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The Philosophy of Sir James Jeans

It is commonly admitted that for some years past physical theory has exerted a predominating influence in general philosophic thought in Great Britain. It is a surprise, therefore, to learn that not for fifty years has a theoretical physicist presided over the British Association, and Sir James Jeans's graceful tribute to the late Sir William Hardy reminds us that even now it is partly by accident that the long period of exclusion has ended. Certainly the fact, which biologists rightly regret, that theoretical physics absorbs an excessive amount of the popular interest in science, cannot be ascribed to excessive opportunity for advertisement. In the circumstances Sir James has every justification for devoting the bulk of his address to the subject nearest his heart, the more so since the task fulfilled in the concluding paragraphs—which are, at best, an attempt to employ reason in a field where reason is particularly ineffective—can be regarded as little more than an acknowledgment of a formal duty.

It is superfluous to say that no commentary on modern physics would be read with more widespread interest than that of Sir James Jeans, but it is very pertinent to add that in fulfilling his duty in this respect he is entitled to more sympathy than he is likely to receive. In late years he has given ample expression to his ideas, and his writings have probably been read by all whom he might have expected to hear or read his address. No fundamental theoretical advances have recently been made, and he has therefore been given the problem of presenting the old truths in a new light. He has done this excellently. The substance of the address, in fact, attracts us less than the workings of the mind which made it, and if, as its author says, the present situation "seems likely to lead to radical changes in our views not only of the universe but also even more of ourselves", it is only fitting that we should welcome the opportunity of watching the ideas of one of the acutest minds in England in process of transition.

There are few minds more instructive to watch and none less wearying, for activity is its very essence. The yearning for new fields to explore which led Sir James, immediately after his triumphs with the old mechanics, to turn unregretfully to the new, shows no sign of abatement, and he is as ready to return to a discarded belief, if it shows new possibilities, as he was earlier to abandon it. This mental agility—or restlessness, to use a more exact word—is so characteristic that it is not inapt to speak of his mind as "for ever voyaging through strange seas of Thought, alone". The comparison with Newton thus suggested is, of course, extravagant, as Sir James himself would insist, but it is convenient because the contrast it evokes is so revealing. Newton, in all his voyagings, saw the boundary of the ocean as an immeasurably distant horizon: Sir James sees it as a bank of fog an arm's-length ahead. To adapt his own favourite metaphor, the river on which he floats perpetually winds, and he cannot imagine what is beyond the next turn. But it would be misleading to direct attention to this intellectual myopia without at the same time pointing out a still more striking quality—namely, the extreme clearness with which he sees the details of his immediate neighbourhood. In Newton's simile, he can only surmise that there is an undiscovered ocean of truth, but there is no better guide to the pebbles on the shore. It is this quality, coupled with the ability to translate vision into words, that captures the attention even of those with whom he is least *en rapport*.

It is important to say this, for otherwise the reader of the new address who has already read "The Mysterious Universe" may think that the change which he observes is a development of physical theory. He would be wrong: it is a development of Sir James's understanding of physical theory. On the question of determinacy, for example, the uncertainty of the former work, with its leaning to the negative side, has now become "complete determinism". It is true that this determinism is said to be different from the old, but, strictly, multiplicity of determinisms is meaningless. Events are either determined or they are not, and in adopting a determinism "which caters for those who ask the question 'What is going to happen next?' ", Sir James becomes definitely a determinist. The physics leading to the conclusion, however, has not changed.

Even more significant is the clarification of his ideas on the distinction between subject and object. In "The Mysterious Universe" this fundamental problem was discussed with no sign of a solution. Were electron waves subjective or objective? Were the waves of one electron in the same category as those of two electrons? Was an electron a particle or a wave and, whichever it was, was it independent of our minds? The darkness which called forth these unanswered questions is now broken by a beam of light—faint, indeed, at times, but indubitably light—which again no fresh physical progress has radiated. The task of physics, says Sir James, is that "of reducing to law and order the impressions that the universe makes on our senses", so that the objective element is our sensations and the subjective all that we contribute in the process of creating law and order. Even the inconspicuous intrusion of an undefined "universe" into this phrase is made innocuous by the pregnant remark that "the Nature we study does not consist so much of something we perceive as of our perceptions". Remove from this dictum the unfortunate vagueness contained in the "so much as", and it could not be improved. Objective Nature is our perceptions; theoretical physics with its matter, atoms, electrons, photons, waves, particles, ethers, equations, and what not, is subjective. The distinction between subject and object, a *sine qua non* of thinking, is restored, clear-cut and absolute. The expression of this achievement is admirable.

Admirable, too, is the likening of the atomism of physics to that of a sum of money: a better way of answering the question, Is the atomic theory true? is scarcely possible. The theory is true in the sense that a sum of money cannot be changed by less than the smallest coin, but if one expects the purchasing power of a shilling to be represented by a combination of the purchasing powers of 48 farthings, and offers, say, a farthing for p. 45 of "Macbeth", he will find that his notion signifies nothing. We need no longer discuss the objectivity of the electron.

Yet, in spite of this great development, Sir James's ideas are still in a state of transition. It is abundantly clear that remnants of the old uncertainty co-exist with the new conviction. Hence arise constantly in the address those infallible witnesses to uncompleted meditation for which contradictions is too strong a term and ambiguities too weak. This state of mind is seen in the removal of matter from objective Nature because it is unobservable, and the immediate introduction of a "mysterious world outside ourselves to which our minds can never penetrate", which obviously bears the same disqualification. It is seen in the appearance, within the compass of a hundred words, of the statements that matter is a pure hypothesis, and that we were wrong to confine it to space and time because it might also exist outside—as though a hypothetical entity could have objective properties. It is seen in the assertion that the electron exists only in our minds but we do not know what put it there, when it has already been made obvious that the need to reduce our sensations (that is, Nature) to law and order put it there. It is seen in the inconsistent remarks (again almost adjacent to one another) first, that in the new physics the mind is an "actor", and next, that it enters physics "only in its capacity as a receptacle".

The same inhomogeneity of thought appears when the possibility of making pictorial representations of Nature, which is removed in the body of the address (we "can never get beyond x, y and z"), is restored in the title. It appears also in the bewildering change of metaphor by which the modern physicist who, in contrast to the old, is represented as building "only on the solid rock, and with the solid bricks, of ascertained fact", is shortly afterwards said to be "concerned with appearances rather than reality". It appears again in the statement, reminiscent of "The Mysterious Universe" period, that "Heisenberg's mathematical equation shows that the energy of a beam of light must always be an integral number of quanta" instead of "the observation that the energy of a beam of light is always an integral number of quanta leads to Heisenberg's mathematical equation". It appears once more—but why continue piecemeal ? It appears, in brief, throughout the address.

Now unless one discerns the source of this welter of paradox one might easily dismiss the whole address as the product of an irresponsible trifler. No profounder mistake could be made. The confusion all proceeds from the fact that the new wine of Sir James's thought is not yet separated from the old bottles. He has seen light, but has not yet adjusted his eyes to a clear view of what it illuminates. Only one thing is needful to convert the apparently muddy swamp into an obviously crystal lake ; namely, the realisation that the truth at which he has arrived is an analysis of mind and not, as he tries to make it, an analysis of matter. Sensations on one hand and, on the other, rational thought "reducing to law and order" those sensations, are the products of a mental analysis, sensations being the object not of a vague undifferentiated "mind" but of that element of mind which reasons and produces theoretical physics.

This is the essence of Sir James's philosophy, and he has not realised it. 'Mind' throughout the address is used indiscriminately for that which perceives and that which conceives. The external world, he says, "is essentially of the same nature as mental ideas" ; and, the external world having already been identified as our perceptions, it follows that perceptions are of the same nature as ideas—which he does not at all mean. By the same oversight he speaks of "knowledge" without distinguishing the reception of sensations from the dawn of ideas. "Nature," he says, "consists of waves . . . of the general quality of waves of knowledge." But again, Nature being our perceptions, it would follow that whether or not I see Sirius when I look in a certain direction depends somehow on my knowledge of its co-ordinates. Sir James does not mean this. He is really thinking of electrons, not "Nature" : it is only our ideas, not our perceptions, that can be represented by "waves of knowledge".

This distinction is particularly significant in relation to the "two determinisms", which can scarcely fail to puzzle many readers. "Things still change solely as they are compelled," says Sir James, "but it no longer seems impossible that part of the compulsion may originate in our own minds." Now everything here depends on what is meant by "things". The uninitiated reader naturally identifies "things" with physical events ; but everyone knows that even if psychology allows us by taking thought to add to our own stature, we cannot thus add to the stature of Snowdon, nor does that stature change when we discover what it is. The content of our perceiving mind (that is, Nature) is given us independently of our will and our knowledge—except, of course, for such trivialities as that if I want to see a penny I can produce one and look at it. It is the creations of our *conceiving* mind that do not act independently of our knowledge of them, and from the proper view-point this appears entirely natural, if not obvious. "Nature no longer forms a closed system detached from the perceiving mind". True, because Nature is the content of the perceiving mind ; but it is still a closed system detached from our cogitations about it.

When Sir James has fully understood the implications of his beliefs—as so logical a thinker must inevitably do—one of the most salutary effects will be the cessation of the somewhat disparaging remarks concerning the 'old' science which he still makes. For indeed, what the 'new' science preaches is precisely what the 'old' science practised. Matter is a hypothesis and nature is our sensations, says Sir James, and no better illustration of this truth could be found than the science of the last 250 years. A billiards-ball and a piece of sugar, for example, are material objects, but did the 'old' science respect their individuality? Did it construct laws of billiards-balls and laws of sugar? Not at all. It ruthlessly broke up the association of white colour, cubical shape, hard feeling, immobility and the rest which make up the sugar, and, coupling the whiteness with the redness of the billiards-ball, made laws of optics; out of the immobility of the sugar and the rolling of the ball it extracted laws of motion; and so on. The naïve world of myriads of objects, each comprising a few sensations, was disintegrated, and the sensations were re-partitioned into a few groups each containing myriads of them.

There is no distinction between old and new science, except that the new has comprehended the old. It may be true to say that the older physicists did not know what they were talking about, but we must not omit to add that nevertheless they were talking sound good sense. We have not superseded their methods; we have simply understood them. Science has not apostatised; it has become self-conscious. For this reason we feel that when Sir James represents the former theoretical physics as a building in ruins, his customary aptness in illustration has deserted him. Much better is his later analogy of the cartographer. The last generation gave us a map of Surrey. We have now produced a map of Europe, but that of Surrey has not thereupon magically fallen to pieces: it still guides us unerringly to Dorking. Nor does anyone know better than Sir James that Newtonian mechanics, so far from being in ruins, is more firmly established than ever as the form taken in ordinary circumstances by the mechanics of relativity.

If, however, the address, as an *ex cathedrâ* statement, leaves something to be desired, there is, we repeat, abundant recompense in its promise of better things to come. If we are inclined to regret that the presidency of our greatest public scientific institution did not wait to adorn a maturer stage of Sir James's intellectual evolution, we draw comfort from the knowledge that other means of expression exist. Those who, oblivious to other considerations, can enjoy felicity of phrasing and ingenuity of illustration, will hear his latest utterance with undiminished pleasure; but when he attains to full consciousness of his own convictions, and to distinctness of vision adds depth of insight, the world will listen. H. D.

Principles of Regulation in the Organism

Features in the Architecture of Physiological Function. By Dr. Joseph Barcroft. (Cambridge Comparative Physiology.) Pp. x+368. (Cambridge: At the University Press, 1934.) 20*s*. net.

TO an outside observer who has had to use and study French, German and English textbooks and comprehensive treatises in the biological sciences, a very definite difference is apparent between the best specimens in each of the three languages, illustrating, I believe, the fundamental characteristics in science of three great nations. The typical French textbook is the 'traité pratique', describing with admirable precision instruments and methods by which results are obtained. The typical German book is the ponderous 'Handbuch' into which facts and results are crowded and systematically arranged. The typically English contribution is the 'Principles', written from a definite point of view and dealing with fundamental mechanisms.

Although the word itself does not appear in the title, the book here under review is a fine specimen of English 'Principles' and might have been designated "Principles of Regulation in the Animal Organism". The main thesis is developed in the three first chapters of the book, devoted to the discussion of Claude Bernard's famous dictum: "La fixité du milieu interieur est le condition de la vie libre". It is shown in these chapters that constancy of the internal environment is the result of an evolutionary process, that most animal functions are independent of such constancy, that a number of mechanisms exist by which lower animals are able to carry on and lead a fairly 'free' life in spite of large variations in the internal as well as the external environment, but that the higher nervous functions, developed especially in mammals (and birds), and constituting the essential basis for the existence of civilised man, do require the constancy within very narrow limits of the 'milieu interieur' as expressed by its chemical composition and temperature. The effects of variations outside these limits in temperature, hydrogen ion concentration and oxygen pressure, are known to Barcroft from personal experience. His discussion of them is most illuminating and should be carefully considered in any experimental study of the bodily functions in man.

