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The Planting of Hardwood Trees

RECENT correspondence in the Press, to which Mr. Alexander Howard refers in a letter on p. 231 of this issue, has directed attention to the alarming rate at which hardwood trees, whether isolated or in hedgerows, woodlands or otherwise, are being felled in many parts of Britain without any attempt at replanting. Various reasons for this state of affairs might be given, including high taxation, which has forced landowners to realise every possible tree in an endeavour to retain possession of their property, the general depression, the break-up of estates, the high level of wages, the remoteness of prospective yields and uncertainty as to the future, which prevent landowners from sinking capital in long-term investments such as plantations. On the other hand, it should be mentioned that recent legislation provides a large measure of relief in regard to taxation and death duties ; among other things, for purposes of probate the value of woodlands is excluded from the total value of an estate, and a landowner therefore stands to benefit his estate by storing up capital in the form of growing timber.

It will be convenient if we approach this question from two points of view, the æsthetic or sentimental on one hand and the economic or utilitarian on the other. These are not necessarily antagonistic. Opinions on the æsthetic value of different classes of trees are governed so much by personal taste or sentiment that agreement on the subject can scarcely be expected. But misdirected sentiment has been responsible for some confusion of ideas. Some writers advocate the wider use of our 'native hardwoods', but include among them various introduced species, such as the 'common' elm, the sycamore, the lime, the walnut and others. At the same time, they have condemned the use of conifers, partly for æsthetic reasons and partly because all our coniferous timber trees except the Scots pine are exotics. This attitude is scarcely reasonable, for among the conifers are to be found some of the most beautiful and interesting trees in the world. Let it be admitted, therefore, that conifers, when used with discretion, have their æsthetic value as well as hardwoods. But when we find, as we now do, that the hardwood trees which have been the glory of English scenery in the past are being extensively felled, and if replaced at all are being replaced mainly by conifers, it is time to call a halt. Here we touch the economic and utilitarian side of the question.

So far as requirements in bulk are concerned, coniferous timbers (softwoods) are of much more importance than hardwoods. They constitute about eighty per cent of the world's consumption of sawn timber, and are used in large quantities for pitprops, telegraph and other poles, paper-pulp and other purposes. Owing to the depletion of the world's timber resources, a serious shortage of softwoods within a measurable period of time is predicted, though hardwoods in general will not be affected to anything like the same extent. It is partly for this reason that in the programme of State afforestation proposed by the Acland Committee of 1916–17, and now being carried out by the Forestry Commission, the area to be afforested with conifers was estimated at 1,770,000 acres and that required for hardwoods at only 100,000 acres, or about 5·3 per cent of the total. This policy has been modified recently in favour of an increased use of hardwoods for afforestation in localities suitable for them, and actually more than six per cent of the total area afforested to date has been planted with hardwoods. The planting of hardwoods, however, is restricted by the fact that the price to be paid by the Commissioners for land is fixed at a comparatively low figure. This means that much of the land acquired is too poor for the cultivation of the more valuable hardwoods, and is fit only for the less exacting conifers. Nevertheless, in areas planted with conifers steps are being taken, on æsthetic as well as on sylvicultural and protective grounds, to introduce broad-leaved trees along the sides of roads, and even within the plantations.

That the private landowner should replace the previously existing hardwood crops by coniferous plantations is not altogether surprising. The latter may possibly yield returns within the lifetime of himself or his heir, but there is small hope of this in the case of the former, if we exclude such short-rotation crops as chestnut coppice and the like. Leaving æsthetic and sentimental considerations out of account, therefore, are there any economic or technical reasons why hardwoods should continue to hold an important place in British forestry? The answer to this question is a decided affirmative. Although the total consumption is considerably less in the case of hardwoods than of softwoods, there are many special purposes for which hardwoods, and definite species of hardwoods, are alone suitable ; and it is important that future supplies of such woods should be ensured. Again, extensive afforestation with introduced conifers is attended with considerable risk from insect pests and fungus diseases, particularly in a country like England, the natural forest vegetation of which consists predominantly of broad-leaved trees. France is now learning this to her cost in the Seine valley, where forests of introduced Scots pine, created on a large scale early last century, are being decimated by fungus diseases. A generous mixture of hardwoods in coniferous crops is one of the best safeguards against such a calamity, and it has the further advantage of reducing the risks from fire and storms as well as of maintaining the fertility of the soil, and with it the health and vigour of the crop. To summarise the position, although there are strong economic reasons for the extensive use of conifers for afforestation, there are equally strong reasons, from several points of view, for paying special attention to the cultivation of hardwood trees.

When we come to consider the question of preventing the destruction of existing woodlands and trees, preserving the beauty of the countryside, and ensuring future supplies of hardwood timber, we are faced with problems of a somewhat complicated nature. State afforestation may be expected to continue, possibly on a more extended scale, and it is hoped that hardwoods will receive due attention. A great deal more might be done by corporations and municipalities to acquire, and even create, woodland areas within easy reach of towns ; the numerous town forests in France, Germany, Austria and other Continental countries, which are so great a boon to the town-dwellers, serve as an example of what might be done in Britain. It is when we consider the question of private estates that the problem presents special difficulties. In some Continental countries, stringent laws exist for ensuring the proper management of private forests and the regeneration of all areas felled. There is much to be said for introducing legislation designed to ensure the regeneration of felled areas, and to improve the admittedly faulty management of so many private woodlands in Britain.

On the Continent, legislation of the kind indicated applies generally to properties with a stated minimum woodland area, and its object is primarily economic. It would not cover the case of individual or hedgerow trees, or that of the numerous small copses, belts of trees, and woodland dells which are such a feature of the English countryside. The Irish Free State, by the Forestry Act of 1928, is making serious efforts to restrict the felling of trees on

private property. In Great Britain similar restrictions, however well-meaning, might prove difficult and costly to apply in practice; better results would probably be achieved, at less cost, by a policy which would give landowners more encouragement to maintain the beauty of their estates as their forbears did. Something might be done by means of State aid to bodies such as the National Trust, for the acquisition of small woodland areas or park lands to be preserved primarily for æsthetic reasons. Last, but not least, there is great need for educating the British public to respect trees and woodlands, which suffer from acts of vandalism unheard of in those European countries in which the 'tree sense' or 'forest conscience' is more fully developed: with the help of schools, the rising generation, at any rate, might be brought up to realise that trees and woods are a heritage which should be valued and respected.

Reviews

The Concept of Time in Physics

The Serial Universe. By J. W. Dunne. Pp. 242. (London: Faber and Faber, Ltd., 1934.) 10*s.* 6*d.* net.

IN 1927, Mr. Dunne published a book recording dream experiences which seemed to indicate prevision of future events. Being a thorough Copernican, he scorned the idea of personal peculiarity and began to examine the concept of time. His conclusions were so strange that stronger observational evidence was generally demanded; yet it was clear even then that the theory was grounded on the general nature of thought rather than the particular data of experience. The issue is now cleared. In his new book, Mr. Dunne applies his theory to the facts of modern physics instead of to dreams. Those facts are numerous and authentic enough: we can no longer evade the challenge by demanding further evidence.

Mr. Dunne's presentation of his case deserves the highest praise. The book is a model of clear thought and expression, and the style excites interest to the point of fascination without sacrifice of critical attention. A mathematical physicist might have expressed a few points differently, but that is immaterial. Whatever verdict awaits the ideas, their cause could scarcely have found a better advocate.

The theory starts from the idea of a *regression*, that is, a series of terms of which each, after the first, demands the next, and which therefore extends to infinity. An artist paints a picture of the universe. But he is a part of the universe, so the picture must include a picture of himself painting the same picture—which, being the same picture, must itself include him; and so on *ad infinitum*. This is a type of all regressions. The first term (the universe) alone does not require the remainder, but when the artist in the second term enters the picture, there is no escape; we are doomed to follow the succession of artists and pictures to the bitter endlessness.

Consider, now, an objective world, A, described from the indications of independent instruments, B. The instruments observe *now*, but we define the world as extended in time, and from memory and calculation represent it as a static four-dimensional thing, along the time dimension of which our instruments move from past to future. The instruments, however, are not inherently independent of A, being so regarded only when they are observing it: a wider view of A shows it as including B. But that puts the artist into the picture. The sequel is inevitable.

This process is linked with the notion of time. The world, A, extends through time, T_1, along which the instrument moves, making contact only at the 'now'. But such a movement requires another time, T_2: the first—a static dimension through which A extends—cannot give meaning to the motion of B along itself. When we retreat a stage and contemplate, as a single system, A with its T_1 and B moving in T_2 to observe A, a third 'time' becomes necessary. Thus we regress—indefinitely.

At each step the abandoned time becomes a new dimension of space—of a continuum, that is, which has as many dimensions (including the three dimensions of 'ordinary' space) as there are possibilities of independent continuous variation of the system located in it. Thus we normally imagine a three-dimensional space world changing in time. When we consider its history, we petrify its eternal progress along T_1 into an A having what is equivalent to infinite space extension in that dimension, and transfer the dynamic element of time to T_2. When we withdraw to watch B observing A, T_2 in turn is fixed, its spirit flying out along T_3. At the next step, the Gorgon's head is shown to T_3, and the vital spark escapes along T_4. Whenever T_n is time, there are $n+2$ dimensions of space—the familiar three plus the $n-1$ quiescent eternities.

We can picture the process as a mad pursuit

of eternity or a relentless tracking-down of change; in either case the effort is Sisyphean. No sooner do we grasp eternity than it is transformed to infinity: we cannot arrest the passage of time in one direction without releasing it in another. The task, however, is not forced on us. We can stop at any stage, provided we stop at the corresponding stage of the physical regress. Thus, if we want only the ordinary three dimensions of space, we must not consider the world as extended in T_1, but merely as existing from moment to moment. The contemplation of world-history commits us to a fourth space dimension and a time, T_2.

The poetry of all this is irresistible, but we are concerned with the truth. Physics explores the world by arbitrarily selecting parts as instruments and giving them independent status. It is thereby committed to a regressive time concept which it has not employed. Anomalies are therefore found: we are involved in 'imaginary' time and indeterminacy. Only by accepting the fact of regression can these anomalies be removed.

Before proceeding to the removal we must examine the general idea; and here caution is necessary. Mr. Dunne's theory—belonging, as we have said, to the world of thought—appeals to a wide public—to the philosopher, the physicist, the psychologist, the humanist and the man in the street. Our point of view is that of the man of science, and we have no intention of leaving it, but we must state what it is.

Science is concerned with pure thought only in the correlation of experience. Our minds, however, can form far more concepts than experience needs. From the scientific point of view, these additional concepts are meaningless; they serve only for intellectual exercise.

History shows that no human power has been more diligently employed than that of asking meaningless questions. We do not attribute this to irony in Nature; it appears to be a by-product of our self-chosen instrument of language. "Who hath given man speech, and who hath set therein a snare?" asked Swinburne. The realm of significance is a mere patch in a boundless waste of grammatical possibility, and no scientific duty is more urgent than that of keeping within its limits.

Many philosophers will not assent to this. They (the 'nominalists' we may call them for identification, without historical or other implications) attach significance to pure thought unrelated to experience. We need not argue the matter here, for our purpose is simply to point out that Mr. Dunne sits above the controversy, calmly telling the disputants the conditions they must respectively observe. The nominalist must accept the whole infinite regression: the man of science, it seems to us, is committed only to the second term—and, with a different history, might have stopped at the first. Let us illustrate this by the example of time.

The regression of time is interwoven with the method of describing the world by selecting parts of it as instruments. The obvious conclusion is that the world should be described otherwise. Science does not in principle depend on experiments: we could merely watch things happen and rationalise the results. For speed, of course, we adopt the experimental method, but it is a *method*, not an essential quality, and we must not attribute to the universe characteristics which belong only to our mode of describing it.

This, however, is no reply to Mr. Dunne. To propose now to renounce the division of the world into instruments and systems observed would be quixotic. The division belongs not only to our experimental procedure but even to our definitions. Take, for example, such a fundamental notion as the strength of an electrostatic field. This is defined in terms of the force it exerts on a unit pole. But the pole changes the field, and the field changes the pole-strength. Instead of expressing the observed behaviour of the whole system, we describe an exploration of a hypothetical field by a hypothetical unchanged pole. The whole of physics is formed of such inventions.

The only practicable course is to adapt our concepts to this procedure. The structure of physics is so massive that it is much simpler to stand on our heads than to invert it, and this Mr. Dunne teaches us to do. Only the nominalist, however, must make the complete overturn. The physicist has merely to cock his head sideways, for one additional element of the regression will correct his imperfect start. Mr. Dunne is unanswerable when he claims that physics has effectively created two notions of time, but we cannot follow him in giving physical significance to others. Physics does not employ a second instrument to watch the first observing the world. In retreating to contemplate such a process, therefore, we step outside the patch of significance into the waste of purely verbal relations.

Using two time dimensions, Mr. Dunne gives an attractive derivation of the world of special relativity. Here time has become space; that is, it has shed its 'becoming' character and assumed infinite extension. But our clock measures becoming; we cannot put it when we like in time as we can put a metre-stick where we like in space—it ticks only when it is. Before using it as a scale for petrified time, therefore, we must multiply its readings first by i to rotate them through 90° to the T_1 axis; and secondly by a factor c to convert the unit of vital time into

that of dead time, or space. This factor Mr. Dunne calls "the velocity of the now"; that is, the rate at which the instrument, which touches the world A only at the now, travels along the T_1 dimension of that world. Distance along T_1 in space units is thus icT_2; or simply icT, since T_2 is measured as time.

This sounds fantastic, but it is rigidly logical. "The velocity of the now" is no more fanciful than the familiar idea that for a man travelling with light, time stands still; he is a travelling 'now'. The significance of this natural 'velocity', dT_1/dT_2, however, is obscured when c is regarded as the velocity of light, for that is dS/dT also; but it becomes extremely suggestive when we consider the ratio of the electromagnetic and electrostatic units. That ratio also is c, and issues from experiments in which it cannot be interpreted as dS/dT without introducing *ad hoc* conceptions. We get a new view of the matter when we consider that in the two systems of units we are implicitly defining time in its moving and static aspects.

Scarcely less illuminating is Mr. Dunne's discussion of the principle of uncertainty. He shows that this arises from the division of the world into instruments and observed systems, and that we can make the uncertainty regress with the instruments, leaving a determinate world behind. The fact that this principle had nothing to do with Nature we had discerned before, but Mr. Dunne's treatment puts it in the clearest possible light.

We are less impressed by Mr. Dunne's interpretation of the quantum of action, which perhaps we have not fully understood, nor do we take kindly to his more general philosophy. Taking force, space and time as elementary indefinables, he works out a scheme of dimensions for each term of his regressive observer, and gives a refutation of subjective idealism in which we feel he has been anticipated by Samuel Johnson. His aim is to reconcile physics and psychology, and the effort is very ingenious. We doubt, however, if a union of the most with the least developed of sciences is yet possible, and we think that in attempting it Mr. Dunne is sacrificing the substance of his idea for the shadow. If force is elementary the passage to general relativity is closed, for that does not recognise force. There is fascination, at least, in describing the physical world in purely temporal terms, putting icT for space and $(ic)^3\,T$ for mass, in relativity fashion; and Mr. Dunne's picture of ic as an operator which rotates one dimension of time into the next presents an imaginative aspect of the process which we feel is badly exchanged for a questionable psychological interpretation.

We are unable also to accept Mr. Dunne's assurance of immortality. It seems to us that on a priori grounds this question can be answered only by experience, and when pure reason offers an answer we can only look for the fallacy. Mr. Dunne argues that the destruction of observer 1, moving along T_1, cannot affect observer 2 moving along T_2, and therefore, since there is no reason why observer 2 should die, he goes on observing. In familiar language, bodily death does not prove cessation of consciousness. We agree; but neither does it prove continuance of consciousness. There is no reason, apart from experience, why observer 1 should cease in T_1; we simply find that he does. Similarly it seems to us that observer 2 might (or might not) cease in T_2; we must wait and see.

Mr. Dunne's book contains so much of real value, however, that only with great reluctance do we record what we believe to be its weaknesses. That a man untrained in theoretical physics should have penetrated the jungle of relativity and quantum theory and reached the central clearing is an event of such magnitude as to make ridiculous any preoccupation with the scratches received on the way. Mr. Dunne's achievement is a great one, and we hope it will receive the recognition it deserves.

HERBERT DINGLE.

Sex and Culture

Sex and Culture. By Dr. J. D. Unwin. Pp. xxiv + 676. (London: Oxford University Press, 1934.) 36*s.* net.

THE principal thesis of this highly elaborate investigation is that there is a causal relationship between sexual opportunity and cultural condition. Sexual opportunity is measured by the kind and amount of regulation that societies employ for controlling or checking the sex impulses before and after marriage. Cultural condition is used in a very narrow sense to stand for the manner in which a people conceives of the power or powers in the universe, as judged by the outwardly observable steps that are taken to maintain right relations with it or them.

Dr. Unwin distinguishes three types of cultural condition: the deistic, which applies to peoples who carry out their rites in temples, through the agency of priests; the manistic, which refers to peoples who pay post-funeral attention to the dead; and the zoistic, or peoples who do neither of these things. The transition from the zoistic to the deistic cultural condition indicates, according to Dr. Unwin, a growth of thought, reflection and energy. Sexual opportunity is determined principally by asking whether or not a people condemns pre-nuptial unchastity. Dr. Unwin claims that an inductive survey of eighty uncivilised peoples (forty-seven zoistic, twenty-one manistic and ten

deistic, two uncertain) establishes a definite relation between degree of sexual continence and cultural condition. The data show, he thinks, that all the peoples who allow pre-nuptial sexual freedom are in the zoistic cultural condition; that all the peoples who impose occasional or irregular continence are in the manistic phase; that pre-nuptial chastity is accompanied by the deistic cultural condition; and that in each class of cases the converse propositions may also be shown to be true. He concludes that cultural condition and sexual opportunity are not only definitely associated in the manner indicated, but also that the relation is a causal one, the reduction of sexual opportunity providing the energy required for cultural change. The transition from association to causal connexion is effected by an appeal to psycho-analysis, which has independently arrived at the conclusion that civilisation or culture has depended upon a restriction or repression of the sexual impulses and a diversion of libidinal energy.

Dr. Unwin has handled his material with great skill, and his induction may possibly be true. Nevertheless, the methods which he has employed seem open to serious objections. First, to judge social energy by reference solely to the way in which a people behaves to the mysterious powers in the universe seems arbitrary procedure, when no account is taken of their arts and crafts, their power of organisation, their skill in war, in trade or generally in the control of natural forces. Even in the magico-religious field proper, the criteria employed are of doubtful adequacy. Secondly, difficulties arise from the relatively small number of cases utilised in the survey. No doubt Dr. Unwin was hampered by the poverty and vagueness of the anthropological material. He asserts that, so far as his knowledge goes, the behaviour of the societies that he has omitted from consideration does not militate against his induction. But in a matter so controversial and in the absence of corroborative evidence from other fields of social energy, his induction rests on a precarious basis and might be shaken by a broader survey. This applies especially to his deistic societies, of which Dr. Unwin enumerates only ten cases, particularly as the evidence regarding pre-nuptial relations is doubtful regarding three or four of them. Thirdly, the method that Dr. Unwin employs is that which a logician would describe as that of agreement and difference. The validity of conclusions so drawn depends upon the elimination of alternative causes. But this Dr. Unwin makes no attempt to do. He does not inquire, for example, whether the prohibition of pre-nuptial relations is correlated with the prevalence of marriage by purchase or other features of the family structure, or again, with the general development of law in other spheres of behaviour.

Finally, Dr. Unwin's conclusions may to some extent be checked by reference to an inquiry conducted on different lines by the late Prof. Hobhouse, Mr. G. C. Wheeler and the present writer in 1915 ("The Material Culture and Social Institutions of the Simpler Peoples"). There the attempt was made to correlate regard for chastity with cultural grade as measured by economic criteria, the peoples being classified into lower and higher hunters, two grades of pastorals and three agriculturals. In the matter of pre-nuptial unchastity, we found no constant tendency, though the cases of condemnation were more numerous among the agricultural and pastoral peoples than among the hunters. If other points relating to chastity are considered, such as the punishment of adultery and the prevalence of wife-lending, we found that, on the whole, there was an increasing tendency for the family life to be consolidated with advance in economic grading. Owing to the vagueness of the evidence, however, we should hesitate to assert universal association between sexual regulation and economic conditions, still more any causal connexion. It may be added that Prof. Westermarck, who has made a very wide survey of the evidence, concludes that there is no relation between the toleration of unchastity and the degree of culture, and that, on the contrary, chastity is more respected in the lowest tribes than in the higher ones.

Upon the whole, my impression is that the evidence available in the present state of anthropology is neither detailed nor abundant enough to afford a satisfactory basis for a generalisation so far-reaching as that propounded by Dr. Unwin.

MORRIS GINSBERG.

Mineral Resources of the French Colonies

Publications du Bureau d'études géologiques et Minières coloniales. *Introduction aux Études Minières coloniales.* Pp. viii+349+9 plates. (Paris: Société d'Éditions Géographiques, Maritimes et Coloniales, 1934.) 36 francs.

THIS volume follows up and forms part of a useful series of publications issued during the last two years or so by the Bureau d'Études géologiques et Minières coloniales on the subject of the mineral resources of the French Colonies. Its object is to give an account of some general aspects of the mining industry with which it is important that colonial miners and geologists should be familiar.

An opening chapter on the genesis of minerals is followed by one on laterite. These are followed

by chapters on alluvial deposits, geophysical prospecting, health, transport, native labour, microscopical studies of coal and metallic ores, commercial problems and the relation of France to its colonies with regard to the supply of metals.

A consideration of these pages shows that France and her colonies are far from self-sufficient in their supplies of metals. The apportionments of mineral resources among the nations of the world are singularly irregular. France has ample home supplies of iron, and therefore has no need at present for her large colonial output in north Africa, which goes largely to Great Britain and Germany. We are reminded, however, that a half a century from now—a short time in the history of a nation—a state of impoverishment in the supplies of iron ore from the eastern basin of France may begin to assert itself, and France may then need her colonial output of iron ore.

New Caledonia produces supplies of nickel matte amply sufficient for the needs of France ; but it is curious to note that a large part of the output of this matte is sent to Great Britain, the United States and Belgium, and from these countries, none of which produces nickel ore, France has to import for her own needs considerable amounts of metallic nickel that has been made in part from New Caledonian matte.

The case of chrome ore is also interesting, for New Caledonia produces ample supplies of high-grade chrome ore, the production of which is controlled by foreign capital. Only a small proportion of the output goes to France, whose further requirements have to be met by importing large amounts of chrome ore and ferro-chrome from foreign countries.

Among other mineral supplies necessary for the metal industries, the French colonies have considerable resources of lead ore, zinc ore and graphite ; but, so far as yet known, very little of the ores of manganese, copper and tin. On the whole, the position as regards the output of metalliferous ores in France and her colonies compares quite unfavourably with the position in the British Empire.

The eminent specialists who have contributed to different sections of the book include such well-known authorities as L. de Launay, A. Lacroix and A. Lambert-Ribot. The book is well indexed and illustrated, and makes a useful addition to the serviceable memoirs already issued by this very active Bureau.

Short Notices

Man versus Rabbit. By A. H. B. Kirkman. (ULAWS Monographs, No. 4b.) Second edition, entirely rewritten. Pp. vi+74+9 plates. (London : University of London Animal Welfare Society, 1934.) 1*s*.

ONLY those who live in the country can properly appreciate the damage done by rabbits, where they are at all numerous. As all gardeners know, the losses they inflict in the course of the year are both serious and exasperating ; and farmers, in many parts of the country, suffer even more severely. Mr. Kirkman, then, has done us great service by presenting in this small volume an able and impartial summary of the methods of 'farming' rabbits for the market, on one hand, and their destruction as 'vermin' on the other. From whichever of these two aspects they are regarded, the manner of their slaughter is an issue of the first importance, which forms the main theme of Mr. Kirkman's book. Its aim is to secure legislation to prohibit the use of steel-traps. He has shown how ineffective they are for their avowed purpose of reducing the rabbit-pest, as well as the harm they do—apart from the cruelty which attends their use —in killing or maiming other animals more or less directly useful to man.

With praiseworthy fairness Mr. Kirkman has cited the views of those who are still in favour of the use of the steel trap. But against them he arrays overwhelming evidence of landowners, game-keepers, farmers and gardeners who deplore their use, employing instead ferrets, nets or gas, according to circumstances. Some may object even to these measures. But we must not let 'humanitarianism' become an obsession. For there can be no doubt that these animals are a grave menace to both gardener and farmer. There are comparatively few of those whose crops are now so seriously menaced, or among sheep-farmers, who would not welcome an Act of Parliament forbidding the use of steel-traps for any purpose whatever.

Evidence is given by Mr. Kirkman to show that, as a means of reducing the rabbit-pest, steel traps are worse than useless, for they kill vastly more bucks than does. The reason for this differentiation is unknown, but it is suggested that the does wander less and are more timid and suspicious. This is only one of many surprises that have come to light in the course of Mr. Kirkman's investigations.

We are glad to find that the author directs attention to the folly of an intensive war on stoats. Besides their help in keeping down rabbits, they are extremely valuable allies in the war that, so far, is only half-heartedly carried on against rats : while the weasel as a mouse-destroyer is no less valuable.

The Design and Construction of High Pressure Chemical Plant. By Harold Tongue. Pp. ix+420+69 plates. (London : Chapman and Hall, Ltd., 1934.) 30*s*. net.

