the occurrence of abundant *Lithothamnion* of which at least three different kinds seem to be recognisable—all the 'pebbles' being seen as nothing but patches of algæ.

We consider the occurrence of these algæ in the Cullygoody limestone as of great importance since they belong to a period even earlier than that represented by the Niniyur flints and limestones. Whereas the latter represent the topmost sub-division of the Trichinopoly Cretaceous, corresponding to the Danian of the European stratigraphical scale, the Cullygoody limestone is a member of the lowermost sub-division—the Utatur stage—which is equivalent to the European Cenomanian.

From the evidence now available it is thus obvious that not only were the algæ abundantly present during the Cretaceous period in India, but also that they have been one of the most important limestone builders in the upper Cretaceous seas of Southern India.

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[1] NATURE, Aug. 8, 1931, p. 225, and Nov. 21, 1931, p. 873.
[2] NATURE, Mar. 19, 1932, p. 441.

Diploidisation of Haploid by Diploid Mycelium of *Puccinia helianthi* Schw.

THE interaction of two haploid cells of opposite sex to produce the diplophase is a phenomenon well known in heterothallic species of the Hymenomycetes and of the smut and rust fungi. Buller[1] has recently shown that a diploid mycelium of *Coprinus lagopus*, on coming into contact with a haploid mycelium of that species, transforms the latter mycelium into the diploid condition. He has introduced the word *diploidisation* "to designate in the Hymenomycetes the process by which a haploid cell, or mycelium, is converted into a diploid cell, or mycelium, by the formation of conjugate nuclei within the cell or mycelium". An extension of the application of this term to designate a similar process in other groups of the Basidiomycetes, such as the smuts and rusts, does not appear inappropriate.

Craigie[2] found that *Puccinia helianthi* Schw. is heterothallic. His experiments showed that the diploid, or æcial, stage could be produced by allowing two haploid pustules of opposite sex to coalesce, or by applying the pycnospore-containing nectar of a haploid pustule of one sex to a similar pustule of opposite sex. Experiments which I have recently carried out show that diploidisation of a haploid mycelium of this rust also occurs when it comes into contact with a diploid mycelium. This phenomenon may very probably be found to occur in other heterothallic eu-autoecious rusts.

Sporidia of *P. helianthi* were sown sparsely on the upper surface of the first two foliage leaves of sunflower seedlings (*Helianthus annuus* L.). From these inoculations there arose forty-nine haploid pustules.

When three weeks old, none of these pustules bore æcia. Twelve of them were then marked, to serve as controls; and beside sixteen others, at a point just beyond the periphery of each, urediniospores of *P. helianthi* were sown. A week later urediniospores were sown similarly beside twelve other pustules; and, a week later still, a sowing of urediniospores was made beside the remaining pustules.

As a result of these inoculations, uredinia (diploid pustules) arose at, or very near to, the margin of each of the thirty-seven haploid pustules. Thus diploid mycelium grew in juxtaposition to haploid mycelium.

From eight to twelve days after the inoculations with urediniospores were made, æcia began to appear on the under side of all the thirty-seven pustules. Usually the æcia first appeared in that part of a pustule lying nearest to the uredinial pustules, and later in the parts more remote (Fig. 1). In a few pustules, the first æcia to appear arose rather irregularly spaced over the whole under-surface of each. No æcia appeared in any of the control pustules.

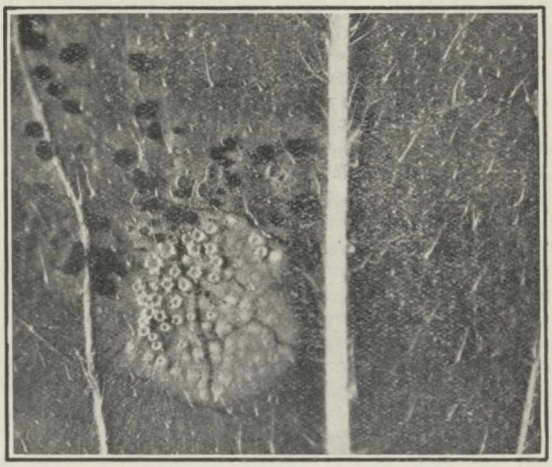

FIG. 1.—The under surface of a part of a sunflower leaf showing a monosporidial (haploid) pustule of *Puccinia helianthi* in which has occurred diploidisation by uredinial (diploid) pustules of that rust. Æcia have appeared at the side of the monosporidial pustule adjoining the uredinial pustules. The photograph was taken fourteen days after the leaf was inoculated with urediniospores, at which time the monosporidial pustule was thirty days old. × 4·5.

A cytological examination of the pustules which produced æcia has not been made, but it is assumed on the basis of these experiments that, when contact between a haploid and a diploid mycelium of *P. helianthi* is established, the diploidisation of the haploid mycelium is effected by successive nuclear divisions and migrations, as has been described by Buller[1] for *C. lagopus*.

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Sept. 16.

[1] Buller, A. H. R., NATURE, **126**, 686, Nov. 1, 1930; "Researches on Fungi", vol. 4, p. 187; 1931.
[2] Craigie, J. H., NATURE, **120**, 116 and 765, July 23 and Nov. 26, 1927.

Helium Content of Beryllium

THE abnormally high helium content of several Palæozoic beryls discovered by Strutt[1] has recently been verified by Paneth and Guenther.[2] Atkinson and Houttermans have discussed[3] the proton bombardment in the interior of the stars and the possible formation of Be^8 which being probably unstable would yield two helium nuclei, and Lord Rayleigh[4] suggests that the

high helium content of beryls might conceivably be due to Be^8 which has existed in geological times even if not known to exist at present. This implies, however, that Be^8 existed at least in Palæozoic times, a relatively very late period since the star state and proton bombardment. The recent experiments of Cockcroft and Walton[5] would indicate that Be^8 can have only a very short life period. A possible source of excess helium might be found, however, in the following proposed mechanism:

$$Be^9 + \alpha\text{-particle} = 3\ He\ \text{nuclei} + \text{neutron},$$

and treating this in a similar manner to Chadwick's treatment,[6] the maximum energy of the emission of the neutron is about $5{\cdot}2 \times 10^6$ electron volts as compared to $5{\cdot}7 \times 10^6$ found in Chadwick's experiments and a maximum energy of about 8×10^6 electron volts given by the equation assuming C^{12} is the end product. If both mechanisms are possible we might then expect two groups of neutrons of different maximum energies. In the Palæozoic beryl, about 300×10^6 years old, radium was detected but no thorium. The α-particle of greatest kinetic energy is therefore from Ra C′ which would give a maximum energy to the neutron of about $7{\cdot}7 \times 10^6$ volts or about $10{\cdot}5 \times 10^6$ if C^{12} is the end product.

Even if every α-particle is effective, however, a maximum of only three times the helium produced by the radioactive integration can be expected. The contribution to the helium which is to be expected from the work of N. Feather,[7] in which it is shown possible to free an α-particle by neutron bombardment of nitrogen or possibly some other element, contained in the mineral, can only be a small fraction of the radioactive helium, since only one neutron is formed from each effective α-particle and but a small fraction of these cause disintegration. Moreover, the sequence of events by which a neutron ejects a proton in the mass of the beryl and this in turn builds Be^8 which breaks down into two α-particles is so unlikely as not to come into consideration at all in accounting for the excess helium.

All the above possible mechanisms are, therefore, insufficient to account for the excess helium in the beryls such as from Chester, Penn., U.S.A., containing $0{\cdot}19 \times 10^{-2}$ gm. uranium which would generate approximately 0·065 c.c. of helium in 300×10^6 years, a reasonable lapse of time since the Palæozoic age, compared to the experimentally determined value of at least 0·68 c.c.

Nevertheless, such possible sources of extraneous helium must be considered when determining geological age by the helium ratio, especially when the lighter elements are in abundance.

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Oct. 8.