Subsequent chapters deal with the mechanisms essential for maintaining the constancy of internal environment and cover a very wide field. It is pointed out that with an intermittent supply a constant internal environment can be maintained only by means of effective storage mechanisms, and these are discussed in three chapters with a wealth of important detail. The succeeding chapters on the integration of adaptation appear to the reviewer as especially significant. Activity of whatever kind demands or produces certain changes in the internal environment, and Barcroft shows how these changes involve always a number of separate factors in such a way that the change in each can be kept within those limits which are essential to the 'free life' of the organism as a whole. The discussion of the mechanisms of oxygen supply to the growing fœtus, involving shifts in opposite directions of the O_2-dissociation curves of the maternal and fœtal hæmoglobins, is especially fascinating and, of course, the adaptations to meet conditions of 'anoxia', a favourite object in Barcroft's own experimental work, are dealt with in a manner that leaves nothing to be desired. 'Anoxia', by the way, is a new and useful term, designating "any condition which retards the oxidation processes in the tissues".

One chapter (x) is devoted to a discussion of the 'all-or-none' relation. The connexion of this with the main theme of the book is not very apparent, although in a 'Handbuch' it would have to have a chapter, and my impression is that it is not yet ripe for really fruitful discussion. It may be something basal, but Barcroft believes it to be a specialised form of reaction.

The last chapter (xv) on "The Chance that a Phenomenon has a Significance" presents to my mind a peculiar charm. It points out several examples of 'accidents', like the yellow colour of the yolk in eggs, turning out to have a deep significance, and I emphatically subscribe to the last paragraph: "Accidents happen in Nature as elsewhere, but having regard to the above and other considerations, I range myself on the side of those who regard a phenomenon as more likely to have a significance than not. Those who think with me must shoulder the burden of discovering what the significance may be, but on our opponents rests the much heavier burden of proving the phenomenon to be an accident, if indeed it be such."

It is inevitable, when so many facts are marshalled, that there should be differences of opinion as to their significance. I do not find more than one or two points on which definitely to disagree with Barcroft, and a few more on which I should put the emphasis differently. Two examples will suffice. When the striking psychical effects of breathing air with 7·2 per cent carbon dioxide are ascribed to the resulting increase in hydrogen ion concentration, I would point to the fact, recently confirmed in Copenhagen, that the pH of the blood can be shifted considerably towards the acid side by taking ammonium chloride, without any disagreeable effects, and I would therefore take the carbon dioxide as such to be responsible.

In Chap. xii on "The Principle of Antagonism", where autonomic innervation is discussed, I believe that the modern views on neurohormones could with advantage have been taken as the starting point.

Barcroft's book is not very easy reading, but requires and repays careful study. A large number of experimental researches from many sources, including, of course, those originating in Barcroft's own laboratory, are discussed and made to form coherent pictures of absorbing interest in many cases, but the significance of these as illustrations of fundamental principles is largely left to be inferred by the reader. The inferences, it is true, are given briefly at the end of each chapter, but I for one must confess that I have had more than once to look over the field again in order to see the facts in the right perspective. Perhaps that is what Barcroft has meant those of his readers to do who are not bright enough to get the right viewpoint at once, but will they? My experience with the book is that it is certainly worth doing.

AUGUST KROGH.

International Quarantine Regulations

Office International d'Hygiène Publique. Application of the International Sanitary Convention of Paris, 1926. International Quarantine Directory (giving Information on the Equipment and Organisation of the Public Health Services of the Ports of Different Countries). Pp. xxxviii + 1039. (Paris: Office International d'Hygiène Publique; London: Dr. M. T. Morgan, Ministry of Health, 1934.) 21*s*.

A WHITE Paper published a few weeks ago (Cmd. 4650), giving the text of the "International Sanitary Convention for Aerial Navigation" signed at the Hague, marks a notable extension to air traffic of 'quarantine' measures which in one or another form have been imposed for centuries on arrivals from foreign countries by sea and land. Drawn up by the International Office of Public Health in Paris in consultation with representatives of the air services, the Convention provides the adhering countries with a practical code of action, defined in terms of maximum permissive action, which can be applied at aerodromes to foreign aircraft likely to be bringing exotic infections. An obvious example of the risk is the case when an air route enables persons or mosquitoes to be brought within two or three days from the West African countries where yellow fever has long been endemic, to East Africa or regions farther afield, which have never yet known yellow fever, but possess the necessary insect carriers as well as human populations which are all too liable to develop the disease in epidemic form, if once the infection is introduced.

The transmission of yellow fever receives special attention in the new Convention, but other infections, notified internationally and habitually guarded against at seaports, are taken into account. When, for example, a country abroad is suffering from severe smallpox or cholera, there are precautions which the health authorities at the aerodromes of arrival can and should properly take, and there are other forms of 'preventive' action which they should reject, even in face of temporary public outcry, as being unprofitable as well as vexatious. Good administration requires international understandings on all these matters.

The new sanitary code for air traffic has been made possible only by the previous overhaul of quarantine measures applied to ships which was undertaken when the general International Sanitary Convention was last revised in Paris in 1926. Important new principles were there introduced. Information about the prevalence of the chief diseases concerned is now exchanged, rapidly and regularly, between the health departments of different countries through the International Health Office in Paris, or its regional bureaux at Singapore, Washington and Alexandria—a system which enables much of the former unwieldy diplomatic procedure to be dispensed with, and saves the ship from many interrogatories and the production of health documents which were generally as useless in practice as they were venerable in origin.

Given the present system of international intelligence, ships are now dealt with according to the particular epidemic risk involved, while in place of measures applied indiscriminately to countries or vessels considered 'infected', the Convention has laid down agreed lines and limits of action dependent on the nature of the voyage and appropriate to the natural history of each infection. Plague now has its special quarantine measures based on rat proofing and rat destruction; typhus on disinsectisation; for cholera and smallpox there is a range of measures between the simplest form of medical inquiry and inspection and the 'observation' and bacteriological examination of persons likely to be incubating the disease, and so forth.

There can be no question of the benefits which the rationalisation thus effected in 1926 has brought to public health, shipping and to the convenience of the travelling public. But it is not to be supposed that all the ports in the world —even the largest—apply the international rules in the same way. There are endless differences in practice, some inherent in the physical configuration or arrangement of the port, some dependent on political engagements and peculiarities of its administration, and many which result from the nature of its principal commerce, its wireless communications, and its general equipment. The International Health Office has consequently done a very useful service by obtaining from one hundred countries and dependencies, covering practically every seaport of importance in the world, a summary describing, *inter alia*, its port sanitary services in general, the methods ordinarily adopted at each port on the arrival of ships, the ports which undertake systematic destruction of rats and the issue of certificates of rat-inspection, the ports which are open to infected ships, and the special agreements which have been made with other countries to facilitate quarantine operations.

The information, well put together under the title of the "International Quarantine Directory", makes a considerable volume designed primarily for the use of port health officers, shipping companies and ships' doctors. The labour involved in its preparation and its translation into English from the equivalent "Répertoire Sanitaire Maritime International", should, however, be repaid later in a wider sense. The different regulations and practices carried out under the name of quarantine and in the interests of the public health can now for the first time be examined as a whole. Their confrontation shows how often, notwithstanding the progress marked by the international agreement of 1926, there is still room for improved and simplified methods based not only on modern knowledge of the nature and transmissibility of infections, but also on the further development of the mutual confidence between the public health administrations of the world which this admirable little technical office in Paris has done so much to bring about in recent years.

The Extent and Causes of Poverty

The Social Survey of Merseyside. Edited by D. Caradog Jones. Vol. 1. Pp. xxii+328. 15*s.* net. Vol. 2. Pp. xvi+413. 21*s.* net. Vol. 3. Pp. xviii+560. 25*s.* net. (Liverpool: University Press of Liverpool; London: Hodder and Stoughton, Ltd., 1934.) 3 vols., 45*s.* net.

MR. CHARLES BOOTH'S great work "Life and Labour of the People", which described conditions in London forty years ago, and introduced the method of measuring the extent of poverty with reference to a defined 'poverty line', has had as its sequel similar studies in a number of towns, including the "New Survey of London Life and Labour", now approaching its completion. The School of Social Sciences and

Administration of the University of Liverpool, under the editorship of Mr. Caradog Jones, has now issued the results of four years' investigation on the social and economic condition of the working classes of Liverpool, Birkenhead and neighbouring smaller towns, assembled under the convenient name of Merseyside.

Though this inquiry includes a much fuller account of local public administration than do the others named, it is mainly on the same lines as the London studies, and since the same definitions of poverty, overcrowding, etc., are used as in London, and as in a recent work by Mr. P. Ford on Southampton, exact comparisons can now be made between the conditions in a number of great towns. It would be tempting to generalise to the whole urban population of England, if it were not for the fact that the proportions suffering from poverty in its various forms vary so greatly from place to place, that no general averages can safely be established. But while the percentages vary, the main causes of poverty and its visible effects are similar in all the towns in which investigations have been made, and some qualitative statements can be made which are probably true for industrial England as a whole. Here, however, we shall deal only with Liverpool, making some comparisons with London.

There is scarcely any question of current economic interest on which these volumes do not throw light. The chapters relating to housing problems, the extent and nature of overcrowding, and the number of, and provision for, subnormal and incapacitated people, are full of interesting detail; and there are many other sections of importance to those who have a practical interest in administrative and social problems.

The most generally interesting section is that relating to the extent and causes of poverty. Poverty is defined, as in all the recent studies of this kind, in relation to an intelligible but conventional minimum standard, computed with reference to the number, sex and age of persons family by family; the standard for food is barely up to that considered necessary especially for young children, though it is not a bare minimum since it takes as its basis the kinds of food which are usually purchased. The allowance for clothing, fuel and other necessaries is very low, and there is no margin for luxuries or for emergencies. For comparison between the towns to which it has been applied, it affords an adequate measurement. In Merseyside in the year 1929 or 1930 more than seventeen per cent of the working-class families failed to reach this standard, judging by their apparent income in the week of investigation, as compared with ten per cent in London at the same date. In 1932–33 the proportion must have been somewhat larger. In income is included receipts from pensions and from the unemployment organisation. It is nearly indifferent whether public relief or charity is counted as income or not, since these sums are rarely sufficient to raise a family above the poverty line.

The proximate causes of poverty can be classed under three main headings: non-existence of an adult male in full work, insufficient employment, and insufficient wages at full work. To the first of these was due the poverty of 5·4 per cent of working-class families in Merseyside, 5·2 per cent in London; to the second 10·9 per cent in Merseyside, 3·5 per cent in London; to the third 0·9 per cent and 1·1 per cent respectively. Lowness of wage-rates is no longer a major cause of poverty; it is replaced by unemployment. It must be remembered that these percentages apply to the working-class population, and they would be reduced if the whole population was brought into the account, in the proportion of about 6 to 5 in London, and probably to a similar extent in Liverpool. On the other hand, while a great number of incompetent persons are included in these figures of poverty, there is also an institutional population to be supported by public or private funds.

A considerable part of vol. 3 is devoted to the study of defective persons, to the consideration of how far they contribute to the poverty total, and in particular what is the extent of the group whose offspring are likely to swell the numbers of the incompetent, the poor and the deseased—characteristics which are certainly to some extent associated. A student of inheritance will find a good deal of material for consideration; but it is not arranged so as to be easy to use, and there are insufficient controls to bring the particular cases of inheritance, for example, of blindness, into relation with a normal population.

The final chapter, on differential fertility, establishes again the often stated fact that the economically undesirable classes are on the whole more prolific than the rest of the people, but it is doubtful whether the figures, even if retabulated so as to bring the problem into the right focus, could serve to measure the present or future effect of this differentiation.

Though all possible use is made of the census and other general sources, the more novel results are obtained by the same method of sampling as has been used in the London inquiry. This investigation appears to have been carried out very conscientiously and successfully, and, though the mathematical basis of the method is not discussed at any length, care has evidently been taken only to use results which may be expected to have sufficient precision.

Short Reviews

Adult Education in Practice. Edited by Robert Peers. Pp. xiv+301. (London: Macmillan and Co., Ltd., 1934.) 7*s*. 6*d*. net.

THIS book is a rather idealistic survey of the progress and practice of adult education in Great Britain. It is written by a number of heads of university extra-mural departments, all of whom have played a leading part in the national development of the movement and possess first-hand knowledge of its several aspects. As a description of the ideals, nature and activities of the movement, of the types of students involved, of the methods of teaching and of the qualities desirable or necessary in extra-mural teachers, the book is extremely interesting. It can be read with value not only by lecturers and tutors taking an active share in adult teaching but also by many academic professors, who often have little idea and less experience of adult education, and who sometimes show what can only be regarded as intolerance and a certain intellectual snobbery concerning it. Much academic teaching would be vastly improved if some of the pedagogic methods and ideals herein discussed were more widely realised.

Ideals and enthusiasm, however, are not enough, and the book would have been more valuable had it been more critical. The adult education movement has had a long and chequered career, and much progress has been made, especially since the War. The facts, however, that this progress has not been even more rapid and extensive and that many fields of knowledge, especially science, are still almost absent from the purview of the movement, suggest the existence of fundamental lacks and defects which need to be recognised and dealt with.