ONE of the pioneer laboratories to study the application of high pressures in chemistry and chemical industry has been the Chemical Research Laboratory at

Teddington directed by Prof. G. T. Morgan; there the author gained his experience and carried out pioneer work. A pleasing feature of the work at Teddington has been the facility afforded to members of industrial firms to gain experience in the design and construction of high-pressure plant. Their needs have given the author a clue as to those aspects of his subject in which information is of the greatest practical value.

The book is essentially a chemical engineering treatise, and is therefore fully illustrated with pictures of actual plant and diagrammatic and detailed drawings. The author has sought to collect together all the information pertinent to the subject. Thus he deals with gas compressors; with the preparation, purification and cost of the industrial gases; with the design of pressure vessels; with the measurement of pressure; with valves, fittings and pipes.

High pressures, together with high temperatures, have set a number of new problems for the metallurgist; the creep of steel, embrittlement and the penetration by hydrogen have been new factors for study, and many unexpected difficulties have developed in the manufacture of large pressure vessels for high-pressure service. Ammonia, methanol, the hydrogenation of fatty oils, of coal oils and of petroleum, are still the large-scale pressure processes. In addition, there is the high-pressure oil cracking industry. An ever increasing number of other products are being manufactured in high-pressure catalytic circulatory plants.

There is a definite need for this book, which will be found to contain a good deal of information now published for the first time.

The Ideas of Physical Chemistry. By H. McKay and H. A. C. McKay. Pp. x+301+8 plates. (London: William Heinemann, Ltd., 1934.) 7*s.* 6*d.* net.

THIS volume, published without preface, but dedicated to the authors' mother and grandmother, appears from the wrapper to have been written for the "layman" or "non-chemical specialist". It is there referred to as an introduction, in which the facts of physical chemistry are described in simple language which anyone can understand. A perusal of the text gives the impression that the authors have attended a recent course of up-to-date lectures on physical chemistry, in connexion with which some modern textbooks were recommended for supplementary reading, and that they have then written up their lecture notes in twenty-seven chapters, in the optimistic expectation that lay readers will possess the same grounding in chemistry and physics as the authors had when they began the course, and will therefore be able to follow their summaries of the subjects thus selected. The impression that the authors are relying on second-hand information, and have not gone back to original sources for the material used in constructing the book, is also suggested by the diagrams which illustrate the text, since these are almost all 'blackboard sketches'. On the other hand, seven plates, mainly of spectra, are admirably reproduced.

The subjects dealt with are not easy to expound or to understand, and it is doubtful whether the lay reader will be able to follow with advantage a narrative in which so much is taken for granted; on the other hand, the serious student ought at least to select for supplementary reading books which are based upon first-hand contact with original sources; but there is perhaps an intermediate grade of readers to whom the present compilation will be useful, and the publishers have done their share in making the book attractive to them.

The Official Year-Book of the Scientific and Learned Societies of Great Britain and Ireland: with a Record of Publications issued during Session 1933–1934. Compiled from Official Sources: Fifty-first Annual issue. Pp. vii+164. (London: Charles Griffin and Co., Ltd., 1934.) 10*s.* net.

THE fifty-first annual issue of this well-known Year-book is likely to be as invaluable as its predecessors. All the particulars are compiled from official sources, and therefore reliable. Government departments as well as learned societies are represented, and information is given concerning address, membership, meetings and publications. To facilitate reference, the societies are classified by subject into fourteen sections, and a good index is appended.

It is gratifying to note that this reference book is receiving increased support. The publishers deserve this encouragement, for the volume is well produced, and is full of useful information. It should be on the shelves of all libraries, institutions, laboratories, etc., which are interested in any branch of science.

Popular Handbook of Indian Birds. By Hugh Whistler. Second edition. Pp. xxviii+513+20 plates. (London and Edinburgh: Gurney and Jackson, 1935.) 15*s.* net.

A REVIEW of the first edition of this useful handbook to the birds of India was published in NATURE of October 6, 1928, p. 533. The book is very good value for its price, which perhaps explains why the first edition was so quickly exhausted. In that edition, 250 common Indian birds were described; in the second edition, 275 are described at length. A new feature is the brief mention with short descriptions of a further 230 species. The requisite number of extra illustrations have been added. The whole text has been revised and brought up to date.

Facts and Theories of Psychoanalysis. By Dr. Ives Hendrick. Pp. xi+308+xii. (London: Kegan Paul and Co., Ltd., 1934.) 10*s.* 6*d.* net.

DR. IVES HENDRICK gives here what is probably the best account of the present position of this art—psychoanalysis can scarcely be said to have reached the position of a science yet. The book is divided into four parts dealing with the facts, theories, therapy and present status of psychoanalysis. The author is largely a Freudian, and so does not approve of the theories of Adler, although to many in Great Britain the latter are more acceptable; but then the theories are not psychoanalysis as it ought to be understood as referring purely to Freudian theory.

Television in Great Britain*

THE report of the Television Committee under the chairmanship of Lord Selsdon, issued last week, seems to have taken the public and most of the experts by surprise, probably due to the fact that during the last nine months, when the Committee was sitting, they had heard practically nothing about television, and the low definition broadcasts that were given did not seem to be of much permanent value. In particular, they find it difficult to believe the following extract from the report: "The time may come when a 'sound' broadcasting service entirely unaccompanied by television will be almost as rare as the silent cinema film is to-day," although the Committee modifies this slightly by saying that, in general, sound will always be the most important factor in broadcasting. The promotion of television, therefore, will not hinder the continual development of sound broadcasting.

Recent advances have contributed largely to the development of a technique whereby the scene to be televised is first photographed on ordinary cinematograph film. It is then developed and scanned by light transmitted through it, and this system is used to provide a method of 'delayed' television when direct scanning by a mechanical device would be difficult or impossible. Equipment is now available in which the cine-camera is connected with the film scanner. The film after exposure is fixed, washed and partially dried. It then passes through the scanner, and after further drying is stored for future use if required. In this way, the new methods of producing rapid and sensitive emulsions for photographic processes have overcome the difficulties due to the comparatively feeble sensitivity of photo-electric cells.

The direct scanning of open-air scenes and studio subjects is now possible without using abnormally powerful illuminating devices. This is done by cathode rays in combination either with minute photo-electric cells or photo-sensitive surfaces. One such device is being developed in the United States, Germany and Great Britain. The image to be televised is focused by means of lenses on to a photo-electric mosaic contained in a cathode ray tube. The cathode ray beam is directed on the surface of the mosaic, and by a method of magnetic control the image is scanned repeatedly. Electrical energy is thus drawn off from the photo-electric mosaic by the cathode ray which is proportional to the light intensity of the picture, and can be transmitted to operate the distant television receiver. The Committee definitely states that satisfactory reproduction of outdoor moving scenes can now be attained by this method when the visibility conditions approximate to those under which satisfactory cinematograph pictures can be taken. It is assumed that the recording apparatus can be located reasonably close to, and at a moderately constant distance from, the scene which is being televised. It is stated that, even in this stage of development, satisfactory reproduction can be obtained of such scenes as a procession, a lawn-tennis match and the finish of a horse race. The transmission of the view of the whole course of a race or similar event would doubtless present much greater difficulty.

On the day following the publication of the report, Baird Television Ltd. gave the first public demonstration of the system as it will be used in the home when the new ultra-short-wave transmission by the B.B.C. begins next autumn. The demonstration was given in Victoria Street, and the Baird transmitters were at the Crystal Palace, a distance of about 10 miles, the wave-lengths used being 7 metres for vision, and 8·5 metres for sound. Two receivers were shown; the sizes of the screens being 12 in. × 9 in. and 8 in. × 6 in. respectively. There were about fifty people present and they could see both screens; sometimes the room was darkened, but at other times it was illuminated by ordinary light, the difference in the visibility of the pictures in the two cases being slight.

The larger of the two receivers had to be adjusted several times during the performance, but the smaller one was not touched. We first saw a 'close-up' of the announcer. It was quite a good picture and easily recognisable—quite as good as the pictures seen in the poorer cinemas. He said that the demonstration was to prove that the television of pictures of high definition over a large area is a practical reality, and that the reception of such programmes in any part of the Greater London area is possible by a Baird receiver. This area has a population of more than ten million people. He contradicted the assertions recently made that with ultra-short wave-lengths (4–8 metres) the maximum range is 5 miles. With the present arrangements, satisfactory results are obtained up to 30 miles from the transmitter. The interference trouble, sometimes produced by motor-vehicles, has been successfully overcome. There was no trace of it in the pictures shown in the offices in Victoria Street on a busy afternoon.

The second item in the programme was given by Miss Alma Taylor from the Crystal Palace. She showed some new fashions in hats and various styles of hairdressing. She also, by means of a

* Report of the Television Committee. (Cmd. 4793.) Pp. 27. (London: H.M. Stationery Office, 1935.) 6*d*. net.

telephone, entered into an animated conversation with a member of the audience. This was real television ; we saw and heard two people talking together at a distance of ten miles. We next saw an out-of-doors horse-jumping and racing competition taking place on the terrace of the Crystal Palace. A boxing match was then shown in one of the studios at the Crystal Palace with the attendant crowd and the noise and cheers. These two were done by 'delayed' television. A proof was given that the interval between the occurrences and seeing them on the screen was 35 seconds. Excerpts were also given from several of the well-known Gaumont-British films including "I was a Spy" and "Jack Ahoy". The singing and the sounds of the dancing were reproduced excellently and the flickering was scarcely noticeable although a picture frequency of only 25 pictures per second was used. A complete "Mickey Mouse" film was shown and was almost as good as those shown in the cinemas.

After seeing this demonstration, we agree with the Committee that there is good entertainment value in high-definition television accompanied by sound. We also agree that in general the sound is the more important factor in broadcasting.

Owing to the close relationship which must exist between sound and television broadcasting, the B.B.C. is obviously admirably suited to be the operating authority. The following advisory committee has been appointed to advise the Postmaster-General on points arising in connexion with television and to exercise control over the actual operation of the service : Lord Selsdon (chairman) ; Sir Frank Smith, secretary of the Department of Scientific and Industrial Research, who will be chairman of a technical sub-committee ; Col. A. S. Angwin, assistant engineer-in-chief of the Post Office ; Mr. N. Ashbridge, chief engineer of the B.B.C. ; Vice-Admiral Sir Charles Carpendale, controller of the B.B.C. ; Mr. F. W. Phillips, assistant secretary of the Post Office.

The transmission of high-definition television is practicable only with ultra-short waves, for a wide band of frequencies is required. Fortunately, there is no difficulty at present in allocating suitable wave-lengths—between 3 and 10 metres—for public television in Great Britain. Technically, it is desirable that the transmitting stations should be situated at elevated points. The mast at present in use in Berlin is 430 ft. high, and the question of employing masts of greater height is being discussed in Germany. The Crystal Palace site of the Baird Television Company was chosen because it is the highest point in London. The top of the south tower of the Crystal Palace is 680 ft. above sea-level, and the Baird aerials on the top of the tower give the maximum possible range of any site in the Greater London area. The premises taken over by the Company cover an area of 40,000 sq. ft. and are all on one open ground floor.

The Committee has come to the conclusion that a start can best be made with a service of high-definition television in London. It points out that there are two systems of high-definition television which are in a relatively advanced stage of development. One of these is owned by Baird Television Ltd. and the other by Marconi—E.M.I. (Electric and Musical Industries) Television Co., Ltd. The Committee suggests that an extended trial of these two systems be made under strictly comparable conditions. They will be installed side by side in a London station and will issue programmes alternately and not simultaneously. Among the conditions imposed are that the price demanded must be considered reasonable by the advisory committee and that the B.B.C. be indemnified against any claim for infringement of patents. The definition also should not be inferior to a standard of 240 lines for scanning and 25 pictures per second. The present experimental transmission gives 30 lines per picture and $12\frac{1}{2}$ pictures per second. The pictures are 'coarse' in texture, and the flickering is objectionable.

The Committee looks forward to the time when there will be a general television service throughout Great Britain. Television broadcasts will be relayed by land line or by radio to substations in various parts of the country. Owners of sound receiving sets will be glad to hear that, during the first experimental period at least, the cost of the new transmission will be borne by the revenue from the existing 10*s*. license fee. Afterwards a reasonable share will have to be contributed by the Treasury and the Corporation.

The smaller of the complete sound and vision receiving sets made by the Baird Television Company is a cabinet 4 ft. high, 2 ft. wide and 2 ft. deep. The size of the picture is 8 in. × 6 in., and it is sufficiently brilliant to be seen quite clearly with ordinary room lighting. It can be used with any type of high-definition transmission having 100–500 lines and 12–50 pictures per second. It can be seen by ten people in a room quite comfortably. It requires little skill to operate. The selling price will be at first about £50 ; but when bulk production has been started it is likely to be reduced considerably. As it is operated on ultra-short wave-lengths, there is no trouble with atmospheres. The Company also produces a larger set suitable for an audience of thirty people and having a screen 12 in. × 9 in. These sets are not likely to become obsolete by changes in transmission technique during the next four years. The price will be at first about £80.

Social and Industrial Aspects of Scientific Research*

IT is difficult to imagine a document which better illustrates alike those social aspects of scientific research to which attention has been repeatedly directed in recent months, at the British Association meetings or elsewhere, and the way in which the direction of scientific research is itself determined by the needs of the community, than the nineteenth annual report of the Department of Scientific and Industrial Research which was issued on February 2. This report covers the period October 1, 1933, to September 30, 1934, and contains the brief report of the Privy Council Committee, signed by Mr. Stanley Baldwin, the longer report of the Advisory Council over Lord Rutherford's signature, and summaries of the work of the National Physical Laboratory, the Chemical Research Laboratory, the various research associations and research boards. Certain of the latter issue their own independent reports, but no one document issued by the Department gives such a comprehensive and lucid account of the way in which the Department of Scientific and Industrial Research serves our national life, whether in departments of State, industry or the social needs of a civilised community.

The expenditure of the Department during the year ending March 31, 1934, was £664,482 gross, or £476,897 net, as compared with £451,987 net in 1932–33. Receipts decreased, however, from £202,749 in 1932–33 to £187,585. This latter sum includes £59,774 in fees for paid work for industry; £10,209 representing contributions from industry for co-operative research; and £99,705 from other Government funds, including a payment of £21,520 from the Road Fund for building and road research and a grant-in-aid of £30,000 from the Empire Marketing Board for food investigation. Net expenditure on the National Physical Laboratory was £118,687; on the Chemical Research Laboratory, £22,164; building and road research, £29,684; food investigation, £10,707; forest products research, £33,911; fuel research, £80,423; and water pollution research, £5,453. The Geological Survey and Museum received £63,426 and research associations a total of £58,992.

Particular stress is laid in the report of the Advisory Council upon the efforts made to improve the position of the research associations, as regards both obtaining greater financial support from industry and also securing the greater financial stability which is essential if long-range researches are to be undertaken and reasonable prospects of a career offered to the scientific staff. This appeal for further support from industry is not, however, based solely on the prospects of future benefits. It rests equally on the results already achieved, and stress is once more laid on these other ways in which science can assist industry by the application of existing knowledge and by the extension of the scientific method and outlook.

An encouraging sign of the growth of this spirit in industry is seen in the expansion of those researches undertaken by the Department with the financial co-operation of industry. As an example of such arrangements during the year may be mentioned the research on such questions as the effect of waves on resistance and pitching of ships and their propulsion, the effect of wind resistance, the behaviour of rudders and the improvement of propellers, which are carried out in the William Froude laboratory of the National Physical Laboratory. This work, which is of fundamental importance in the design of new ships, is financed as to one half by industrial subscriptions.

Other examples of such co-operative research are found in the investigations, also at the National Physical Laboratory, bearing on the practical development of steels for use at high temperatures, as in the turbine or in chemical engineering, investigations at the Building Research Station covering the safety factors of steel-work, the discovery of British sources of materials for increasing the resistance of concretes and mortars to chemical attack, the effect of sea-water on concrete, problems of driving concrete piles, welding in steel structures, and the continuous study of heating and ventilating problems throughout the year in a 'controlled weather' house which is now being erected through the financial co-operation of industry secured through the Institution of Heating and Ventilating Engineers.

The bearing of this co-operative work at the Building Research Station on the housing question needs no emphasis. It is, however, worth noting that the introduction of new materials and the displacement of obsolete regulations offer most hopeful lines of radical development in the building industry, and both alike depend on the continuous application of scientific research. The survey, conducted by the Building Research Station and the Fire Offices Committee of the fire insurance offices, of the problems of testing building materials for their resistance to fire, is overcoming difficulties in the way of provision for fire-testing stations where large-scale experiments can be conducted.

Building research in fact figures prominently in the report. Proposals made by the Advisory Council are concerned with an expansion of the

* Department of Scientific and Industrial Research. Report for the Year 1933–34. (Cmd. 4787.) Pp. iv+192. (London: H.M. Stationery Office, 1935.) 3s. net.

activities of the Station whereby the results of research and investigation would become available at an earlier date and also with the special problems involved in the construction of flats. These include investigations on fire risks designed to test whether regulations in Great Britain are too restrictive or not, and others relating to the transmission of sound through the structural elements or through floors and partitions.

From housing questions it is an easy transition to problems bearing on food supply, and here the work of the Department affords a striking example of scientific co-operation with the Dominions overseas. Even the brief summary contained in the Advisory Council's report indicates our immense debt in this field to Sir William Hardy, and the work of the Food Investigation Board is steadily growing in importance. At the Covent Garden laboratory there is a full-time officer, experienced in the examination of experimental consignments of fruit and vegetables sent to Great Britain, whose services are also available for Dominion and Colonial Governments. A definite advance has been recorded during the year in the application of gas-storage to shipments of chilled beef from Australia and New Zealand, and a modified method of stowage has been developed which promises to be more effective and economical.

Investigations in this field range over almost every type of foodstuff. A storage atmosphere has been worked out, for example, in which the characteristic flavour of Cox's Orange Pippin apples can be retained during six months' storage. Experiments at a Wiltshire factory have shown that rapidly growing pigs are more suitable for bacon production than slowly growing pigs. With lighter salting supplemented by cold storage, a method of cure has been evolved which produces salted herrings more delicate in flavour and more suited to the modern palate than those previously available. Problems of the herring industry have also been considered, and the discovery that herrings, frozen in brine at $-20°$ C., make good kippers after four months' storage at that temperature, which is now being tested on a semi-commercial scale, may enable supplies to be carried over from periods of glut to the times of shortage experienced particularly in winter.

Besides the Food Investigation Board, several of the research associations are concerned with investigations on foodstuffs. The Research Association of British Flour Millers is studying the reasons for one flour giving better bread and dough than another, and developing methods of measuring the physical properties of dough. The Research Association for the Cocoa, Chocolate, Sugar Confectionery and Jam Trades has indicated methods for preventing boiled sweets being reduced to a sticky mass by the absorption of moisture and has also suggested modifications in the composition of such sweets to prevent coalescence under the influence of heat.

Turning from food to clothing, we are still within the field in which the activities of the Department touch the home. The British Boot, Shoe and Allied Trades Research Association has done much to improve footwear service by providing knowledge which makes shoes more hygienic and comfortable, while the Leather Manufacturers Research Association has given a good deal of attention to the prevention of mould growth on leather. The Wool Industries Research Association's new process for unshrinkable wool, yarns and fabrics is being exploited under mill conditions, and materials should be available for the public early in this year. New motor fabrics from wool and rubber latex are also being introduced to the public. The Linen Industry Research Association has investigated the behaviour of linen under repeated launderings, and other research in this field is undertaken by the Launderers' Research Association.

Leaving the home we come naturally to transport, where the Road Research Station is responsible for fundamental work on road construction, which has a vital bearing on safety on the roads; skidding problems and lighting problems are both being investigated.

Space permits not even the briefest reference to many other ways in which the work of the Department of Scientific and Industrial Research is affecting almost all our public services—power, water, lighting, gas, fuel—and steadily raising their efficiency. Mention should, however, be made of the work of the Forest Products Research Laboratory on Empire timbers, of investigations on the detection of toxic gases and the production of cheap and efficient respirators for use in industries where dust is a menace to health, investigations on cylinder wear of internal combustion engines—probably the most important cause of deterioration in the engines of motor-cars—radio research on the propagation of waves and long-distance transmission, dental investigations, illumination research, investigations on lubricants and on atmospheric pollution, if only to illustrate the immense range of activities of this one Department. Nor should it be forgotten that, in the various institutions aided by the Department, new instruments and methods are continuously being developed by which the control of existing processes or the solution of urgent problems is being achieved. The interpretation and exposition of the record of work contained within the covers of this report is a task to which every scientific worker might well address himself.

Obituary

DR. F. A. DIXEY, F.R.S.

FREDERICK AUGUSTUS DIXEY commenced his scientific career as a medical man and took the degree of B.M., B.Ch., Oxon, in 1884, followed by the D.M. in 1891. He was for a while demonstrator in physiology at University College, London, and also at Oxford from 1883; and a histological preparation made by him was used for an illustration still reproduced in Quain's "Anatomy". But it was as an entomologist that Dixey will be remembered: his first entomological publication was on the phylogenetic significance of wing markings in certain Nymphalid butterflies, and until his death on January 16, in his eightieth year, he was associated with the study of evolutionary entomology at Oxford, so intimately bound up with the name of Poulton.

Dixey was a true Darwinian and supporter of the current theory of mimicry as produced by natural selection. He especially studied the Pierinæ, or 'white' butterflies, on which he became an acknowledged expert, and made two subjects particularly his own. Fritz Müller in 1878 had shown that two distasteful species might benefit by resembling each other: "they may even have gone to meet each other" he wrote; but Müller did not develop this theory. Dixey approached the subject independently through practical study of specimens and, in an important contribution on the phylogeny of the Pierinæ following on the lines of his first paper, he introduced in 1894 the term 'reciprocal mimicry' to express the production of a superficial likeness between distasteful forms of widely removed affinities by the apparent interchange of characters peculiar to each. This term was superseded by 'diaposematism' to bring it into conformity with others used by Poulton. The theory of Müller and its important extension by Dixey were controverted by G. A. K. Marshall on statistical grounds; but R. A. Fisher in 1930 stated that Marshall's arguments were untenable.

"The Relation of Mimetic Patterns to the Original Form", followed by "Mimetic Attraction" (1896–97) showed the successive steps through which a complicated mimetic pattern could be evolved in simple and easy stages from a form presenting merely the ordinary aspect of its own genus, and that the process of gradual assimilation, starting from one given point, may take several divergent paths at the same time. In other words, the members of a single group may assume several different mimetic developments, each one corresponding to a distinct model, but all derived by easy stages from the same original form.

A characteristic of natural selection is the production of one effect by different means, and in a study of mimetic butterflies of New Guinea, Dixey showed how a certain type of coloration was produced by spot and stripe markings the position of which, different in absolute detail, resulted in a uniform appearance relatively to the whole exposed surface of the wings.

Dixey was convinced of the importance of studying geographical distribution in its relation to mimicry, and made this the subject of his presidential address to Section D (Zoology) of the British Association in 1919. Coincidence, sometimes invoked to explain mimicry, can produce resemblance, and, in the guise of *advocatus diaboli*, he demonstrated examples from different parts of the world bearing similar patterns. But such resemblances are crude, and lack the perfection of detail of typical mimicry, and thus coincidence fails to explain the latter.

Seasonal forms of butterflies and the possible direct influence of climate were the subject of Dixey's second address, on "Entomology and Evolution", to the Entomological Society (now Royal) of which he was president in 1909–10. He maintained that the Lamarckian interpretation of the effect of climatic conditions was not justified: "the modification is not inherited from the soma of the parent but is consequent upon the direct action of this external influence upon that parent's germ plasm".

Dixey's other favourite subject, in which he will long be recognised as a master, was the study, in Pierinæ, of specialised scent-producing scales to which Fritz Müller had directed attention in 1877–78. He found in 1899 that the peculiar scent of a male 'green-veined white' (*napi*), which had long been known to exist, could be detected on a brush used for removing scales from the wing, and in 1904 wrote that the scent of male butterflies is associated with specialised scales, confined to that sex, which can be removed from the wing and their odour perceived. Such scales are confined to the upper surface of the wing, and may be aggregated to form scent-producing organs supplied with air by special tracheæ. These studies culminated in a memoir (1932) containing 437 drawings of scent-scales in different species of Pierinæ.

At the time of his death Dixey had commenced the final copy of a paper on specialised scales on a portion of the wing of an American Pierine which, it is hoped, may be published as a posthumous contribution. The investigation of special scent-producing structures, carried on by Dixey, has been splendidly developed along different lines, following Fritz Müller's suggestion of 1877, by H. Eltringham. Elaborate apparatus on both wings and abdomen of male Danaine butterflies have been minutely described, and their use in the field has been witnessed by more than one observer. Further developments have resulted in the discovery of an intricate scent-producing apparatus on the head of a minute 'caddis-fly', and specialised glands, the function of which is unknown, are being discovered on many different parts of the body in insects of diverse kinds.

Dixey returned to histology in 1931, and published an account of the development of wings in Lepidoptera.

Dixey was elected a fellow of the Royal Society in 1910, and was vice-chairman of the Association of British Zoologists: he was a familiar figure at meetings of the British Association, and played a genial part in the social gatherings.

G. D. HALE CARPENTER.

SIR WILLIAM SLINGO

THE death on January 19, at the age of seventy-nine years, of Sir William Slingo marks the passing of a distinguished civil servant and engineer, whose career has been associated with wide and far-reaching developments in the art of communication.