[1] *Proc. Roy. Soc.*, A, **80**, 572; 1908. A, **84**, 194; 1910.
[2] *Z. Phys. Chemie*, B., **112**, 170; 1928.
[3] NATURE, **123**, 567; 1929.
[4] NATURE, **123**, 607; 1929.
[5] *Proc. Roy. Soc.*, A, **136**, 743; 1932.
[6] *Proc. Roy. Soc.*, A, **136**, 699; 1932.
[7] *Proc. Roy. Soc.*, A, **136**, 709; 1932.

Natural Melody

IN his letter in NATURE of November 5 on "Natural Melody" Sir Richard Paget inquires whether such an effect can have been produced in Nature, as, for example, by a broken bamboo stem. The following extract from Godinho de Eredia's "Report on the Golden Chersonese": 1597–1600 (English translation by Mr. J. V. Mills of the Malayan Civil Service) may be of interest, though it concerns speech, not melody:

"To conclude entirely with the Peninsula, I will relate a curious phenomenon which occurs at the mouth and entrance of the River Panagim [now called the River Linggi. J.B.S.]: here there are dense thickets of Bamboos, and among them are two very tall stout Bamboos which are set in such a manner that one of them towers over the other; now it is an actual fact that by day and by night human voices are heard proceeding from these Bamboos; one of them says '*Suda*', that is to say, '*Enough*', and the other replies '*Bolon*', which is as much as to say '*Not yet*'.

"I always regarded this as a worthless fairy-tale, until Affonso Vicente, Ambassador to Achem, assured me that he personally heard these voices saying '*suda*', '*bolon*', when he went to this place on the Panagim for the sole purpose of observing this most curious occurrence in the year 1595."

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An Epithelial Tumour of the Intestine of a Frog

THE following report is made because a similar pathological condition has not previously come to my attention. The frog, *Rana pipiens*, was brought to the laboratory from the frog tanks with a number of others for the use of students. There was nothing in its external appearance to indicate any abnormality. It seemed as well nourished as any. When the abdomen was opened it was found to be nearly filled with an irregularly cubical mass, the liver was much compressed and only about two centimetres of intestine could be found. In colour the mass was pale yellowish brown; its consistency varied, some parts being quite firm to the touch and others cystic. On section, tubular openings coursing irregularly through the mass were disclosed, and where these were near the surface they gave the impression of a cyst when palpated. These tubes appeared to be the missing intestine. The entire specimen was submitted to the Department of Pathology, which reported as follows:

"Large yellowish tumour mass occupying main part of abdomen of frog, with a lumen suggesting intestine.

"Section shows tumour to be of epithelial origin; the cells are arranged in irregular acini suggesting a tumour arising from intestine.

"Epithelial tumour."

It is remarkable that the frog could have lived in spite of the interference with digestion and absorption that would seem inevitable from the presence of so large a mass in the abdomen, and especially of one involving the intestine to so great an extent. Inspection and handling of the voluntary muscles did not reveal any atrophy. I shall be much interested to hear from anyone who has observed a similar condition, and should like to secure all the information possible as to the frequency of occurrence, rate of growth, and effect on health and length of life.

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Oct. 21.

Research Items

Precious Stones in Medieval Folklore.—Dr. J. P. Heather has made a study of the references to precious stones in the middle-English verse of the fourteenth century, comparing these with the treatment of the subject in the Anglo-Norman lapidaries (*Folk-lore*, vol. 42, pt. 3). Although precious stones are connected with animals on many occasions in the verse, especially as similes, reference to the belief, common in the lapidaries, that precious stones were found in the heads of animals, such as toads, vultures, crabs, practically do not occur; yet their frequency in later literature suggests that they were well known among the people. In another direction, stones were connected with Nature. In the works of the poet Gower each of the fifteen stars has its herb and its precious stone, and stones are enumerated as set in the crown of the sun. The first three, Lieuchis, Astrices and Ceramius, "no persone hath upon erthe". Six of the remainder—crystal, adamant, smaragdine, elitropius, jaspis and jacinthus—are well known; but ydriades and dendides are not traceable in the lapidaries. Precious stones have their effect on both men and women in regard to their qualities and character, while some improve their moral qualities. Other stones confer invisibility, or invincibility in combat, or eloquence, and so forth. In virtue of a hyacinth engraved with a figure, half woman and half fish, set in fine gold, covered with wax and held in the fist, "you will be seen of no man". The property of a stone to which reference is made most frequently in verse is that of shining with its own, and not reflected light, this quite overshadowing the magical property, though the latter is well known. Thus the carbuncle in "The Romaunt of the Rose" gives forth a light at night by which "men mighte seen to go, for nede, a myle or two, in lengthe and brede". References to the healing power of the stones are not frequent, though there is abundant evidence that it did exist. In regard to use, reference is most frequent in relation to burial rites.

The State in Ancient India.—The concept of the State in ancient India and the sphere of State-action, topics upon which there is much difference of opinion among European and Indian scholars, is discussed by R. Pratapagiri in the *Journal of the University of Bombay*, vol. 1, pt. 1. The end of the State is to maintain *dharma*, upon which the security and prosperity of the realm depend. The different orders and castes are to be strictly confined to their appointed functions and it is the duty of the king both to protect the four orders in the performance of these functions and to see that they carry them out. Otherwise the State would dissolve into mutually repellent atoms. Further, it is the duty of the king to lead back into the right path any who stray from the rules of their caste or order. The king not only could, but also should, interfere in the most private relationships of life. The only limits to the power of the State are of a theocratic nature. It is the duty of the king to protect the sacred groves and the castes and orders engaged in religious observance. By this protection and restriction he increases the *dharma* in his realm. He is therefore the root of *dharma*. It follows that the ancient Indian State is of the autocratic type and highly centralised, the king being executive, administrative and legislative head, as well as military leader, guiding and controlling the religious, moral and social life of his people. Hence when imperial government was established, and especially under the Mauryan monarchs, the growth of the king's authority led to the establishment of councils and a bureaucratic system which usurped the place of the ancient meetings of the folk. The kingship was not a constitutional institution limited by checks, as some think, but an autocracy of which the only limitation was its end—the maintenance of *dharma*.

Characteristics of Geographical Races of Beetles.—While the geographical variations of morphological characters within a species have been extensively studied, practically no work has been done on the physiological differences between geographical races. A recent paper by Krumbiegel on the races of the beetle *Carabus nemoralis* (*Zoolog. Jahrb., Systematik*, 63, 1932) is largely physiological in its outlook and methods and deserves, therefore, special attention. Temperature reactions of various geographical races of the beetle have proved to be in direct correlation with the climatic conditions of the respective areas of their occurrence. Positive reactions to light increased in their regularity and intensity when a series of races ranging from north European to the Mediterranean were examined. These physiological characteristics were found to change gradually from north to south. Particularly interesting is the fact that two races from widely distant areas can differ physiologically just as much as two distinct species, while morphologically they are clearly conspecific. Moreover, the races which can be easily separated by their reactions towards light are often almost identical morphologically. An exact morphological analysis, however, revealed differences between them, namely, in the shape of the eyes and in their structure.

Control of the Citrus Black Fly in Jamaica.—The citrus black fly (*Aleurocanthus woglumi* Ash.) is one of the major pests affecting citrus trees in Jamaica. The control of this insect by the use of insecticides presents great difficulties, especially as citrus trees in Jamaica are rarely cultivated in regular groves, but are scattered among other trees which also harbour the pest. The question of its control by biological means is discussed by Mr. W. H. Edwards, the Government entomologist, in *Entomological Bulletin* No. 6 (1932) of the Jamaica Department of Science and Agriculture. The recent introduction of the Chalcid parasite, *Eretmocerus serius* Silv., for the purpose of attempting to control the citrus black fly in Cuba, has been attended by remarkable results, since this pest seems to have been eradicated in regions where the parasite was liberated. This outcome naturally suggested trial of the same experiment in Jamaica and supplies of parasitised black fly nymphs were sent by Dr. J. G. Myers from Cuba. Mr. Edwards states that the breeding out of these parasites from the material thus obtained has been successful and that liberations have already taken place in three selected localities. While it is premature to assert whether the parasites will establish themselves under these

new environmental conditions, as successfully as they have done in Cuba, there is every reason to believe that they will do so. If the expected result follows, the introduction should prove of immense benefit to the Jamaican citrus-growing industry.