The last third of the book consists of various appendixes which bring together in convenient form various official regulations and prospectuses and useful lists of addresses and references concerning adult education. W. B. B.

A Textbook of General Botany: for Colleges and Universities. By Prof. Richard M. Holman and Prof. Wilfred W. Robbins. Third edition. Pp. xv+626. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1934.) 25*s*. net.

AN appendix of books for collateral reading makes this a good textbook for students reading for a general degree in the subject. The book itself is well written, with a good choice of subject matter. It is profusely illustrated, with splendid diagrams and photographs. Though written by American teachers for American students, the material for study is very general, and the types are those usually accepted for all students. A list of reference books is, of course, essential to students, but that given in this volume has a distinctly American character, which is a pity, since the book itself might be thoroughly recommended to British students, too. For a book of more than six hundred pages, with a wealth of illustrations, the price is reasonable.

Elementary Engineering Thermodynamics. By Prof. Theodore H. Taft. Pp. v+229. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1933.) 16*s*. 6*d*. net.

THIS book deals briefly with the fundamental principles of thermodynamics and their applications to some of the more common problems in mechanical engineering. The subject matter includes work on the general properties of gases and vapours; the flow of fluids through nozzles; elementary consideration of the steam turbine and reciprocating engine; refrigeration; fuels and combustion.

Although the author has presented nothing that is new, he has certainly made clear many points not easily understood by the student beginning this subject. The diagrams provided contribute largely to the utility of the work, and several problems have been fully worked out as illustrations of some of the more important and often less-understood principles. The book can be recommended to students reading for degrees and wishing to supplement their lecture course.

Traffic and Trunking Principles in Automatic Telephony. By G. S. Berkeley. Pp. xi+241. (London: Ernest Benn, Ltd., 1934.) 10*s*. 6*d*. net.

THE object of this book is to bridge the gap between theory and practice. To students and engineers of telephony it can be commended. The growth of automatic telephony has been marvellously rapid, and few outside the Post Office are aware of the numerous problems that had to be satisfactorily solved before progress could be made. Questions are often set on this subject in technical examination papers, and examples with answers are given at the end of the chapters. 'Trunking' in telephony means that branch of the subject that is concerned with the provision and arrangement of the plant required to carry the traffic with a specified grade of service. In the second edition, it would be useful if the author utilised some of the theorems given in the theory of statistics to 'holding time', 'traffic flow' and 'busy hour' problems.

Logic in Practice. By Prof. L. Susan Stebbing. (Methuen's Monographs on Philosophy and Psychology.) Pp. ix+113. (London: Methuen and Co., Ltd., 1934.) 2*s*. 6*d*. net.

THIS very able little book goes a long way to prove that logic is a human science, and not merely a more or less coherent collection of dry and irrelevant dogmas. The grounds of our beliefs, the purpose of thinking, the importance of form, and the fundamental principles of deduction and induction are analysed and explained in a way that should make their understanding easy and interesting. What adds to the value of Dr. Stebbing's book is the choice of the examples, which should make nonsense of the frequent reproach that formal logic is an idle game. T. G.

The New Elementary Particles

By PROF. E. N. DA C. ANDRADE

ABOUT three years ago, the first period of investigation of the structure of the atomic nucleus may be considered to have closed. This period, of which the achievements include the artificial disintegration of the nuclei by alpha particles, the investigation of the energies of the protons ejected from these nuclei and the first investigation of nuclear levels by means of the beta ray spectra, was characterised by the general belief that all nuclei were, in the ultimate, to be considered as being built up of protons and electrons. The only other particle of an elementary kind which was considered as a nuclear constituent was the alpha particle, and this was generally accepted as being itself built up of 4 protons and 2 electrons.

It was stated as axiomatic that the unit of mass was always found in conjunction with the unit positive charge, and that the electron, the unit charge of negative electricity, had no positive counterpart—the unit positive charge could not exist apart from matter, in the ordinary sense, or the unit of matter apart from positive charge. Not only have both these beliefs proved to be untenable, with the result that, as will be discussed later, the electron is no longer considered to be one of the ultimate constituents of the nucleus, but also a particle of mass 2 and charge 1, which is, then, an isotope of hydrogen, of double the mass of the ordinary hydrogen atom, has been discovered. The new particles—the neutron, the positive electron or positron, and the isotope of hydrogen—have recently been the subject of a number of important researches, and their discovery has, as is usually the case, solved certain problems, and raised a host of new ones in their place.

The discovery of the neutron was the result of work in Germany, France and England, but the critical experiments found Cambridge ready to recognise their implication, since, many years ago, Lord Rutherford had contemplated the possible existence of such a particle, that is, a particle having mass, but no charge, in contradistinction to the electron which has charge but no material mass. He had even looked for it, but without success. The first step towards the new discovery was furnished by the experiments of Bothe and H. Becker, who in 1930 were working on the effect of bombarding various elements with the alpha rays from polonium, which have the advantage of being free from the accompaniment of beta and gamma rays. They were looking for long-range protons on the lines of the experiments of Rutherford, Chadwick, Pose and others. They found that certain light elements, notably lithium, boron and fluorine, gave rays which passed through 2 mm. of brass, while beryllium was particularly productive of such rays. The rays were more penetrating than was to be anticipated of any known corpuscular radiation, and the experimenters assumed without question that they were gamma rays.

The work was continued by Joliot and Irène Curie-Joliot, who used a much stronger source of polonium and showed that the radiation excited in the beryllium nucleus could penetrate several centimetres of lead: since then, it has been detected through 30 cm. of this metal. The French workers found that the beryllium radiation could expel protons from paraffin wax, protons which they detected in a Wilson cloud chamber. The range of these protons was, however, such as to offer great difficulties on the supposition that the radiation was of a wave nature, impelling the protons by the Compton effect. It was left for Chadwick, who, within a day or two of the French publication, was experimenting on the subject, to point out that all the difficulties could be met if the radiation was of a particle nature.

Both a wave-packet and a particle can transfer energy and momentum to a second particle. In both cases a particle of a certain energy, $h\nu$ for a wave-packet, and approximately $\frac{1}{2}mv^2$ for a particle, strikes the proton, say, considered to be at rest: the result of the collision is that the proton moves off in a certain direction with a part of the energy, while the impinging unit moves off in another direction with the remainder. In the case of an impinging particle, however, the momentum is obtained from the energy by multiplying by 2 and dividing by the velocity of the particle in question (supposing that relativity considerations can be neglected), while in the case of the wave-packet we divide by c. Since we have to consider both energy and momentum equations, the laws of collision are clearly different in the two cases, one where we deal with particles only, and the other where we deal with wave-packets and a particle. Suffice to say that the observed range of the struck proton can be easily reconciled with the particle law, but not with the Compton, or wave-packet, law. The deciding factor is not a qualitative observation, which furnishes no criterion, but a quantitative measurement.

The particle concerned clearly cannot have any charge, or its interaction with matter would stop it within a small fraction, of the order of a hundredth, of the distance which it actually traverses in a metal. Since Chadwick's announcement early in 1932, neutrons have been produced from other light elements, for example, boron, and by other means than the impact of alpha particles, notably that of protons accelerated in an electric field. The equations for the transfer of momentum which established the particle nature of the neutron, also showed that its mass is approximately that of the proton. The exact mass of the neutron can be obtained by considering the masses of the particles concerned in its production ; for example, in the case of an alpha particle striking the nucleus of the 11 isotope of boron

$$_5B^{11} + {}_2He^4 = {}_7N^{14} + n,$$

the neutron being denoted by *n*. The masses being accurately known from Aston's measurements, and allowance being made for the mass equivalent of the kinetic energy, a value of 1·0066 was obtained by Chadwick, which has been confirmed by the consideration of collisions with other atoms*. Other methods give slightly different results, however, and while it can be stated that the mass of the neutron lies very close to that of the proton, there is some doubt as to whether it is slightly greater, slightly less, or equal to that mass.

The history of the positive electron starts with the experiments of C. D. Anderson, of Pasadena, who was using a Wilson chamber, operating in a magnetic field of some 15,000 gauss, to detect particles released by cosmic rays. The curvature of the tracks of the particles gives their energies, but the sign of the charge cannot be decided unless we know the direction in which the particle is travelling. Anderson found not only that a particle, which from the appearance of the track (density of ions) was an electron, could pass through a plate of lead 6 mm. in thickness placed across the chamber, but also that the curvature was markedly different on the two sides of the plate. Supposing, as is only natural, that the greater curvature is on the emergent side of the plate, we can at once deduce the direction of travel, which, in the case of one of Anderson's early photographs, implies a positive charge on the particle. The mass of the particle can be deduced from the fact that the velocity of a particle making a track of given curvature in a given field depends upon its mass, while the ionisation depends upon the velocity and the charge, but not on the mass. Ordinarily, the ionisation produced by a proton of given curvature of path will be much greater than that produced by an electron of the same curvature in the same field. Anderson concluded that he had a record of a particle of positive charge and of mass much less than that of a proton.

About the same time, Blackett and Occhialini were experimenting on the same lines with a chamber in a magnetic field, with the great advantage that, with the help of a coincidence method employing Geiger-Müller counters, they had devised an automatic release, the effect of which was that the expansion only took place on the passage of a cosmic particle, when they had something to record. They obtained records of groups of particles, often round about twenty in number, the tracks of which all radiated from a point. This furnishes a new type of evidence of direction of travel, since it is very difficult to imagine any mechanism which can lead to many independent particles all rushing to the same point. The groups, or 'showers' as the experimenters called them, are evidently produced by one cosmic ray particle of high energy interacting with an atom of matter in the neighbourhood of the chamber. By a consideration of the tracks in showers and of tracks passing through a plate of metal, of the ionisation, the field and the curvature of the tracks, Blackett and Occhialini were led to the conclusion that the particles had a positive charge of magnitude equal to that of the electron charge and had the mass of the electron. To such particles, the name positive electron or positron has been given. The same conclusion has been furnished by further experiments of Anderson. It is noteworthy that Dirac's theory had already, in a sense, predicted the existence of such particles, and also given a reason why they should only be observed under exceptional conditions, since their free life must be very short.

The discovery of the isotope of hydrogen, of mass 2, has been so recently discussed in NATURE (March 31, p. 481) that there is no need to trace its history. Let us call the nucleus of mass 2 and charge 1 a diplon, and write it $_1H^2$, while a hydrogen gas made up of molecules of this kind, $_1H^2{}_2$, we will call diplogen. The use of the new atoms as projectiles has led to very interesting results in the field of artificial disintegration. In the experiments of Lawrence, Lewis and Livingstone, of Rutherford and Oliphant, and of Cockcroft and Walton, bare diplons produced in a discharge tube are accelerated in a field of some hundreds of thousands of volts, and the stream is directed on to light elements. Nuclear reactions of the type

$$_5B^{10} + {}_1H^2 = 3\ {}_2He^4$$

have been produced, to be added to what is fast becoming a special chemistry of the nucleus. Oliphant, Harteck and Rutherford have been led by this type of experiment to the belief that the helium isotope $_2He^3$ can exist.

According to G. N. Lewis and his collaborators at Berkeley, a diplon has been recently disintegrated into two protons by proton bombardment, the energy of the impinging particles corresponding to 1·5 or 3 × 10^6 volts, so that in any case there is no need to consider it as a fundamental constituent of atomic nuclei. Lawrence

* See also NATURE, August 18, p. 237. Ed.

and his collaborators, and Cockcroft and Walton, have likewise found that the diplon is unstable in a strong nuclear field. As for the alpha particle, while it is convenient, especially for radio-active considerations, to regard it as a separate entity, there is little doubt that it is a particularly stable structure built of the fundamental entities of nuclear structure.

We are left then with the neutron and the positron as fundamental new particles to be added to the proton and the negative electron. Clearly, on paper, two or more kinds of these particles can be used to build up nuclei of any given mass and charge. Before the new discoveries, the proton and the electron were taken as basic particles: there is now a measure of agreement that the proton and the neutron are to be taken as the fundamental constituents of all nuclei, the electron as such having no existence in the nucleus.

The reasons that have led to this conclusion can only be very briefly indicated. One is that difficulties concerning the measured spin of certain nuclei, which arise if the electron be considered as a nuclear component, can be explained on the proton-neutron basis. Again, the number of particles in the nucleus gives a wrong type of statistics for the nuclear particles, as evidenced by the alternating intensities in band spectra, if the electron is admitted as a nuclear particle. For nitrogen, for example, the total number of nuclear particles should be even, as it is on the basis of 7 protons + 7 neutrons, while it is odd on the basis of 14 protons + 7 electrons. Another argument against the nuclear electron is furnished by Dirac's electro-dynamics, which leads to grave difficulties if we try to confine an electron in the limited nuclear space. A rough analogy, which must not be pressed, is offered by the classical treatment of the light quantum, which must travel and cannot be confined to one spot. Fermi suggests that the electron is ejected from the nucleus by a quantum switch somewhat analogous to that which ejects the photon, or light quant, from the atom. When a neutron switches over to a proton a negative electron is liberated; when a proton switches over to a neutron a positive electron is yielded. We can, then, think of neutron and proton as two different internal quantum states of one and the same fundamental particle.