At the age of fifteen years, Slingo entered the Post Office as a telegraphist, and twenty-eight years later was appointed to the Engineering Department, from which he eventually retired as engineer-in-chief in 1919 after a career in the civil service of nearly fifty years. During that period, which covered the growth of the trunk telephone system, the transfer of the National Telephone Company's plant to the State and the subsequent developments of telephony in Great Britain, Sir William Slingo played a very active part. He was primarily responsible for the compilation of an inventory of the National Telephone Company's plant on its acquisition by the State. On the basis of this inventory, an award of 12½ million pounds sterling was made to the Company instead of the twenty-one millions claimed.

Although at the outset Slingo was a telegraph engineer, at an early stage he proceeded to widen his outlook on telephone problems, and made substantial contributions to other branches of electrical engineering. He was responsible for the design and installation of one of the earliest electrical lighting plants in London, when he acted as consulting engineer to the Drapers Company for an installation at the East London People's Palace.

To Sir William Slingo's credit must be placed the achievement of building up the nucleus of an engineering staff from a group of telegraphists whose previous training was mainly that of manipulative skill. In doing this, he first made himself proficient in the art, and then for many years carried on single-handed the pioneer work of training the telegraph engineers of the future. He founded on his own initiative at the General Post Office, the Telegraphists School of Science, beginning with a handful of students, which had grown to 850 when he relinquished the post of principal. Many engineers of established reputation in the art of tele-communications received their earliest training in that school. Sir William Slingo's work during this period in furthering the study of telegraph and telephone engineering and placing it on a more scientific basis, at a much earlier date than otherwise would have been the case, exercised a wide influence; and, particularly in the development of telegraphy, British practice was largely followed in other countries.

After his retirement from the Post Office, Sir William continued to be actively engaged on communication work. Amongst other enterprises, on behalf of the Marconi Company he had acted as administrator general for the Peruvian system of posts, telegraphs and wireless services, a system which he reorganised and placed on a sound basis.

Sir William's professional reputation as an engineer was of the highest, but it is probable he will be best remembered and honoured by his early services in the training of telegraph engineers. A. S. A.

DR. JOHN HOWARD

DR. JOHN HOWARD, of the Fuel Research Station, Greenwich, was killed on January 3 through being caught by an avalanche and swept down a hillside in the neighbourhood of Vent. His companion was Mr. Kenneth F. Armstrong, who was also killed. Dr. Howard was the only son of Mr. and Mrs. Fred Howard. Mr. Fred Howard was formerly Mayor of Holborn.

John Howard was born in London and educated at Oundle School, where he specialised in history before going over to the science side, and was head of Sydney House. In 1927 he became a scholar of Corpus Christi College, Oxford, and took his B.A. degree in 1930 and B.Sc. in 1931, being 'proxime' in the Gibbs scholarship in chemistry. His work was directed by Dr. Hammick, with whom he later published two papers. Whilst at College he became sergeant in the artillery battery of the Oxford University Officers Training Corps and obtained his Certificate B. In 1931 he gained a Commonwealth fellowship and worked at Princeton University with Prof. H. S. Taylor upon "The Adsorptive and Catalytic Properties of Chromium Oxide Gel". He submitted a thesis on this subject and was awarded his Ph.D. He published papers in association with Prof. Taylor. He took an active part in a number of sports, particularly in swimming, rugby, fives and shooting. He was captain of the school shooting team at Oundle and won the Stock Exchange Cup for shooting while at Oxford.

Dr. Howard was appointed to the staff of the Department of Scientific and Industrial Research in 1933, and was assigned for duty at the Fuel Research Station, where he commenced an investigation to determine the causes of the deterioration of catalysts in the hydrogenation process. He took a very broad view of the study of science, and his knowledge of history, which was inspired by his mother, who was a graduate in history at Manchester, aroused his interest in the general trends taking place in the fuel industry. As a result he was concentrating upon the effects of the economic changes upon the development of the uses of fuel, and he was acting as the personal assistant of the Director of Fuel Research. He had a very good knowledge of languages and had taken up the study of economics. He had a charming personality and had established a real friendship with his colleagues on the staff.

WE regret to announce the following deaths:

Prof. Oliver P. Jenkins, emeritus professor of physiology and histology in Stanford University, an authority on American fishes, on January 9, aged eighty-four years.

Prof. Hugo Junkers, founder and until 1932 head of the aircraft firm of that name at Dessau, who was a pioneer in the development of all-metal aircraft, on February 3, aged seventy-six years.

Prof. Emanuele Paternò, formerly professor of general chemistry in the University of Rome, and an honorary fellow of the Chemical Society.

News and Views

Planetary Atmospheres

WE are glad to be able to publish as a special supplement this week a survey of existing knowledge of the atmospheres of the planets, which formed the subject of the presidential address delivered by Prof. H. N. Russell at the recent Pittsburgh meeting of the American Association. Prof. Russell is known to all astronomers for his work on stellar development, and particularly by his division of stars into the two types of 'giants' and 'dwarfs' in which the temperature is rising and falling respectively. In recognition of this and other contributions to astrophysics, he was awarded the Gold Medal of the Royal Astronomical Society in 1921, and he has been similarly honoured by a number of other leading scientific societies. In his address Prof. Russell first points out that the presence of atmospheres on Jupiter, Saturn, Mars and Venus was proved, many years ago, by telescopic observations of clouds, polar snow-caps and twilight. The moon has no trace of atmosphere, nor has Mercury. The spectroscope enables information about the composition of these atmospheres to be obtained, but it will not detect hydrogen, nitrogen, helium or other inert gases in such atmospheres. Tests for oxygen and water-vapour are complicated by the presence of these substances in the earth's atmosphere. By taking advantage of the Doppler shift of the lines when a planet's distance is changing rapidly, this difficulty can be escaped. The latest observations at Mount Wilson show no traces of oxygen or water-vapour, either on Mars or Venus. The small amount of water required for the Martian polar caps might escape detection. Bands due to carbon dioxide have been discovered in Venus, and they indicate a layer of the gas at least two miles thick. The major planets show other bands—increasing in strength from Jupiter to Neptune—all due to methane (CH_4) the simplest hydrocarbon. Ammonia gas gives weaker bands in Jupiter and Saturn.

PHYSICO-CHEMICAL explanations are available for these facts. Small bodies, such as the moon, have not sufficient gravitational attraction to prevent their atmospheres from escaping into space. Middle-sized planets, like the earth, probably lost almost all their initial atmospheres while they were in process of formation, and intensely hot. As the rocky crust solidified, water vapour and carbon dioxide would escape from it and be added to the residual nitrogen, argon and neon. The free oxygen on the earth is probably a product of plant life. Venus appears to be a planet on which life did not start—leaving the carbon dioxide unaffected. Large planets would retain hydrogen and all other gases. There is a great excess of hydrogen in the sun. If the same were true of the planets, they would cool down into rocky cores, surrounded by oceans thousands of miles deep, and then by atmospheres highly compressed by their own weight. The chemical equilibria in such mixtures have been carefully studied, as they are of industrial importance. At high temperatures and low pressures, hydrogen, nitrogen and carbon dioxide would prevail—at low temperatures and high pressures, hydrogen, methane, ammonia and water. The surface temperature of Jupiter is about − 120° Centigrade, and the ammonia is on the point of condensation, probably forming the clouds visible in the planet. Saturn is colder, and almost all the ammonia is frozen out. In Uranus and Neptune it is completely gone, enabling us to look deep into the atmospheres of hydrogen and methane, which must be very extensive.

Inland Water Survey

THE Minister of Health (the Right Hon. Sir Hilton Young), and the Secretary of State for Scotland (the Right Hon. Sir Godfrey Collins), have appointed a Committee to advise on the Inland Water Survey for Great Britain, on the progress of the measures undertaken and on further measures required and, in particular, to make an annual report on the subject. The members are as follows: Col. Sir Henry G. Lyons, F.R.S., Sir Charles H. Bird, Prof. W. S. Boulton, Mr. G. Dallas, Mr. G. J. Griffiths, Lieut.-Col. F. Hibbert, Sir Clement D. M. Hindley, Mr. S. R. Hobday, Mr. W. A. Millar, Mr. D. Paul, and Mr. B. Verity. The secretary to the Committee is Mr. I. F. Armer, and any communications relating to the work of the Committee should be addressed to him at the Ministry of Health, Whitehall, S.W.1. In constituting this Committee, it is stated that the object has been, not to appoint representatives of organisations or interests, but to obtain a body of men of different classes of experience serviceable for the work to be undertaken.

THE class of experience chiefly represented upon the Committee is, however, that of water users; and we are disappointed that little attention seems to have been paid to the recommendations of the British Association Committee on Inland Water Survey by the Ministry of Health. The need for a scientific survey of the water resources of Great Britain was brought out at the York meeting of the Association in 1932 through a paper in which Capt. W. N. McClean described some of his work on river flow. The result was the appointment of a strong committee, with Vice-Admiral Sir Percy Douglas, formally hydrographer of the Navy, as chairman, and Capt. W. N. McClean as secretary. This Committee produced a valuable report, in which the scientific aspects of inland water survey were clearly presented. It is surprising, therefore, to record that not a single member of the British Association Committee, which was responsible for directing public attention to the whole subject and suggesting a possible programme of work, is included among the members of the Committee just appointed.

Commemoration of Prof. Haber's Death

WHEN Prof. Fritz Haber died in Switzerland a year ago, we were glad to publish in the columns of NATURE an eloquent tribute to his greatness, written by one of his old pupils. By the irony of political circumstances in Germany, the loss of this chemical genius was limited in the journals of that country to a bare announcement, and no obituary notice at all adequate to the influence of his life and work appears to have been published at the time. It is not surprising, therefore, that Haber's scientific friends desired to honour his memory on the anniversary of his death, and that a number of them assembled for this purpose in the Harnackhaus of the Kaiser Wilhelm Gesellschaft on January 29, in spite of the official disapproval of the celebration to which we referred last week (p. 176). The Berlin correspondent of *The Times* reported that the speakers at the meeting laid emphasis on Haber's devotion to his country and his scientific services. Prof. Max Planck, who presided, recalled that Haber's synthetic nitrate process had saved Germany from military and economic collapse in the first months of the War. "We repay loyalty with loyalty," he said, and he laid particular emphasis on the last three words in his closing tribute to "this great scholar, upright man, and fighter for Germany." Prof. Otto Hahn, director of the Kaiser Wilhelm Institute for Chemistry, and other speakers also bore testimony to the debt owed by Germany to Haber for his outstanding contributions to pure and applied chemistry, and in doing so they expressed the feelings of their colleagues throughout the world. It will be remembered that Haber resigned his post at Dahlem in the spring of 1933 and afterwards accepted an invitation of laboratory hospitality at Cambridge, where he went in October of that year. He intended to reside there permanently but died at Basle, where he had gone for a short holiday, on January 29, 1934.

British Industries Fair

THE British Industries Fair, 1935, organised by the Department of Overseas Trade, is being held at Olympia and the White City, London, on February 18–March 1. This year the Engineering and Hardware Section is to be held at Castle Bromwich, Birmingham, not simultaneously with the London sections, as previously, but later, on May 20–May 31. The textile and furnishing exhibits will be shown at the White City and the general articles, other than engineering and hardware products, will be exhibited at Olympia. There are 1,550 exhibitors at Olympia and the White City, of which more than 750 are from London. There are again notable increases in the space taken and the number of exhibitors, compared with last year's figures. An indication of the remarkable growth of the Fair is given by the fact that the advance catalogue, which is issued in nine languages, runs to 684 pages, or about 152,000 words. The exhibits of products of scientific interest at the Fair again cover a wide range and reveal markedly the increasing use of scientific products, both materials and instruments, in the field of industry. The Committee responsible for the organisation of the united exhibit of scientific instruments is to be congratulated on the important display at Olympia of scientific, optical and photographic instruments. Microscope object-glasses of great refinement of construction; microscope projection apparatus; sound projection apparatus for cinemas, with suit-case sound sets for commercial and educational purposes; various forms of planimeters; pocket cameras and aircraft cameras; distant-reading thermometers; geophysical apparatus for prospecting for gold, minerals and oil—these are but a few examples, selected almost at random, of the products that are being shown in this united exhibit. It is worth notice that, until two years ago, practically all the various forms of planimeters used in Great Britain came from abroad; and similarly, the particular geophysical apparatus referred to above was practically a German monopoly. It is good to note the enterprise of British scientific instrument manufacturers in these new fields.

Whales and Whaling

THE International Convention for the Regulation of Whaling, which came into force last month, is a first and important step towards the permanent preservation of whales and whaling. Since whales are killed almost entirely outside territorial waters, any effective measures having these ends in view must be taken by all great whaling countries in common; and one of the most important aspects of this Convention is that it inaugurates international treatment of the whaling industry. The Convention is concerned with the whalebone whales, on which all but a small part of modern whaling is based. It prohibits the capture of right whales, which have been reduced in numbers almost to disappearance, and requires a far more thorough utilisation of the carcases of other whalebone whales than was customary. A quite common practice was to produce oil from the blubber (from which oil is most easily obtained) alone. The Convention requires the utilisation of specified parts of the carcase, in which it follows the whaling regulations of the Falkland Islands Dependencies, and recent Norwegian law. This is economically sound, since it enables a given quantity of oil to be obtained from fewer whales. There is reason for supposing that the whales so saved may in a single season reach some thousands. Lastly, the Convention provides for the collection and collation of the statistics of both capture and manufacture, which should prove of the greatest value in the development of a full and satisfactory regulation of whaling. It makes no provision for the limitation of whaling, and as this will probably prove essential if the industry is to be maintained, it is a step only towards the solution of the main whaling problem; yet it is a valuable advance, in which it is greatly to be hoped the few whaling States not at present signatories will soon see their way to participate.

The Hoover (Boulder) Dam

THE completion, just announced, of the great concrete structure originally known as the Boulder

Dam, but afterwards officially designated the Hoover Dam, across the Colorado River in Black Canyon, which forms the boundary between the States of Arizona and Nevada, at a point about twenty-five miles south-east of Las Vegas, Nevada, marks the attainment of an advanced stage in the execution of the notable Boulder Canyon Project, the Act for which was approved by the United States President in December 1928. The project in its entirety comprises not only the construction of a dam and the formation of an artificial lake, respectively the highest and the most capacious of their kind in the world, but also other incidental works involving an expenditure estimated at the time at 165 million dollars. The probable outlay is now given as 385 million dollars. The dam has a maximum height of about 730 ft., an extreme length of 1,180 ft., a crest width of 45 ft. and a bottom thickness of 650 ft. It contains about 4½ million cubic yards of concrete, and will be the retaining wall of a reservoir having a length of 115 miles and a total cubic capacity of 30,500,000 acre-feet. It is designed to impound the flood water of the Colorado River for use in irrigation, and will serve to regulate the flow of that stream so as to improve its navigability, and protect the adjacent valleys from overflow, water shortage and silt accumulation. Irrigation and protection from inundation of valuable farm lands in Southern California are the primary and essential objects of the undertaking, but hydraulic turbines of exceptional calibre are also being installed to enable electric power to be generated, the revenues from which will fully recoup the outlay on the entire scheme, which, including a main irrigation canal, 80 miles in length, with an extension 130 miles long to adjacent valleys, is among the most remarkable instances of engineering enterprise in modern times.

Anti-Noise Exhibition

THE Prime Minister will open on May 31 at the Science Museum, South Kensington, an Anti-Noise Exhibition which is being arranged through the Anti-Noise League. The Exhibition will remain open throughout the month of June and probably conclude with a congress during the last week. The chairman of the League, Lord Horder, broadcast on the subject of the Exhibition on January 20. It is proposed that the Exhibition shall present a comprehensive survey of the whole problem of noise in its many aspects. The practical co-operation of a number of institutions and public bodies has already been obtained, including the Ministry of Transport, the Air Ministry, the National Physical Laboratory, the Post Office Research Laboratories, the British Broadcasting Corporation, the Industrial Health Research Board, and a number of industrial research laboratories. Dr. G. W. C. Kaye, of the National Physical Laboratory, is chairman of the Research and Development Section of the Exhibition, Prof. Cave-Browne-Cave, of the Transport and Machinery Section, Mr. Hope Bagenal, of the Building Section, and Sir Henry Richards, of the Organising Committee. The Science Museum has placed generous accommodation, including a cinema theatre, at the disposal of the Exhibition and it is hoped to display many interesting exhibits of noise abatement appliances. A small silent house is to be erected which will incorporate the latest architectural and building designs and materials for sound proofing and sound absorption. There will be a number of demonstrations, including silenced pneumatic drills, motor-cycles, typewriters, vacuum cleaners, electric motors, circular saws and so on. The latest devices for the measurement, analysis and filtering of noise will be shown, the psychological aspects of noise will receive attention, and experiments on the value of ear defenders, the masking of noises, the effect of noise on loudness of speaking and the use of noise-level alarms will claim the interest of most people. The effect of noise on output in industry will be illustrated by the results of recent investigations.

The Microscope and the Metal Industries

Dr. C. H. DESCH delivered a Research and Development Lecture under the auspices of the Royal Institution and the British Science Guild on February 6, taking as his subject "The Microscope and the Metal Industry". Although a careful drawing of a metallic object (the edge of a razor) was published by Robert Hooke in 1665, it was two hundred years before any further use was made of the microscope in the study of metals. H. C. Sorby, a Sheffield amateur, began in 1854 to apply the microscope to polished and etched surfaces of steel and succeeded in identifying correctly a number of separate constituents in the varieties of steel and cast iron available to him. It was twenty years before these results attracted any attention, but from that time onwards, the microscope has become an indispensable tool in the metallurgical industry. Specimens of metals are ground and polished, care being taken to avoid distortion, and are then etched by means of a suitable reagent which will distinguish between the various constituents. All metals and alloys are built up of crystals, and the relative sizes of the component crystals frequently determine the properties of the mass. With this object in view, systematic measurements of crystal size are made as metals are passing through the processes of manufacture. The reading of a micro-section may be compared with the reading of a map, which conveys the more information the greater the experience of the person using it. A further important application of the microscope is in the study of failures. The fracture of crankshafts and other moving parts by fatigue, the cracking of boiler plates and superheater tubes, the breakage of wire ropes, and the cracking of severely cold-worked sheets, are typical examples of occurrences on which the microscope is capable of throwing light by indicating the nature of the processes concerned in the failure, and thereby giving a clue as to their origin. The microscope has now become an essential part of the equipment of every works dealing with the production of metal, and also with the transformation of metals into useful products on a large scale.

Electrical Development in Northern Ireland

AN experiment on the co-ordination of electricity distribution is now in its fourth year in Northern Ireland. With the exception of the areas covered by the county borough undertakings of Belfast and Londonderry and by the Antrim Electricity Supply Co., practically the whole of Northern Ireland is included. By an Act passed by the Parliament of Northern Ireland in 1931, a Board was set up, the duties of which were to promote, co-ordinate and improve the supply distribution of electricity generally throughout the country. The Act specially laid down that the Board should not be a profit-earning body and that the members should not be financially interested in any company engaged in electrical work. In a paper read to the Institution of Electrical Engineers on January 23, Mr. C. R. Westlake showed that the policy of co-ordination is proving successful, and that the public now has a service of electricity supply not possible under the previous types of control. The main source of supply in Northern Ireland is the harbour power station of the Belfast Corporation, and the area round it is populous. The area taken for primary development covers 1,200 square miles and has a population of about 300,000. The Board can purchase its supplies from any authorised undertakers, and it has adequate equipment to provide for rapid and continuous growth. The problem is to supply energy at rates low enough to secure growth and at the same time to secure sufficient revenue. Notwithstanding the competition of gas companies, more than 50 per cent of the potential consumers are already connected, and where there is no competition, 'saturation' is attained almost immediately. Whole areas hitherto without supply have now amenities usually associated with city life without loss of their rural surroundings. This successful experiment shows the trend of public policy towards the co-ordination of all public utility undertakings.

Japanese Patents and Inventions

ON December 23, 1934, the *Japan Times and Mail* published a special "Invention Number" in connexion with the commemoration of the jubilee of the Japanese patent law. The number contains much interesting matter regarding the birth and growth of the Patent Bureau, the increase in the number of patents applied for and sanctioned, and the place of Japan as a great industrial nation. The early history of the Patent Bureau, which in 1933 had a staff of 600, was dealt with in a broadcast address by the Minister of Finance, Mr. K. Takahashi, who was the first chief of the Bureau. The first law enacted by the Government for the protection of inventions, he said, was the so-called expedient monopoly regulations promulgated on April 7, 1871. This, however, was never enforced and in the following year was abolished. A special committee was next appointed to examine the British and American patent laws, and from its work sprang the first Trade-Mark Act in Japan, promulgated on October 1, 1884, followed by the Patent Act of April 18, 1885. This Act came into force on July 1, and No. 1 patent was issued that day to a Tokyo citizen, Zuisho Hotta, for a coating material for ships and iron bridges. For the first twenty years, patents and inventions failed to attract much public attention, and whatever progress was made in industry was due more to successful imitation of Western practices than to original discovery or invention. From the time of the Russo-Japanese War, however, largely through the action of the body now known as the Imperial Invention Association, invention has been encouraged by the Government, and to-day Japan now claims to rank only behind the United States and Germany in the number of patents granted. In several of the contributions to the "Invention Number", recognition is given to the debt Japan owes to foreign countries, but there is also a just sense of pride in the status to which she has attained through her own initiative.

Gas Warfare by Air

THE large number of publications in Germany dealing with all aspects of gas warfare which have appeared during the last two years is well known to all in touch with the German technical press, and increasing attention has been devoted to this matter in Great Britain also in recent months. The pamphlet entitled "The Menace of Aerial Gas Bombardment" by Lieut.-Col. N. G. Thwaites, which has now been issued by the *New Commonwealth*, is a welcome statement of the facts in a matter in which conflicting expert opinions have confused the public mind. Reviewing the situation in the different countries of Europe, Col. Thwaites points out that the danger of gas attack from the air is taken very seriously by Germany, France and Italy, while Russia is openly preparing for chemical warfare. In Germany no opportunity is lost of educating the public in anti-gas precautions, and a widely circulated "Handbook of Air Defence" was issued in May 1934. Equipment of the public with gas masks has not yet proceeded very far. In France the public has been made aware of the danger of aerial gas attack, and gas masks are now being sold in large quantities after testing by the authorities. In Italy, anti-gas precautions are dominant among the measures taken for defence against air attack, and the supply and distribution of gas masks has been carried further than in other countries; in Poland a League for Aerial Defence against Gas receives strong support from the Government.

COL. THWAITES proceeds to discuss briefly the measures being taken in Great Britain, as well as the probability and horrors of gas warfare. In his view, the defence measures so far taken are futile, and no merely technical remedy is likely to suffice for long. He considers that the only effective remedy is the abolition by mutual agreement of all national military air forces and the establishment of an international air force for policing purposes. The alternative policy of isolation is no longer possible and the present condition of air strategy puts a premium on the aggressor. The technical difficulties in the

(*Continued on p.* 227.)

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The Atmospheres of the Planets*

By Dr. Henry Norris Russell, Research Professor of Astronomy and Director of the Observatory, Princeton University, N.J.

Direct Telescopic Observations

As soon as telescopes became good enough to give a tolerable view of details on the planets, evidence began to accumulate that some of them, at least, possessed atmospheres. Doubtless the first to be noticed were the changes in the markings on Jupiter, which differ radically from one year to the next, and often appear suddenly and last but a few weeks, though thousands of miles in diameter. Only clouds, forming and dissolving in a Jovian atmosphere, can account for such rapid and capricious changes.

Evidence for an atmosphere on Mars is afforded by the polar caps. The steady shrinkage of these during the summer, accompanied by the growth of the opposite cap during the long cold polar night, is explicable only by the melting or evaporation of deposits of some snow-like substance, which is carried as invisible vapour to the opposite pole, and there deposited. A permanent, non-condensible atmosphere is required for the transport of this vapour.

Venus, when it is considerably nearer to the earth than to the sun, shows a crescent phase, like that of the moon, and for the same reason. As it comes more nearly into line between us and the sun, its crescent narrows, and the horns begin to project beyond their normal positions, so that it has been seen as three-quarters of a circle, and even as a thin bright ring, with a dark interior. This remarkable phenomenon can be seen only when Venus is within about a degree of the sun, and no chance to observe it again will occur until near the end of the present century; but it has been recorded in the past by several competent observers. Such an extension of the horns—and, above all, the ring-phase—can be explained only as effects of twilight; the illuminated atmosphere of the planet being visible across the narrow dark strip of its surface on the side farther from the sun.

For the three brightest planets, then, the presence of an atmosphere is proved by observation, in three quite different but equally conclusive ways, all of which were well known to astronomers before the end of the eighteenth century.

Later observations have added evidence of the same type—a few white spots on Saturn, appearing at irregular intervals of some decades, which change shape, shift and disappear as clouds would do; occasional though fugitive clouds, and a measurable effect of twilight, upon Mars; and elusive markings on Venus, which can be photographed only with ultra-violet light, and change greatly between one evening's observations and the next.