A New Species of *Coeloplana*.—A single specimen of *Coeloplana metschnikowii* was discovered in the Red Sea and described in 1880, and no other species, indeed no other specimen, was recorded until 1902 when Abbott gave an account of two new species from Misaki, Japan. Since then seven other species have been described, namely, two more from Misaki, two from Annam, two from French Indo-China and one from Amboina. The latest of the four species from Misaki is *C. echinicola* described by H. Tanaka (*Mem. Coll. Sci.*, Kyoto Imp. Univ., ser. B, vol. 7, No. 5, Art. 12, 1932) who obtained specimens on the test of a sea-urchin, *Toxopneustes pileolus*. This species is distinguished by its coloration and by the large number (thirty-two, eight larger and twenty-four smaller) of its dorsal processes. The author states that asexual reproduction by means of laceration occurs especially during the night in early summer. One fairly large individual produced more than ten lacerated pieces in a week but this process ceased after the middle of August and in September this *Coeloplana* disappeared entirely from the littoral zone. In another paper (Art. 11) in the same journal the author gives an account of re-organisation in regenerating pieces of *Coeloplana*.

New Thermophilic Organisms.—During the summer of 1930, Dr. E. Hindle visited the thermal springs at Bax, near Bordeaux, and on the surface of the pool of hot water in the market place noticed a floating scum of organic matter, consisting of blue-green algæ and other filamentous organisms, some of which he collected and brought back for examination (*J. Roy. Micr. Soc.*, vol. 52, pt. 2, 1932). When examined four weeks later, the only obvious living organisms were bacteria, but as the temperature of the thermal pool was about 54° C., some of the material was incubated in boiled tap-water at this temperature for one or two weeks and a variety of micro-organisms developed in the liquid, including at least two groups of which there is only one previous record of their active life at such high temperatures. At least two species of amœbæ were observed in the cultures, one comparatively large, 20–30μ in diameter, the other smaller and probably, from its structure and the absence of any flagellate phase, belonging to the genus *Hartmannella*. The larger species soon died out but the *Hartmannella* has been cultivated and found to be very susceptible to slight alterations in temperature. In spite of abundant growth at 53°–54° C. for nearly a year, all attempts to raise the temperature at which the species would grow by even 1° C. gave negative results; when the temperature was so raised all active forms quickly disappeared. Encysted forms were unaffected and when grown again at 54° C. active amœbæ resulted. The cysts withstand temperatures ranging from below 0° C. to at least 60° C. and dried cysts kept in an unheated shed were found to be alive ten months later. The original material from Bax, when reheated at 54° C., also showed the presence of spirochætes identical with those commonly found in rivers and pools; these thermophilic races have probably been derived from individuals to which such high temperatures would be rapidly fatal.

Bud Mutation in *Ficus*.—Mr. K. P. Biswas, curator of the Herbarium, Royal Botanic Garden, Calcutta, reports an interesting bud mutation on one of the branches of a tree of *Ficus Krishnæ* DC., which has been growing in the nursery of the Garden for thirty-two years. *Ficus Krishnæ* itself is a species of uncertain status and origin. Only ten per cent of the seed breed true, the other ninety per cent give *Ficus Bengalensis* L. The plant was named by C. de Candolle in 1901, but the Indian view is that it is a garden variety of *F. Bengalensis*, and Prof. Molisch when visiting Calcutta in 1929 also considered it a mutation of this species. A bud mutation now developed in the Botanic Garden has broad flat leaves like the leaves of *F. Bengalensis*, and suggests that *F. Krishnæ* may prove to be a chimæra with a core of *F. Bengalensis*. Dr. S. Hidayetulla has taken up the study of the genetics and cytology of this species.

Surveys in South Georgia.—The highly indented coastline of South Georgia affords numerous harbours and anchorages, many of which have been used and roughly surveyed by whalers and exploring expeditions, but most were not accurately charted until the "Discovery" expedition took the work in hand. The results of this work, during such time as was available in the seasons 1926–27, 1928–29 and 1929–30, is now published in the "Narrative of Hydrographic Survey Observations in South Georgia and the South Shetland Islands, 1926–1930, by Lieut.-Comdr. J. M. Chaplin, R.N. (*Discovery Reports*, Vol. 3, pp. 297–344). Some of the work was done in R.R.S. *Discovery* and S.S. *William Scoresby*, but most in a motor-boat. Altogether 357 miles of coast-line were surveyed under conditions of no small difficulty, since on about one day in four the weather prevented work being done. All the harbours were hydrographically surveyed in addition. The volume includes reproductions of the Admiralty charts on which the surveys appear. The work in the South Shetlands was very limited and in the South Orkneys was confined to Borge Bay on Singy Island, which is also known to the whalers as Bruce Bay. In the South Orkneys, practically all the coast-line of Coronation Island needs to be re-surveyed, and in the South Shetlands many corrections will have to be made to charts. Among the photographs reproduced in this volume is a striking one of a discoloured iceberg which shows how ice may be taken for land and explains some of the erroneous landfalls of polar regions.

Schuster-Smith Magnetometer at Helwan.—Continuous terrestrial magnetic registration has now been in progress at Helwan, Egypt, for twenty-four years, and data of great value have been accumulated (though unfortunately the hourly values have not been published). The absolute values of the horizontal and vertical force have been derived hitherto from a Kew magnetometer, but recently the instrumental equipment of the Observatory has been greatly improved by the installation of a Schuster-Smith magnetometer. This is a copy, on a slightly smaller scale, of the original instrument designed at the National Physical Laboratory, with certain improvements. Its constants have not been determined by measuring the dimensions of the coil, but have been obtained by comparison with the standard Schuster-Smith magnetometer at Abinger. Its great advantage is the speed and accuracy of the measures which it

affords. Comparisons of its determinations with those simultaneously made with the Kew magnetometer, over a period of five months, are reported on in Bulletin No. 35 (Cairo, 1932) of the Helwan Observatory; they disclose a difference of about 30γ between the two sets of measures. From January 1, 1932, the new instrument is to be adopted as the Helwan standard instrument.

A Centrifugal Machine for Examining the Adhesion of Layers of Lubricant to Metallic Surfaces.—In a paper read before the Institution of Petroleum Technologists, W. F. Parish and L. Cammen describe a high-speed centrifugal machine, built on the lines of the Sperry gyroscope, and capable of being rotated without appreciable vibration up to speeds of 18,000 revolutions per minute. An oil film present on the rotor of this machine is thrown off in stages, as the speed of rotation is increased. The first portions to fly off are those constituting the thick film responsible for the 'complete' or 'film' lubrication, in which the laws of hydrodynamics hold good. The outer portions of this layer are torn off fairly easily, the inner portions less so, the adhesion to the metal apparently increasing on passing from the exterior to the interior of this fluid film. Possibly the intensity of the attraction to the metal varies as the inverse square of the distance in this region. When the whole of this outer film has been thrown off, there still remains a layer of oil, termed the 'Langmuir' layer, which is many molecules thick, and can be wiped off by a piece of paper. It cannot, however, be thrown off by centrifugal force, until speeds many thousands of revolutions greater than those needed to remove the whole of the 'Coulomb Law' or loosely attached layer are reached. When this 'Langmuir' layer has been removed by wiping, further centrifuging causes a fresh, very similar layer of oil to appear, almost certainly by extrusion of oil occluded in very fine cracks in the metallic rotor. Several such films can be reconstructed from the occluded oil, after wiping off each film in succession after formation. The authors state that the occluded oil is prevented from coming out during the first centrifuging by the restraining effect of the first 'Langmuir' film. The instrument has been used as a means of performing a 'mechanical fractionation' on castor oil, some part of which appears to have a different affinity for the metal from the rest.