Finally, a word may be said about the hypothetical 'neutrino', a particle which not only has not been detected, but may even be impossible to detect. The trouble is that the experimental facts of the beta ray spectrum are against the conservation of energy and momentum, both linear and angular: on the other hand, the conception of conservation is a valuable and familiar tool, the use of which is involved in all our usual atomic calculations, and the desire to preserve it justifies strange assumptions. Now the conservations can be retained even for the beta ray spectrum if we introduce a new particle with certain *ad hoc* properties. The mass must be much less than that of the electron, probably zero, like that of the light quant. The spin quantum number must be $\frac{1}{2}$, as with the proton and electron. The ionisation produced must be extremely minute, say one ion in a path of 150 km. in air at N.T.P., which is one reason why detection is so unlikely: further, any reaction with nuclei must be extremely small. A particle with these properties and lack of properties has been called a neutrino. An entity which it is practically impossible to detect is not a very attractive hypothesis, but in the present stage of development it is, to say the least, a convenient way of expressing our difficulties about conservation—of packing them all in one bag, as it were. The neutrino may be likened to one of the face-saving formulæ so popular with our statesmen: it may not solve any problem, but with a new word it stops troublesome questions for the time being.

Recent Gliding Performances and their Meteorological Conditions

By Sir Gilbert Walker, C.S.I., F.R.S.

The impelling force in the life of one at least of the ablest designers of sailplanes and aeroplanes is the desire to quicken and cheapen transport, with the object of facilitating acquaintance with other countries and promoting international good feeling. Whether the need of national defence is admitted or not, airmindedness is warmly to be welcomed, and far more people can cultivate it by sailplanes than by power-driven machines. But in Great Britain, habits change slowly, and comparatively few have realised the chances offered by gliding of indulging their love of adventure, or of developing the team spirit.

Even in Germany, where the movement secured a firm hold owing to treaty restrictions on power-flight, the removal of the restrictions ten years ago led to a critical period when the survival of gliding was in doubt: the situation was then saved by the formation of the Rhön-Rossitten Association, with a material subsidy from Government, a central institution for research, and the consequent growth of technical ability. In England, growth has naturally been dependent on local enthusiasm: of the clubs that were started, many lasted long enough to train their members to glide downhill for short periods: but it is soaring that is the soul of the movement, and the transition to this has in many cases involved great difficulties. Soaring requires machines that are more costly to buy and to maintain, suitable sites and increased facilities for repairs and for teaching. When, however, the onward march has begun, every step forward makes progress easier. At the first gliding competition at the Wasserkuppe in 1920, the record flight was only of 2 min. 22 sec. duration and 1,830 metres length; in 1922, the distance record was 6 miles; in 1925, 12 miles; and in 1930, 60 miles. Since then the use of the ascending columns under cumulus clouds, of the upwinds in front of line-squalls, and of local convection currents, has greatly extended cross-country flights; and the record at this year's competition was 235 miles.

Recent British performances have shown skill comparable with these: and in several long flights the limit has only been imposed by the dimensions of our island, the flights appearing capable of indefinite extension, but for the need of alighting on reaching the coast. Thus in 1933, near Marlborough, Mr. G. E. Collins climbed in a two-seater to 2,150 ft. with very little wind and no clouds, by the use of thermal currents. In March this year, Mr. P. A. Wills reached 4,600 ft. in a journey of 55 miles, and Mr. Collins covered 45 miles with a passenger. But the climax came on August 5 last, when Mr. Wills climbed from Sutton Bank, near Thirsk, to 6,000 ft. above sea-level; and Mr. Collins flew 98½ miles from Dunstable to the coast near Hunstanton. Both Mr. Collins and Mr. Wills have been awarded the 'Silver C', the most advanced certificate attainable, of which there are only about thirty holders in the world.

These performances are of the happiest significance as evidence that gliding has taken root in England; and they raise questions of considerable physical interest regarding the extent and origin of the up-currents that make them possible. Both pilots have been good enough to provide me with notes on their flights, and on these the following accounts of the conditions are based.

At Sutton Bank, there is a steep semicircular amphitheatre or bowl facing west, where the ground rises from 350 ft. above sea-level to 950 ft. There was on August 5 a light south-south-west wind of 5–10 m.p.h. with fairly developed cumuli at about 4,500 ft. On the upward wind-component made by the impact of the air on the slope, the ordinary 'hill-lift' would have raised the sailplane to 100 ft. or so above the crest. Mr. Wills "kept on getting thermal lift [that is, on convection currents] and circling up to about 3,000 ft., starting over the valley and finishing about a half-mile 'inland', when the lift would fade out. . . . There was blue sky over and round the bowl, cumuli everywhere else." In the meantime, Mr. Dewsbery had started near the north end of the bowl and struck a 'thermal' quite low down; at a time when Mr. Wills lost his lift and began to descend very fast, 10 ft. a second sometimes, his companion went on climbing, shot vertically past him half a mile away and finally went off across country; he could find lift in any direction and finally landed near Bridlington, about 55 miles away. About one and a half hours after this loss of height, Mr. Wills struck an up-current about a mile 'inland' which took him right up to a cumulus, whereupon he hastily left it. The rate of climb averaged 4–6 ft./sec. below the cloud and in it "he could not evade about 12–14 ft./sec."; to get the upward velocity of the air there must be added to these figures the sinking speed of the sailplane, or 3 ft./sec.

The pilot's anxiety to keep out of the cloud was not unnatural. Thus on July 15, in order to get out of a cloud, Mr. Wills had pushed the stick hard forward, so as to dive rapidly. The speed went up to 50 m.p.h., but the rate of *climb* was still 5 ft./sec. The stick was pushed yet farther forward, the speed rose to 70 m.p.h., and still rising slowly he shot out of the side of the cloud; on this the machine started descending at a rate beyond the range of the indicator! This contrast of the vertical currents on the margin of a cumulus cloud is well known to advanced pilots.

Let us consider how far these experiences agree with ordinary meteorological ideas. It is known that, apart from heat effects, a very light wind blowing across a ridge with gently sloping sides will flow without turbulence and with stream-lines tending to be parallel to the slopes. If the wind is strong, or the slopes steep, an eddy will form on the lee-side which produces a down current dangerous to aviators. The lift produced by the upward component on the windward side will raise a glider above the crest to a height (the hill-lift) dependent on the conditions, but something like a quarter of that of the ridge.

Thermal currents will considerably modify the previous effects, and may be produced in two ways. Above an area that is more strongly heated by the sun than its neighbourhood, there will be an upflow recognisable by the soaring of birds or the bump experienced by aircraft. Typical sites are a dry or rocky area, or a town surrounded by cultivation; the opposite occurs over a lake. Similar results are produced by the temperature contrasts between slopes facing the sun and those inclined away from it: in the tropics, up and down currents exceeding 5 ft./sec. are caused soon after sunrise in this way. The ground on the top of a hill in sunshine will be hotter than the surrounding air at the same level, and this explains the frequent attainment by sailplanes of heights far in excess of those due to hill-lift alone. The heating of the air is due to conduction and is determined by the temperature of the ground: its power of radiating heat to the air is immaterial.

The second way in which thermal currents may form is to be found over a large flat area in which, owing to heating from below, the air conditions are unstable. The equilibrium breaks down by the formation of columns of uprush, with slow descent in the interspaces. If there is a slight breeze, these columns will move with it; but those of the first type would be anchored at their base and incline forwards with the breeze. The columns may extend high enough for condensation to occur. Isolated columns will then produce cumulus clouds, but columns of the second type tend to form in a geometrical pattern and the clouds are then strato-cumulus, arranged either in lines or in a rectangular pattern: in this last case, however, the pattern is at times not conspicuous and the clouds are wrongly classed as cumulus.

When vertical instability is combined with hill-lift, the joint effect depends on circumstances. Sometimes there is an eddy on the windward side of the hill with an area of down-draught as well as a bigger one of rising air; and sometimes the ordinary stationary eddy producing a descending current on the lee-side is replaced by a series of such eddies travelling with the wind.

Normally, in England the vertical temperature gradient is less than the unsaturated adiabatic of 10° C. in a kilometre; but it is usually greater than that of the saturated adiabatic of about 6° in a kilometre. Accordingly, if the uprush extends to the dewpoint level, it will thereafter meet with greater instability—as was indicated by Mr. Wills's upward air velocities of 7–9 ft./sec. below and 15–17 ft./sec. in the cloud. He agrees with me in thinking that up-currents adapted for soaring occur on days when the lapse rate is considerably less than the dry adiabatic. On August 5, the information available regarding upper air temperatures indicates a vertical gradient of only about 7° a kilometre: winds were also normal in type.

Naturally, up-currents are much stronger in the tropics than in temperate latitudes: accordingly, the German gliding expedition to Brazil found no difficulty in soaring to 5,000 ft., and on one occasion reached a height of 12,600 ft. Such soaring was only possible in a land-wind; a sea-wind brought in cold air below which led to greater stability and compelled immediate descent.

With reference to Mr. Collins's experience, the problem of cross-country flying turns on that of finding sufficient rising columns. One method is to soar as high as possible in an up-current (often called a 'stepping-stone') and then to glide nearly horizontally until another up-current is found; soaring is performed on that and the process repeated indefinitely. As the angle of descent should not exceed 1 in 15, a climb of 2,000 ft. means a horizontal distance of nearly six miles; and this should suffice for finding another 'stepping-stone'. A second method for a skilled pilot is to travel in the ascending air in front of a line squall as it moves across country. A third method was foreshadowed in one of the Royal Aeronautical Society's lectures in 1933, and consists in using the up-current under a longitudinal 'cell', that is, one of the long straight strato-cumulus rolls, usually parallel to the wind and now called by English gliders a 'wind-street'. This assists further search for 'stepping-stones', but the direction of travel is prescribed. If freedom in this respect is essential, the first method must be followed. Thus on July 15, Mr. Collins flew in a west-south-west wind from Dunstable to Hanworth, which lies south-south-east of the starting point, in a direction at right angles to the wind. One ingenious plan to lessen the trouble of finding 'thermals' is that of a distinguished pilot at Rossitten, who has trained hawks to accompany him in his flights; these unconsciously show him the up-currents which they employ.

On August 5, Mr. Collins started at 10.45 from the bowl at the north end of the Dunstable ridge and spent half an hour before a cloud enabled him to circle up a thousand feet. A series of clouds used as 'stepping-stones' are clearly indicated on the record of his 'altigraph', and by them at 11.30 he had reached a height of three thousand feet above his starting point. He then made use of a 'cloud-street', the altigraph showing a rhythmic series of ups and downs. More 'cloud-hopping' brought him to another 'cloud-street', which by 13.15 hr. was higher than the former and carried him along at a height of nearly five thousand feet. Having no parachute and not wishing to fly in the clouds, he had at one stage to travel at 70 m.p.h. to keep out of them. His downward glide lasted until he was at 1,500 ft.; he was then over sandy, dry heath and there found a 'thermal' which took him again to cloud level. The flight had to end when he reached the sea, and being still high he looped down, landing after 4½ hours in the air on the beach at Holkham Bay.

It would appear that most of the methods of using up-currents for cross-country flight have now been tackled. Perhaps the next problem is that of 'dynamical flight'—the use of variations in the horizontal velocity of the wind, as in the non-flapping flight of birds in gusty weather under overcast skies.

Obituary

PROF. M. S. PEMBREY, F.R.S.

MARCUS SEYMOUR PEMBREY succeeded Starling as professor of physiology at Guy's Hospital, London, in 1899 and retired after thirty-four years at that post last year. For most of this time he lived on a small farm in Sussex, which with little help but that of his family he worked himself. It was almost a principle with him that the physiological life could be lived only in the country, and even then only by those who, so far as possible, produce the food necessary for their own life. He seemed to enjoy the sturdiest of health and it was a great shock for his friends to hear of his death, at the age of sixty-eight years, in a nursing home at Oxford on July 23, barely a year since his retirement to a farm in Wychwood Forest on the Cotswolds.

Pembrey, after graduating in medicine at Oxford in 1892, worked with J. S. Haldane in Burdon Sanderson's laboratory for three years, and was then appointed lecturer in physiology in the Charing Cross Hospital Medical School, where he stayed until he went to Guy's four years later.

The work which Pembrey began with Haldane at Oxford he continued for some years after he moved to London ; in fact, throughout his whole career the field in which he worked, though its boundaries grew, was essentially the same. In his early work, by weighing the carbonic acid expired, he studied the reaction of animals to changes in external temperature, and was able to trace the acquirement of the power of regulating body temperature. For this he compared the chick before hatching and at different intervals after it, and also new-born mammals and the same animals some days later.