The extent of atmosphere can also be roughly estimated from the results of direct telescopic observation. The surface details of Jupiter (and of Saturn when any appear) may be seen, and photographed, close up to the limb, despite the very oblique angle of view. It is therefore evident that there can be no such extensive gaseous mantle as veils the earth. At least, there is none above the visible cloud surfaces of these great planets—how much there may be below is another matter. The rarefied layer which exists, however, suffices to cut down the apparent brightness of the edge of the planets' discs. The effect of contrast against a dark sky conceals this in an ordinary telescopic view; but the first look at one of these planets in strong twilight shows that it is actually of surprising magnitude.

There is more 'limb-light' on Mars, and there may be more atmosphere above the visible surface—the real surface, this time; but an atmosphere as thick as the earth's, even if free from clouds or haze, would produce a much greater effect.

For Venus the layer which produces the elongation of the crescent is remarkably thin, rising only about 4,000 ft. above the visible surface. But this represents only the part of its atmosphere which is hazy enough to be seen through the glare of our own sky close to the sun. The top of the atmosphere must be much higher; and the bottom, if the visible surface is composed of clouds, much lower, so that its whole amount may be great.

The celestial body which we can observe in far the greatest detail tells quite another story. The moon, viewed telescopically, shows no more atmosphere—whether in the artist's or the physicist's sense—than a bare plaster cast illuminated by a powerful searchlight. Far more delicate tests are possible here than in other

* From the address delivered on December 31, 1934, at Pittsburgh by Dr. H. N. Russell as retiring president of the American Association for the Advancement of Science.

instances, and neither refraction nor twilight is present to the minutest degree. Our satellite is naked rock *in vacuo*. Mercury, too, appears to be without an atmosphere, though the evidence is less detailed.

Presence of Oxygen and Water Vapour

The existence of atmospheres on the majority of the planets—though not on all—is thus established by direct telescopic observation. To determine their composition, we must, as usual, have recourse to the spectroscope: but we meet with two difficulties.

In the first place, many possible atmospheric constituents show no selective absorption whatever in the region accessible to our study. Hydrogen, nitrogen, helium, neon and argon belong to this group, and are hopelessly beyond the reach of our investigation. Secondly, the other gases of the earth's atmosphere absorb too much for our advantage. The worst by far is ozone. Though present in but small amounts, and mainly in the higher layers, it cuts off the whole spectrum short of 2900 A., and deprives us of any hope of studying the most interesting parts of all celestial spectra.

Were we working in the infra-red, water vapour would be almost as troublesome. There are long stretches of the solar spectrum, within the range of present-day plates, in which we can find out little or nothing about the sun's own spectrum. The great wide lines of the water vapour bands, often overlapping, hide almost everything else. The band near 11500 A. is quite hopeless; that at 18000 A. would be worse, if our photographs got so far; one near 9600 A. is still very bad; while in those near 8200 A. and 7200 A. the solar lines can be picked out, with care, among their stronger telluric neighbours.

Oxygen reveals itself by a strong band, with very regularly spaced lines, at λ7594 (Fraunhofer's *A*), the weaker *B* band near 6867, and the much fainter α band at 6277. The terrestrial origin of all these lines is conclusively settled by two tests: first, their changes with the altitude of the sun (varying the air-path) and, for the water vapour lines, with weather conditions; second, the absence of the Doppler shift, due to the sun's rotation, when light from the east and west limbs is compared. The absence of even faint components of solar origin is explained by the high temperature, which dissociates such molecules completely. The intensities of these bands are in inverse order of the abundance of the molecules which produce them—an apparent anomaly, explained by the circumstances of their origin.

The ozone band is part of the main system of the O_3 molecule, and, like all such bands, is very intensely absorbed, a layer of the gas, at its worst, being as opaque as one of metal of equal mass per square centimetre. For water vapour, the main absorption bands lie far in the infra-red, and are very strong—those with which we are now concerned involve high harmonics of the fundamental vibrations. The coefficient of absorption, and the intensity of the bands, diminish rapidly with increasing order of the harmonics and diminishing wave-length.

The oxygen bands are produced by a 'forbidden' transition within the molecule, for which the probability of absorption is exceedingly small. This is why the whole mass of oxygen above our heads (equivalent to a layer two kilometres thick at standard temperature and pressure) produces absorption lines no stronger than the sodium vapour in a Bunsen flame an inch thick, which contains but a minute percentage of the vapour of the metal. The principal bands of oxygen, in the ultra-violet beyond λ1800, are so strong that light of shorter wave-length cannot be observed at all in air. The experimenter must put his whole spectroscope in a gas-tight case, and pump it out to an almost perfect vacuum.

In the visible spectrum, the portions cut out by oxygen or water vapour are very small in extent; but they come exactly in the wrong place—in other words, they hide, line for line, absorption by these same gases which might be produced in the atmosphere of a planet. If the planet's atmosphere was decidedly richer in either constituent than the earth's, we might detect the fact, for the lines in the planet's spectrum would be stronger than in that of the moon. Comparisons of this sort, however, must be made with great precautions. The moon and planet must be at the same altitude when the observations are made (to get equal air-paths). It is not safe, either, to observe the planet early in the evening and wait until the moon rises to the same height, for a change in temperature may have caused the precipitation of water out of the air, though the oxygen, of course, remains the same. With sufficient patience, a time may be found when planet and moon can be seen together, at equal altitudes, and observed almost simultaneously, with the same instrument.

Early observations of this sort were supposed to show the presence of oxygen and water vapour on Venus and Mars; but the careful and accurate work of Campbell, in 1894, led him to the conclusion that there was no perceptible difference in the strength of the bands in the two cases, and hence that the amounts of these two important substances, above the visible surfaces of either planet, did not exceed one fourth of those above an equal area of the earth's.

A more delicate, and very ingenious, test was invented, independently, by two distinguished

American observers, Lowell and Campbell. When Mars (or Venus) is approaching us, or receding, most rapidly, the lines in its spectrum are displaced, by the Doppler shift, while lines produced in the earth's atmosphere are, of course, unaffected. Were this shift great enough, the planetary and telluric lines would appear double, and the former, even though faint, could readily be detected. The greatest available shift is not enough to resolve the lines completely; but measures of the blended lines suffice to show whether any important planetary contribution is present. A still more delicate test is afforded by microphotometer measures of the contours of the lines, which would reveal even a slight asymmetry. These observations are very exacting—requiring high dispersion and a great deal of light—so that the best evidence is that from the great coudé spectrograph of the 100-in. telescope at Mount Wilson. St. John and Nicholson found, in 1922, that there was no perceptible trace of planetary lines in Venus, and Adams and Dunham, in 1934, have come to the same conclusion in the case of Mars. An amount of oxygen, on either planet, equal to a thousandth part of that above an equal area on earth, could certainly have been detected. For water vapour, the tests have so far been less delicate, and are not fully decisive—though the quantity present on either planet must be small. More delicate tests, with stronger lines, may soon be made on new red-sensitive plates.

There can be no reasonable doubt, on quite different evidence, that some small amount of water vapour is actually present in the atmosphere of Mars. Radiometric observations of the planet's heat show definitely that the surface rises to temperatures above 0° C. at noon every day in the Martian tropics, and at the pole at midsummer, though falling far below freezing at night. The polar caps must therefore really be composed of snow, and evaporate into water vapour, even if the pressure is so low that the ice turns directly into vapour without melting. The only plausible alternative suggestion—carbon dioxide—would volatilise at much lower temperatures than the actual polar caps do. But, judging from the amount of solar heat available to evaporate them, the polar caps must be very thin—probably only a few inches thick. The vapour resulting from the gradual sublimation would never attain any considerable density, and might easily fail of detection by the tests which have so far been practicable.

Identification of Carbon Dioxide

No such independent evidence is available for Venus; but Adams and Dunham, in 1932, discovered, in the infra-red region of its spectrum, three beautifully defined bands with heads at λ7820, λ7883 and λ8689, and evidently of atmospheric origin. They had not then been observed elsewhere; but an immediate suggestion regarding their origin was obtained from the theory of band spectra—by that time well developed. The spacing of the individual lines in a band arises from the rotation of the molecule, and depends upon its moment of inertia. For the new planetary band, it showed that the otherwise unknown molecule involved must have a moment of inertia of $70{\cdot}5 \times 10^{-40}$ c.g.s. units. This agreed almost exactly with that of the molecule of carbon dioxide—already known from laboratory observations in the infra-red. All doubt regarding this identification was removed when Dunham, passing light through 40 m. of carbon dioxide at a pressure of 10 atmospheres, found that the strongest of the bands found in Venus was faintly absorbed. Recently, Adel and Slipher, using a path of 45 m. through gas at 47 atmospheres pressure, have found the bands considerably weaker than as they appear in the planet. They conclude that the amount of carbon dioxide above the visible surface of Venus is at least two mile-atmospheres—that is, equivalent to a layer two miles thick at standard atmospheric pressure and temperature. The whole amount above the planet's solid crust may be much greater. For comparison, it may be noted that the whole atmosphere of the earth amounts to five mile-atmospheres, and the oxygen in it to one and a quarter.

These bands do not show in the solar spectrum, even when the sun is setting. But there is very little carbon dioxide in the earth's atmosphere, and the whole amount in the path, even at sunset, amounts to only thirty feet under standard conditions.

The weak absorption in these bands, like that in the visible bands of water vapour, arises because they involve high harmonics of the fundamental vibration frequencies—in this case, the fifth.

Ammonia and Methane in the Major Planets

So far, we have had to do with bands of familiar and readily identified molecules; but the major planets have been much more puzzling.

Jupiter shows a conspicuous band in the orange, which was discovered visually by Huggins in the earliest days of spectroscopy; and fainter ones in the green. These appear more strongly in Saturn, but only in the spectrum of the ball of the planet, and not at all in that of the ring—which might be anticipated, since the ring consists of a multitude of tiny isolated satellites, and should be quite devoid of atmosphere. Uranus, though its light is faint, shows the same bands, much more strongly, and many others in addition. One of

these, which closely coincides with the *F* line of hydrogen (λ4861), led Huggins to conclude that the planet's atmosphere was rich in hydrogen.

This interpretation, though quite permissible at the time, was erroneous, for the line is absorbed only by dissociated *atoms* of hydrogen, which will not be present except at very high temperatures.

The bands cut out so much of the red and orange light that the whole disc of Uranus appears decidedly green—an unusual colour, noticed from the time of the planet's discovery.

In Neptune's spectrum, the bands are of enormous strength, cutting out the red almost entirely and making the planet look still greener. They are hard to observe visually in so faint an object, and the full realisation of their intensity came only with the admirable photographs of V. M. Slipher, in 1907. In later years, and with modern plates, Slipher has extended his observations far into the red, finding bands of ever-increasing strength—up to λ10000 for Jupiter, where there is light enough to follow the spectrum farthest.

For more than sixty years after their first discovery, and twenty-five after Slipher's spectrograms, these bands presented one of the principal unsolved puzzles of spectroscopy—for no one had duplicated them in the laboratory. To be sure, one group, near λ7200, agrees fairly well with a band of water vapour, but the still stronger water-bands deeper in the red are absent, so that this must be a chance coincidence.

When the radiometric measures of Coblentz and Lampland, and of Nicholson and Pettit, showed that the temperature of the visible surfaces of Jupiter and Saturn must be well below − 100° C., while Uranus and Neptune are doubtless colder, the range of possibilities was very much narrowed. But it was not until 1932 that a young and brilliant German physicist, Rupert Wildt, realised the solution of the problem.

Other gases, like water vapour and carbon dioxide, have strong fundamental absorptions in the infra-red, and fainter harmonics in the more accessible part of the spectrum, which demand a long absorbing path in the laboratory to bring them out. Utilising observations of this sort, Wildt showed that certain bands in the spectrum of Jupiter near λ6470 and λ7920 agreed with those of ammonia, and others, at λ6190, λ7260, and λ8860, with bands of methane. The original comparison was not quite conclusive, for with the moderate dispersion then employed the planetary bands had not been adequately resolved into their component lines. This was soon accomplished by Dunham, who found so complete a coincidence of the accurately measured individual lines that both identifications were put beyond all question. For ammonia, more than sixty lines were found to agree, and for methane eighteen lines in part of one band. Some expected band lines were naturally blended with solar lines; but not one of importance failed to appear.

From these comparisons, Dunham estimates that the quantity of ammonia gas above the visible surface of Jupiter is equivalent to a layer ten metres thick under standard conditions. In Saturn it is less.

The climax of the tale came in 1934, when Adel and Slipher announced that practically all the bands had been identified, and were due to methane. The 45-m. path, and the 40-atmosphere pressure, got enough of the gas into the way of the light to produce bands intermediate in intensity between those in Jupiter and in Saturn. At this high pressure, the lines flowed together, and produced diffuse bands; but the agreement of these with the planetary bands was so complete as to be decisive.

A further, and wholly conclusive, test could be added. The fundamental frequencies of vibration of the methane molecule were already known, from observations in the infra-red. For the higher harmonics of these vibrations, the frequencies are not exact multiples of the lowest, but nevertheless bear a simple numerical relation to them (as is well known in the case of other gases). Applying this test, the strongest bands (including Huggins's band in the orange, and the one coincident with the blue hydrogen line) were found to be harmonics, from the third to the eighth, of one of the fundamental frequencies, while another slower vibration was represented by all its harmonics from the eighth to the sixteenth. The remaining bands were accounted for by combinations of these harmonics with other known frequencies, all of types consistent with the well-established rules which govern band spectra. Thirty-six bands in all have been identified. Many of these appear only in Uranus and Neptune, and have not yet been produced in the laboratory, but the harmonic relations just mentioned make their identification certain. The higher gaseous hydrocarbons, ethane, ethylene and acetylene, all have bands in places clear of disturbance by the methane; and all were looked for in vain. All the planetary bands of any importance are accounted for by methane alone—it is a clean sweep.

From the published data, it appears that the amount of methane above the visible surface of Jupiter is of the order of one mile-atmosphere. There must be much more on Uranus, and especially on Neptune; but we cannot yet estimate its amount.

There is still plenty of work to do upon these bands; but mainly for the theoretical investigator. Adel calculates that the band at λ5430,

when fully resolved, should consist of eighteen different overlapping systems of many lines each. Fortunately, the astrophysicist need not wait to draw his conclusions until this has been completely analysed.

Atmospheres in Relation to Planetary Masses

The results of observation can be summarised in a sentence. Large planets have atmospheres containing hydrogen compounds; middle-sized planets, atmospheres containing oxygen compounds; and small planets no atmospheres at all. The reason, in the last case, was found by Johnstone Stoney in 1897. It is simply that small bodies have not sufficient gravitative power to keep their atmospheres from diffusing away into the vacuum of interplanetary space. At the surface of any planet, there is a certain velocity of escape, depending only on its mass and radius. A body projected from its surface, in whatever direction, with this or any higher velocity, will fly off in a parabolic or hyperbolic orbit and never return—unless, indeed, it meets with some obstacle or resistance on its outward way. For the moon this velocity is 2·4 km. per second; for the Earth, 11·2 km./sec.; for Jupiter, 60 km./sec.

Now the molecules of any gas are continually flying about in all directions, with average speeds which depend upon their weights. At 0° C. the average speed for a hydrogen molecule is 1·84 km./sec., for oxygen, 0·46 km./sec.; for carbon dioxide, 0·39 km./sec. If an atmosphere of hydrogen could be put upon the moon, every molecule that was moving but a little faster than the average would fly off at once into space, unless it was thrown back by collision with another, and the atmosphere would diffuse away in a very short time. With an escape velocity three times the average speed, enough fast-moving molecules would get away to reduce the atmosphere to half its original amount in a few weeks (according to Jeans). The rate of loss falls off very rapidly beyond this, so that, with an average velocity one fifth that of escape, the atmosphere would remain for hundreds of millions of years. The moon's surface reaches a temperature exceeding 100° C. during every rotation, and it follows that neither air nor water-vapour could permanently remain above its surface. If at any time in its past history, it has been really hot, like molten lava, it could have retained no trace of atmosphere.

For Mercury, the escape velocity is half as great again as for the moon; but the planet, being so near to the sun, is much hotter, and it, too, cannot retain an atmosphere. Mars, with an escape velocity of 5 km./sec., could not hold hydrogen; but should retain water-vapour—as it appears to have done—and all heavier gases. Venus and the earth, at their present temperatures, should retain even hydrogen, and the major planets would do so even if incandescent.

This reasoning explains the cases of Mercury and the moon, and leads to the important conclusion that all smaller bodies, such as the asteroids and satellites, must be wholly devoid of atmosphere—except perhaps bodies like Neptune's satellite, which is relatively massive and must be very cold. We cannot be sure about Pluto, for we know neither its size nor its mass; but it is probable that, at most, it may have a thin atmosphere, like Mars.

The same principle was invoked, shortly after its discovery, to explain the great difference in mean density between the major and the terrestrial planets. The Moon, Mercury, Mars, Venus and the Earth all have densities between 3·3 and 5·5 times that of water. The rest are almost certainly what we know the Earth to be, spheroids of rock, with cores of metallic iron of varying sizes. For the major planets, the densities range from 1·6 for Neptune to 0·7 for Saturn. Moulton suggested, about 1900, that they contained great quantities of light substances, which the smaller terrestrial planets had not been able to keep from diffusing away into space. This has been fully confirmed by later studies.

From the ellipticity of a planet and the changes in its satellites' orbits caused by the attraction of its equatorial bulge, information may be obtained regarding the degree to which the density increases toward its centre. Applying this to Jupiter and Saturn, Jeffreys concludes that they contain cores of rock and metal, like the inner planets, surrounded by vast shells of ice—frozen oceans thousands of miles deep—and above this, again, atmospheres of great extent. Throughout most of the atmospheres, the pressure must be so great that the gas is reduced to a density as great as it would have if liquefied, or even solidified, by cooling. Indeed, Wildt believes that the enormous pressure would actually solidify even the 'permanent' gases.

Now this outer layer is of low density—less than 0·78 for Jupiter and 0·41 for Saturn—according to Wildt's calculations. This excludes all but a few possible constituents. Frozen oxygen has a density of 1·45, nitrogen 1·02, ammonia 0·82. Only hydrocarbons (methane 0·42, ethane 0·55), helium (0·19) and hydrogen (0·08) come within the limits even for Jupiter. We can therefore conclude, from considerations of density alone, that the outer parts of Jupiter probably, and of Saturn certainly, contain great quantities of free hydrogen or helium. Uranus and Neptune are similar to Jupiter.

Evolution of Atmospheres

It is generally believed that the planets have been produced, in some way or other, from matter ejected or removed from the sun. No really satisfactory theory of the process of formation has yet been devised; but no other hypothesis has yet done better, and the isolation of the sun and planets in space makes a common origin highly probable.

Now we know the composition of the sun—at least of its outer layers—much better than we do that of the planets. Quantitative spectroscopic analysis, though still beset with difficulties, has advanced far enough to show that most of the sun's outer layers is composed of hydrogen; next come helium, oxygen and carbon, followed by nitrogen, then silicon and the metals. A mass of matter removed from the sun and allowed to cool without serious loss would therefore closely resemble the major planets. If small enough to lose all its atmosphere, it would be like the moon or the asteroids—though there are difficulties in seeing how such small masses could have escaped diffusing away altogether before the more refractory constituents solidified.

The history of a body of intermediate mass is more interesting. Hydrogen and helium would be lost while the body was still very hot. So would most of the other light gases such as neon and nitrogen (which at the temperature even of the sun's surface is dissociated into atoms). Free oxygen, too, would escape, but a good deal might be retained in combination with silicon and the metals. As the gaseous mass cooled, by expansion and radiation, drops of molten metal and lava would form within it, as Jeffreys suggests, and fall toward the centre, building up a molten core. After the first turbulence was over, there would remain a molten planet surrounded by an atmosphere containing heavy inert gases such as argon, perhaps some carbon dioxide, and as much of the nitrogen and neon as had failed to escape. Menzel and I, a few years ago, noticed that neon, while apparently fully as abundant in the stars and nebulæ, is but 1/500 as abundant in the earth's atmosphere; while nitrogen, which is cosmically an abundant element, showing strong spectral lines, forms but a very small portion of the earth's mass. It appears, therefore, that a mass of the earth's magnitude must have lost almost, though not quite, the whole of its primitive atmosphere.

Still following Jeffreys, it appears that, as the molten earth cooled, the two thousand mile deep sea of lava solidified first at the bottom (where the melting point was greatly raised by pressure) and so gradually to the surface. During this process, great quantities of gases, mainly water vapour, must have been evolved from the solidifying magma and escaped to the surface, forming a new atmosphere which now would not escape, since the surface was cooler. With solidification would come rapid superficial cooling and an ocean would bathe the rocky crust, leaving an atmosphere of moderate extent. Carbon dioxide—evolved from the magma, and perhaps partly primitive—would be a major constituent, along with nitrogen, argon, neon and other minor leftovers. The presence of free oxygen seems very unlikely, for practically all volcanic rocks and gases are unsaturated with respect to this element—the former containing much ferrous iron, and the latter being often actually combustible when they meet the air.

The present rich supply of oxygen appears to be a by-product of terrestrial life. (This suggestion is more than a century old.) The earth, indeed, may be regarded as an intensively vegetated planet, from the atmosphere of which the greedy plants extract the remaining residue of carbon dioxide so rapidly that if it were not returned to the air by combustion, respiration and decay, the whole supply would be exhausted in a decade or so. Oxygen removed from the atmosphere by these processes is speedily returned by plants; but there is another process of slow depletion which is irreversible. During rock-weathering, about half the ferrous iron of the rocks is oxidised to the ferric state. Goldschmidt (from whose admirable geochemical papers the present discussion is borrowed) concludes that the amount of 'fossil' oxygen thus buried in the sedimentary rocks is at least as great as that now present in the atmosphere, and may be twice as great. An amount of carbonaceous or other organically reduced material equivalent to both the free and the fossil oxygen must also be in the sediments—which is not unreasonable. Given time enough, this inexorable process of rock-decay might exhaust the remaining oxygen of our atmosphere, and put an end to all that breathes. But this danger is indefinitely remote—a billion years away anyhow, since life has lasted that long, and only half the oxygen has been used up; and probably much longer, for volcanic gases are still carrying 'juvenile' carbon dioxide into the air that has never been there before.

It is of no small interest, however, to look at Mars and see there what looks very like the end of this process. The reddish colour of the planet—unique among the heavenly bodies—is just what might be expected, and indeed is almost inevitable in a surface stained with ferric compounds. (The unoxidised rocks of the moon are grey or, at most, brownish.) Wildt suggests that, in the thin atmosphere of Mars, the ozonised layer produced

by the action of ultra-violet light at the top of the atmosphere should be near the surface—not high up as it is here—and that oxidation processes at the planet's surface might thus be accelerated.

It would be premature, however, to conclude that Mars must be a lifeless planet. The depletion of oxygen would be very slow, and plant-life would probably adjust itself—as it has done on earth in response to far more rapid climatic changes. Whether animal life, if ever present, could have survived, is speculation. A race of no more intelligence and engineering skill than our own could presumably meet the situation and survive in diminished numbers breathing electrolytic oxygen—provided that it paid any attention to changes so slow as to be imperceptible in a thousand generations!

While Mars resembles the final stage of our suggested process, Venus seems to be at the beginning, and much like what a lifeless earth would be. We do not know how life began here, but conditions may well have been much less favourable on Venus. Wildt concludes that the powerful 'blanketing' effect of the atmospheric carbon dioxide, combined with the stronger solar radiation, may raise the temperature at the planet's actual surface to 100° C. or higher—in which case the failure of life to develop is not surprising. The real puzzle is the apparent absence of water on the surface of Venus. The planet is almost a twin of the earth in size, mass, density and so on, and one might have expected an ocean of comparable volume. Wildt suggests that all the water has gone into hydrated minerals; but how this could happen unless there was much less there originally than on earth is hard to understand.

Course of Chemical Changes

For the major planets, we have to consider the course of events in a cooling mass containing an excess of the lighter elements and especially of hydrogen. The condensation of the refractory constituents should take place much as for a smaller body. The principal constituents of the rocks, however—potassium, sodium, magnesium and calcium, and likewise silicon—are not reduced from their oxides by hydrogen, and would form rocks not unlike those of the earth. But at high temperatures the oxides of iron are reduced by hydrogen. My colleague, Prof. H. S. Taylor, remarks that the drops of molten lava falling through a hydrogen atmosphere reproduce fairly closely the conditions of a blast furnace. We may conclude then that most of the iron would go into the core and less into the rocky shell.

After the core solidifies, the remainder of the mass will remain fluid over a wide range of temperature. Its principal elementary constituents will be hydrogen, helium, oxygen, carbon and nitrogen, with smaller quantities of the other inert gases, sulphur and the halogens.

The principal reactions which occur in such a gaseous medium at different temperatures and pressures have been carefully studied, for, in addition to their theoretical interest, they are of great practical importance in chemical industry.

When oxygen, carbon and hydrogen are considered, the main reaction is

$$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O.$$

The formation of methane is accompanied by diminution of volume: hence it will be favoured by high pressure. High temperature works the other way: from the free-energy data it appears that, at 1000° C. and atmospheric pressure, the equilibrium inclines to the side of carbon dioxide, even in the presence of a large excess of hydrogen. Below 300° C. practically all the carbon should go into methane: at about 600° the amounts of the two gases should be comparable.

With hydrogen and higher hydrocarbons, the tendency of the reaction is always toward methane at low temperatures. With saturated hydrocarbons, this involves no change of volume and should not be affected by pressure. Formation of methane from unsaturated hydrocarbons should be favoured by high pressure. The exclusive presence of methane in the planets' atmosphere might thus have been predicted.