Astronomical Topics

The Partial Lunar Eclipse of September 14.—Prof. C. D. Perrine, director of the Cordoba Observatory, sends a note on the final phase of this eclipse. He states that the departing shadow was dark greyish, almost black, and that it was considerably broader than the amount to be expected at the time, which was, however, not accurately noted. Its sharpness recalled a partial solar eclipse. He thinks that it was from fifty to a hundred miles broader than the computed value, and asks what the appearance was to those who saw the maximum phase of the eclipse. This was observed by the writer of this note, and there was an unmistakable sunlit rim at the moon's north limb; it was not measured, but agreed roughly with the predicted amount.

Prof. Perrine notes in his letter that there was still a considerable amount of volcanic ash in the air at the time; if the terrestrial region throwing the shadow had been in his neighbourhood, we might ascribe the broadening of the shadow to this cause; but actually it was far north of the equator, indeed near the arctic circle; the cause therefore is unexplained.

Star of Greatest Known Mass.—A few years ago Prof. J. S. Plaskett announced that the star B.D.+6° 1309, in Monoceros is a very massive spectroscopic binary, the minimum masses of the two components being 76 and 63 times that of the sun; this was the most massive star known, for Miss Maury showed that the mass of some 300 times the sun, announced by Ludendorff for Upsilon Sagittarii, was based on a misinterpretation of the shifts of lines in its spectrum; it is a massive star, but far below Ludendorff's estimate. Dr. J. A. Pearse announces (*Mon. Not. Roy. Astro. Soc.*, Oct.) the detection of another very massive star at Victoria Observatory; this is H.D. 698, magnitude 7, in Cassiopeia; its spectral type is *B9sek*; it is a binary with a period of 55·9 days, eccentricity 0·03; both spectra are visible, but that of the smaller star is faint; the minimum masses are 113·2 and 44·9 times that of the sun. An interesting feature is that for part of the revolution the *K* line of calcium appears triple, the third component being due to interstellar calcium. The strength of the latter line is used to deduce the distance of the star, which comes out as 1220 parsecs. The absolute magnitudes are −3·1 for the brighter star, and −1·6 for the fainter one, which is of type *B5*. The star gives further confirmation of the existence of interstellar calcium. It is only in very distant stars that the lines due to it can be detected, and only in certain spectral types; since if the star has broad calcium lines of its own, these mask the interstellar ones, unless they are separated by rapid motion in the line of sight.

Annual of the Astronomical Observatory of Madrid.—The annual of this Observatory, besides giving the usual information of an astronomical almanac, contains much other interesting matter. There is a table of the parallaxes, magnitudes and spectral types of the 36 newest stars, and another of the elements of comets seen at more than one apparition (there are two omissions, the comets Pons-Coggia-Winnecke-Forbes and Grigg-Skjellerup); there is also a definitive orbit of comet Wilk, 1930 II, by Rafael Carrasco:

T	1930 Jan. 22·305227 U.T.	
ω	157° 29′ 18·78″	1930·0
Ω	179 0 11·78	
i	124 31 0·23	
log q	9·8276021	
log a	2·8975315	
Period 22197 years.		

He gave similar elements last year, but the present investigation is more exhaustive, including all known observations. Mr. F. E. Seagrave found a similar period, but he did not include so many observations.

Another useful chapter deals with the families of asteroids discovered by Prof. Hirayama, with diagrams showing how they are grouped. There is also a table of all the asteroids arranged in order of period, which for many purposes is more useful than the order of discovery. Finally, there are details of the observations of solar prominences made at Madrid in 1930.

Archæology of Central America*

IN default of any statement to the contrary, it is to be assumed that "Contributions to American Archæology" is to serve as a medium of publication for results of the activities of the Carnegie Institution of Washington in American archæological investigation which are not on a sufficiently large scale to justify a separate monograph. The magnitude of an excavation, fortunately, is no gauge of its importance, and although neither of the investigations in the field recorded here proved sensational in its results, each makes a contribution to the archæology of Central America of specific interest, if of limited range.

(1) The excavation of mounds at Baking Pot, British Honduras, by Mr. Oliver Ricketson afforded some interesting, if somewhat obscure, evidence bearing on burial customs under the Mayan 'Old Empire'. The mounds in question, situated about six miles from El Cayo, consist of two groups, lying in a clearing, and each surrounded by innumerable small house-mounds. Of these, Group II. was examined superficially only. Group I. consisted of three small plazas on which were a number of mounds or pyramids. A squarish dome-shaped mound and a low platform mound on plaza 3 were the sites of the chief excavation. A fire-pit on plaza 2 was excavated to a depth of two metres by the removal of ashes and small flints showing the effects of intense heat. It was too deep for a cooking-pit and may have served as a crematorium.

On excavation, Mound G, the first of the two mounds on plaza 3, proved to be a burial mound, rectangular in outline with offsets on three sides. An unusual feature was the occurrence of several retaining walls of roughly worked stone on the slopes of the mound. If the top of the mound had once been reached by a stairway on the western slope, obviously the side of approach, it must have been of plaster and had vanished.

Fifteen burials were discovered in that part of the mound which was excavated. The last uncovered was apparently that of a person of importance, as it occupied a stone vault centrally situated in the mound and consisting of rough limestone blocks, the inner faces of which had been smoothed. They had been set in mortar and a cover was formed by limestone slabs, of which the edges had not been trimmed. The dimensions of the chamber, which was at a depth of two metres from the surface of the mound, were two metres in length by 45-50 cm. in width by 50 cm. in height. A narrow shelf of stone extending into the grave on both sides at the bottom reduced the width available for the disposal of the body to not more than 39-42 cm.; but its function was not evident. On the floor of the grave beyond the skeletal remains at head and foot were two black tripod pots.

The skeletal remains were badly preserved and offered little opportunity for examination. The body evidently had been laid on its face. With it were ear plugs and crude beads of jade, shell rosettes, fragments of worked bone, eleven small pieces of iron pyrites, and a number of small fragments of jade, round or in thin plaques.

The other skeletal remains found in the mound were in poor condition, and preservation of anything but fragments was in most cases impossible. Ten skulls were recovered in a condition which permitted of partial examination. Six show fronto-occipital deformation in varying extremes. Five are male, four indubitably female, and one probably female. The average cephalic index is 86·37, six ranging above this average to a maximum of 96·8.

The disposition of fourteen of the burials in the earth of the mound, some within, some without the retaining walls, is suggestive. Four are buried so near the surface and in such relation to one another as to suggest that they were sacrificial victims killed and hurled from the top of the mound and then buried as they lay.

Evidence for dating the site is lacking until the pottery has been more closely examined. Though not an important centre, it was evidently thickly populated at some time—it is suggested, on general grounds, not later than the transition between the Old Empire and the New, say the seventh to eighth century A.D.

(2) The study of the astronomical system of the Mayas has amply repaid the great amount of time and thought that has been spent upon it. The present work brings out the striking fact that the Mayas adopted the position value of numerals, with its necessary adjunct, a sign for zero, at least a thousand years before this step was taken in Europe. Their numerical system, which takes twenty as its base, is now thoroughly understood, and has brought to light the accurate knowledge that the Mayas attained with regard to the heavenly movements. Dr. Teeple gives 365·2420 days as the Maya determination of the length of the tropical year; this is about as accurate as the mean length of the Gregorian year, which is 365·2425 days; the truth lies midway between them; "but the Maya figure was reached a full thousand years before the Gregorian one".

In spite of this knowledge, the Maya appear to have used the 365-day year, letting the seasons drift round it; they also used a second reckoning by 260-day periods, called *tzolkins*; thus 73 *tzolkins* are exactly 52 of their years. No natural period coincides with the *tzolkin*, but it is very close to three-quarters of the eclipse-year, or interval between successive passages of the sun through the moon's ascending node. The Dresden Codex, the date of which is given as about A.D. 1100, is concluded to be an eclipse table. The mean length of the lunation was not so well determined as that of the tropical year. Two different values are mentioned, one being a day wrong in two centuries, the other a day in three centuries. Five Venus revolutions (synodic) were taken as equal to eight of their 365-day periods; this is right within a few hours.