Some of Pembrey's most interesting observations were on the respiratory activity of hibernating animals, dormice, bats, hedgehogs and marmots, during their sleep, during the process of waking and after it. He recorded the type of respiratory movements, the activity of respiratory exchange and the relation between the carbonic acid formed and oxygen used. This relation, the 'respiratory quotient', he found to be far lower during the winter sleep than was compatible with the complete oxidation of foods ; some intermediate product of oxidation was retained in the body : on the other hand, during the period before the sleep came on, when the animal was putting on fat, it was higher than the oxidations alone could account for. He was convinced and stoutly maintained to the end that these facts necessitated the belief that, in the former condition, fat was being converted into glycogen and in the latter the converse change was occurring. These views he supported by many other experiments.

Later, Pembrey was one of the first to seize upon the methods introduced by Haldane and his pupils for obtaining alveolar air and collecting the whole expired air from a man in all sorts of circumstances, to study the respiratory activity of men during exertion, in the state of 'second wind', and also in various pathological conditions.

In 1898 Pembrey contributed two important chapters to Sharpey-Schafer's "Textbook of Physiology" on the chemistry of respiration and on animal heat respectively. These will always be valuable to students of nineteenth century physiology. They were subjects which he had even then made his own, and on which all his most important later work had direct bearing.

MR. J. W. E. HEATH

THE death occurred, on July 24, at Oxhey, Herts, after a brief illness, of Mr. John William E. Heath, at the age of seventy-eight years. A Londoner, he was born in 1856 at 33 Upper Gloucester Place, Dorset Square. He retired from staff duties at the Royal Institution in 1925, after forty-six years' service, which began with an engagement as a junior helper in the laboratory there, entering with some previous apprenticeship in assaying. In later times he acted as lecturer's assistant in the historic lecture theatre. Heath had in turn seen eight years' service with Prof. Tyndall, thirty-six years' with Sir James Dewar, and two years' with Sir William Bragg.

As the helper and advisor of two generations of the leading men of science in their lectures and accompanying experimental demonstrations at the Institution, it would be true to say that he was eminently successful. Of placid disposition, endowed with abounding patience, he was specially competent to carry out the varied duties falling within this particular sphere of work. Elected into the Chemical Society so far back as 1891, Heath's certificate for fellowship stated that he had had great experience as an assistant, and had given valuable aid in all the original investigations conducted at the Royal Institution for the previous ten years. The signatures appended were : James Dewar, F. A. Abel, G. D. Liveing, W. C. Roberts-Austen, Ludwig Mond.

Heath lost an eye in an explosion of a glass cylinder at the Royal Institution (about 1904), during the course of experimental work for the purification of helium (tediously accumulated from the 0·1 per cent source from the King's Well, Bath). This misfortune he bore with a calm philosophy, not unmixed with an amused sense of the impeachment of friends that one eye seemed to serve him equally as two. He had held an appointment as a gas examiner under the Hertfordshire County Council for an extended period, and was, in fact, at work in such capacity to within ten days of his death.

We regret to announce the following deaths :

Sir Edgeworth David, K.B.E., C.M.G., emeritus professor of geology in the University of Sydney, known for his work in the Antarctic and on the geology of Australia, on August 28, aged seventy-six years.

Prof. Carl Jensen, director of the Serum Laboratory in the Royal Danish Veterinary and Agricultural Institute, Copenhagen, a pioneer in cancer research, on September 3, aged seventy years.

News and Views

Prof. I. P. Pavlov, For.Mem.R.S.

WE join with men of science the world over in congratulating Prof. Pavlov on the attainment of his eighty-fifth birthday. His devotion to, and understanding of, physiology appear to have revealed to him the secret of normal living even under the adverse conditions of the changing political states of his native land. He looks upon the Revolution as a grand-scale physiological experiment, which everyone hopes will ultimately turn out as successfully as Pavlov's experiments. The son of a village priest, Ivan Petrovitch Pavlov was born on September 14, 1849, and qualified in medicine in 1879. Then began his physiological career, which happily still goes on. Possessing a highly critical, yet productive mind, his investigations were prosecuted with extreme care, and his findings have consequently withstood the test of time. His additions to the knowledge of the working of the living body are of considerable magnitude and of the first order of importance, not only to physiologists but also to medical men and psychologists. The possession of the rare combination of a keen intellect with surgical skill and mechanical ingenuity led to important discoveries in the normal processes of digestion.

PAVLOV realised at an early stage of his career that the mode of working of an organ in the normal living body may be quite a different affair from the behaviour of the same organ under artificial conditions of isolation in a strange medium. His studies were carried out on normal dogs and he exploited the natural appetite of dogs for his researches. After the preliminary operation of bringing the duct of a salivary gland to the outside of the cheek or neck, or arranging an external opening for the stomach, complete healing was ensured and the dogs taken home to be well cared for with the aid of his wife and children. The dogs were trained to allow the attachment of bottles for the collection of juices and to a sound-proof room fitted with many silent and ingenious devices, for example, pneumatically operated feeding tables. Always exercising the greatest care to eliminate extraneous factors, Pavlov achieved his aim of studying the effect of one cause at a time even in such a complicated machine as a healthy living dog. Pure gastric juice was made available, and the part played by nervous action on the composition and flow of digestive juices could be assessed. This led on to the analysis of the rôle of the higher centres of the nervous system in secretory activity and formed the test method in his investigation of conditioned reflexes. The latter constitutes one of the most valuable contributions to the understanding of the working of the brain, and is a great step forward in the placing of psychology on a scientific basis. Prof. Pavlov figured as a "Scientific Worthy" in our issue of January 3, 1925, when an article on his life and work by the late Prof. E. H. Starling was published.

George Bentham (1800-84)

SEPTEMBER 10 is the fiftieth anniversary of the death of George Bentham, whose "Genera Plantarum" is still regarded as the standard work on the subject. Born in 1800 at Stoke, near Portsmouth, Bentham (who was a nephew of Jeremy Bentham, the distinguished jurist) in his earlier years studied law and philosophy. Though called to the Bar, he soon abandoned law for botany. He was elected a fellow of the Linnean Society in 1828, and in the following year became honorary secretary of the Horticultural Society. He travelled extensively, making botanical collections, which he ultimately presented to the Herbarium at Kew. Between 1832 and 1836 he published his important "Labiatarum, Genera and Species". He became friendly with Sir Joseph Hooker, director of Kew Gardens, who assisted him in the compilation of his greatest work, the "Genera Plantarum", which appeared at intervals between 1865 and 1883. From 1854, he was engaged at Kew, working quietly and systematically at the description of flowering plants. Here he assisted in the preparation of floras of the British Colonies. Bentham's "Handbook of the British Flora" (published in 1858) is still the standard guide to the naming of the native plants of Great Britain. He tells us that he "amused himself by writing it before breakfast". He was president of the Linnean Society from 1861 until 1874, and was made a fellow of the Royal Society in 1864. In 1878, on the completion of his labours on the Australian flora, he was made C.M.G. He died at Kew.

Centenary of the Death of Thomas Telford

ON September 2, Sir Henry Maybury, president of the Institution of Civil Engineers, placed a wreath on the tomb of Telford in Westminster Abbey, while Mr. W. H. Budgett, divisional inspector in Scotland for the Ministry of Transport, placed a laurel wreath at the memorial seat at Westerkirk, Dumfriesshire. Born at Westerkirk in 1757, Telford was educated at the parish school, and when fourteen years old was apprenticed as a mason. Down to 1783 he was a workman employed in his native district of Eskdale. Leaving home, he studied architectural and structural design at Edinburgh, proceeding afterwards to London, when he embarked upon the career which ultimately brought him fame and honour. The Institution of Civil Engineers began to take shape in 1818, and on February 3, 1820, the group who were fostering a scheme of association resolved to ask Telford to become their first president. Telford accepted, and gave an inaugural address, providing his colleagues with much counsel for the future. At the same time, he presented a large collection of books and drawings with the object of founding a library. There is a fine portrait of Telford in the Institution's house at Great George Street, by Lane, showing him seated; in the background is a view of Menai Bridge. Most of the exhibits of the Telford Centenary Exhibition in London have been re-arranged at Aberdeen for the benefit of members of the British Association.

Scientific Institutions in South Africa

AT a meeting of the Royal Society of South Africa on June 20, Mr. L. Crawford read a paper on the South African Literary and Scientific Institution (1833–1857). The South African Literary Society was started in 1824; John Fairbairn and Thomas Pringle were two of its sponsors, but it encountered the hostility of the Governor, Lord Charles Somerset. He refused to grant it a licence and the project was dropped until 1829. The Society then began to hold meetings, papers were read and prizes offered for essays, one of these being limited to students of the South African College, founded in the same year. The South African Institution was founded also in 1829 on the same lines, and in 1832 the two societies amalgamated, becoming the South African Literary and Scientific Institution. Reports of the meetings and papers read appeared in the *South African Quarterly Journal*, but in 1835 that *Journal* came to an end and information about the later history of the Institution is difficult to find. The Institution's own minute books, etc., have disappeared. In 1834, Sir John Herschel arrived in South Africa. He was a strong supporter of the Institution during the four years he was there; for nearly three years he was president. He specially pressed the claims of meteorology on the Institution. In 1836 the *Cape Almanac* speaks of the rooms of the Institution and its Museum. After 1838 it is certain the Institution declined, so much that in 1850 John Fairbairn suggested in the *Commercial Advertiser* that a new Institution be formed and for permanence should be attached to the public library. This appeal met with no response. The Institution disappeared from the list of societies in the *Almanac and Annual Register* in 1858, so it may be taken that it came to an end in 1857, but from the first annual report of the South African Museum in 1856 it is learned that, in the previous year, what was left of its collections, books, etc., had been handed over to the Museum.

River Gauging

THE agitation on behalf of the establishment of a national Inland Water Survey will be supported during the meeting of the British Association at Aberdeen by a series of demonstrations of the process of river gauging on the River Dee, which are being undertaken by Capt. W. N. McClean with the aid of his apparatus, employed on the survey of the Ness Basin, and apparatus used by Prof. S. M. Dixon in connexion with gaugings of the River Severn. The demonstrations will take place on September 11 and other dates, as may be found desirable, at Woodend, above the Cairnton Intake of the Aberdeen Water Supply, the water authority of Aberdeen having kindly co-operated in providing a site for the gaugings and by installing two water-level recorders at Cairnton and Cults. Woodend Reach is of the 'pool' type and about 200 feet in width at normal water level. The maximum surface velocity is expected to vary from 3 ft. per sec. at low water to 10 ft. per sec. on a normal flood. At low water the depth on the section is 3 ft. over the greater part with a deeper strip on the south side. The two types of gauging apparatus to be employed are (1) the Ness Basin type consisting of a ropeway, twin punts and stream-lined rod with current meter on the lower end, and (2) the Severn type, consisting of a ropeway with suspended current meter and sinker weight. A comparison of the two methods under identical conditions promises to provide useful data for inland water survey purposes.

A Survey of Aberdeen

FOR the Aberdeen meeting of the British Association, a pamphlet has been prepared entitled "A Scientific Survey of Aberdeen and District", and presented to all members. This marks a continuation of the policy adopted last year at Leicester. These slight volumes of uniform size and type are more convenient and, be it said, more useful than the varied and often ponderous handbooks that in former years were distributed at each centre of meeting. The new series gives a wealth of information without a bewildering mass of detail. Various authors have contributed to the work: Mr. J. McFarlane contributes a geographical introduction, followed by Prof. A. W. Gibb and Dr. A. Bremner on the geology, Prof. J. Ritchie on the animal life and Mr. A. MacGregor on the flora. A number of articles treat of archæology, agriculture and the various industries of the town and district. Many members will turn with interest to the chapters on the fishing and granite industries which have done so much for the modern development of Aberdeen. The article on the trades shows, however, that Aberdeen has various other thriving industries, some with obvious local associations such as shipbuilding and fertilisers and others of more recent development. A final chapter gives biographical notes on some of the better-known men of science associated with the north-east of Scotland.

Alcoholism and Male Mortality

AN informative paper on this subject was read by Dr. Rudolf Bandel, of Nuremberg, before the recent International Congress on Alcoholism held on July 30–August 3 in London. Prof. Bandel stated that Hindhede in 1923 was the first to demonstrate the considerable fall in the male death rate in Denmark associated with the decrease in the consumption of alcohol brought about by the War. A similar fall in the male mortality along with decrease in alcohol consumption has been observed elsewhere, for example, in Germany, Belgium, Sweden, Hungary, the United States, and in a lesser degree in Switzerland, Holland and Norway. It was not so marked in the last three countries, because either, it is suggested, the decrease in alcohol consumption during the War was not so pronounced, or else the alcohol consumption before the War was not so high as in the other countries. On the other hand, in countries such as Italy and Spain, which did not reduce their alcohol consumption during the War, the male mortality has not fallen but rather risen, especially in Spain, where the consumption of alcohol since 1919 has been very considerable. Population statistics show that the death rate of married men is less affected by the alcohol curve than that of widowers, divorced persons and unmarried men, who are all more susceptible to the influence of alcohol. Moreover, the specific mortality of Jews, whose sobriety is proverbial, scarcely fell at all as the result of reduced consumption during the War, in contrast with that of the Christian population of the same region in Prussia and at Budapest. Dr. Bandel also pointed out that remarkable variations might be found in the male mortality due to various causes under the influence of alcohol consumption, especially in the case of suicides and deaths from accidents, pneumonia, tuberculosis and diseases of the digestive organs.