The formation of ammonia from its elements, in accordance with the equation

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

liberates less energy. With excess of hydrogen, and at atmospheric pressure, the amounts of nitrogen and ammonia should be equal between 200° and 300° C.; ammonia should predominate at lower temperatures, and at higher pressures. The oxides of nitrogen are endothermic, and so would tend to dissociate, rather than to form.

We may now form a definite picture of the successive reactions which will occur in the atmosphere of a cooling major planet. At temperatures of about 1000°, the predominant hydrogen will be mixed with steam, free nitrogen and carbon dioxide—the carbon monoxide which occurs in stellar atmospheres having long ago been completely oxidised. With falling temperature, the carbon dioxide will be converted into methane before the water reaches its critical temperature and begins to condense. After most of it has been precipitated, the nitrogen will go over into ammonia. These reactions, however, will run their course at these relatively low temperatures only with appropriate activation. For the formation of methane, an excellent catalyst is available in the partially reduced oxides of iron which should

be present on the rocky surface exposed to hot hydrogen. These would be equally good for the ammonia, but they may be at the bottom of the sea by the time the proper temperature is reached. An adequate activation, however, would be furnished by electrical discharges—and, if terrestrial thunderstorms are any guide, these should be abundant so long as vapours arising from the hot ocean are being condensed. When the temperature has fallen to that which the earth at present enjoys, there will be an extensive atmosphere of hydrogen, mixed with the simple hydrides—methane, ammonia and water vapour—along with any inert gases which may all along have been present, but with little or no free nitrogen or carbon dioxide. Below this will be an ocean—perhaps very deep, strongly alkaline with ammonia, and incidentally containing in solution any compounds of sulphur and the halogens which may originally have been present. The conditions in such an alkaline ocean —its action on the rocky bed, the compounds which it will hold in solution, and the deposits which it may form—would be of great interest, but are outside our present scope.

With further cooling the water will freeze, but at a temperature below 0° C. depending on the percentage of ammonia. With one part of the latter to two of water, the freezing point would drop to −100° C., but it is doubtful if there is enough ammonia for this. The major planets—even Jupiter—are still colder, and the water must be thoroughly frozen out of their atmospheres, leaving only ammonia and methane. The ammonia, indeed, must be at the point of precipitation. Dunham has obtained in this way a minimum temperature for Jupiter's visible surface. The ten metres of ammonia above the surface, under the planet's surface gravity, should exert a pressure of 1·5 mm. (on the familiar laboratory scale). The vapour tension of the solid (below the triple point) has this value at −107° C. At a lower temperature, the observed quantity of ammonia could not exist in the atmosphere—it would partially condense itself by its own weight.

If the atmosphere consists mainly of hydrogen this limit may be lower, for the mean molecular weight is diminished, and the partial pressure of the ammonia in the same proportion. With a large excess of hydrogen, the pressure may be reduced to one sixth of the previous value and the limiting temperature to −120° C.

The direct radiometric observations of Jupiter indicate a temperature of about −135° ; but this determination is complicated by large and rather uncertain corrections for the absorption of infra-red radiation in the atmospheres of the earth and the planet, so that the agreement is about as good as could be expected. It is, therefore, very probable that the clouds which form Jupiter's surface are composed of minute crystals of frozen ammonia. A perfectly absorbing and radiating planet, at Jupiter's distance and heated exclusively by the sun, would have a mean temperature of −151° C. The excess in the actual temperature may be attributed partly to the fact that we observe the sunlit (and warmer) side ; partly to the 'greenhouse' effect of the atmosphere, which lets in the short-wave radiation from the sun much more easily than it lets the long-waves emitted from the planet's surface out again ; and partly, perhaps, to some residual internal heat in the planet. The existence of the latter is made probable by the rapid changes in the cloud-forms, which often suggest the ascent of new material from below. The variety of colours upon the surface, which range from clear white through pinks and browns almost to black, remain unexplained.

On Saturn, where the ammonia bands are fainter than on Jupiter and the surface gravity is less than half as great, the limiting temperature may be 10° or 15° lower. The radiometric observations indicate about the same difference.

Uranus and Neptune, being farther from the sun, should be still colder. The ammonia should be frozen out of their atmospheres, leaving them clear to a greater depth, which may explain the extraordinary strength of the methane bands in their spectra. The methane itself must be nearly ready to condense on Neptune, despite its very low boiling point. Assuming, roughly, that Neptune has six mile-atmospheres of methane above its surface, the pressure, due to this alone, would be about 500 mm. and the limiting temperature −165° C. A large excess of hydrogen might reduce this to −183°. Solar radiation alone would maintain a mean temperature near −220°. Whether the difference arises from the powerful 'greenhouse' effect of the methane itself, or from internal heat, cannot yet be determined. It may be, however, that if the methane could once be frozen out of Neptune's atmosphere, the surface temperature would fall so much that it would stay frozen, and leave the planet with an atmosphere which, apart from the inevitable Rayleigh scattering, exerted no influence upon visible light.

The problem of planetary atmospheres, so perplexing a few years ago, is now far advanced toward its solution. Towards its interpretation many sciences have contributed—astronomy, physics, chemistry, geology, biology and technology. No one of them alone could have resolved the difficulties. It may, therefore, be appropriate that the attention of so general a scientific gathering may have been invited for a while to it : for it truly illustrates the old motto "In union there is Strength".

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organisation of an International Air Police are insignificant compared with the difficulty of finding any practical defence scheme which has the remotest chance of becoming effective.

Civil Aviation Wireless Plans

THE plans which have been approved for the establishment of new civil aviation wireless stations in Great Britain will provide for the establishment of a chain of wireless stations throughout the country, so as to afford full facilities for direction-finding, for communication with aircraft, and between airports. Three new stations came into operation last year, at Hull, Portsmouth and Newtownards (Belfast). A further six are under construction and will be placed at suitable sites during 1935. These sites are being chosen with the object of providing a direction-finding network covering the new internal routes, as well as to serve the needs of individual aerodromes. The equipment will be mounted on vehicles capable of being easily moved from place to place. A limited number of permanent stations of higher power are also to be erected. The first of these will be established at Heston Airport to relieve the growing congestion at Croydon. It is also the intention of the local authorities to build a station in the Channel Isles. Three new permanent direction-finding stations, in addition to those already existing at the same points, are being brought into operation at an early date on the Continental airway, at Pulham, Lympne and Croydon. The radio-beacon at Croydon is now being modified to operate on the aural principle, thus making it available for any aircraft fitted with an ordinary receiver. On the completion of this reorganisation there will be available for the assistance of aircraft flying on the Continental routes seven direction finders, seven transmitters and one radio-beacon.

A New Depth-Sounding Recorder

THERE are several types of marine devices for finding the depth of the sea by means of 'echo-sounding'. One or two of these not only give isolated indications of the depth of the sea, but also provide a more or less continuous record of the sea bed. The British Admiralty uses a low-frequency type of oscillation which is reflected from the bottom of the sea, the time of going and returning being marked on an electro-chemical recorder. A high-frequency system using the vibrations of a quartz piezo-electric oscillator, devised by Langevin and Chilowsky, has been developed commercially in Great Britain by the Marconi Sounding Device Co. An entirely new type of high-frequency echo depth recorder which possesses important advantages was described to the Institution of Electrical Engineers on January 2 by A. B. Wood, F. B. Smith and J. A. McGeachy. This device can give a continuous record of the depth of water beneath a survey motor-boat of about 2 ft. draught travelling at full speed. According to the specification, it had to measure a depth ranging up to 200 feet with a maximum inaccuracy of about one foot. The method employed gives a practical application of the phenomenon of magneto-striction. Two oscillators of this type—a transmitter and a receiver—are mounted in water-filled tanks and fitted in a chosen position in the motor-boat. The transmitter is excited into resonant vibration at regular intervals of time depending on the range of depth to be recorded. A short train of high-frequency sound waves is directed vertically downwards to the sea-bed and reflected back to the receiver. The induced currents are amplified, rectified and passed through a recorder. During the time the sound impulse is travelling from the transmitter to the receiver via the sea bed, the recording point has travelled a corresponding distance on the paper. The time for the going and return journey is thus found. The method has been proved satisfactory for depths exceeding 400 fathoms.

Vital Statistics for 1933

LAST week (p. 181) we printed a note referring to the provisional figures of the vital statistics for 1934. The Registrar-General's Statistical Review for 1933, Tables (Part II, Civil) is now available (London: H.M. Stationery Office. 2*s.* 0*d.*). It includes a table showing the populations of England and Wales, Scotland and Ireland as enumerated at each Census from 1821 until 1931, and as estimated for each year 1894–1933 inclusive. The population of England and Wales is now estimated as 40,350,000 at the middle of 1933, the 1931 Census figure being 39,952,377. The births registered during 1933 numbered 580,413 a decrease of 33,559 on the previous year's figure. The consequent birth rate of 14·4 per 1,000 population is the lowest recorded for England and Wales, being 0·9 below that for 1932 the previous lowest, and 1·4 below that for 1931. The only countries showing a lower rate in 1933 were Sweden (13·7) and Austria (14·3). The proportion of the sexes in the births registered during the year was 1,046 males to 1,000 females.

Association of American Geographers

THE thirty-first annual meeting of the Association of American Geographers, with Dr. Wallace W. Atwood presiding, was held at the University of Pennsylvania, Philadelphia, on December 27–29. Forty-nine papers were presented, including six in the field of geomorphology, five in climatology, and two in cartography. The remaining papers ranged the whole field of geography, and included discussions of particular problems or areas. A half-day session was devoted to a conference on regional geography. As retiring president, Dr. Atwood addressed the Association on "The Increasing Significance of Geographic Conditions in the Growth of Nation States". For the forthcoming year the following officers were elected: *President*, Prof. Charles C. Colby, University of Chicago; *Vice-President*, Col. C. H. Birdseye, U.S. Geological Survey; *Treasurer*, Prof. John E. Orchard, Columbia University; *Councillor*, Prof. Kirk Bryan, Harvard University; *Secretary*, Prof. Frank E. Williams, University of Pennsylvania.

Congress on Dog Breeding

AN event of considerable interest to geneticists, psychologists, and especially to dog fanciers, is to take place at Frankfort on Main on April 22–25, when the Fédération Cynologique Internationale (F.C.I.) is to hold its third congress, which will be followed (April 26–28) by a dog show, open to all the world, and providing classes for all the known breeds. Discussion at the congress will deal mainly with the inheritance of the physical and mental characters of the dog, and papers will be presented by Prof. Henseler, of the Institüt für Tierzucht und Züchtungsbiologie in Munich; Prof. Pirocci, of Milan; Dr. Méry, of Paris; and Major Most, of Berlin. Particulars concerning membership and programmes may be obtained from Fr. Bazille, Rotenwaldstr. 83a, Stuttgart-W.

Holly Lodge Farm

ACCORDING to *The Times* of February 6 the Conservative Parliamentary Agricultural Committee on February 5 unanimously adopted the following resolution: "That in view of the authoritative opinions on the educational and research value of the Holly Lodge and Crown Farms, Walton-on-Thames, especially in view of the Government's policy for the greater home production of fruit, vegetables, and flowers to replace foreign imports, this Committee expresses the earnest hope that these farms will not be destroyed under the reservoir scheme of the Metropolitan Water Board."

Announcements

PROF. A. C. SEWARD, professor of botany in the University of Cambridge, has been elected president of the South-Eastern Union of Scientific Societies in succession to Prof. H. L. Hawkins. The annual congress will be held at Bournemouth on June 26–29.

PROF. A. L. GOODHART, professor of jurisprudence, Oxford; Sir Walter Moberly, chairman of the University Grants Committee; and Prof. G. P. Thomson, professor of physics, Imperial College of Science, have been elected members of the Athenæum Club under the provisions of Rule II of the Club, which empowers the annual election by the Committee of a certain number of persons of distinguished eminence in science, literature, the arts, or for public service.

ON February 18 in the Lecture Hall of Manson House, Portland Place, Col. MacArthur, late R.A.M.C., will be presented with the Chadwick Gold Medal and Prize of £100 which, under the scheme of the trust, may be awarded once in five years to the medical officer of the Navy, Army or Air Force who has most distinguished himself during that period in promoting the health of the men of the Service to which he belongs.

SIR PETER CHALMERS MITCHELL, who has been a member of Council since 1900 and secretary since 1903 of the Zoological Society of London, retires from that office on April 29, 1935. It is therefore proposed to present to the Society a portrait in oils of Sir Peter, by Mr. William Nicholson. Fellows and friends of the Society are invited to send contributions to the Portrait Secretary, c/o F. W. Bond, Zoological Society of London, Regent's Park, N.W.8.

AT the meeting of the Industrial Research Council, Irish Free State, on February 2, it was announced that Mr. Eugene Boyle has been appointed chemical engineer for research on waxes under Prof. J. Reilly in University College, Cork.

AT the twenty-ninth annual meeting of the Botanical Society of America on December 27–29 in Pittsburgh, Pennsylvania, the following elections were made: *President*, Dr. Aven Nelson, University of Wyoming; *Vice-President*, Dr. K. M. Wiegand, Cornell University; *Corresponding Members*, Sir David Prain, lately director of the Royal Botanic Gardens, Kew; Prof. G. Haberlandt, emeritus professor of botany, University of Berlin; Prof. Alvar Palmgren, professor of botany, University of Helsingfors.

THE first (January) issue of the *Traveller*, the quarterly journal of the University Travel Guild, contains short accounts of excursions of scientific, historical, architectural, musical, etc., interest which are being arranged by the Guild in 1935. Tours of scientific interest include "Palestine of the Bible", under the leadership of Dr. E. W. G. Masterman; "Dalmatia—a Botanical Tour", under the leadership of Dr. W. B. Turrill; and Roman France. Copies of the *Traveller* (price 4*d*., or including postage 6*d*.) and further particulars of the University Travel Guild can be obtained from its offices, 25 Cockspur Street, London, S.W.1.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An inspector of mine beacons in the Department of Mines, Southern Rhodesia—The Official Secretary, Office of the High Commissioner for Southern Rhodesia, Crown House, Aldwych, London, W.C.2 (Feb. 16). A lecturer in botany and physics at the Cheltenham Technical College—The Secretary (Feb. 18). A technical officer in the Admiralty Technical Pool—The Secretary to the Admiralty (C.E. Branch), Whitehall, London, S.W.1 (Feb. 18). A lecturer in hygiene and public health in the Charing Cross Hospital Medical School, 62 Chandos Street, W.C.2—The Dean (Feb. 20). An assistant inspector of guns (metallurgy) in the Metal and Steel Factory, Ishapore (Indian Ordnance Department)—The Secretary, Military Department, India Office, London, S.W.1 (Feb. 20). A general manager and engineer in the Electricity Department of the Metropolitan Borough of Battersea—The Town Clerk, Battersea Town Hall, London, S.W.11. An assistant chemist, a junior chemist, and a biologist on the staff of the Research Association of British Flour Millers—The Director of Research, Old London Road, St. Albans.

Letters to the Editor

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

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 235.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Light of the Night Sky

I HAVE succeeded in exciting the auroral green line under conditions which indicate that it must have been produced in a manner similar to that in the light of the night sky. In order to describe my experiments properly, it is necessary first to recall the excitation of the green line in active nitrogen[1]. In that experiment it was possible for the first time to produce the green line under conditions which give some clue to its production in both the aurora and the night sky, since there are metastable nitrogen molecules in active nitrogen, and one would certainly expect metastable nitrogen to play an important rôle in the upper atmosphere. My recent discovery of a new modification of active nitrogen[2], the afterglow of which was a very faithful reproduction of that part of the auroral spectrum which is due to nitrogen, added an argument for the hypothesis that the green line is excited by metastable nitrogen molecules.

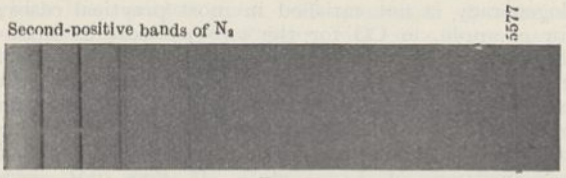

FIG. 1.

In the new experiments, a very small amount of oxygen, about one per cent, was introduced into the tube in which the new afterglow was discovered. The discharge, and not the afterglow, was photographed with the current in the tube interrupted periodically. At first the interruptions were spaced so that the current was on long enough to allow the current in the bulb of the tube to reach its full value. The discharge in the bulb was green-white, and the green line was absent under these conditions. When the current was interrupted more rapidly, the discharge in the bulb was much weaker and its colour was red. Certain very profound changes took place in the spectrum of the discharge in the bulb. The most important one was the presence of the green line, with an intensity which resembles very closely its intensity in auroral and night sky spectra, and also unaccompanied by other oxygen lines (Fig. 1). The first-negative bands of N_2^+, which are strong in the discharge when the current is allowed to reach its full strength, were almost completely missing. The second-positive bands of N_2 were present. The recently discovered Vegard-Kaplan intercombination bands of nitrogen were excited, but in the rapidly interrupted discharge the high wave-length members of the system increased greatly in intensity relative to the other N_2 bands, as compared with their intensity in the slowly interrupted discharge. The Goldstein bands, to which attention was directed recently by Hamada[3] in connexion with the light of the night sky, were missing in the rapidly interrupted discharge, although they were present in the slowly interrupted one.

The most important results of these experiments are the excitation of the green line, the increased intensity of the long wave-length members of the Vegard-Kaplan system and the absence of the Goldstein bands. The first two indicate that the members of the Vegard-Kaplan system probably occur in the night sky, and the absence of the Goldstein bands casts some doubt on Hamada's identification of the X_1 and X_2 lines as members of that system. The absence of the first-negative bands is in good agreement with their very feeble excitation in the light of the night sky. Longer exposures have been started in an attempt to observe the red oxygen lines which usually accompany the green auroral line and also to observe the visible members of the Vegard-Kaplan system. It is believed that we have a very good reproduction of the light of the night sky in these experiments and hence a means for identifying the radiations which are actually observed in the night sky.

With regard to the identification of the two X_1 and X_2 lines, 4416 and 4168, it may be said that Dufay observed two lines in the night sky at 4422 and 4171 which are probably identical with Rayleigh's line. The Vegard-Kaplan bands (2,14) and (3,14) lie at 4423 and 4170 respectively. Dufay also observed lines at 4268, 4044, 3984 and 3951. Vegard-Kaplan bands nearest to these lines lie at 4271, 4043, 3978 and 3947. These agreements, together with the above mentioned experimental results, indicate that we have definitely identified some of the radiation in the night sky.

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Dec. 29.

[1] Kaplan, *Phys. Rev.*, **33**, 154; 1929.
[2] Kaplan, NATURE, **133**, 331; 1934.
[3] Hamada, NATURE, **134**, 851; 1934.

Zero Point Energy and Physical Properties of H_2O and D_2O

THE marked differences between the physical properties of H_2O and D_2O (and of all polar compounds of H and D) cannot be due to intramolecular differences, which are far too small, but must be connected with differences of effective intermolecular forces. It is possible to account for these differences in a quantitative way by taking into consideration the differences in the frequency of angular vibration or *libration* of a molecule in the field of its neighbours. The mean frequency in ice can be calculated from the model of the water molecule already put forward[1]. The frequency found, $\nu_B = 14{\cdot}3 \times 10^{12}$ sec.$^{-1}$, is large enough to have a zero point energy of 17 per cent of the total energy of ice. As in such a libration only the hydrogens

are effectively in motion, it is decreased by the factor $\sqrt{2}$ on substituting D for H. Apart from less important changes due to symmetry conditions and the differences in the nuclear spins, this change of frequency accounts for the greater part of the difference of energy content and specific heats of H_2O and D_2O. Thus the differences of the heats of evaporation of D_2O and H_2O ices at the melting points is calculated 0·35, as against the observed value[2] of 0·32 k. cal. per mol. This may be regarded as the best check of the essential correctness of the theory. The difference of the specific heats of ice are calculated as 0·7 and observed[3] *c.* 1 cal. per mol. degree.

In water ν_B must clearly have a lower value than in ice, from which it follows that the molecular latent heat of fusion of D_2O ice must be greater than for H_2O ice. This is also in agreement with experiment. Besides the librations, the water molecules undergo normal vibrations but of lower frequency $\nu_A = 5 \times 10^{12}$ sec.$^{-1}$ and far less affected by the substitution of D for H. Using the frequencies ν_A and ν_B it is possible to calculate the specific heat of ice. At the melting point it is 9·35 as against 8·85 cal. per mol. degree observed.

Wave-length shifts corresponding to $\nu_A = 4{\cdot}6 - 6{\cdot}7$, $\nu_B = 15 \times 10^{12}$ sec.$^{-1}$ have been observed in the Raman spectra of water by Magat[4] in reasonable agreement with the values derived by calculation from the model.

Corresponding energy differences may be expected to occur in the solid or liquid state of all hydrogen compounds which possess polar properties. The difference in the energies of H and D hydroxyls will depend on the temperature and the vibration frequency and hence on the field in which the hydroxy group is placed. The stronger the binding the greater the difference. Hence this difference will increase as we pass from the amphoteric hydroxyl bond to that of the alcohols and from them to the hydrogen bond of acids. Similarly, in the hydration of ions the difference will depend on the relative hydration energy and will be accordingly greater for strongly polarising ions. A study of the physical properties of D compounds cannot fail to throw light on the structure of the corresponding H compound and may prove a powerful method for discovering the principles of structure of molecular solids and liquids.

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[1] J. D. Bernal and R. H. Fowler, *J. Chem. Phys.*, **1**, 515; 1933; and *Proc. Roy. Soc.*, A, **114**, 1; 1934.
[2] G. N. Lewis, *J. Amer. Chem. Soc.*, **55**, 3057; 1933. V. K. La Mer and W. N. Baker, *ibid.*, **56**, 2641; 1934; and L. Jacobs (private communication).
[3] L. Jacobs (private communication).
[4] Magat, *J. de Phys.*, **5**, 347; 1934.

The Pair Bond Theory of Valency

THE method of molecular orbitals (Hund, Mulliken, Lennard-Jones), which is especially designed for the description of a completed molecule can be worked out in high approximations only in the simplest cases. In more complicated ones, it is therefore not able to describe the process of dissociation, which is clearly the essential requirement of a theory of valency. Accordingly it is necessary to resort to the correlation table which, however, gives only qualitative results, and no information regarding the quantitative loss or gain of energy. An additional assumption is therefore necessary, and this is found in the hypothesis that bonding power is always ascribed to the lowest one of a group of terms, resulting from the same atomic term by splitting due to the removal of a degeneracy. The wave-function of this term in the case of one electron linking the two cores A and B is

$$a\psi_A + b\psi_B \qquad (1)$$

and

$$\{a\psi_A(1) + b\psi_B(1)\}\ \{a\psi_A(2) + b\psi_B(2)\} \qquad (2)$$

in the case of two electrons. The wave-function (1) shows that a linkage can be brought about by a single electron only if the atomic fields in question are either equal ($a = b$) or almost equal ($a \approx b$), and this is why the method of molecular orbitals has recently been interpreted as leading to a single-electron bond theory. When the degeneracy of the fields gradually disappears, function (1) becomes, however, simply ψ_A or ψ_B, whichever is lower, showing that the bonding power ceases when the difference between the eigen-values of ψ_A and ψ_B is no longer negligible.

In our opinion, therefore, the degeneracy of (1) is not sufficient to be used as a foundation of a theory of valency, because the condition of approximate degeneracy is not satisfied in most practical cases; for example, in CO for the two p electrons introduced first into the field composed of C^{2+} and O^{4+}. Even in the case of exactly equal cores (except protons) the degeneracy is apparently too weak to bring about an actual chemical union by overcoming the repulsion of the cores (existence of Li_2, but non-existence of Li_2^+, etc.). It does not seem possible to reduce, as viewpoint (1) does, the linkage to a phenomenon of non-premotion of the single electron and to consider the interaction of several electrons on the same orbital as more or less negligible.

The interaction of the electrons, however, leads us to wave-functions of the type (2) with pairs of electrons on the same molecular orbital. The degeneracy due to the equality of the electrons is always rigorous and remains so, even if the degeneracy of the fields disappears completely ($a \gg b$ or $b \gg a$), that is, when the molecular orbital gradually changes into an atomic orbital, or in other words, the bond changes from covalency to electrovalency. This view, that the effect of degeneracy of the electrons predominates over the effect of degeneracy of the nuclear fields, leads to an interpretation of the orbital method as a pair bond theory of valency, without resorting to strict localisation of the bonds. It is our intention to show that this can be developed in detail.

Mathematically this second view is fully equivalent to the first, and it does not require the additional assumption of the preservation of approximate degeneracy for unequal fields. As either interpretation is based on a hypothesis, a decision between them is possible only by comparing their consequences with the experimental evidence, and the spectroscopical data on the dissociation of molecules, especially such as NO, BeO, CaF, etc., and CO_2 appears to be in better agreement with a pair bond theory of valency. A critical analysis of chemical

data, which in the light of this view has already been described[1], indicates that the experimental evidence is in better agreement with a uniform pair bond theory than with a single-electron bond theory of valency. A full report will be given elsewhere.

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Dec. 10.

[1] R. F. Hunter and R. Samuel, *J. Chem. Soc.*, 1180; 1934.

Reafforestation of Forest Trees in Great Britain

SEVERAL letters and articles have recently appeared in the public Press directing attention to the necessity for the reafforestation of the hardwood trees of Great Britain.