Dr. Teeple has made great endeavours to correlate Maya dates with our calendar, but is at present not quite confident of the accuracy of the relation that he gives provisionally, though he has little doubt that the matter will eventually be settled. A hopeful point is that a total eclipse of the sun is calculated to have occurred on July 16, A.D. 790, on the site of a monument concluded to record an eclipse. The date agrees with Mr. Goodman's correlation.

(3) The excavation of the building since known as "the Temple of the Wall Panels" at Chichen Itzá, was undertaken as a part of the intensive campaign of excavation by the Carnegie Institution on that site. Its specific object was to further the investigation of the fusion of the Nahua and Mayan architectural systems which took place when, in the last 250 years before Chichen Itzá was abandoned in the middle of the fifteenth century, the city reached the height of its glory as a religious centre under alien overlords of

* Contributions to American Archæology, vol. 1, Nos. 1-4. No. 1: Excavations at Baking Pot, British Honduras, by Oliver Ricketson, jr.; No. 2: Maya Astronomy, by Dr. John E. Teeple; No. 3: The Temple of the Wall Panels, Chichen Itzá, by Karl Ruppert; No. 4: Notes on the Metates of Chichen Itzá, Yucatan, by Gustav Strómsvik. (Publication No. 403.) Pp. iii+157+49 plates. (Washington, D.C.: Carnegie Instutition, 1931.)

Mexican extraction. It was in this period that there was an outburst of architectural activity, in which the fundamental conception was Mayan, but the presence of an alien influence is to be seen in serpent columns, sloping lower walls, and other features.

The Temple of the Wall Panels was chosen for excavation on account of its central position in what is known as the Monjas group. This group would appear to have been the nucleus of the city, as it contains most of the pure Mayan buildings of Chichen Itzá, as well as structures that are doubtful and others that are certainly Nahua. The Temple of the Wall Panels was seen to be late from the presence of the drums of round columns on the mound ; but beyond the fact that it was small, before excavation nothing was to be seen of its original plan or elevation. When finally cleared, it was found to face west and to consist of a solid pyramidal substructure surmounted by a temple, with a colonnade, forming an integral part of the building, lying directly to the west. The entire edifice rests on a terrace reached by two steps. The temple consisted of two chambers, each covered by a vaulted roof. Of the outer facing, little remains. In the debris of the talus on the northern and southern sides were discovered sculptured stones from panels and mask elements which had fallen from the outer walls. Two warriors are represented on the north panel, one having a long-nose head and an elaborate feathered headdress. The figures are the full height of the panels.

The entrance to the outer chamber is by a triple doorway, 6·71 metres wide, divided by two round columns. Each chamber has a crude shrine or altar. In the inner room a beautifully carved stone was discovered, the figures representing warriors.

In excavating the colonnade, of which the roof probably formed the approach to the temple, sculptured stones were found which had fallen face down. They were for the most part in sequence and have been fitted together. They proved to be elements of the panels of the exterior walls. They were not executed with that fineness of which the Chichen Itzá artists were capable, and it is evident that for detail and finish dependence was placed on the stucco, of which some still adheres to the stone. These panels are elaborately carved with numerous figures of men and animals.

Certain features justify the assignment of the temple to the Nahua period. These are the colonnade, serpent columns, roof *adornos*, a battered basal zone, sculptured panels depicting feathered serpents, the acoutrements of the warriors, and the sun-disk motive. The Atlantean figures which form part of the Nahua sculptural complex are here represented only in a column drum which had been re-used. This presupposes the building and razing of a structure of Nahua type before the erection of the Temple of the Wall Panels.

(4) The metate or milling stone upon which the peoples of aboriginal America grind their maize-corn was, and still is, among many of the Indian tribes the most important article of household equipment. Except for certain ceremonial examples from Central America, it is normally of simple and purely utilitarian form. This typological stability gives it a peculiar archæological significance, as it is little likely to be affected by fortuitous circumstance. It is therefore an admirable source of evidence for certain fundamental groupings. The metates of Chichen Itzá are considered by Dr. Strómsvik as falling into a classification of 'heavy grooved type', 'three-legged ungrooved large type', and 'three-legged ungrooved small type'. While suggesting the intrusion of an alien influence, he points to the necessity of more data on the distribution and cultural affinities of grooved and ungrooved metates in Mexico and Central America.

The A.I.V. Process of Conserving Green Fodder

IN these days of economic nationalism and of devalued currency in terms of gold, it is a cardinal principle to produce as much at home as natural conditions allow. Although only the Dr. Panglosses believe that Great Britain could feed her people entirely and adequately from her own resources, yet all who have studied the question think that we could go a long way towards this goal. Great Britain, for example, is one of the most favoured nations in regard to grass production, yet it imports many million pounds' worth each of butter, cheese, eggs, meat, and concentrated feeding stuffs which could be produced at home. The annual bill for imported concentrated foods is so high that efforts have been made recently to dry artificially the young, protein-rich grass and so conserve it for winter 'keep'. Up to date, experiments made with this object in view in Germany and Great Britain have failed to bring conviction to the economist, and it now looks as if the desired end is to be achieved by a modification of the old practice of ensiling. The ensiling of green fodder crops for use as winter keep has made great headway in New Zealand, the United States, Holland, and Germany, but the English farmer has been slow to realise its advantages. However, he has now an opportunity. Thanks to the enterprise of Imperial Chemical Industries, Ltd., a new chemical method of ensiling, which hails from Finland, has been launched in Great Britain, large-scale experiments having been undertaken at the company's research station at Jealott's Hill, Berks, and at various other places.

When ensilage is made in the ordinary way, in tower, stack, or pit, the green fodder undergoes various changes, due to enzymes and bacteria, which usually entail a loss of 15-30 per cent of its nutrients, and much more if anything goes wrong with the process. In the new Finnish process—called the A.I.V. process, after the initials of the discoverer, Prof. A. I. Virtanen —such changes are inhibited by maintaining the fodder at a hydrogen ion concentration of 3-4. This is achieved by spraying a dilute acid liquor on to the green crop as it is charged into a pit silo ; and mould-growth is prevented by spraying the top layer with an anti-mould preparation, called 'Homesurma' (mould-death). The composition of the acid liquor is not revealed, but it is stated to consist mainly of hydrochloric acid, whilst 'Homesurma' is said to consist chiefly of allyl mustard oil. When the pit is fully charged, it must be sealed on the top as tightly as possible, for example, by means of sacking covered with clay or loam, as ingress of air is fatal to success. According to Prof. Virtanen, A.I.V. fodder contains a much higher content of digestible protein than ordinary silage ; and he estimates the loss of nutrients in the preparation to be 0·2 per cent from respiration, nothing from decomposition of proteins, and 1·3 per cent from escaped juice.

The A.I.V. process has achieved remarkable success in Finland, where it has been taken up by the butter co-operative export society, Valio, which controls 90 per cent of the butter exported from that country, In 1927 and 1928, the process was being worked out

and tested mainly in the laboratory; in 1929, it was used on 3000 farms, and 30,000 metric tons of A.I.V. fodder was produced; in 1931, 100,000 tons was made on approximately 10,000 farms; and in 1932 the process is being used on 13,000 farms. All kinds of green crops have been ensiled, but legumes or young grass are best for feeding to milch cows.