Recent Archæological Exploration in Great Britain

THE month of August, as usual, has been fruitful in results of archæological exploration on sites in various parts of Great Britain. Among the more important, Dr. R. E. Mortimer Wheeler's excavation of the great earthwork of Maiden Castle provides abundant material bearing on the Roman and pre-Roman occupation of the site. The discovery of four gold coins of the fourth century and a gold ring as treasure trove have necessitated an inquest in which the Prince of Wales, as owner of the land, is interested. It is anticipated that these objects will be handed eventually to the Dorchester Museum for custody. Evidence of a stone age settlement has been found, and it is expected that the excavation of the ditch now being undertaken will throw light on the origin of the work. Another hill-fort site will be available for the inspection of members of the British Association attending the Aberdeen meeting. This is the prehistoric fort on Finavon Hill on the main road from Aberdeen to Forfar at the entrance of Strathmore, which recently has been under excavation by Prof. Gordon Childe. On the hill-top are the remains of ramparts, still 12 ft. in height, but which, it is estimated, once stood nearly 20 ft. high by 20 ft. thick. The stone coping exhibits the curious character of vitrification, due apparently to exposure to intense heat, occasionally found in these Scottish forts. In the course of the excavation, pottery, flint implements, spindle-whorls, broken animal bones and a little iron were found; but there is nothing which would make it possible to assign a date to the fort with any certainty. It is, however, thought to be pre-Roman, rather than Roman, in dating. A brief account of the exploration of the fort appears in the *Times* of August 30.

MORE satisfactory, though still not very precise, evidence of dating has been obtained in the excavation of a hill fort at Breddin Hill Camp, Montgomeryshire, where of three phases of occupation, two are certainly pre-Roman, while the latest is characterised by the occurrence of fragments of late Romano-British wares, probably made on the hill, though whether after the Roman evacuation is still undecided. In an account of this, the second, season's exploration in the *Times* of August 31, it is stated that, up to the present, work has concentrated on the main entrance to the camp, which is of a somewhat unusual type. It is an incurved entrance, but is complicated by the fact that a rampart leads down from it on either side of the road of approach. Near the gate, the stone walling had been reinforced by some form of timbering, the main posts resting in holes. There were no guard chambers. This gate was evidently pre-Roman and showed no signs of reconstruction. At the back of the incurve of the eastern rampart was a hut contemporary with it, and nearby was another and later hut, representing the second phase. This, the six post holes suggest, may have been circular in form. A potsherd of Early Iron Age type points to a pre-Roman dating. Trenches dug across two of the ancient field divisions revealed that here, as elsewhere in Britain, the cultivation terraces are the outcome of the methods of primitive agriculture on the hillside. When ploughing caused the soil to travel downhill, the low retaining walls were gradually heightened with stones.

Russian Studies of the Stratosphere

WE learn from an article by Prof. P. A. Molchanov in the *Moscow News* that the recent All-Union Conference for the Study of the Stratosphere decided to call an international conference, with the same objects, to meet in the U.S.S.R. in 1936, the date to be fixed in relation to the total solar eclipse. The Soviet conference of last spring was mainly devoted to a review of the present state of knowledge of the problems of the extra-tropospheric regions of the atmosphere, with some references to their relation to the meteorological processes of the troposphere. Molchanov dealt with exploration by *ballon sonde* and *radio sonde*, and with the rôle of the stratosphere as stabiliser in atmospheric processes. Andriev discussed acoustic methods of investigation, and attention was specially directed to the prominence of the warm sound-reflecting regions during the polar night, at heights believed to be of the order of 30 km., and therefore likely to be accessible to the *ballon sonde*. Andriev also laid stress on the existence of air masses of unequal densities in the stratosphere, and urged their closer study. Ionospheric problems were treated by Tverskoi, who discussed the sources of ionisation in the atmosphere, and Bontch-Bruewitch, who reviewed the results of experimental soundings of the ionosphere (NATURE, Feb. 3, 1934, p. 175). Special enthusiasm was shown in the section of the conference dealing with cosmic rays, Joffe, Skobeltzyn and Eigenson being among the speakers. Detailed discussion of the 'stratostat' and the stratospheric aeroplane occupied the technical section. The conference, under the presidency of Vavilov, passed resolutions dealing with the world conference, as already mentioned, and with the special need of co-operation among Soviet, American and Canadian scientific workers in polar atmospheric researches.

Scientific Research in the Building Trades

THE Department of Scientific and Industrial Research is presenting a building research exhibit at the Building Trades Exhibition to be held at Olympia on September 12–26. Most of the work has been carried out at the Building Research Station, Watford; the main exception being the timber portion of the exhibit, for which the Department's Forest Products Research Laboratory at Princes Risborough is responsible. The exhibit covers structural steel, plain and reinforced concrete, cement and cement products, natural stone, limes and plasters, brick and timber; codes of practice for the use of certain of these materials, and aspects of heating and lighting involved in securing comfortable conditions in a building. One of the chief researches is that dealing with steel-frame buildings, to which work the British Steel Work Association makes a substantial contribution. This work has already led to savings amounting to as much as twenty per cent in the cost of steelwork in steel-frame buildings. Various aspects of stone decay and the problems involved in the preservation, cleaning and restoration of stone structures are illustrated on the stand; methods of assessing the quality of samples of Portland stone by laboratory tests are also shown. An exhibit on brick and brick-masonry illustrates the procedure used to determine the strength of individual bricks and brick-masonry walls. The section dealing with heating, ventilation and natural lighting includes special instruments devised for comparing different methods of heating, the use of air spaces and metallic surfaces in providing thermal insulation, and the problem of the exclusion of solar heat.

Developing the Electric Grid System

Two important statements were made in the *Times* of August 28 concerning the electricity system of Great Britain. An electricity commissioner said that the completion of the grid system and its operation under the Central Electricity Board have solved the problem of bulk supply, but the problem of distribution still remains to be dealt with. The new electricity commissioner, Mr. J. M. Kennedy, was specially appointed to deal with the problem of distributing to the consumer. An official of the Central Electricity Board said that from the technical point of view the grid system is working satisfactorily. It has fully justified itself as an instrument for the efficient production of current and for bulk distribution. Extensive developments are in progress. Two of a series of five water-power plants being erected by a power company are now completed in Kirkcudbrightshire. They will supply millions of units per annum to the Grid for distribution in north-west England and central Scotland. The cost of tapping the Grid and installing a switching and transformer station a year or two ago was more than £20,000; one was recently completed in Northumberland at a cost of £6,000. He said that Great Britain is ahead of the world in domestic, commercial and rural electrification. Notwithstanding the great difference in population, there are more electric cookers in use in Great Britain than in the United States of America. In some parts of London, working-class houses of a rateable value of £18 a year are being fitted with electricity at the rate of 300 a week. The applications of electricity to industry are increasing rapidly.

International Conference on Soil Physics

A CONFERENCE of the First Commission (Soil Physics) of the International Society of Soil Science was held at the Centre de Recherches Agronomiques, Versailles, on July 2–5, under the presidency of Prof. G. W. Robinson, of Bangor. The programme, arranged in consultation with the French organising committee under the able direction of Dr. A. Demolon, included an official opening by the Minister of Agriculture, three paper-reading sessions with discussions, and a closing session. The communications and discussions covered the subjects of mechanical analysis and soil structure, moisture, colour and temperature. Resolutions embodying suggestions for future work were passed, and a committee was set up in association with the Society of Rheology to draw up a lexicon of terms used in soil physics in the principal European languages. In addition to the business programme, excursions were made to the College and Experiment Station at Grignon, sewage irrigation farms, and other objects of interest in the Seine valley. Entertainments were arranged, including a banquet at Saint Germain. At the conclusion of the Conference, the delegates made a short excursion in Alsace as guests of the Société Commerciale des Potasses d'Alsace. This excursion included a visit to the State potash mines at Mulhouse, tours in the Vosges and in the Colmar-Strasbourg district, during which palæo-loess and other soil profiles were examined, and a visit to the historic laboratory of Jean Baptiste Boussingault at Liebfrauenberg.

Commercial Timbers of Australia

SINCE the War, most States possessing forests of any importance have, owing to a greater world demand or greater competition, been engaged in an endeavour to place their commercial timbers on foreign markets; or, in some cases, in attempts to develop an interior market. Research officers have been studying the properties and uses of the principal commercial timbers of the country concerned with the object of providing purchasers and users with the necessary information in a concise form. Australia has been engaged on research in this direction at the Division of Forest Products. Pamphlet No. 47, "Properties of Australian Timbers (1)" (Government Printer, Melbourne, 1933) by H. E. Dadswell, has recently appeared. This first part of the series deals with the timbers of the genus *Eucalyptus* which are known as the 'Ash Group'. The real value of this type of research in most countries with forest resources is correctly enunciated by Mr. I. H. Boas, chief of the Division of Products: "Many Commercial timbers in Australia occur only

(*Continued on page* 375.)

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The New World-Picture of Modern Physics

By Sir James H. Jeans, F.R.S., President of the British Association

Presidential address delivered at Aberdeen on September 5, 1934

THE British Association assembles for the third time in Aberdeen—under the happiest of auspices. It is good that we are meeting in Scotland, for the Association has a tradition that its Scottish meetings are wholly successful. It is good that we are meeting in the sympathetic atmosphere of a university city, surrounded not only by beautiful and venerable buildings, but also by buildings in which scientific knowledge is being industriously and successfully accumulated. It is especially good that Aberdeen is rich not only in scientific buildings but also in scientific associations. Most of us can think of some master-mind in his own subject who worked here. My own thoughts, I need scarcely say, turn to James Clerk Maxwell.

Whatever our subject, there is one man who will be in our thoughts in a very special sense to-night—Sir William Hardy, whom we had hoped to see in the presidential chair this year. It was not to be, and his early death, while still in the fulness of his powers, casts a shadow in the minds of all of us. We all know of his distinguished work in pure science, and his equally valuable achievements in applied science. I will not try to pay tribute to these, since it has been arranged that others, better qualified than myself, shall do so in a special memorial lecture. Perhaps, however, I may be permitted to bear testimony to the personal qualities of one whom I was proud to call a friend for a large part of my life, and a colleague for many years. Inside the council room, his proposals were always acute, often highly original, and invariably worthy of careful consideration; outside, his big personality and wide range of interests made him the most charming and versatile of friends.

Limitations of Theoretical Physics

Now I must turn to the subject on which I have specially undertaken to speak—the new world-picture presented to us by modern physics. It is a full half-century since this chair was last occupied by a theoretical physicist in the person of the late Lord Rayleigh, and in that interval theoretical physics has experienced many and revolutionary changes. The main edifice of science has grown almost beyond recognition, increasing in extent, dignity and beauty, as whole armies of labourers have patiently added wing after wing, story upon story, and pinnacle to pinnacle. Yet the theoretical physicist must admit that his own department looks like nothing so much as a building which has been brought down in ruins by a succession of earthquake shocks.

The earthquake shocks were, of course, new facts of observation, and the building fell because it was not built on the solid rock of ascertained fact, but on the ever-shifting sands of conjecture and speculation. Indeed it was little more than a museum of models, which had accumulated because the old-fashioned physicist had a passion for trying to liken the ingredients of Nature to familiar objects such as billiard-balls, jellies and spinning tops. While he believed and proclaimed that Nature had existed and gone her way for countless æons before man came to spy on her, he assumed that the latest newcomer on the scene, the mind which could never get outside itself and its own sensations, would find things within its limited experience to explain what had existed from all eternity. It was expecting too much of Nature, as the ruin of our building has shown. She is not so accommodating as this to the limitations of the human mind; her truths can only be made comprehensible in the form of parables.

Yet no parable can remain true throughout its whole range to the facts it is trying to explain. Somewhere or other it must be too wide or too narrow, so that "the truth, the whole truth, and nothing but the truth" is not to be conveyed by parables. The fundamental mistake of the old-fashioned physicist was that he failed to distinguish between the half-truths of parables and the literal truth.

Perhaps his mistake was pardonable, perhaps it was even natural. Modern psychologists make great use of what they describe as 'word-association'. They shoot a word at you, and ask you to reply immediately with the first idea it evokes in your uncontrolled mind. If the psychologist says 'wave', the boy-scout will probably say 'flag', while the sailor may say 'sea', the musician 'sound', the engineer 'compression', and the mathematician 'sine' or 'cosine'. Now the crux of the situation is that the number of people who will give this last response is very small. Our remote ancestors did not survive in the struggle for existence by pondering over sines and cosines, but by devising ways of killing other animals without being killed themselves. As a consequence, the brains we have inherited from them take more kindly to the concrete facts of everyday life than to abstract concepts; to particulars rather than to universals. Every child, when first it begins to learn algebra, asks in despair "But what are x, y and z?" and is satisfied when, and only when, it has been told that they are numbers of apples or pears or bananas or something such. In the same way, the old-fashioned physicist could not rest content with x, y and z, but was always trying to express them in terms of apples or pears or bananas. Yet a simple argument will show that he can never get beyond x, y and z.