The Forestry Commission appointed shortly after the War for the purpose of replacing the losses resulting from the excessive war demand for home grown timber, has now had about fifteen years of steady work. The Commissioners were empowered to purchase land, and plant woodlands throughout the country; but their efforts have been confined mostly to the planting of softwoods, and with the exception of some limited areas there has been little or no planting of hardwood trees.

It is not generally realised that for quite a considerable time before the War, and during the years which have passed since, vast quantities of trees of oak, and ash, beech, walnut, etc. have been hewn down and gone into consumption. The destruction has proceeded on a scale far beyond anything which occurred during the previous hundred years, and now gradually every tree which is realisable has to come down, including every kind which possesses a monetary value, whether of mature growth or wholly immature. The tragic condition is particularly noticeable throughout Sussex, a county which was formerly one of our most beautifully wooded and richest in hardwoods.

Anyone who has travelled over long distances in India, America, and other parts of the earth, has seen areas which thoughtless men have denuded of all trees and are now barren wastes. We are bringing about the same condition in England, and Sussex is by no means the only county which has suffered. As a writer has said: "Wherever man has settled the forests disappear. Up till now the march of civilisation has everywhere proclaimed the destruction of trees over the wide surface of the globe."

In 1925 I read a paper on this subject at the meeting of the British Association at Southampton, and again each year excepting one at the subsequent meetings until that in London in 1931; but the public is still quite unaware of the true state of affairs. It is not realised that the once beautifully timbered parks and woodlands throughout the country are being completely wiped out.

Great Britain has been famous all over the world for the beauty and wealth of her woodlands, and because of the planting done by our landowners we were able before the War to boast of a fully sufficient reserve of valuable timber. The "march of civilisation" has overtaken us, and unless something is done there will be no escape from a deplorable result. The Irish Free State has handled this situation, and under the Forestry Act of 1928 made very stringent orders for the protection of its woodlands. Application has to be made to the Department of Lands, Forestry Division, Dublin, and permits must be obtained by "*any* person who wishes to fell *any* tree on his holding", and licences may contain stipulations for replacement. In England, Scotland and Wales, thousands of hardwood trees have been cut down and practically nothing planted; in southern Europe for every tree that is allowed to be felled hundreds are planted. There must surely be something seriously wrong with us if we allow this state of affairs to continue.

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Interpretation of Animal Behaviour

IN a recent article on the "Interpretation of Animal Behaviour"[1] the view was advanced that a preoccupation with teleological explanations was necessarily somewhat unscientific and philosophical.

Since the future development of psychology—and probably of biology—will depend largely on whether men of science agree to recognise the validity of purposive concepts or decide to consider them as being inadmissible, the question is of great importance. Already, the nature and content of the problems investigated depend largely on what the investigators concerned think on this point.

It is generally agreed, of course, that science necessarily operates in a world of objective fact and that it must be deterministic. But it is unwise to assume that vitalistic theories or teleological interpretations are less scientific and deterministic, or more metaphysical, than are mechanical theories using efficient causation. After all, the *facts* alone can be considered objective and *all* modes of interpretation or of analysis of them are, in a sense, subjective.

Again, the doctrines of efficient and of final causation are both philosophical in so far as they are merely principles of explanation not themselves contained in the facts studied. Nor can it be maintained that preoccupation with teleology is necessarily unscientific. In fact, the principal claim of the vitalist school is that the category of final causation is a legitimate weapon of *scientific* analysis, capable of being applied rigidly to particular problems. It is difficult to understand why unfortunate teleologists should necessarily be relegated to the same scrap-heap as the universally despised metaphysicians!

Both the believers in efficient causation and the teleologists agree on one point: the present moment is not understandable in isolation. Mechanists insist that the past is immanent in the present, teleologists insist that the future is equally immanent in the present. Clearly both are justified in their beliefs, but why should the latter alone be condemned as unscientific anthropomorphs?

If I may paraphrase Prof. A. N. Whitehead, is it not true to say that those psychologists who are animated by the purpose of showing that neither they themselves nor the animals have purposes, form an interesting subject for psychological investigation?

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Jan. 16.

[1] NATURE, **134**, 996, Dec. 29, 1934.

I AM afraid I neither realise the basis nor appreciate the strength of Mr. Lauwerys' clearly implied prophecy that fruitful developments of biology and psychology—by which I trust he means the study of behaviour, since that is the matter under discussion—depend largely on the acceptance of teleological ideas in general, and the concept of purpose in particular. The issues as they are stated are unfortunately vague, and difficult to discuss in a short space, but if prophecies in these matters are of any value, it seems to me that the futures of these subjects depend only upon the further recognition of sensible problems, capable of investigation, within the fields of objective fact to which they refer. The criterion of objective fact, from the point of view of science, is that it constitutes a datum that is public in the sense defined by Hogben, and is capable of expression without fear of ambiguity.

The methods by which facts such as these may be analysed can be many and varied, provided they conform to the demands of proper scientific procedure. Since it is perfectly legitimate to regard 'explaining' in science as being synonymous with generalising and hypothesising, it seems to me idle to contend that in science 'interpretations' and 'explanations' are any more subjective than the primary data to which they relate. In this connexion it is well to remember that both opponents and protagonists of classical behaviourism agree that this school of psychology breaks down as a final philosophy because of its indefensible but necessary assumption that the objective facts of experience are unrelated to subjective experience. But in any event the whole question raised by Mr. Lauwerys is completely irrelevant. Determinism, if need be, could flourish in the thickest undergrowths of a solipsist's mind.

Mr. Lauwerys states that it is the teleologist who insists that the future is immanent in the present. In so far as the merits of a deterministic hypothesis are weighed by its value for purposes of prediction, this, by definition, is also part of the determinist's creed. Mr. Lauwerys is simply making a false antithesis. Merely agreeing that the prediction of the future is a worthy aim of science does not give to teleology any virtue that makes it necessary in scientific research.

I am not prepared to say whether or not the category of final causation is a weapon of scientific analysis. If it is, Mr. Lauwerys and those who agree with him have the task of showing that it can operate as such. At the moment, those who conduct their investigations according to everyday deterministic methods, without any appeals to teleology, are doing most, if not all, of the work of extending our reliable knowledge of phenomena.

THE WRITER OF THE ARTICLE.

Effect of Ultra-Centrifuging on the Cells of the Root-Tip of the Bean

ROOT-TIPS of the bean were centrifuged in the Beams ultra-centrifuge at approximately 400,000 times gravity for twenty minutes. The effect is shown diagrammatically in Fig. 1. Fig. 1(*a*) is a control cell showing the normal distribution of the cytoplasmic components and inclusions. Fig. 1(*b*) represents an ultra-centrifuged cell showing the redistribution of the cytoplasmic components and inclusions into layers in the order of their relative and decreasing specific gravity, as follows: (1) a layer of starch grains and plastids (when present in the cell); (2) a layer of mitochondria (plastidome and pseudo-chondriome); (3) a layer of cytoplasm (which is often quite free of various cytoplasmic components); (4) a layer of osmiophilic platelets (Golgi bodies of Bowen); (5) a layer composed of, or formed by, the fusion of vacuoles and (6) a layer of lipoid material. Thus, it is evident from this study that the osmiophilic platelets are discrete

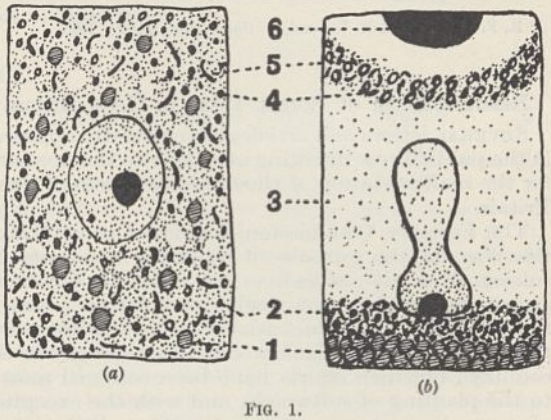

FIG. 1.

structures in plant cytoplasm, and differ greatly in specific gravity from the plastids and mitochondria.

The nucleus is frequently stretched in the direction of the centrifugal force with the nucleolus constituting its heaviest component. In extreme cases, the nucleolus is thrown completely out of the nucleus centrifugally.

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Some Recent Atomic Weight Determinations

IN conjunction with Mr. H. S. Patterson, a number of new determinations of the limiting ratios of certain gases with oxygen have been carried out, using an improved microbalance apparatus in which errors due to adsorption have been eliminated. A more detailed account of the apparatus and results will be published elsewhere.

The gases used were nitrous oxide, ethylene, carbon dioxide and carbon tetrafluoride. The measurements obtained from these gases lead to the following values of the atomic weights:

$N_{N_2O} = 14{\cdot}006(8)$. $C_{C_2H_4} = 12{\cdot}012(2)$.
$C_{CO_2} = 12{\cdot}010(1)$. $F_{CF_4} = 18{\cdot}995$.

The compressibilities at 21° C. of the gases can be calculated from the data and are appended below in comparison with the values obtained on an Andrew's compression apparatus[1].

Gas	$A_{21°C.}$ microbalance	$A_{21°C.}$ Andrew's apparatus
Nitrous oxide	0·00559	0·00567
Ethylene	0·00636	0·00612
Carbon dioxide	0·00522	0·00526
Carbon tetrafluoride	0·00418	0·00420

Whilst the values of nitrogen and fluorine are in close agreement with the accepted values, carbon

is distinctly higher than the accepted C = 12·00. Nevertheless, this high result, which indicates about one per cent of the 13 isotope, is in agreement with the spectroscopic work of Jenkins and Ornstein[2], and the value of C = 12·011 of Woodhead and Whytlaw-Gray[3]. Indeed, the agreement between our values from two entirely different gases and those of the other workers is so close that it seems very improbable that they are in error, and consequently that the true atomic weight of carbon is 12·01.

The value of F = 18·995 does not agree with the preliminary value of F = 19·01 which we published in these columns[4], using methyl fluoride. Consequently, these measurements have recently been repeated with the new apparatus. The new data lead to an atomic weight of F = 18·995 and a compressibility of $A_{21°C.} = 0·0090$. As would be expected, the adsorption error does not affect the compressibility to any marked extent. This last figure is in agreement with $A_{21°C.} = 0·0088$, measured on the Andrew's apparatus. It leads to $A_{0°C.} = 0·0117$, which does not confirm the value of Moles and Batuecas[5]. Consequently, our previous criticisms[6] still hold good.

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Jan. 4.

[1] Cawood and Patterson, *J. Chem. Soc.*, 156, 619; 1933.
[2] *Proc. K. Acad. Wetench. Amsterdam*, **33**, 1212; 1932.
[3] *J. Chem. Soc.*, 209, 846; 1933.
[4] Patterson and Cawood, NATURE, **128**, 375; 1931.
[5] *J. Chim. Phys.*, **18**, 353; 1920.
[6] Patterson and Cawood, NATURE, **129**, 245; 1932.

Effect of Temperature on the Absorption of Crystals in the Infra-Red

IN a recent publication, Matossi and his collaborators[1] have investigated experimentally the influence of temperature on the absorption of crystals in the infra-red; this is to some degree an extension of the classical work of Rubens and Hertz[2].

A rather interesting point raised is that the fundamental feature of the earlier work—the distinction between regions sensitive and insensitive to temperature—may be spurious, and due to the shift with temperature of the band as a whole.

It is possible to say, however, that the distinction drawn by Rubens and Hertz does exist, though not in the form suggested by these investigators—that the 'inner' vibrations are the insensitive, and 'outer' vibrations the sensitive ones. The theory of the damping of the infra-red vibrations[3] shows that this is due to the coupling between the main vibrations and combinations of two other normal vibrations; and, further, that (*a*) the absorption on the short wave-length of the main vibration (λ_0) up to a point roughly $\lambda_0/\sqrt{2}$, is due to summation tones, and (*b*) the absorption on the long wave-length side is due to difference tones.

In the language of the quantum theory, the summation tones are produced by jumps from lower to higher quantum levels, whereas in a difference tone one of the jumps is from an excited to a lower level. It is obvious that, at very low temperatures, very few oscillators are in an excited state, hence the absorption due to difference tones must decrease to zero as the temperature decreases to zero.

It is also clear that absorption due to summation tones must be relatively insensitive to temperature, since at very low temperatures, where most oscillators are in the ground state, we can still have jumps from the ground state to excited states.

Hence the absorption on the short wave-length side of the main vibration should be relatively insensitive, that on the long wave-length side sensitive, to temperature. The distinction is obviously of the same kind as between the Stokes and anti-Stokes lines in the Raman effect[4].

There is unfortunately no experimental data in the region between λ_0 and $\lambda_0\sqrt{2}$, where one would expect the really interesting effects; it is to be hoped that experimenters will investigate this region as well as the other regions.

A more detailed treatment of the absorption in the infra-red will be given in a forthcoming paper.

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Dec. 19.

[1] F. Matossi and H. Brix, *Z. Phys.*, **92**, 303; 1934. F. Matossi and H. Kindler, *Z. Phys.*, **92**, 312; 1934.
[2] H. Rubens and G. Hertz, *Berlin Ber.*, 256; 1912.
[3] M. Born and M. Blackman, *Z. Phys.*, **82**, 551; 1933. M. Blackman, *Z. Phys.*, **86**, 421; 1933. See also W. Pauli, *Verh. d. D. Phys.*, 6, 10; 1925.
[4] A. Smekal, *Naturw.*, **11**, 873; 1923.

Surface Tension of Urine during the Menstrual Cycle

WE have recently carried out in this laboratory surface tension measurements in connexion with the excretion of capillary-active substances in the urine of the normal human female. Over a period of twenty-eight days the surface tension of the first morning specimen each day was determined, and the centrifuged deposit examined microscopically for blood corpuscles, so that the onset of menstruation could be ascertained as early as possible. A typical curve of the variation is shown in Fig. 1, and from this the following interesting observations can be made.

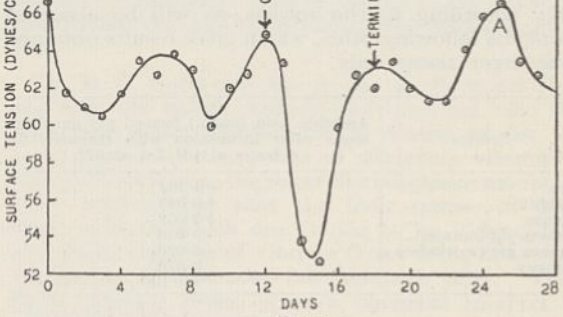

FIG. 1.

The curve consists of four phases corresponding in temporal relation to the four divisions into which—on physiological evidence—the human period can be divided, namely, resting, constructive, destructive and repair stages.

As regards the length and rhythm of cycle, it appears that the measurement of surface tension possibly provides a new means of estimating these hitherto inaccessible factors. For example, the curve shown is one of a cycle of length 25 days and of normal rhythm.

At the loop *A* on the diagram where one cycle ends

and the next commences, the surface tension attains a maximum value and capillary activity is at a minimum. This corresponds in time to that period where, according to recent physiological investigations, ovulation probably occurs[1].

As regards the nature of the substances causing this variation of surface tension, we can at present say nothing definite. It is known, however, that certain hormonic activities, such as excretion of prolan *A* near the midpoint of the cycle[2], are of a periodic nature, and it is, we think, legitimate to suggest that these causative substances are at least linked with the hormones responsible for the menstrual cycle.

Further work is being carried out on these and kindred problems, a full account of which will be published shortly.

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Dec. 19.

[1] "Periodic Fertility and Sterility in Women", H. Knaus. Vienna, 1934.
[2] R. Kurzrok, I. J. Kirkman and M. Creelman, *Amer. J. Obst. and Gyn.*, Sept. 1934.

Biological Formation of Ascorbic Acid

WE have already reported[1] that the spleen, kidney and liver tissues of the rat are able to form significant amounts of ascorbic acid, as determined titrimetrically, when incubated with mannose for three hours at *p*H 7·4 at 37°. The brain, heart-muscle and leg-muscle tissues of the rat have also been found to share this power, though to a less extent. It has been possible, further, to extract the mannose dehydrogenase system from the spleen, kidney and liver tissues of the rat[2]. A similar enzyme system has also been extracted from germinating *mung* (*Phaseolus mungo*), which can convert mannose into ascorbic acid at *p*H 5·8, but not at *p*H 7·4. This is perhaps related to the acidity of the germinating *mung*.

The ability with which the isolated tissues convert mannose into ascorbic acid *in vitro* differs considerably according to the species, as will be observed from the following table, which gives results obtained with liver tissue only.

Species	Ascorbic Acid (mgm.) formed per gm. liver tissue after incubation with mannose for 3 hours at *p*H 7·4 at 37°
Rat	+0·300
Rabbit	+0·040
Pigeon	+0·053
Guinea pig (normal)	−0·030
Guinea pig (scorbutic)	−0·020
Monkey	−0·010

It will be noticed that the liver tissues of the rat, rabbit and pigeon—species known to be independent of an external source of vitamin C—are able to form ascorbic acid from mannose, whereas the liver tissues of the guinea pig, both normal and scorbutic, and monkey, which are dependent on an outside supply of vitamin C, are apparently unable to do so.

It has generally been found that the other sugars studied, glucose, fructose, galactose, rhamnose, xylose and arabinose, are converted into ascorbic acid by the tissues of none of these animals under our conditions of experiment, with the exception that the liver tissue of the pigeon can convert glucose into ascorbic acid (0·033 mgm. ascorbic acid being formed per gm. of the tissue). Preliminary experiments indicate the possibility that prolonged incubation of glucose with the liver tissue of the rat may also produce ascorbic acid.

It is necessary to state that, in the absence of biological tests, which are presenting several technical difficulties, this work involves the assumption that the substance titrating with 2 : 6-dichlorophenol indophenol consists solely of vitamin C.

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[1] Guha and Ghosh, NATURE, **134**, 739; 1934.
[2] Guha and Ghosh, *Current Science*, **3**, 251; 1934.

Alleged Œstrogenic Activity of the Male Sex Hormone

CORRELATION of molecular structure of the sex hormones with that of the sterols and bile acids is now almost complete, and leads to the conclusion that the hormones are biological degradation products of cholesterol. Adopting the working hypothesis that the male hormone (androsterone) is the immediate precursor of the female hormone (œstrone), a study of the action of various tissue extracts on androsterone has been commenced in the hope of converting this hormone into œstrone by biochemical means. The œstrus test gives a very sensitive method of detecting any such conversion.

The œstrogenic action of various testicular extracts[1] and male hormone extracts prepared from urine (for example, hombreol) has led to the suggestion that the male hormone has the same effect on the female genital tract as the female hormone[2]. If this were true, then of course the biological test would be valueless as a means of detecting dehydrogenation of the androsterone molecule. However, it is certain that the œstrogenic activity of male hormone preparations is due to the presence of substances other than this hormone, for no œstrogenic activity could be detected with pure crystalline androsterone prepared from cholesterol by the method of Ruzicka[3].

Four injections of 0·25 mgm. of androsterone, dissolved in sesame oil, were made into each of five ovariectomised mice at 12-hour intervals. Vaginal smears were examined during 72 hours following the last injection, and showed no sign of œstrus. These mice were afterwards given four injections of 0·25 γ of œstrone, and then showed a full œstrous response. Two other castrated female mice received a total of 10 mgm. each of androsterone with completely negative results. Post mortem examination of these two animals showed no enlargement of the uterus or any other symptoms normally associated with the action of œstrogenic substances.

The androsterone used in these experiments was generously presented by Ciba, Ltd., at the request of Prof. Ruzicka.

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[1] Brouha and Simonnet, *C.R. Soc. Biol.*, **99**, 41; 1928.
[2] St. Skowron and E. Turyna, *Pol. Gaz. Lek.*, Nr. 18; 1934. St. Skowron, NATURE, **134**, 627; 1934.
[3] Ruzicka, Goldberg, Meyer, Brüngger and Eichenberger, *Helv. Chim. Acta*, **17**, 1395; 1934.

Mr. Mallock's Electrical Calculating Machine

READERS of NATURE may be interested in some details from my own experience of the electrical calculating machine invented by Mr. R. R. M. Mallock, constructed by the Cambridge Instrument Company, and mentioned in the issue of January 12, p. 63.

Through the kindness of Mr. Mallock and the hospitality of Mr. C. C. Mason, of Cambridge, I was privileged for a few days in October 1933 to see the machine at work. Being a little sceptical, I had provided myself beforehand with certain problems, for some of which I had solutions. I first proposed the solution of six simultaneous equations (coefficients all to 3 decimals), knowing the answers to be :

0·866, − 0·415, 0·173, 0·337, − 0·126, 0·079.

Under Mr. Mallock's direction I set up the coefficients on the switchboard while he connected the plugs. First approximations were quickly read off as : 0·8711, − 0·4046, 0·1866, 0·3493, − 0·1246, 0·0659. Refinements gave in a few minutes the satisfactory results :

0·8650, − 0·4149, 0·1722, 0·3370, − 0·1258, 0·0794.

Much of the time was taken up by questions and explanations, but I note from my records the total time as "11.48 a.m. to 12.26 p.m., 6/10/33". This very short time could have been greatly reduced.

On other occasions I observed the machine perform, to my proposals, the solution of algebraic equations, of characteristic equations of matrices (latent roots), the evaluation of determinants and of quadratic forms in several variables in specified regions, and cognate problems. It seems to me that in this realm, which is one of wide physical and statistical application, the machine has remarkable potentialities, and one hopes that its merits will gain it not merely the publicity, but also the opportunity for practical service which it awaits.

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Jan. 22.

A. C. AITKEN.

Points from Foregoing Letters

THE origin of the light of the aurora and of the night sky has been much debated. Prof. J. Kaplan states that he has succeeded in obtaining in the laboratory the green line λ5577, identical with that present both in the aurora and the light of the night sky. This he has done by means of a rapidly interrupted electrical discharge through nitrogen gas containing 1 per cent oxygen. The light emitted contained also other bands (Vegard-Kaplan system) which probably occur in the night sky.

Heavy and ordinary water differ in many of their chemical properties more than would be expected from the extra weight of the hydrogen atom present in the heavy variety. Mr. J. D. Bernal and Mr. G. Tamm ascribe these differences to the angular vibration (libration) of the molecules. Having calculated the energy associated with such libration, they find that it accounts for differences in the specific heat, and heats of evaporation and fusion of H_2O and D_2O, and also for the wave-length shift in the spectrum of light scattered by water.

By centrifuging the cells of the root tips of the bean, Dr. H. W. Beams and Mr. R. L. King note that various cell constituents arrange themselves in layers according to their specific gravity. They submit diagrams showing, among other things, that the Golgi bodies (platelets coloured black by osmium reagent) are in this way separated from the mitochondria (protoplasmic rods and granules), from which they cannot otherwise be readily distinguished.

From the density of several gaseous compounds of carbon (CO_2, C_2H_4, CF_4) compared with that of oxygen by means of a micro-balance, Dr. W. Cawood concludes that 12·01 is a more exact value for the atomic weight of carbon, which would indicate the presence of about 1 per cent of the ^{13}C isotope. The compressibilities of those gases, based upon the newly calculated atomic weight, agree with those experimentally determined. For the atomic weights of nitrogen and fluorine, determined in the same way, the values 14·006 and 18·995 are given.

Dr. Blackman discusses in the light of the quantum theory whether, in the infra-red absorption spectrum of crystals, one should expect certain regions to be insensitive to temperature changes, as was experimentally stated to be the case by Rubens and Hertz. He concludes that the absorption on the short wave-length side of the main vibration should be less sensitive than that on the long wave-length side, and appeals for further experimental work in this field.

Messrs. C. F. Selous and P. W. Perryman give a graph showing how the surface tension of urine varies during the menstrual cycle. It has a maximum value at the time when ovulation probably occurs and a minimum during menstruation, due possibly to the presence of hormones such as prolan A, the hormone stimulating the growth of the follicle containing the ova.

Dr. B. C. Guha and Mr. A. R. Ghosh report that not only the spleen, kidney and liver but also the brain and heart and leg-muscle tissues of the rat have apparently the power of producing vitamin C (ascorbic acid) from the sugar-like substance mannose. They further find that the liver tissues of only those animals which are known to be independent of outside supplies of vitamin C can bring about the conversion of mannose into ascorbic acid. They have hitherto relied upon a chemical method of estimating the quantity of vitamin C produced.

Male hormone (androsterone) prepared from cholesterol (a common wax-like substance present in wool-fat, blood, etc.) has no effect upon the female genital tract according to Mr. F. L. Warren. This shows that the results obtained by previous investigators, who have reported that testicular extracts have the same effect on the female genital tract as the female hormone, must be due to some other substance present in those extracts. Mr. Warren suggests that the male hormone may be the immediate precursor of the female hormone and hopes to convert one into the other by biochemical means.

Research Items

Race and Constitutional Types. Studies of human morphological (constitutional) types have been made in accordance with a variety of methods, depending for the most part on inspection rather than measurement, with the object of determining the character and frequency of such types within a given population. It has been suggested, further, that the morphological type correlates with functional and psychic type to make a 'bio-type', and also with race. Thus in a study of the population of Germany, it has been found that, of Kretschmer's three types, the leptosome corresponds to the Nordic, the athletic to the Dinaric and the pycnic to the Mediterranean and the Alpine. An additional character would, therefore, appear to be afforded for racial classification. This method of analysis, however, hitherto has been applied only to Europeans. With the view of determining its value to the anthropologist, it has now been applied to natives of Indo-China and Madagascar by Dr. G. Machado da Sousa (*L'Anthropologie*, **44**, No. 5–6). It would appear that the classification based upon European material does not hold good when applied to other races, the combination of characters of which the types are composed being different, while of the methods employed two only, those of Viola and of Manourvrier, were found suitable. It appears, however, that among the natives of Indo-China there is no correspondence in the types obtained by the two methods. As regards characters, among the Indo-Chinese, cranial form and morphological type do not correspond; but, on the other hand, there is a certain relation between the type and the form of the face. Generally, there would appear to be no correlation between racial type and constitutional type, though it is possible in the two races under consideration to recognise two extreme types of individual morphology.