The ordinary winter ration used in Finland for 800-gallon cows consists of concentrates, turnips, hay and straw: in the A.I.V. ration, all the turnips and much (in some cases all) of the concentrates are eliminated, together with much of the hay. Expenditure on imported concentrates has been reduced by 50-80 per cent, and at the same time the milk yield has increased. The animals readily eat the fodder, ensiled grass being preferred. The free acid is said to disappear before the fodder is fed, but on most of the Finnish farms using the process a small amount of chalk is included in the silage ration. It has been found that the animals do not tire of A.I.V. fodder, and that their general health remains excellent: the distribution of lime and phosphorus in the teeth and bones, and of lime, phosphorus, and chlorine in the muscles and blood, remains normal. The quality of the milk resembles that of summer milk, both the butter-fat and protein contents being slightly higher than when the cows are fed on the ordinary winter ration; and the butter made from winter milk lacks its usual brittleness owing to the oleic acid-content being maintained at summer level. Further, the high vitamin content is held to be of great importance to public health, as the majority of the inhabitants of northern countries rely mainly on milk and milk products for their supplies of vitamins A and D, and hitherto it has been found that the growth of children in Finland is practically confined to the months from July to December.

The only capital cost involved is that of making the silo pit, which has a diameter of 16½ ft. and a depth of 4 ft. 9 in. In Finland, where family labour is abundant and wood is cheap, this cost is very low. Unless the subsoil is chalk, the pit must be lined with wood, or with cement if there is danger of water seepage. A light wooden superstructure, which is transferable from pit to pit, must also be provided; it is placed over the pit when the green material reaches the ground level, and filling then proceeds until the superstructure is also full. The fresh material is then weighted, in a day or two it sinks to the ground level, and the superstructure is removed. Working costs vary with the crop ensiled, the yield per acre of the crop, and with the cost and efficiency of the labour. With labour, as in England, at about 8*d.* per hour, the cost per ton of dry matter (about twenty per cent of the green weight) is estimated to be about 22*s.* 6*d.*; if to this figure we add £2 per ton of dry matter as the inclusive cost of growing grass for ensilage with the aid of manures, we obtain a total of £3 2*s.* 6*d.* per ton, to which must be added a further small sum for cost of acid and depreciation of the silage pit.

Large-scale trials of the process are being made in Denmark as well as in Great Britain; in addition, the process has found a footing in Sweden and Norway; whilst in Germany, where some of Prof. Virtanen's claims are contested, the process, in its essential principles, has been officially adopted and is being widely advocated. If found to be a success in Great Britain, the adoption of the process will not only save the country millions of pounds per annum on imported concentrates, but will also provide what appears to be the only practical, economic solution of the problem of utilising flush growth of grass, which is one of outstanding importance in the management of grassland.

Buffalo-Fly in Northern Australia

FOR years past, serious complaints have come from cattle raisers in the northern areas of Australia about heavy economic losses due to irritation of stock by the buffalo-fly. This led the Commonwealth Council for Scientific and Industrial Research in 1930 to invite Prof. Eduard Handschin, of Basle, to undertake inquiries in Java and neighbouring islands, as well as on the mainland. The object was to examine possibilities of parasitic control of the pest. Prof. Handschin's full report is not yet available, but it is of interest at this stage to record some of the results of his eighteen months' work.

As with other alleged economic pests in Australia (flying fox, for example), careful inquiry has shown that *Lyperosia exigua* de Meijere, though serious in some places, is by no means responsible for all the damage hitherto attributed to it. This fly is present everywhere in the Dutch East Indies, where it is not regarded as a pest: its bad name in Australia is due in part to faulty observation. March and bush flies (*Tabanus* and *Biomyia* spp.) worry cattle more, in Handschin's opinion, than does *Lyperosia*. Loss of condition in travelling mobs is often put down to 'fly worry' when it is due rather to innutritious dry grass and water scarcity. Further, the quality of the stock in northern Australia is admittedly low. This undoubtedly increases the attractiveness, or susceptibility, of the cattle to the fly. Poor quality of stock is probably a cause rather than an effect of the abnormally heavy infestation that is frequently observed. In short, it is usual to attribute all fly damage to *Lyperosia* and to make it the scapegoat for every economic loss in northern Australia.

Nevertheless, it remains a distinct menace to cattle-raising, and its passage eastwards into the dairying herds of the coastal areas of Queensland might have serious results. Such spread is already occurring, but its geographic limits are set by conditions of temperature and humidity. The influence of these on time of development has been partially worked out by Handschin, who feels justified in maintaining that the buffalo-fly will never become established in the more southerly parts of Australia (western or eastern) and probably never farther south than Rockhampton in Queensland. There may be temporary incursions to lower latitudes, but they will not survive.

In the sparsely settled areas of the north, parasitism seems the only possible means of control. Nieschulz had already found a number of parasites in Java, mostly primary parasites of saprophagous *Muscidæ*, not confined to any species of these, but as easily bred on *Lyperosia* as on them. Twelve of them were reared in the laboratories of the Veterinary Research Institute at Buitenzorg, and *Spalangia sundaica* Graham (n. sp.), which was the must abundant in the field, offered the greatest promise as a possible control for *Lyperosia*. The female lives about 27 days and lays 160-170 eggs, each in a separate puparium of a fly.

There is a northern Australian species tentatively named *S. orientalis* Graham (n. sp.), morphologically quite distinct from *S. sundaica*, the female of which lives for 15 days and lays 75-85 eggs. In the hope of producing a more effective race, Handschin endeavoured to cross these two species. Males only were produced, indicating that fertilisation had not occurred. In the meantime, however, a special strain

of *S. sundaica* was reared for several generations on *Lyperosia* puparia only, and when the male of this was crossed with *S. orientalis* female, remarkable results were obtained, the female offspring living 32 days (instead of 15) and producing 250 eggs (instead of about 80). In other words, the time of life of the indigenous species was doubled and the fecundity trebled, both highly important characteristics in a fight against *Lyperosia*. The reverse cross gave females living only 10 days, instead of the 27 of the *S. sundaica* female, and producing 100 eggs instead of 180.

Five generations of the more promising cross were bred by Handschin, using all possible combinations of the parent and derived stock. The results are certainly striking, but further research is urgently necessary. Arrangements are in train for breeding the first cross and releasing it in selected areas near Darwin. If results justify it, the work will be extended in the wet season to the Gulf Country in North Queensland. The chances of appreciable success are, however, not great; hence no relaxation of quarantine restrictions can be permitted. An interim report on Handschin's observations, including descriptions of *S. sundaica* and *S. orientalis*, has been published.

A. C. D. R.

Liquid Fuels

THE second jubilee memorial lecture to the Society of Chemical Industry, given by Dr. A. E. Dunstan, deals with the whole question of the utilisation of petroleum, oil from coal, synthetic oils, and related subjects, and is printed in *Chemistry and Industry* for October 7 and 14. Natural gas is also dealt with.

Dr. Dunstan pointed out in what directions the industrial processes are undergoing modification. In the case of motor spirit, the tendency to gum formation, which is always present to some extent, is minimised by the addition of inhibitors such as di- and tri-hydric phenols and some aromatic amines and derivatives. Tendency to freezing in the case of spirit for use in military aviation is overcome by blending with methyl and ethyl alcohols, the hygroscopic properties of which may be restrained to some extent by the addition of benzene, amyl and butyl alcohols and phenol as binders.

A limit appears to have been reached in the increase of compression ratio possible without detonation even when special fuels are used, and research into the effects of other factors in engine design is suggested. The relation between chemical composition (paraffinic, naphthene, aromatic) and tendency to detonation in a fuel is not absolute, and anti-knock valuation can be made only by engine tests. The restriction on the use of cracked spirit for aviation may be removed if the authorities can be satisfied as to its keeping properties. Compression ignition (Diesel type) is steadily advancing in importance as compared with spark ignition, particularly for heavy transport, and Dr. Dunstan pointed out its advantages. Even if the price of fuel were equal to that of petrol, there would still be a very substantial margin of benefit from compression ignition. The bearing of this on the liquid fuel industry was made clear.

The production of oil from coal was carefully discussed and the conclusion reached that it appears to represent strategic rather than economic advantages. If the total coal used for power, heating, etc., as well as hydrogenation is taken into account, the most successful processes of hydrogenation will at present make only 1 ton of oil from 4 tons of coal, and the plant is not only extremely complicated but also exceedingly costly. Although hydrogenation appears to be the most hopeful line technically for the production of liquid fuels, its application to coal or even tar cannot be put forward at the present stage as a business proposition.