Physical science obtains its knowledge of the external world by a series of exact measurements, or, more precisely, by comparisons of measurements. Typical of its knowledge is the statement that the line $H\alpha$ in the hydrogen spectrum has a wave-length of so many centimetres. This is meaningless until we know what a centimetre is. The moment we are told that it is a certain fraction of the earth's radius, or of the length of a bar of platinum, or a certain multiple of the wave-length of a line in the cadmium spectrum, our knowledge becomes real, but at that same moment it also becomes purely numerical—a knowledge of the value of a ratio. Our minds can only be acquainted with things inside themselves—never with things outside. Thus we can never know the essential nature of anything, such as a centimetre or a wave-length, which exists in that mysterious world outside ourselves to which our minds can never penetrate; but we can know the numerical ratio of two quantities of similar nature no matter how incomprehensible they may both be individually.

For this reason, our knowledge of the external world must always consist of numbers, and our picture of the universe—the synthesis of our knowledge—must necessarily be mathematical in form. All the concrete details of the picture, the apples, the pears and bananas, the ether and atoms and electrons, are mere clothing that we ourselves drape over our mathematical symbols—they do not belong to Nature, but to the parables by which we try to make Nature comprehensible. It was, I think, Kronecker who said that in arithmetic God made the integers and man made the rest; in the same spirit, we may add that in physics God made the mathematics and man made the rest.

The modern physicist does not use this language, but he accepts its implications, and divides the concepts of physics into observables and unobservables. In brief, the observables embody facts of observation, and so are purely numerical or mathematical in their content; the unobservables are the pictorial details of the parables.

The physicist wants to make his new edifice earthquake-proof—immune to the shock of new observations—and so builds only on the solid rock, and with the solid bricks, of ascertained fact. Thus he builds only with observables, and his whole edifice is one of mathematics and mathematical formulæ—all else is man-made decoration.

For example, when the undulatory theory had made it clear that light was of the nature of waves, the scientists of the day elaborated this by saying that light consisted of waves in a rigid, homogeneous ether which filled all space. The whole content of ascertained fact in this description is the one word 'wave' in its strictly mathematical sense; all the rest is pictorial detail, introduced to help out the inherited limitations of our minds.

Then scientists took the pictorial details of the parable literally, and so fell into error. For example, light-waves travel in space and time jointly, but by filling space and space alone with ether, the parable seemed to make a clear-cut distinction between space and time. It even suggested that they could be separated out in practice —by performing a Michelson-Morley experiment. Yet, as we all know, the experiment when performed only showed that such a separation is impossible; the space and time of the parable are found not to be true to the facts—they are revealed as mere stage scenery. Neither is found to exist in its own right, but only as a way of cutting up something more comprehensive—the space-time continuum.

Thus we find that space and time cannot be classified as realities of Nature, and the generalised theory of relativity shows that the same is true of their product, the space-time continuum. This can be crumpled and twisted and warped as much as we please without becoming one whit less true to Nature—which, of course, can only mean that it is not itself part of Nature.

In this way, space and time, and also their space-time product, fall into their places as mere mental frameworks of our own construction. They are of course very important frameworks, being nothing less than the frameworks along which our minds receive their whole knowledge of the outer world. This knowledge comes to our minds in the form of messages passed on from our senses; these in turn have received them as impacts or transfers of electro-magnetic momentum or energy. Now Clerk Maxwell showed that electromagnetic activity of all kinds could be depicted perfectly as travelling in space and time—this was the essential content of his electromagnetic theory of light. Thus space and time are of preponderating importance to our minds as the media through which the messages from the outer world enter the 'gateways of knowledge', our senses, and in terms of which they are classified. Just as the messages which enter a telephone exchange are classified by the wires along which they arrive, so the messages which strike our senses are classified by their arrival along the space-time framework.

Classical Physics

The classical physics, assuming that each message must have had a starting-point, postulated the existence of 'matter' to provide such starting-points. But the existence of this matter was a pure hypothesis; and matter is in actual fact as unobservable as the ether, Newtonian force, and other unobservables which have vanished from science. Early science not only assumed matter to exist, but further pictured it as existing in space and time. Again this assumption had no adequate justification; for there is clearly no reason why the whole material universe should be restricted to the narrow framework along which messages strike our senses. To illustrate by an analogy, the earthquake waves which damage our houses travel along the surface of the ground, but we have no right to assume that they originate in the surface of the ground; we know, on the contrary, that they originate deep down in the earth's interior.

The Newtonian mechanics, however, having endowed space and time with real objective existences, assumed that the whole universe existed within the limits of space and time. Even more characteristic of it was the doctrine of 'mechanistic determinism', which could be evolved from it by strictly logical processes. This reduced the whole physical universe to a vast machine in which each cog, shaft and thrust bar could only transmit what it received, and wait for what was to come next. When it was found that the human body consisted of nothing beyond commonplace atoms and molecules, the human race also seemed to be reduced to cogs in the wheel, and in face of the inexorable movements of the machine, human effort, initiative and ambition seemed to become meaningless illusions. Our minds were left with no more power or initiative than a sensitised cinematograph film; they could only register what was impressed on them from an outer world over which they had no control.

Theoretical physics is no longer concerned to study the Newtonian universe which it once believed to exist in its own right in space and time. It merely sets before itself the modest task of reducing to law and order the impressions that the universe makes on our senses. It is not concerned with what lies beyond the gateways of knowledge, but with what enters through the gateways of knowledge. It is concerned with appearances rather than reality, so that its task resembles that of the cartographer or map-maker rather than that of the geologist or mining engineer.

Now the cartographer knows that a map may be drawn in many ways, or, as he would himself say, many kinds of projection are available. Each one has its merits, but it is impossible to find all the merits we might reasonably desire combined in one single map. It is reasonable to demand that each bit of territory should look its proper shape on the map ; also that each should look its proper relative size. Yet even these very reasonable requirements cannot usually be satisfied in a single map ; the only exception is when the map is to contain only a small part of the whole surface of the globe. In this case, and this only, all the qualities we want can be combined in a single map, so that we simply ask for a map of the county of Surrey without specifying whether it is to be a Mercator's or orthographic or conic projection, or what not.

All this has its exact counterpart in the map-making task of the physicist. The Newtonian mechanics was like the map of Surrey, because it dealt only with a small fraction of the universe. It was concerned with the motions and changes of medium-sized objects—objects comparable in size with the human body—and for these it was able to provide a perfect map which combined in one picture all the qualities we could reasonably demand. But the inconceivably great and the inconceivably small were equally beyond its ken. As soon as science pushed out—to the cosmos as a whole in one direction and to sub-atomic phenomena in the other—the deficiencies of the Newtonian mechanics became manifest. No modification of the Newtonian map was able to provide the two qualities which this map had itself encouraged us to expect—a materialism which exhibited the universe as constructed of matter lying within the framework of space and time, and a determinism which provided an answer to the question "What is going to happen next ?"

The Particle- and Wave-Parables

When geography cannot combine all the qualities we want in a single map, it provides us with more than one map. Theoretical physics has done the same, providing us with two maps which are commonly known as the particle-picture and the wave-picture.

The particle-picture is a materialistic picture which caters for those who wish to see their universe mapped out as matter existing in space and time. The wave-picture is a determinist picture which caters for those who ask the question "What is going to happen next ?" It is perhaps better to speak of these two pictures as the particle-parable and the wave-parable. For this is what they really are, and the nomenclature warns us in advance not to be surprised at inconsistencies and contradictions.

Let me remind you, as briefly as possible, how this pair of pictures or parables have come to be in existence side by side.

The particle-parable, which was first in the field, told us that the material universe consists of particles existing in space and time. It was created by the labours of chemists and experimental physicists, working on the basis provided by the classical physics. Its time of testing came in 1913, when Bohr tried to find out whether the two particles of the hydrogen atom could possibly produce the highly complicated spectrum of hydrogen by their motion. He found a type of motion which could produce this spectrum down to its minutest details, but the motion was quite inconsistent with the mechanistic determinism of the Newtonian mechanics. The electron did not move continuously through space and time, but jumped, and its jumps were not governed by the laws of mechanics, but to all appearance, as Einstein showed more fully four years later, by the laws of probability. Of 1,000 identical atoms, 100 might make the jump, while the other 900 would not. Before the jumps occurred, there was nothing to show which atoms were going to jump. Thus the particle-picture conspicuously failed to provide an answer to the question "What will happen next ?"

Bohr's concepts were revolutionary, but it was soon found they were not revolutionary enough, for they failed to explain more complicated spectra, as well as certain other phenomena.

Then Heisenberg showed that the hydrogen spectrum—and, as we now believe, all other spectra as well—could be explained by the motion of something which was rather like an electron, but did not move in space and time. Its position was not specified by the usual co-ordinates x, y, z of co-ordinate geometry, but by the mathematical abstraction known as a matrix. His ideas were rather too abstract even for mathematicians, the majority of whom had quite forgotten what matrices were. It seemed likely that Heisenberg had unravelled the secret of the structure of matter, and yet his solution was so far removed from the concepts of ordinary life that another parable had to be invented to make it comprehensible.

The wave-parable serves this purpose ; it does not describe the universe as a collection of particles but as a system of waves. The universe is no longer a deluge of shot from a battery of machine-guns, but a stormy sea with the sea taken away and only the abstract quality of storminess left—or the grin of the Cheshire cat if we can think of a grin as undulatory. This parable was not devised by Heisenberg, but by de Broglie and Schrödinger. At first they thought their waves merely provided a superior model of an ordinary electron ; later it was established that they were a sort of parable to explain Heisenberg's pseudo-electron.

Now the pseudo-electron of Heisenberg did not claim to account for the spectrum emitted by a single atom of gas, which is something entirely beyond our knowledge or experience, but only that emitted by a whole assembly of similar atoms ; it was not a picture of one electron in one atom, but of all the electrons in all the atoms. In the same way the waves of the wave-parable do not picture individual electrons, but a community of electrons—a crowd—as for example the electrons whose motion constitutes a current of electricity. In this particular instance the waves can be represented as travelling through ordinary space. Except for travelling at a different speed, they are very like the waves by which Maxwell described the flow of radiation through space, so that matter and radiation are much more like one another in the new physics than they were in the old.

In other cases, ordinary time and space do not provide an adequate canvas for the wave-picture. The wave-picture of two currents of electricity, or even of two electrons moving independently, needs a larger canvas—six dimensions of space and one of time. There can be no logical justification for identifying any particular three of these six dimensions with ordinary space, so that we must regard the wave-picture as lying entirely outside space. The whole picture, and the manifold dimensions of space in which it is drawn, become pure mental constructs—diagrams and frameworks we make for ourselves to help us understand phenomena.

Materialism or Determinism ?

In this way we have the two co-existent pictures—the particle-picture for the materialist, and the wave-picture for the determinist. When the cartographer has to make two distinct maps to exhibit the geography of, say, North America, he is able to explain why two maps are necessary, and can also tell us the relation between the two—he can show us how to transform one into the other. He will tell us, for example, that he needs two maps simply because he is restricted to flat surfaces—pieces of paper. Give him a sphere instead, and he can show us North America, perfectly and completely, on a single map.

The physicist has not yet found anything corresponding to this sphere ; when, if ever, he does, the particle-picture and the wave-picture will be merged into a single new picture. At that moment, many of the major problems of physics will be solved, and many of the puzzles of philosophy as well. But at present some kink in our minds, or perhaps merely some ingrained habit of thought, prevents our understanding the universe as a consistent whole—just as the ingrained habits of thought of a 'flat-earther' prevent his understanding North America as a consistent whole. Yet, although physics has so far failed to explain why two pictures are necessary, it is, nevertheless, able to explain the relation between the particle-picture and the wave-picture in perfectly comprehensible terms.

The central feature of the particle-picture is the atomicity which is found in the structure of matter. But this atomicity is only one expression of a fundamental coarse-grainedness which pervades the whole of Nature. It crops up again in the fact that energy can only be transferred by whole quanta. Because of this, the tools with which we study Nature are themselves coarse-grained ; we have only blunt probes at our disposal, and so can never acquire perfectly precise knowledge of Nature. Just as, in astronomy, the grain of our photographic plates prevents our ever fixing the position of a star with absolute precision, so in physics we can never say that an electron is here, at this precise spot, or that it is moving at just such and such a speed. The best we can do with our blunt probes is to represent the position of the electron by a smear, and its motion by a moving smear which will get more and more blurred as time progresses. Unless we check the growth of our smear by taking new observations, it will end by spreading through the whole of space.