Problem of Immunity in Cancer. Dr. M. J. A. des Ligneris has recently described researches carried out to investigate whether the serum of animals treated by injections of cancerous tissues acquire specific antibodies to malignant cells (*Pub. South African Inst. Med. Res.*, No. 34. "Studies on Cell Growth. (2) The Growth *in vitro* of Normal Mouse Cells and of Mouse Cancer Cells (Carcinoma, Sarcoma) in Neutral and Immune Media (Serum plasma)"). Dr. des Ligneris inoculated two sheep eight times each, at intervals of 8–10 days, with crushed mouse carcinoma (63 of the Imperial Cancer Research Fund), and two similar sheep at the same times with crushed normal organs of healthy mice. Fragments of normal mouse organs (spleen, lungs, liver and kidney), of mouse carcinoma 63, and of mouse sarcoma 37 were grown in tissue cultures, employing sera and plasma obtained from normal rats, fowls, rabbits and sheep. Upon these cultures was tested the action of sera and plasma from the inoculated sheep. Of the results of these experiments Dr. des Ligneris says that they "clearly show that, in the serum of sheep treated with repeated injections of mouse carcinoma tissue, the developing antibodies have, for all practical purposes, none other than anti-species characters; it was not possible to detect in these sheep sera any kind of antibody capable of showing any specifically 'anti-malignant' characteristics".

Early Development of the Ferret. W. J. Hamilton describes (*Trans. Roy. Soc. Edin.*, 58, 251–278; 1934) the early development of the ferret, based on the examination of living and of fixed material. The egg is richly supplied with fat in the form of globules. At one pole of the egg is a cytoplasmic crescent, covering about one half of the egg, and here the fat globules are less densely present. In life, the zona pellucida appears as a homogeneous membrane, surrounding the perivitelline space in which the egg can rotate. The first cleavage produces two cells similar in appearance but not equal in size, and their next division is not synchronous, hence a three-cell stage is produced. In the four-cell stage the cells are usually arranged in the form of a cross, and one of the cells was found to be smaller than the other three. At the sixteen-cell stage one cell is centrally placed; it has the same morphological characters as the other cells and the fat is equally distributed among the cells. A little later a cavity—the blastocœl—arises as an intercellular space or by the fusion of intercellular spaces. The blastocyst increases very rapidly in size, the trophoblast becomes attenuated and the inner cell mass (produced by the division of the central cell of the sixteen-cell stage) becomes lenticular and later forms the embryonic disc. The central cell mass is attached at one point to the trophoblast and the disappearance of the covering trophoblast takes place relatively early in the ferret. Endoderm cells arise from the convex surface of the disc as a continuous layer; they are at first flattened but later, under the anterior part of the embryonic disc, they become columnar, forming the prochordal plate. Fat is found in the embryonic ectoderm and in the trophoblast, but not in the endoderm cells. The paper is illustrated by eighty photomicrographs.

Insects and Spiders from East Greenland. In the *Annals and Magazine of Natural History* of December, Mr. David Lack contributes a short account of some insects obtained by the Cambridge expedition to Scoresby Sound in lat. 70° N. Most of the collection was made around Hurry Inlet, a subsidiary fjord running north from Scoresby Sound, on August 1–15. The list given by Mr. Lack includes all the orders of insects collected, excepting the Diptera which are not yet identified, and various specialists are responsible for the names given. Of the eight species of Collembola recorded, four are new to Greenland: one species of Lepidoptera is new to science and one other species, together with a single species of Aphididæ, have not been previously recorded from Greenland. Two other species of Lepidoptera, it may be added, are new to east Greenland, but were previously known from west Greenland. All the other species listed were already known from east Greenland. The present collection emphasises the poorness of the insect fauna of east as compared with west Greenland. The Ichneumonids collected by the expedition form the subject of a separate paper by Mr. M. A. Roman, of Stockholm, in the same issue of the journal. They are represented by eleven species, of which one, and the female of another species, are new to science. A third paper by Mr. A. Randell Jackson deals with the spiders, of which there are thirteen species. Among these latter, five appear to have been previously unrecorded from

Greenland, including one new species. The general conclusion is that, so far as is at present known, the spider fauna of Greenland is mainly American, which may be contrasted with that of Iceland, which is mainly European.

Fossil Starfishes. The *Proceedings of the Royal Society of Victoria*, 46 (New Series), Part 2, May 1934, contains two interesting papers on fossil star fishes: "A Lower Cretaceous Brittle-star from Queensland" by Frederick Chapman, and "The Palæozoic Starfish of Victoria" by Robert B. Withers and R. A. Keble. The brittle-star is a new species of *Ophiacantha*, *O.* (*Ophioglyphoida*) *fosteri*, found on the fractured faces of a bore-core obtained at Cleeve, near Longreach, Queensland. The Asteroidea are dealt with in the second paper. There are now fifteen recognisable species known from Victoria, of which ten are new. They are all from the Silurian, and are distributed over eight genera; *Hudsonaster*, *Caractacaster*, *Promopalæaster* and *Petraster* are restricted to the Ordovician in England and America; *Urasterella*, *Salteraster* and *Schuchertia* begin in the Ordovician, but range into the Silurian. *Palasterina* alone of the eight genera does not occur elsewhere lower than the Silurian. As the authors state, "this would seem to indicate that asterid distribution started from a point in the Northern Hemisphere".

Cytological Studies in Pears. In a recent paper (*J. Pomol. and Hort. Sci.*, 12, No. 4, pp. 321–326, December, 1934), Mr. A. A. Moffett, of the John Innes Horticultural Institution, reports an interesting study of the cytology of thirty-four varieties of pear. Chromosome numbers of these varieties have been determined. Twenty-seven diploids, each with 34 chromosomes, and seven triploids, with 51 chromosomes, have been found. The triploids are relatively infertile, and, apart from the variety Pitmaston Duchess, are not cultivated extensively. This is partly due to the unequal reduction of the triploid at the formation of gametes; but the paper under review shows that there is a marked difference in the vigour of the pollen. Pollen from a diploid plant usually germinates readily, the greater number of varieties having a pollen germination of more than 50 per cent, while pollen from a triploid rarely attains more than 25 per cent germination.

Temperature and Humidity near the Ground in India. In a paper on micro-climatology by L. A. Ramdas, which appeared in *Current Science* of May 1934, reference is made to some interesting facts concerning the diurnal variation of the air temperature and the pressure of aqueous vapour in the first few feet above the ground. In temperate latitudes, as is well known, the surface turbulence set up by solar radiation during the day tends to die out completely on clear windless nights, when the air becomes stratified and the lowest temperature is to be found on the ground itself. Judging from the results obtained at Poona, this is not generally the case within the tropics, even in winter, for the accumulated solar heat there is great enough to maintain a layer of turbulence all through the night, although a very shallow one compared with the layer at its maximum development in the afternoon. An unexpected result was also obtained in connexion with the pressure of aqueous vapour, which showed a minimum close to the ground at night in the autumn, although in sunny weather evaporation from the ground tended to give a maximum near the ground, as was to be expected. The explanation was apparent when measurements were made of the water content of samples of surface soil exposed under natural conditions; it appears that the surface soil became sufficiently desiccated by evening in the autumn to become an absorber of water vapour at night, and that this was the cause of the night minimum close to the ground. The two phenomena together resulted in the layer of deposition of dew beginning at some height between six and twelve inches, and in an increase of the amount with height above the ground.

Isotopic Ratio of Oxygen and the Atomic Weight of Hydrogen. It has been pointed out that in the paragraph appearing under the above heading in NATURE of December 22, p. 977, the term "atomic weight of hydrogen" was used throughout instead of "the mass of the hydrogen isotope, H^1". It may be mentioned that the research was undertaken to discover where the discrepancy between the chemical atomic weight of hydrogen (1·00777) and the mass of the hydrogen isotope, H^1 (1·00756, on the scale O = 16), lay. The hydrogen used for the best atomic weight determinations has been obtained electrolytically, and contains a very small proportion of the heavy isotope, H^2 ($H^1 : H^2 = 30{,}000 : 1$). Its atomic weight should therefore approximate closely to the mass of the hydrogen isotope, H^1. The re-determination of the isotopic ratio of oxygen gives the value 1·00763 for the mass of the isotope, H^1, which is nearer the chemical value.

Experiments with Positrons. In a paper contributed to the German Physical and Mathematical Conference at Pyrmont in September 1934 (*Phys. Z.*, 35, 999; 1934), E. Rupp describes a number of fundamental experiments with positrons. An apparatus for the artificial production of positrons is described. Accelerated protons impinge on a layer of lithium within a hemispherical cup of aluminium foil. α-Rays emitted from the lithium strike the aluminium, and give rise to positrons. The positrons obtained had velocities varying from 800 to 1,000 kilovolts. The value of the ratio of the charge to the mass was determined by applying a magnetic and an electric field in the usual way, and was found to be identical, within the limits of experimental error, with that for electrons. An attempt was made to determine the mass of the positron by studying the diffraction of positrons at aluminium and gold foils. Assuming that the positron, like the electron, is associated with a wave-motion, it would be expected that the relationship $\lambda = h/mv$ would hold, λ being the wave-length, m the mass, and v the velocity of the positron, and h Planck's constant. It was found, however, that no definite diffraction occurred, but there was a continuous scattering. The absorption of positrons by aluminium, copper and gold foils was also investigated. To a first approximation, the absorption is proportional to the atomic weight of the absorbent. The production of X-rays by bombardment of anticathodes by positrons was studied. The X-rays obtained from all the substances investigated (gold, copper, silver, graphite, rock-salt and galena) were monochromatic, the wave-length being independent of the velocity of the positrons. The X-rays from all the substances examined had the same absorption coefficient, which is thus a characteristic of positrons, and not of the substance used as the anticathode.

Pittsburgh Meeting of the American Association

THE ninety-fifth meeting of the American Association for the Advancement of Science was held at Pittsburgh on December 27–January 2, and during the week members of this and associated organisations numbering nearly four thousand participated there in a most successful series of meetings. Joined with the city as hosts were the Carnegie Institute of Technology, the University of Pittsburgh, the Pennsylvania College for Women, Duquesne University and the Mellon Institute. Dr. Thomas S. Baker, president of the Carnegie Institute of Technology, was chairman of the local committee and Dr. Davenport Hooker, of the University of Pittsburgh, vice-chairman. Arrangements for sessions were admirably provided in the group of academic and public buildings in the Schenley Park centre.

Two previous meetings have been held in Pittsburgh, both of them marked by events of especial significance in the history of the Association. The first in June 1902 was the last of the fifty-one summer meetings; at it was adopted a new plan for mid-winter Convocation Week meetings, bringing together a large group of scientific organisations, the first of which was held in Washington in the following December. This plan, which has been followed ever since, has served well to develop scientific work and influence in the country. The second Pittsburgh meeting was held in December 1917 with a programme devoted to national preparedness and effective participation in the War. It exercised an important influence on the country at this crucial period.

Pittsburgh played a prominent part in early colonial history. Its strategic location and the immense value of the natural resources of the region gave support to the later initial enterprises in manufacturing lines, and led to the development of mining and other industrial activities on the immense scale that characterises this region to-day. The secret of its success has been the application of science to the utilisation of natural resources. In consequence, it offers attractions to scientific organisations which were well utilised in planning and carrying out the programme of the meeting.

In all, forty-two affiliated societies met in conjunction with the fifteen sections of the Association. The programmes were replete with papers of striking value, and attendance was larger than for several years past. A few of the outstanding features may be mentioned briefly.

The evening general sessions were held in the Carnegie Music Hall. On December 27, President Thorndike presided and responded to the addresses of welcome from the city and the universities. The address was given by Dr. William A. White of the U.S. Public Health Service on "Man, the Great Integrator"; it was illustrated by examples from the field of psychiatry showing the reciprocal relation of the world within and the world without; it demonstrated how psychiatry, like general science, has discarded many of the older traditional ways of thinking and as a result has discovered a new world of thought and knowledge of great significance to the understanding of man and to culture in general.

On December 28, Prof. E. A. Hooton of Harvard delivered the Sigma Xi address on "*Homo sapiens*, Whence and Whither". On December 29, Dr. Charles F. Kettering, director of General Motors Research, spoke on "Some Future Problems of Science and Engineering". On December 31 came the address of the retiring president of the Association, Dr. Henry Norris Russell of Princeton, on "The Atmospheres of the Planets" [see p. 219]. The Josiah Willard Gibbs lecture was given by Prof. Albert Einstein [see NATURE, Jan. 19, p. 111].

Among special afternoon lectures was one to mark the quarter centennial of the discovery of the north pole. It was given on December 27 by Prof. Wm. H. Hobbs of Michigan on "The Career of Admiral Peary, the Discoverer of the North Pole". Prof. H. H. Newman of Chicago delivered an illustrated address on December 28 on "Twins Reared Apart and the Nature-Nurture Problem". On December 28 also, W. R. Chapline of the U.S. Forest Service lectured on "Forestry fosters New Approaches to Watershed Conservation", describing with sound films researches of the U.S. Forest Service dealing with stream-flow and erosion problems on forest and range lands. On December 29, Prof. M. H. Liddell of Purdue spoke on "The Acoustics of the Auditory Spectrum", and was assisted by Prof. C. T. Knipp of Illinois, who demonstrated the Knipp singing tubes. On December 30, Dr. Phillips Thomas of the Research Department of Westinghouse, under the title "Ramblings in Research", gave a remarkable demonstration of recent discoveries not previously presented publicly.

The American Society of Naturalists in its annual symposium dealt with "Cytogenetic Evolutionary Processes and Their Bearing on Evolution Theory". Prof. A. F. Shull of Michigan took as the subject of the presidential address "Weismann and Haeckel: One Hundred Years".

The Committee on the Place of Science in Education presented programmes of invited papers at two sessions, and had a largely attended luncheon, after which Dr. E. L. Thorndike, president of the Association, spoke on "Psychology of Attitudes".

Many symposia and joint sessions were arranged by various sections and affiliated societies. In one, the Ecological Society of America with the Society of American Foresters included an invitation paper by Dr. R. Maclagan Gorrie on "The Work of the Forest Research Institute, Dehra Dun, India", illustrated by fine moving pictures. A symposium on science and the Press was largely attended [see p. 239].

The production of active immunity against poliomyelitis was reported in papers by Dr. Maurice Brodie of New York City and by John A. Kolmer of Temple University, and a series of invited papers on sulphur-containing compounds in their relation to cancer, arthritis, muscular dystrophy and cystinuria were presented in two especially important symposia in the Section of Medical Sciences.

The twelfth annual American Association prize of one thousand dollars was unanimously awarded by the committee to Dr. Vern O. Knudson of the University of California at Los Angeles, for his paper entitled "The Absorption of Sound in Gases". Dr. Knudson has cleverly adapted methods employed in acoustics to the important domain of molecular interactions. Above a frequency of 4,000 cycles per

second the attenuation due to the absorption of sound in oxygen is so rapid that it decreases to a millionth of its initial intensity in travelling a distance of 60 m. In an atmosphere of oxygen the consonants of high frequency in speech sounds could scarcely be heard across an ordinary street. The absorption of sound in a room at high frequencies is more influenced by the humidity and temperature of the air than by the absorbing boundaries of the room or the audience. The 'acoustic transparency' of the air at any temperature and humidity can be calculated. A new technique is furnished for investigating not only the nature of molecular collisions but also the nature of the molecular forces involved.

The only foreign delegates present at the meeting were the representatives of the South African Association for the Advancement of Science and the Royal Society of South Africa; they were Prof. H. B. Fantham and Mrs. Fantham (Dr. Annie Porter), of McGill University, Montreal.

The new Committee on Organisation recommended that the Council promote the establishment of local branches, as long since provided for in the constitution. It was voted to encourage the formation of such branches under the direction of the general secretary. On application of a group of seventy-five persons such a branch was established at Lancaster, Pa., and steps taken to assist in the organisation of other places.

By the courtesy of the Mellon Institute, the annual science exhibition occupied an entire floor of the splendid new building of the Institute. The exhibits of the National Bureau of Standards on deuterium and its compounds from twenty-five co-operating laboratories, the Bartol Research Foundation exhibit of cosmic ray apparatus, and the Columbia University demonstration of the production of artificial radio-active substances stood out among a long series of unusual research exhibits for their truly remarkable character.

The addresses of the retiring vice-presidents, given at various times, included the following: *Mathematics*, Prof. Charles N. Moore of the University of Cincinnati, on "Mathematics and Science"; *Physics*, Dr. Clinton J. Davisson of the Bell Telephone Laboratories, New York City, on "Electron Optics"; *Chemistry*, Prof. Arthur B. Lamb of Harvard University, on "Crystallogenetic Adsorbents"; *Astronomy*, Dr. Vesto M. Slipher of Lowell Observatory, Flagstaff, Ariz., on "The Atmosphere of the Planets as Inferred from Their Spectra"; *Geology and Geography*, Dr. Rollin T. Chamberlin of the University of Chicago, on "Certain Aspects of Geologic Classifications and Correlations"; *Zoology*, Dr. George L. Streeter of the Carnegie Institution, Baltimore, Md., on "The Education of an Anatomist"; *Botany*, Dr. Karl M. Wiegand of Cornell University, on "A Taxonomist's Experience with Hybrids in the Wild"; *Anthropology*, Dr. T. Wingate Todd of Western Reserve University, on "Anthropology and Growth"; *Psychology*, Dr. Walter R. Miles of Yale University, on "Training, Practice and Mental Longevity"; *Education*, Prof. Walter F. Dearborn of Harvard University, on "The Mental and Physical Growth of Public School Children"; *Social and Economic Sciences*, Prof. Wesley C. Mitchell of Columbia University, on "The Social Sciences and National Planning"; *Engineering*, Dr. Charles F. Kettering of the General Motors Corporation, Detroit, Mich., on "Some Future Problems of Science and Engineering"; *Medical Sciences*, Dr. Cyrus C. Sturgis of the University of Michigan, on "Review of Some of the More Recent Advances in the Study of Blood Diseases"; *Agriculture*, Dr. Albert R. Mann of Cornell University, on "The Agricultural Significance of State and National Planning".

The following officers were among those elected for the year 1935: *President*, Prof. Karl T. Compton of Massachusetts Institute of Technology; *General Secretary*, Prof. Otis W. Caldwell of Teachers College, Columbia University; *Vice Presidents of the Sections*: Prof. T. H. Hildebrandt of the University of Michigan (Mathematics); Dr. John T. Tate of the University of Minnesota (Physics); Prof. Moses Gomberg of the University of Michigan (Chemistry); Dr. H. R. Morgan of the U.S. Naval Observatory (Astronomy); Prof. Walter E. McCourt of Washington University (Geology and Geography); Dr. Oscar Riddle of the Station for Experimental Evolution, Cold Spring Harbor, N.Y. (Zoological Sciences); Prof. E. W. Sinnott of Columbia University (Botanical Sciences); N. C. Nelson of the American Museum of Natural History, New York City (Anthropology); Joseph Peterson of George Peabody College for Teachers, Nashville (Psychology); Shelby Harrison of Russell Sage Foundation, New York City (Social and Economic Sciences); Dr. George Sarton of Harvard University Library (Historical and Philological Sciences); H. N. Davis of Stevens Institute of Technology, Hoboken, N.J. (Engineering); Stanhope Bayne-Jones of Yale University Medical School (Medical Sciences); H. K. Hayes of the University of Minnesota (Agriculture); Prof. F. B. Knight of the University of Iowa (Education).

HENRY B. WARD.

Science and the Newspaper Press in the United States

ONE of the leading features of the recent meeting of the American Association for the Advancement of Science held at Pittsburgh, Pennsylvania, was a symposium on the relation between science and the Press. Although within the past decade Press reports of scientific work have become far more satisfactory than formerly, and distrustfulness of the Press on the part of scientific men has been greatly reduced, certain difficulties still exist. The object of the symposium was to bring these difficulties frankly into the open, in the hope that recognition and subsequent discussion might lead to their eventual removal.

The speakers at this symposium were: Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, who is president-elect of the American Association; Mr. David Dietz, science editor of the Scripps-Howard Newspapers, and president of the National Association of Science Writers, Cleveland, Ohio; Mr. Robert D. Potter, Science Service, Washington, District of Columbia, speaking for the director, Mr. Watson Davis; Dr. Edward R. Weidlein, director of the Mellon Institute for Industrial Research, Pittsburgh, Pennsylvania; Mr. William L. Laurence, science news editor, the *New York Times*, New York; Dr. Benjamin C. Gruenberg,

American Association for Adult Education, New York; Mr. Gobind Behari Lal, science editor, Hearst Newspapers, New York; Mr. Thomas R. Henry, staff correspondent, the *Washington Star*, Washington; and Mr. Howard W. Blakeslee, science editor, the Associated Press, New York. It is expected that the contributions of these writers and others will be published in a forthcoming number of *Science*.

It was gratifying to note the interest taken in this symposium by the members of the Association, and to observe the co-operative spirit—indeed, the cordial relationship—that now exists between the scientific men and the representatives of the Press. For it is only within the past few years that science and the Press have come really to understand and to appreciate each other.

The present system of reporting science in the Press of the United States may be said to have had its inception in 1921. In that year, the late Mr. Edward Willis Scripps established the organisation known as 'Science Service', which had as its object making "the greatest use of the press in the way of disseminating the knowledge which is the result of painstaking research carried on by a few hundred, or at least a few thousand, well trained men with great mental capacity". In the same year the Scripps-Howard newspapers appointed Mr. David Dietz as science editor, and Mr. Alva Johnston was selected to write the articles on science for the *New York Times*.

The Boston meeting of the Association in 1922 was reported to the Press by Science Service, Mr. Dietz and Mr. Johnston. For his work in reporting this meeting Mr. Johnston was awarded the Pulitzer prize of one thousand dollars for "the best job of reporting done during the year". The award naturally attracted attention to science writing, and within the next few years several other newspapers, among them the *Washington Star*, the *New York Herald-Tribune* and the *Detroit News*, designated young men of outstanding ability as scientific writers for them.

In 1927 the Associated Press, a co-operative Press association furnishing news to about 1,300 newspapers, appointed two of its ablest young men as science editors, whose duty it was to write science exclusively for the member newspapers. In selecting the men for these positions, Mr. Kent Cooper, the general manager, adopted the principle that the best results in writing science for the Press are to be obtained by men who are, primarily, trained journalists of exceptional ability. This principle has proved to be sound, and has been generally followed by the Press in the United States.

In April 1934 there was organised the National Association of Science Writers, with the membership limited to staff members of newspapers and press associations who devote their major efforts to science. The purpose of this Association is "to foster the dissemination of accurate scientific knowledge by the press of the Nation, in cooperation with scientific organisations and individual scientists". The charter members were twelve in number, representing the Associated Press (2), Science Service (2), the Scripps-Howard Newspapers, the *Philadelphia Inquirer*, the *Washington Star*, the *New York Times* (2), the Hearst Newspapers, the *New York Herald-Tribune* and the *Detroit News*. One honorary member was elected. Mr. David Dietz, science editor of the Scripps-Howard Newspapers, who is a fellow of the Royal Astronomical Society and has attended and reported meetings of the British Association, was elected president.

The growth of interest in science on the part of the Press of the United States is well shown by the fact that at the recent Pittsburgh meeting of the Association there were sixteen science writers from other cities, ten of them members of the National Association of Science Writers. At the meeting in Boston in the preceding year there were ten from other cities. At the Boston meeting in 1922 there had been only four.

Appreciation of the excellent work the science writers connected with the daily Press are doing is being shown in many different ways. As examples it may be mentioned that during the past year the commencement oration at the Massachusetts Institute of Technology, at Cambridge, Massachusetts, was delivered by Mr. Howard W. Blakeslee, science editor of the Associated Press, and the commencement oration at the Carnegie Institute of Technology, at Pittsburgh, Pennsylvania, was given by Mr. Waldemar Kaempffert, science editor of the *New York Times*. Also, Mr. Thomas R. Henry, science writer for the *Washington Star*, was elected a member of the Washington Academy of Sciences as an appreciation of his work, and shortly thereafter addressed the Academy on the relation between science and the newspapers.

In the United States, the newspapers have now become an important element in the scientific complex of the country. They are by far the most important intermediary between those who are engaged in scientific work and the public at large. As such, they are the most important factor, so far as science is concerned, in what is commonly called adult education. It is a pleasure to be able to state that they appreciate their responsibilities and are doing everything in their power, at no small expense to themselves, for the common good.

University and Educational Intelligence

BIRMINGHAM.—The Huxley Lecture is to be delivered on March 14 at 5.30 p.m. in the medical theatre by Sir Thomas Lewis, who has chosen for his subject "Clinical Science within the University".

CAMBRIDGE.—Prof. Othenio Abel, recently appointed professor of geology and palæontology in the University of Göttingen, will give three lectures on palæobiology and evolution in the Department of Zoology at 5 p.m. on February 11, 13 and 15.