University and Educational Intelligence

BIRMINGHAM.—The Huxley lecture is to be delivered by Sir Arthur Salter in the Medical Theatre of the University, Edmund Street, on December 1 at 5.30. The subject of the lecture is: "Next Steps in World Recovery".

CAMBRIDGE.—Sir Charles Sherrington, Waynflete professor of physiology in the University of Oxford, has been appointed Rede lecturer for the year 1933.

W. G. Walter, of King's College, has been elected to the Michael Foster research studentship in physiology.

Dr. E. T. S. Walton, of Trinity College, has been awarded the Clerk Maxwell scholarship.

The Adam Smith prize has been divided between K. S. Isles, of Gonville and Caius College, and J. H. Kirk, of King's College.

Dr. N. J. T. M. Needham, of Gonville and Caius College, has been approved for the Sc.D. degree.

The Governing Body of Emmanuel College invites applications for a research studentship which will be awarded in July 1933. The award will be made on evidence submitted by the candidates which should include (1) a birth certificate, (2) two certificates of good character, (3) a statement of the proposed course of research, (4) evidence of general ability and of special fitness for the proposed course of research, supported by letters from two professors and other teachers, (5) a statement of emoluments or awards, already granted, or likely to be granted, from other bodies or persons and tenable at Cambridge. Applications must be sent to the Master in time to reach him not later than June 30. Preference will be given to candidates who have already completed one but not more than two years of research. The studentship has a maximum annual value of £150 and is awarded and normally held for two years but may be renewed for a third year. The studentship is not tenable by a woman or by a graduate of the University of Cambridge.

LONDON.—The University Court has gratefully accepted an offer received from Mr. William Page to give to the University, subject to certain conditions, the copyright and material of the Victoria County History.

THE building extension of the Northampton Polytechnic Institute, St. John Street, E.C.1, will be officially opened by H.R.H. Prince George on December 2, at 7 P.M.

THE twentieth election to Beit fellowships for scientific research will take place on or about July 14, 1933. Not more than three fellowships will be awarded on this occasion. Candidates must be graduates of a university of the British Empire and under twenty-five years of age. The annual value of a fellowship is £250 and it is tenable at the Imperial College of Science and Technology. Further information can be obtained from the Rector, Imperial College, South Kensington, London, S.W.7.

Calendar of Geographical Exploration

Nov. 21, 1793.—Japan and Russia

A storm drove a Japanese vessel carrying rice to Yezo far out to sea, and in early June of the following year the Japanese sailors reached the Aleutian Islands, recently taken by the Russians. They remained there some ten months and reached Okhotsk at the end of June of the next year. Thence they were taken overland to Irkutsk, where they remained eight years. They were then taken to St. Petersburg, where the Czar received them and gave them furs. Finally they were sent back by sea round Cape Horn to Japan with Capt. Krusenstern's expedition, which was intended to conduct a Russian envoy to Japan. They were handed to the Japanese authorities in 1805. A Japanese work written in 1830, in four volumes, describes their experiences. It is also interesting to note that Krusenstern's voyage was the first Russian circumnavigation of the globe. He left Kronstadt in 1803, rounded Cape Horn, made some observations in the Marquesas Islands and thence proceeded to Kamchatka and Japan; he examined the strait between Sakhalin and the mainland but thought that Sakhalin was a peninsula of Asia. Lisianski, who accompanied Krusenstern in another vessel, discovered the island named after him. The Russian voyage added much to the scientific knowledge of the Pacific; observations of temperature in deep waters and of currents and tides were taken and astronomical records were kept.

Nov. 21, 1754.—Basin of the Saskatchewan

Anthony Hendry, on an expedition for the Hudson Bay Company, reached his farthest west, about 114° W., a little south of 52° N. Hendry left York Factory at the mouth of the Hayes River in June 1754, and using various portages reached Moose Lake and the Saskatchewan River. He explored the region between the north and south branches of that river, spent the winter with the Blackfeet Indians and returned via the Red Deer River to the South Saskatchewan.

Nov. 23, 1878.—British Honduras

Henry Fowler, the Colonial Secretary, started from Belize, went up the Belize River and explored much of the previously unknown interior. Capt. T. A. Joyce, of the British Museum, has carried out important archæological work in this region in recent years, disclosing a great wealth of Maya ruins. These surveys have also contributed to geographical knowledge of a little-known region.

Nov. 25, 1913.—Gertrude Bell in Arabia

Gertrude M. L. Bell arrived at Damascus, whence she set out on her 1500 mile journey in Arabia. She travelled to Hasan near Teima and thence turned east, reaching Hayil, which had only once previously seen a European woman, Lady Anne Blunt, who had visited it in 1878. The cool reception which she received here made it impossible for her to go south as she had hoped and she turned north-east to the Euphrates, returning to Damascus via Bagdad and Palmyra. Her Arabian experiences began in 1899; her subsequent travels and archæological explorations made her reputation as an authority on Asia Minor and the northern borderlands of Arabia. She died in Bagdad in 1926 while engaged in the organisation of a museum of antiquities.

Societies and Academies

LONDON

Royal Society, Nov. 10.—Lord Rutherford, C. E. Wynn-Williams, W. B. Lewis and B. V. Bowden: Analysis of α-rays by an annular magnetic field. With the assistance of Dr. J. Cockroft, an electromagnet has been designed which provides a uniform magnetic field, of the order of 10,000 gauss, in an annular gap in which α-rays can be bent into a circle of 40 cm. radius. The particles are emitted from a source placed in the gap, and are detected by a small ionisation chamber symmetrically situated on the opposite end of a diameter. The interior of the whole magnet is exhausted to a low pressure (0·001 mm. mercury). As in previous experiments the ionisation chamber is connected to an amplifier, and individual α-particles are automatically counted by a system of thyratrons. The analysis is carried out by adjusting the magnetic field so as to bring groups of different velocities successively on to the slit of the counting chamber, the high velocity edge of a group being very sharply defined. Moreover, it is necessary to measure small changes of the magnetic field with great accuracy. A special method has been developed for this purpose, and the relative velocities of a number of α-particle groups have already been determined with an accuracy of about 1 in 3,000. The weak group of α-particles from radium C, numbering only 1 in 4,000 of the main radium C′ group, comprises two distinct components.—W. A. Bone, D. M. Newitt and D. T. A. Townend: Gaseous combustion at high pressures (14). Explosions of hydrogen–air and carbonic oxide–air mixtures at initial pressures up to 1,000 atmospheres. With regard to the actual explosions it was found that:—(1) In those of theoretical hydrogen–air media there was a quite definite increase in the explosion times with density at initial pressures exceeding 250 atmospheres; although at 750 atmospheres detonation was instantaneously set up at the firing point with such violence as to preclude work at any higher pressures; (2) in explosions of theoretical carbon monoxide–air media the characteristic lag in the explosion time, as well as the exothermic effects observed during the cooling period—both of which had hitherto consistently increased with the density—reached their maxima at an initial pressure somewhere between 350 and 500 atmospheres, and thereafter remained constant up to 1,000 atmospheres, indicating that the nitrogen activation effect had reached maximum within this density range; (3) in $2CO + O_2 + 3{\cdot}76CO$ explosions the explosion times, which were always very much shorter than in the corresponding $2CO + O_2 + 3{\cdot}76N_2$ explosions and had remained nearly constant up to initial pressures of 250 atmospheres, began definitely to increase thereafter with the density, and about the same point some slight carbon deposition began to be manifest during the explosions, the two circumstances probably being connected. The rates of pressure fall during the first second of the cooling period immediately after the attainment of maximum pressure were always much faster than in the corresponding $2CO + O_2 + 3{\cdot}76N_2$ experiments.