The Faculty Board of Archæology and Anthropology has appointed T. T. Paterson, of Trinity College, and J. R. B. Stewart, of Trinity Hall, to Anthony Wilkin studentships.

LONDON.—The County Borough Council of Croydon is making a grant of £10,000, payable over ten years, towards the erection of new buildings in Bloomsbury, and the Westminster Bank has granted £500 for the same purpose.

OXFORD.—The scientific work of early members of Oriel College was the subject of a public lecture by Dr. Gunther on February 2. The benefactions to the library and list of graduates show that medical studies flourished there at the end of the sixteenth

century, when Thomas Coghan wrote his "Haven of Health", for the welfare of students living in Oxford. Special mention was made of the work of Hariot the mathematician, of Merrett and Dyer among botanists, and finally of Gilbert White and of those Tractarians who attended scientific lectures.

At a meeting of Congregation to be held on February 12, details of the establishment of a museum of the history of science will be presented. It is suggested that the museum shall consist of the collection of scientific instruments and books presented to the University by the late Mr. Lewis Evans in 1924, any additions made to the collection since 1924, and any further additions of objects and books illustrating the history of science, with special reference to scientific work in Oxford, as may be accepted or acquired by the University after the passing of the statute. A committee, consisting of the Vice-Chancellor, the proctors, and six others, would be appointed. The duties of the committee would be to appoint a curator of the museum, to accept or otherwise acquire, outright or on loan, objects and books illustrating the history of science, and to formulate rules for the governing of the museum.

Science News a Century Ago

The Royal Geographical Society

At a meeting of the Royal Geographical Society held on February 9, 1835, an extract was read from the private journal kept by Mr. Oldfield, late surgeon with Mr. Lander, detailing the circumstances which attended the attempt made by the expedition to ascend the Tshadda (Benue), the great eastern confluent of the Quorra (Niger). From these it appeared that the chief difficulty arose from the alarm, and consequent hostility, of the natives, which made it impossible to obtain supplies of provisions. Otherwise the stream, though rapid, running at the rate of 2¼ knots, was easily ascended by the steamer, and though navigation of the river was uncertain, the bed of the river being thickly set with small islands and shoals, it was not difficult, and appeared even clearer where the expedition stopped than lower down. The utmost extent reached was 110 miles.

Chesney's Expedition to the Euphrates

A century ago both the British and Indian Governments were taking steps to further the project of shortening the passage to India by means of steam navigation. In connexion with this, Col. Francis Rawdon Chesney (1789–1872) was entrusted with the task of exploring the route via the Euphrates. For this expedition, Laird's of Birkenhead constructed two small iron steamers, the *Euphrates*, 105 ft. long, 50 h.p., and the *Tigris*, 86 ft. long, 20 h.p., which were to be conveyed to Syria and transported in sections across the desert to the banks of the Euphrates. When ready, the steamers were stowed aboard the sailing vessel *George Canning*, which left Liverpool on February 11, 1835, with some of the members of the expedition. Writing of this event, the *Athenaeum* said that it was intended that the *George Canning* should call at Cork, from which place she was to be escorted to the River Orontes by H.M. Steam Vessel *Alban*. Some workmen from Laird's accompanied the expedition, which included also some artillerymen who had been instructed in iron working.

While the main object of the expedition was to survey the Euphrates as far as the Persian Gulf, attention was not to be entirely confined to steam communication, for it would provide opportunity, said the *Athenaeum*, "to make the necessary examinations of that celebrated part of the world, where the first human formations may be looked for with confidence". The expedition met with many difficulties and it was not until March 16, 1836, that the steamers began the descent of the river. On the passage down, the *Tigris*, with all her journals and surveys, was lost, and Chesney was nearly drowned. He, however, continued the voyage in the *Euphrates* and on June 19, 1836, reached the Indian Ocean. His account of the expedition was published in 1850.

Matthias Baldwin's Locomotives

No one in America contributed more to the improvement of the locomotive than Matthias Baldwin (1795–1866), who in 1835 transferred his works from Minor Street, Philadelphia, to Broad Street. The Franklin Institute was much interested in his work and on February 12, 1835, the committee on science and the arts of the Institute submitted a report on the locomotives he was then building, in which it found "numerous improvements affecting nearly every part of the machine". The report made special mention of his improvements in the valves, the feed pumps, the reversing gear and the axles and wheels. Mr. Baldwin, it was stated, "has completed several engines; one of them may be seen in operation on the Philadelphia and Trenton Rail-road, and four on the state road to Columbia; all of which, as well as one in use at Charleston, South Carolina, have given entire satisfaction by their performance. . . . The Committee are informed that some of these improvements have been secured to their inventor by patents; and that he richly deserves to reap the benefit of them, will be admitted by any one who is aware of the extensive use and increasing demand for these costly structures."

Lyell and the Geological Society

At the anniversary meeting of the Geological Society held early in February 1835, the Wollaston Medal was awarded to Gideon Mantell (1790–1852), the Lewes surgeon who had made a close study of the chalk formations in Sussex. The meeting was followed by a dinner, of which Lyell, the president of the Society, wrote to Mantell: "The dinner went off famously, more than a hundred present. After the toasts had been given of the King, Royal Family, Geological Society, late president and president, I gave you. I send you a copy of my speech almost word for word as delivered. . . . I assure you I had the feeling of the meeting with me, and in some respects it produced a better effect than if you had been there. It was by far the longest toast given, but I am sure they were not tired. Lord Lansdowne, who was on my left hand, asked all about you. I got him to give Oxford and Buckland. Fitton gave Cambridge, followed by Sedgwick; Sedgwick the Royal Society, answered by Lubbock; Buckland the Linnean; I the Astronomical, answered by Baily; Greenough the Geographical, answered by Murchison. We then drank Burnes who made a good speech."

Societies and Academies

LONDON

Royal Society, January 31. R. T. HILL and A. S. PARKES: Hypophysectomy of birds. (6) Plumage changes in hypophysectomised fowls. Hypophysectomy of the Brown Leghorn cock results in the loss of most or all of the black pigment from the feathers of the under-neck, breast and legs. The later growing feathers, particularly, are usually devoid of black and may be extensively fringed. The new plumage over the rest of the body is characterised by loss of black pigment and increase of fringing due to lack of barbules. These changes are so similar to those which follow thyroidectomy that they may reasonably be supposed to be due to thyroid deficiency, which is well known to follow hypophysectomy in mammals. (5) Effect of replacement therapy on the gonads, accessory organs and secondary sexual characters of hypophysectomised fowls. Fowls injected with ox anterior lobe extract for 4–6 days after hypophysectomy all showed a temporary increase in the size of the comb and, in the male, the atrophy of the testes was slightly retarded. Prolonged injection after operation, however, failed to avert (*a*) the comb shrinkage, (*b*) the testes atrophy, or (*c*) the plumage changes, which follow hypophysectomy. Attempts to restore the atrophied gonads and combs of hypophysectomised birds by injections of anterior lobe and urine of pregnancy extracts were comparatively unsuccessful. H. MUIR EVANS: The brain of *Gadus* with special reference to the medulla oblongata and its variations according to the feeding habits of different Gadidæ (1 and 2). The divergence of opinion of the significance of the various lobes in *Gadus* has necessitated a detailed microscopic examination of serial sections of the medulla of the whiting; the result of which is to confirm the views of Goronowitsch and others, and to dispute the conclusions of C. J. Herrick. The facial lobes described by the former writers are held to be true facial lobes, comparable to the single facial lobe of the roach, as a type of cyprinoid brain, which is the result of the fusion of two facial elements. Different species of gadoids can be classified according to their diet, and both diet and dentition are reflected in the pattern of the medulla oblongata. At one extreme is the haddock, feeding on crustacea and mollusca, with a large facial lobe and a small somatic sensory lobe, and at the other end species like the ling and the pollack, feeding almost entirely on fish, with a small facial lobe and a very large somatic sensory lobe. In between there is a gradual transition both in types of medulla and in feeding habits, as we pass from the haddock to the cod, whiting, ling, pollack and hake. H. W. FLOREY and H. E. HARDING: A humoral control of the secretion of Brunner's glands. The secretion of Brunner's glands of the cat occurs independently of extrinsic innervation. The glands are activated after the taking of food by a blood-borne stimulus—a hormone or secretagogue.

PARIS

Academy of Sciences, December 26 (*C.R.*, 199, 1537–1694).* LOUIS MÉDARD: The Raman effect of binary mixtures of sulphuric and nitric acids. A line with frequency about 1,400 cm.$^{-1}$, very intense even with very low concentrations of sulphuric acid (0·005 per cent), is described. This is called the sulphonitric line. LETORT: The kinetics and energy of activation of the thermal decomposition of the vapour of acetaldehyde. RAYMOND CHARONNAT: Researches on the reaction of J. H. de Boer. Study of the alizarin-zirconyl complex and its reaction with fluorides in acid solutions. GEORGES DENIGÈS: The micro-estimation of caffeine by colorimetry. A modification of Weidel's reaction giving quantitative results. M. TIFFENEAU and MLLE. B. TCHOUBAR: The vinylic and hydrobenzoinic dehydration of the α-cyclane-glycols. The extension of the hydrobenzoinic transposition to the cyclane series. MLLE. S. CAILLÈRE: Study of the dehydration of the fibrous parasepiolite of Madagascar. JACQUES DE LAPPARENT: Boehmite and diaspore in the Ayrshire fireclays. MAURICE DREYFUSS: Methods for the separation of the clay fraction of the sedimentary rocks. The colloidal suspension of the clay is stabilised by the addition of soap, gum arabic, or preferably gelatine, and the stabilising substance removed by appropriate treatment. PAUL LEMOINE, RENÉ HUMERY and ROBERT SOYER: The discovery of the Weald under the Paris region. EDMOND DARTEVELLE and DANIEL SCHNEEGANS: The fossiliferous deposit of Futa (French Equatorial Africa) and the Quaternary of the coast zone of the Congo. This deposit must be attributed to the Pleistocene. One of the species, *Pachymelania aurita*, characterises the Quaternary deposits of Senegal, Guinea and the Ivory Coast. ROBERT LAFFITTE: The Eocene in the eastern Aurès. LÉON MORET and DANIEL SCHNEEGANS: The problem of the limestone Flysch of the mountain of Autapie near Colmars (Basse-Alpes). MARCEL THORAL: The age of the Archæocyathus limestones of the Montagne Noire (Hérault, Tarn and Aveyron). ADOLPHE LEPAPE: The origin of the helium of natural gases. The localisation of the richest natural gas deposits in the old lake deposits. Analyses of gases from various sources are calculated to show the proportion of helium in the 'nitrogen', and this figure serves as the most useful basis for discussion of the analyses. CAMILLE DAUZÈRE and JOSEPH BOUGET: The cause of the variations of the [electrical] conductivity of the air in grottos. The variations depend on the direction and velocity of the air currents in the cave. R. FAILLETTAZ: A new method of recording atmospherics for the prediction of storms. FRÉDÉRIC ROMAN and MARCEL SOLIGNAC: The discovery of a layer of Pontian mammals at Douaria (northern Tunis). HENRI HUMBERT and PIERRE CHOUX: *Alluaudiopsis fiherenensis*, a new Didereaceæ of Madagascar. EMILE MICHEL-DURAND: Metabolism of the phosphorus in the leaves of the mistletoe. WILLIAM SCHOPFER: The synthesis of a growth factor by a micro-organism. RAYMOND HAMET: The production of an isomer of corynanthine by the methyl esterification of its product of alkaline saponification. AUGUSTE CHEVALIER: The micro-bioclimates of the Cape Verde Islands and the adaptations of the vegetation. PAUL BECQUEREL: The longevity of macrobiotic seeds. RAYMOND HOVASSE: The existence of a parabasal apparatus in the flagellated cells of swimming larvæ of the sea-urchin *Paracentrotus lividus*. R. MORICARD: The existence of relations between the gametotrope mitosine, the modifications of the radial vacuome and the start of the precessive reduction mitosis of ovulation and of the formation of the yellow body in the rabbit. JEAN ROY: Experiments of crossing and artificial fertilisation realised in *Bryocamptus pygmæus*. JACQUES BENOIT: Sexual activation

(* *Continued from p.* 199.)

produced by artificial lighting in the duck during the resting period of the sex organs. ETIENNE WOLFF : The experimental production and determinism of an unknown monstrosity, the anterior symely. ALBERT GORIS and HENRI CANAL : The essence and heteroside of *Primula acaulis*. MME. ANDRÉE ROCHE and JEAN ROCHE : The osmotic pressure and molecular weight of the hæmerythrine of the siponcle. PHILIPPE LASSEUR and MARC BENOIT : Observations on the Gram stain. J. RÉGNIER and MLLE. S. LAMBIN : Study of a case of microbial antagonism (*B. Coli-Staphylococcus aureus*). VITO VOLTERRA : Mathematical discussion of the preceding note. HECTOR DIACONO : The reversibility of certain metalloprotein precipitates by the action of sodium thiosulphate. The serological behaviour of the complex arising from hæmolytic sera and syphilitic sera. L. DELHERM and H. FISCHGOLD : d'Arsonval currents diminish neuromuscular excitability. Y. MANOUÉLIAN : Syphilitic umbilical hæmorrhage and treponemes.

GENEVA

Society of Physics and Natural History, December 6. JEAN and L. DESHUSSES : Some special insects injurious to crops in French Switzerland. M. GYSIN : The metamorphic tillites of Kundelungu and of Haute-Lufira (Belgian Congo). In the region of Haute-Lufira, the conglomerate of the base of the Kundelungu (tillite), instead of being purely detritic, shows an abnormal strongly crystalline facies. It contains large crystals of glaucophane-hornblendes, of garnet and of dipyre, as well as numerous thin plates of biotite. The pebbles of the conglomerate are laminated and entirely recrystallised. The author attributes this metamorphism of the tillites to the perimagmatic actions of the neighbouring diabases, conjugated with the metamorphism of dislocation of the Lufilian orogenesis.

December 20. M. GYSIN : Origin of the chloritic rocks of the Haute-Lufira (Belgian Congo). In the Haute-Lufira (Belgian Congo) basin, the sediments of the Kundelungu form a series of parallel folds, oriented W.N.W.-E.S.E. These folds are marked out by dislocation zones containing tectonic breccia, crushed rocks impregnated with quartz and oligist, chloritic rocks and diabases. The author describes the mineralogical constitution of the chloritic rocks, which are principally formed of a pale green chlorite, colourless in thin section, presenting the characters of leuchtenbergite. The formation of the chlorite appears to be due to the action of mineralised solution on the crushed dolomites, more or less metamorphosed by the diabases. E. JOUKOWSKY and J. BUFFLE : Observations on the salts dissolved in the surface waters and the phreatic waters of the Canton of Geneva. The authors give some indications on the relations existing between the water of the Arve and the underlying phreatic sheet. They quote some figures for dissolved salts which appear to prove that the river does not dissolve material picked up from the bed and carried along, at least for a distance of 25 km. WEIGLE and SAINI : The structure of ammonium bromide at a low temperature. The study of ammonium bromide by means of the X-rays (powder method, with high dispersion) has shown that below − 39° C. this salt is no longer cubic ; it becomes tetragonal. WEIGLE and LUTHI : The dispersion of butyl alcohol for 9 cm. waves. P. BALAVOINE : The present hygienic state of the waters of rural springs of Genevan territory.

LENINGRAD

Academy of Sciences (*C.R.*, 4, Nos. 1–2). S. BERNSTEIN : Trigonometric interpolation by the method of least squares. P. NOVIKOV : A generalisation of the second principle of separability. S. LEITMANN and S. UCHODIN : The combined dispersion and the association of molecules. I. CHVOSTIKOV : Fluorescence of solutions of platinum cyanides. G. RUMER : Contribution to the wave theory of the neutron. S. ARTSYBYSHEV and U. PARFIANOVICH : Penetration of copper into rock salt by electrolysis. The rate of diffusion of copper ions into rock salt at different temperatures follows the exponential law. A. LEVASHOV : Problem of relativisation of the classical mechanics (1). G. GIMMELMANN and M. NEUMANN : Spark ignition of a mixture of methane and oxygen. A. KUDREVATOV : Analysis of calcium fluoride. M. KABACHNIK and M. KATZNELSON : Amidation in the alkaloid series by means of sodium and potassium amides (2). The α- and α′-aminoanabasines. F. BEREZOVSKAJA, M. KOGON and E. MOSKALENSKAJA : Combined action of ultra-violet radiation and of platinum on the transformation of fumaric and the maleic acids and of their salts. P. LAZAREV, A. GAMBURCEVA, S. ABRIKOSOV and B. SHAPOSHNIKOV : Influence of the illumination of human skin on the adaptation of the eye during peripheric vision. The limit of the visual reception decreases after the insolation of the skin. This suggests that the ultra-violet rays produce certain substances in the skin which are absorbed into the blood and affect certain brain centres. P. LAZAREV : Laws of action of light on the eye and on the skin. The sensitiveness of the skin and of the eye to light is subject to analogous variations according to seasons, physiological state of the organism, etc. V. ALPATOV and O. NASTIUKOVA : Influence of ultra-violet radiation on the division rate of *Paramecium caudatum* in relation to temperature during and after radiation. A. BAJEV : Formation of ammonia and respiration in the erythrocytes of birds. H. J. MULLER and A. PROKOFJEVA : Continuity and discontinuity of the hereditary material. G. LEWITSKY and M. SIZOVA : Regularities in chromosome transformations induced by X-rays. R. DOZORCEVA : Artificial mutations in *Pteromalus puparum* induced by radium irradiation. The irradiation by β- and γ-rays intensified the mutation process, but many of the mutations are lethal. A. GUHL : Mutations produced by X-rays in the parasitic wasp, *Pteromalus puparum*. Results were similar to those described in the preceding paper. A. PROKOFJEVA : Morphological structure of chromosomes of *Drosophila melanogaster*. M. BELGOVSKIJ : Effect of hybridisation on mutability of the white gene in *Drosophila simulans*. It appears that hybridisation cannot increase the spontaneous mutation rate to a significant degree, and therefore it cannot be considered an important factor in evolution.

MELBOURNE

Royal Society of Victoria, December 13. LEO W. STACH : The genera of Catenicellidæ. The status of generic names applied to the Catenicellidæ is discussed, and a systematic synopsis is appended which includes descriptions of the new sub-families Catenicellinæ, Cornuticellinæ and Ditaxiporinæ. The following new genera are also described : *Carinatocella*, *Cornuticellina*, *Ditaxiporina*. The new name, *Carinatocella harmeri*, is proposed to replace *Catenicella carinata*, Busk, 1852 (non d'Orb. 1851).

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, **20**, 565–599, Nov. 15, 1934). T. E. STERNE: The accuracy of least squares solutions (see NATURE, Sept. 15, 1934, p. 421). GARRETT BIRKHOFF: Ideals in algebraic rings. NATHAN KAPLAN: V_3 in R_6 of $[1,2]_a$. P. A. SMITH: The fundamental group of a group manifold. H. S. VANDIVER: On the foundations of a constructive theory of discrete commutative algebra. H. B. CURRY: Functionality in combinatory logic. GEORGE H. SHORTLEY: The calculation of relative multiplet strengths in a transition array. S. S. STEVENS and E. B. NEWMAN: The localisation of pure tones. Tones were generated by a loud speaker, which was mounted on a 12-ft. horizontally rotating arm able to move round an observer on a platform 9 ft. above the roof of a building, thus avoiding reflection by vertical surfaces. The observer was asked to locate, by ear and without moving, the position of the loudspeaker working at different frequencies. Accuracy of localisation below 1,000 cycles and above 7,000 cycles is roughly the same; between 2,000 and 4,000 cycles it is relatively poor and a minimum. This suggests a dual mechanism for localisation: phase-difference at the two ears for low frequencies, and intensity-difference for high frequencies. G. H. PARKER: Acetyl choline and chromatophores. When protected from destruction in the blood by physostigmine, acetyl choline induces slight concentration of melanophore pigment in fish (blanching). Heavy doses limit heart action, and the resulting loss of circulation induces melanophore dispersion (darkening).

Forthcoming Events

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

Sunday, February 10

BRITISH MUSEUM (NATURAL HISTORY), at 3 and 4.30.—H. W. Parker: "Reptiles of Commerce".*

Monday, February 11

BRITISH MUSEUM (NATURAL HISTORY), at 11.30.—Miss L. E. Cheesman: "The Mountains of Papua".*

VICTORIA INSTITUTE, at 4.30.—Rev. D. E. Hart-Davies: "Biblical History in the Light of Archæological Discovery since the year 1900" (Gunning Prize Essay).

ROYAL GEOGRAPHICAL SOCIETY, at 5.—Major R. A. Bagnold: "The Movement of the Desert Sand".

UNIVERSITY COLLEGE, LONDON, at 5.—Dr. R. H. Ing: "The Chemical Structure of Drugs in relation to their Physiological Action" (succeeding lectures on February 18, 25, March 4, 11 and 18).*

Tuesday, February 12

PHARMACEUTICAL SOCIETY OF GREAT BRITAIN, at 8.30.—Sir Robert Robertson: "The Work of the Government Laboratory".

Thursday, February 14

LONDON MATHEMATICAL SOCIETY, at 5—(in the rooms of the Royal Astronomical Society, Burlington House, W.1).—Dr. Max Born: "Quantum Electrodynamics".

BEDFORD COLLEGE FOR WOMEN, at 5.15.—Comm. R. T. Gould: "Ways of Measuring Time—Modern Clocks".*

CHEMICAL SOCIETY, at 5.30.—(at the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1).—Prof. R. Whytlaw-Gray: "The Process of Coagulation in Smoke" (Liversidge Lecture).

ROYAL EMPIRE SOCIETY (EDUCATION CIRCLE), at 8.—Discussion on "How Africans Educate Themselves", to be opened by the Rev. E. W. Smith.

Friday, February 15

ASSOCIATION OF APPLIED BIOLOGISTS, at 2.30.—Annual General Meeting to be held at the Imperial College of Science and Technology, South Kensington, London, S.W.7.*

GEOLOGICAL SOCIETY OF LONDON, at 3.—Annual General Meeting.

J. F. N. Green: "The Moines" (Anniversary Address).

Official Publications Received

GREAT BRITAIN AND IRELAND

The Scientific Proceedings of the Royal Dublin Society. Vol. 21 (N.S.), No. 15: The Cellulose of Marine Algæ. By Dr. Thomas Dillon and Tadhg O'Tuama. Pp. 147–152. 6*d*. Vol. 21 (N.S.), No. 16: The Thermal Decomposition of Hydrogen Peroxide in Presence of Glass Wool and Copper Sulphate. By Dr. Kenneth C. Bailey. Pp. 153–164. 1*s*. Vol. 21 (N.S.), No. 17: On the Preparation and Properties of Alginic Acid and on the Extraction of Marine Algæ with various Solvents (Preliminary Note). By Vincent Barry and Dr. Thomas Dillon. Pp. 165–166. 6*d*. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.)

Modern Anthropology versus Biblical Statements on Human Origin. By Sir Ambrose Fleming. Pp. 25. (London: Victoria Institute.) 1*s*.

The Scientific Proceedings of the Royal Dublin Society. Vol. 21 (N.S.), No. 18: A Crate for the Collection of Fæces and Urine adjustable for Metabolism (Solid and Liquid) Experiments with Pigs, Sheep and Cattle of various Sizes. By E. J. Sheehy. Pp. 167–173. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 6*d*.

Weather Studies, No. 1: Unofficial Meteorology. By Sir Napier Shaw. Pp. 26. (Huddersfield: Thunderstorm Census Organisation.) 1*s*.

The Journal of the Institute of Metals. Vol. 55. (No. 2, 1934.) Edited by G. Shaw Scott. Pp. 304+17 plates. (London: Institute of Metals.)

Proceedings of the Royal Irish Academy. Vol. 42, Section B, No. 8: A List of the Irish Hemiptera (Heteroptera and Cicadina). By J. N. Halbert. Pp. 211–318. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 3*s*. 6*d*.

Annual Report of the New Commonwealth, 1933–1934. Pp. 64+5 plates. (London: The *New Commonwealth*.)

Report of the Television Committee. (Cmd. 4793.) Pp. 27. (London: H.M. Stationery Office.) 6*d*. net.

The National Institute of Industrial Psychology. Report 6: A Vocational Guidance Research in Fife. By Dr. F. M. Earle and J. Kilgour. Pp. 101. 4*s*. 6*d*. A Contribution to the Problems of Vocational Guidance in Great Britain. Pp. 27. (London: National Institute of Industrial Psychology.)

The University of Durham (Durham Division): Department of Science. Record of the Period October 1924 to December 1934. Pp. 21. (Durham.)

OTHER COUNTRIES

Osmania University, Hyderabad. Publications of the Nizamiah Observatory. Astrographic Catalogue 1900·0, Hyderabad Section (Part 3), Dec. + 36° to + 39°, from Photographs taken and measured at the Nizamiah Observatory, Hyderabad, under the direction of T. P. Bhaskaran. Vol. 9: Measures of Rectangular Co-ordinates and Diameters of 65,782 Star-Images on Plates with Centres in Dec. + 39°. Pp. xxv+239. (Begumpet: Nizamiah Observatory; London: Percy Lund, Humphries and Co., Ltd.) 15 rupees; 20*s*. net.

Conseil Permanent International pour l'Exploration de la Mer. Bulletin hydrographique pour l'année 1933. Pp. x+113. (Copenhague: Andr. Fred. Høst et fils.) 7.00 kr.

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