Society of Public Analysts, Nov. 2.—Theodore Rendle: Observations on changes in raspberries after picking. The ripening process in raspberries is more rapid than in most fruits. Accompanying the ripening

there occurs the production of a relatively large amount of volatile organic bodies not due to the action of micro-organisms. The pectic substances in raspberries are subject to rapid change, with the destruction of their gelling power; this change is arrested by the application of heat.—W. R. Schoeller and H. W. Webb: The separation of uranium from tantalum, niobium and titanium. Uranium is quantitatively precipitated by tannin from neutralised tartrate solution in presence of ammonium acetate and chloride. It is quantitatively precipitated from oxalate solution by tannin and a slight excess of ammonia. Uranium, like zirconium, thorium, aluminium and iron (group *B*) can be quantitatively separated from tantalum, niobium and titanium (group *A*) by tannin precipitation of the last three elements from feebly acid oxalate solution half-saturated with ammonium chloride. In tartaric hydrolysis, uranium interferes with the normal course of precipitation in the case of niobium, but not of tantalum or of mixed pentoxides in which tantalic oxide preponderates.—E. J. King: A new form of filter stick: its use in gravimetric analysis. A new form of filter stick, particularly suitable for the micro-analysis of silicic acid, has been devised.—F. J. Warth: A new method for the iodimetric titration of phenols. The conditions under which iodine is absorbed by phenols are discussed. Under certain specified conditions, in the presence of sodium hydroxide two-thirds of the theoretical amounts of iodine are absorbed by phenols, including the cresols.

PARIS

Academy of Sciences, Oct. 10 (195, 589–632).—Maurice Fréchet: The behaviour of certain nuclei of Fredholm repeated indefinitely and the probabilities in chain.—J. Mirguet: A class of surfaces admitting a continuous tangent plane.—A. Kulakoff: The relations between the real parts of the characters of groups.—Pierre Dive: The identity of two bodies possessing the same Newtonian potential in a common interior region.—J. Pérès and L. Malavard: The application of the electrical method to a problem concerning the wing of finite spread.—Li Hen: Some statistical properties of the Cepheids.—P. de Fonbrune: A new micro-manipulator. A pneumatic control is described possessing the advantages that the needle or micro-pipette is unaffected by shaking of the hand; all movements of the control lever are exactly reproduced on the microscopic scale by the needle point. More than one of these instruments can be used in the field of the objective at the same time.—A. Piccard and M. Cosyns: The study of the cosmic radiation at great altitudes. Results obtained during the ascent made on August 18, 1932. A curve is given showing the relation between the barometric pressure and the intensity of the radiation, the latter measured by two types of ionisation chamber. As regards the effects of screens, 4 cm. of paraffin had no visible effect, but 4–5 cm. of lead caused a diminution of 20–35 per cent.—Mlle. Suzanne Veil: The periodic precipitation of some silver salts. Study of the precipitation of silver arsenate, chromate and phosphate in gelatine.—Kapp: The determination of hydrogen sulphide in trade effluents. The errors caused by the oxidation of the gas by the oxygen dissolved in the effluent can be avoided by adding cadmium sulphate: cadmium sulphide is not readily oxidised and can be carried to the laboratory for analysis without change.—A. Stieber: Two combinations of boron trichloride, one with hydrogen arsenide and the other with phosphorus trichloride. These new compounds have the formulæ $BCl_3.AsH_3$ and $BCl_3.PCl_3$.—G. Schuster: The use of hydrobromic acid for the characterisation of the arylarsinic acids.—G. Florence, J. Enselme and M. Pozzi: Contribution to the study of the variations as a function of the *p*H of the ultra-violet spectra of some hexavalent heterocyclic compounds.—J. Durand: The granite of Laguépie (Tarn-et-Garonne).—J. Malavoy and S. Serpokryloff: New geological observations in the loop of the Niger.—F. Link: Records of atmospherics. The observations were made at the Observatory of the Pic-du-Midi at an altitude of 2,860 metres, between November 1931 and August 1932. A statistical study of the results gave maxima corresponding to heights of 35 km. 115 km. and 235 km. The first maximum corresponds with the maximum ozone concentration, the second with the Kennelly-Heaviside layer and the third to the reflecting layer found by the echo method.—Paul Chauchard: The variations of salinity measured by means of the electrical conductivity: study of the Rance at Le Chatelier.—N. Em. Renescu and B. B. Olszewski: Chloral hydrate in the organism. The narcotic action of chloral hydrate has been variously attributed to chloroform produced by decomposition, to the formation of carbon monoxide, and to the effects of unchanged chloral hydrate. The author's experiments are in agreement with the last view. Chloral was found in relatively large quantities in all the organs, whilst chloroform was found in traces only and was absent from some organs.—J. R. Denis, P. Paris and P. Rémy: New experiments, under natural conditions, on the phototropism of fresh-water plankton.—Emile André and Armand Bloch: The etho-esters of glycerol or etho-glycerides of the liver oil of *Scymnorhinus lichia*.—M. Aynaud: The parasitism of Infusoria in the walls of the stomach of the sheep.—A. Lacassagne: The appearance of cancer of the breast in male mice, submitted to injections of folliculin.

Forthcoming Events

MONDAY, Nov. 21

ROYAL SOCIETY OF ARTS, at 8—(Fothergill Lecture).—Com. A. N. G. Firebrace: "Fire Fighting".

CHADWICK PUBLIC LECTURE, at 7.30—(at the Technical College, Bradford).—Prof. S. D. Adshead: "Some Recent Developments in the Housing Problem".

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Evelyn Cheesman: "The Island of Malekula, New Hebrides".

TUESDAY, Nov. 22

BRITISH SCIENCE GUILD, at 4.30—(Eighth Annual Norman Lockyer Lecture, in the Goldsmiths' Hall, Foster Lane, E.C.).—Sir Frank Smith: "Industrial Research and the Nation's Balance Sheet".

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30—(at the School of Hygiene and Tropical Medicine, Keppel Street, W.C.1).—Gabrielle M. Vassal: "Life in the French Congo".

KING'S COLLEGE, LONDON, at 5.30.—M. T. Halcrow: "The Water Power Developments of the British Isles" (succeeding lectures on Nov. 29 and Dec. 6).

UNIVERSITY OF LEEDS, at 8.—Dr. C. D. Ellis: "Recent Advances in our Knowledge of the Atom".

WEDNESDAY, Nov. 23

ROYAL ANTHROPOLOGICAL INSTITUTE, at 5—(at the School of Hygiene and Tropical Medicine, Keppel Street, W.C.1).—Discussion on "The Evidence of Man's Kinship with the Primates", to be opened by Dr. Solly Zuckerman.

FRIDAY, Nov. 25

CHADWICK PUBLIC LECTURE, at 7.30—(at the Town Hall, Gateshead).—Dame Louise McIlroy: "Maternal and Infant Welfare".

CHEMICAL SOCIETY, at 5.30—(Fourth Liversidge Lecture, in the Chemistry Lecture Theatre, University of Birmingham).—Dr. F. W. Aston: "Physical Atomic Weights".

UNIVERSITY COLLEGE, LONDON, at 5.30.—Sir James Frazer: "The Fear of the Dead in Primitive Religion" (succeeding lectures on Nov. 29 and Dec. 1).

ROYAL INSTITUTION, at 9.—Dr. H. Knox-Shaw: "Observational Evidence for the Expansion of the Universe".

SATURDAY, Nov. 26

UNIVERSITY OF CAMBRIDGE, at 5—(Henry Sidgwick Memorial Lecture in the College Hall, Newnham College).—Sir James Jeans: "The Farthest Depths of Space".

Official Publications Received

GREAT BRITAIN AND IRELAND

Birmingham Bureau of Research on Russian Economic Conditions. Memorandum No. 7: i. Foreign Trade; ii. Monetary Conditions; iii. Indices of Wholesale Prices; iv. State Budget. Pp. 24. (Birmingham: The University.)

Medical Research Council. Special Report Series No. 174: Medical Uses of Radium; Summary of Reports from Research Centres for 1931. Pp. 59+4 plates. (London: H.M. Stationery Office.) 1*s*. 3*d*. net.

Journal of the Chemical Society. October. Pp. iv+2505–2667+viii. (London: Chemical Society.)

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