Now the waves of an electron or other piece of matter are simply a picture of just such a smear. Where the waves are intense, the smear is black, and conversely. The nature of the smear—whether it consists of printer's ink, or, as was at one time thought, of electricity—is of no importance ; this is mere pictorial detail. All that is essential is the relative blackness of the smear at different places —a ratio of numbers which measures the relative chance of electrons being at different points of space.

The relation between the wave-picture and the particle-picture may be summed up thus : the more stormy the waves at any point in the wave-picture, the more likely we are to find a particle at that point in the particle-picture. Yet, if electrons really existed as the point-particles of the particle-picture, and the waves depicted the chances of their existing at different points of space—as Maxwell's law does for the molecules of a gas—then a gas would emit a continuous spectrum instead of the line-spectrum that is actually observed. Thus we had better put our statement in the form that the electron is not a point-particle, but that if we insist on picturing it as such, then the waves indicate the relative proprieties of picturing it as existing at the different points of space. But propriety relative to what ?

The answer is—relative to our own knowledge. If we know nothing about an electron except that it exists, all places are equally likely for it, so that its waves are uniformly spread through the whole of space. By experiment after experiment we can restrict the extent of its waves, but we can never reduce them to a point, or indeed below a certain minimum ; the coarse-grainedness of our probes prevents that. There is always a finite region of waves left. The waves which are left depict our knowledge precisely and exactly ; we may say that they are waves of knowledge—or, perhaps even better still, waves of imperfections of knowledge—of the position of the electron.

Knowledge and Nature

Now we come to the central and most surprising fact of the whole situation. I agree that it is still too early, and the situation is still too obscure, for us fully to assess its importance, but, as I see it, it seems likely to lead to radical changes in our views not only of the universe but also even more of ourselves. Let us remember that we are dealing with a system of waves which depict in a graphic form our knowledge of the constituents of the universe. The central fact is this : the wave-parable does not tell us that these waves depict our knowledge of Nature, but that they are Nature itself.

If we ask the new physics to specify an electron for us, it does not give us a mathematical specification of an objective electron, but rather retorts with the question : "How much do you know about the electron in question ?" We state all we know, and then comes the surprising reply, "That is the electron". The electron exists only in our minds—what exists beyond, and where, to put the idea of an electron into our minds we do not know. The new physics can provide us with wave-pictures depicting electrons about which we have varying amounts of knowledge, ranging from nothing at all to the maximum we can know with the blunt probes at our command, but the electron which exists apart from our study of it is quite beyond its purview.

Let me try and put this in another way. The old physics imagined it was studying an objective Nature which had its own existence independently of the mind which perceived it—which, indeed, had existed from all eternity whether it was perceived or not. It would have gone on imagining this to this day, had the electron observed by the physicists behaved as on this supposition it ought to have done. But it did not so behave, and this led to the birth of the new physics, with its general thesis that the Nature we study does not consist so much of something we perceive as of our perceptions ; it is not the object of the subject-object relation, but the relation itself. There is, in fact, no clear-cut division between the subject and object ; they form an indivisible whole which now becomes Nature. This thesis finds its final expression in the wave-parable, which tells us that Nature consists of waves and that these are of the general quality of waves of knowledge, or of absence of knowledge, in our own minds.

Let me digress to remind you that if ever we are to know the true nature of waves, these waves must consist of something we already have in our own minds. Now knowledge and absence of knowledge satisfy this criterion as few other things could; waves in an ether, for example, emphatically did not. It may seem strange, and almost too good to be true, that Nature should in the last resort consist of something we can really understand; but there is always the simple solution available that the external world is essentially of the same nature as mental ideas.

At best this may seem very academic and up in the air—at the worst it may seem stupid and even obvious. I agree that it would be so, were it not for the one outstanding fact that observation supports the wave-picture of the new physics whole-heartedly and without hesitation. Whenever the particle-picture and the wave-picture have come into conflict, observation has discredited the particle-picture and supported the wave-picture—not merely, be it noted, as a picture of our knowledge of Nature, but as a picture of Nature itself. The particle-parable is useful as a concession to the materialistic habits of thought which have become ingrained in our minds, but it can no longer claim to fit the facts, and, so far as we can at present see, the truth about Nature must lie very near to the wave-parable.

Let me digress again to remind you of two simple instances of such conflicts and of the verdicts which observation has pronounced upon them. A shower of parallel-moving electrons forms in effect an electric current. Let us shoot such a shower of electrons at a thin film of metal, as Prof. G. P. Thomson did. The particle-parable compares it to a shower of hailstones falling on a crowd of umbrellas; we expect the electrons to get through somehow or anyhow and come out on the other side as a disordered mob. But the wave-parable tells us that the shower of electrons is a train of waves. It must retain its wave-formation, not only in passing through the film, but also when it emerges on the other side. And this is what actually happens: it comes out and forms a wave-pattern which can be predicted—completely and perfectly—from its wave-picture before it entered the film.

Next let us shoot our shower of electrons against the barrier formed by an adverse electromotive force. If the electrons of the shower have a uniform energy of ten volts each, let us throw them against an adverse potential difference of a million volts. According to the particle-parable, it is like throwing a handful of shot up into the air; they will all fall back to earth in time—the conservation of energy will see to that. But the wave-parable again sees our shower of electrons as a train of waves—like a beam of light—and sees the potential barrier as an obstructing layer—like a dirty window pane. The wave-parable tells us that this will check, but not entirely stop, our beam of electrons. It even shows us how to calculate what fraction will get through; and just this fraction, in actual fact, does get through; a certain number of ten-volt electrons surmount the potential barrier of a million volts—as though a few of the shot thrown lightly up from our hands were to surmount the earth's gravitational field and wander off into space. The phenomenon appears to be in flat contradiction to the law of conservation of energy, but we must remember that waves of knowledge are not likely to own allegiance to this law.

A further problem arises out of this experiment. Of the millions of electrons of the original shower, which particular electrons will get through the obstacle? Is it those who get off the mark first, or those with the highest turn of speed, or what? What little extra have they that the others haven't got?

It seems to be nothing more than pure good luck. We know of no way of increasing the chances of individual electrons; each just takes its turn with the rest. It is a concept with which science has been familiar ever since Rutherford and Soddy gave us the law of spontaneous disintegration of radioactive substances—of a million atoms ten broke up every year, and no help we could give to a selected ten would cause fate to select them rather than the ten of her own choosing. It was the same with Bohr's model of the atom; Einstein found that without the caprices of fate it was impossible to explain the ordinary spectrum of a hot body; call on fate, and we at once obtained Planck's formula, which agrees exactly with observation.

Determinism in Nature

From the dawn of human history, man has been wont to attribute the results of his own incompetence to the interference of a malign fate. The particle-picture seems to make fate even more powerful and more all-pervading than ever before; she not only has her finger in human affairs, but also in every atom in the universe.

The new physics has got rid of mechanistic determinism, but only at the price of getting rid of the uniformity of Nature as well!

I do not suppose that any serious scientist feels that such a statement must be accepted as final; certainly I do not. I think the analogy of the beam of light falling on the dirty window-pane will show us the fallacy of it.

Heisenberg's mathematical equation shows that the energy of a beam of light must always be an integral number of quanta. We have observational evidence of this in the photoelectric effect, in which atoms always suffer damage by whole quanta.

Now this is often stated in parable form. The parable tells us that light consists of discrete light-particles, called photons, each carrying a single quantum of energy. A beam of light becomes a shower of photons moving through space like the bullets from a machine-gun; it is easy to see why they necessarily do damage by whole quanta.

When a shower of photons falls on a dirty window-pane, some of the photons are captured by the dirt, while the rest escape capture and get through. Again the question arises: How are the lucky photons singled out? The obvious superficial answer is a wave of the hand towards Fortune's wheel; it is the same answer that Newton gave when he spoke of his 'corpuscles of light' experiencing alternating fits of transmission and reflection. But we readily see that such an answer is superficial.

Our balance at the bank always consists of an integral number of pence, but it does not follow that it is a pile of bronze pennies. A child may, however, picture it as so being, and ask his father what determines which particular pennies go to pay the rent. The father may answer "Mere chance"—a foolish answer, but no more foolish than the question. Our question as to what determines which photons gets through is, I think, of a similar kind, and if Nature seems to answer "Mere chance", she is merely answering us according to our folly. A parable which replaces radiation by identifiable photons can find nothing but the finger of fate to separate the sheep from the goats. But the finger of fate, like the photons themselves, is mere pictorial detail. As soon as we abandon our picture of radiation as a shower of photons, there is no chance but complete determinism in its flow; and the same is, I think, true when the particle-photons are replaced by particle-electrons.

We know that every electric current must transfer electricity by complete electron-units, but this does not entitle us to replace an electric current by a shower of identifiable electron-particles. Indeed the general principles of quantum-theory, which are in full agreement with observation, definitely forbid our doing so. When the red and white balls collide on a billiard table, red may go to the right and white to the left. The collision of two electrons A and B is governed by similar laws of energy and momentum, so that we might expect to be able to say that A goes to the right, and B to the left, or vice versa. Actually we must say no such thing, because we have no right to identify the two electrons which emerge from the collision with the two that went in. It is as though A and B had temporarily combined into a single drop of electric fluid, which had afterwards broken up into two new electrons, C, D. We can only say that after the collision C will go to the right and D to the left. If we are asked which way A will go, the true answer is that by then A will no longer exist. The superficial answer is that it is a pure toss-up. But the toss-up is not in Nature; it is in our own minds: it is an even chance whether we choose to identify C with A or with B.

Thus the indeterminism of the particle-picture seems to reside in our own minds rather than in Nature. In any case this picture is imperfect, since it fails to represent the facts of observation. The wave-picture, which observation confirms in every known experiment, exhibits a complete determinism.

Again we may begin to feel that the new physics is little better than the old—that it has merely replaced one determinism by another. It has; but there is all the difference in the world between the two determinisms. For in the old physics the perceiving mind was a spectator; in the new it is an actor. Nature no longer forms a closed system detached from the perceiving mind; the perceiver and perceived are interacting parts of a single system. The Nature depicted by the wave-picture in some way embraces our minds as well as inanimate matter. Things still change solely as they are compelled, but it no longer seems impossible that part of the compulsion may originate in our own minds.

Even the inadequate particle-picture told us something very similar in its own roundabout stammering way. At first it seemed to be telling us of a Nature distinct from our minds, which moved as directed by throws of the dice, and then it transpired that the dice were thrown by our own minds. Our minds enter into both pictures, although in somewhat different capacities. In the particle-picture the mind merely decides under what conventions the map is to be drawn; in the wave-picture it perceives and observes and draws the map. We should notice, however, that the mind enters both pictures only in its capacity as a receptacle—never as an emitter.

The determinism which appears in the new physics is one of waves, and so, in the last resort, of knowledge. Where we are not ourselves concerned, we can say that event follows event; where we are concerned, only that knowledge follows knowledge. Even this knowledge is one only of probabilities and not of certainties; it is at best a smeared picture of the clear-cut reality which we believe to lie beneath. And just because of this, it is impossible to decide whether the determinism of the wave-picture originates in the underlying reality or not—Can our minds change what is happening in reality, or can they only make it look different to us by changing our angle of vision? We do not know, and as I do not see how we can ever find out, my own opinion is that the problem of free-will will continue to provide material for fruitless discussion until the end of eternity.

The contribution of the new physics to this problem is not that it has given a decision on a long-debated question, but that it has reopened a door which the old physics had seemed to slam and bolt. We have an intuitive belief that we can choose our lunch from the menu or abstain from housebreaking or murder; and that by our own volition we can develop our freedom to choose. We may, of course, be wrong. The old physics seemed to tell us that we were wrong, and that our imagined freedom was all an illusion; the new physics tells us it may not be.

The old physics showed us a universe which looked more like a prison than a dwelling-place. The new physics shows us a building which is certainly more spacious, although its interior doors may be either open or locked—we cannot say. But we begin to suspect it may give us room for such freedom as we have always believed we possessed; it seems possible at least that in it we can mould events to our desire, and live lives of emotion, intellect and endeavour. It looks as though it might form a suitable dwelling-place for man, and not a mere shelter for brutes.

Philosophical Implications

The new physics obviously carries many philosophical implications, but these are not easy to describe in words. They cannot be summed up in the crisp, snappy sentences beloved of scientific journalism, such as that materialism is dead, or that matter is no more. The situation is rather that both materialism and matter need to be redefined in the light of our new knowledge. When this has been done, the materialist must decide for himself whether the only kind of materialism which science now permits can be suitably labelled materialism, and whether what remains of matter should be labelled as matter or as something else; it is mainly a question of terminology.

What remains is in any case very different from the full-blooded matter and the forbidding materialism of the Victorian scientist. His objective and material universe is proved to consist of little more than constructs of our own minds. To this extent, then, modern physics has moved in the direction of philosophic idealism. Mind and matter, if not proved to be of similar nature, are at least found to be ingredients of one single system. There is no longer room for the kind of dualism which has haunted philosophy since the days of Descartes.

This brings us at once face to face with the fundamental difficulty which confronts every form of philosophical idealism. If the Nature we study consists so largely of our own mental constructs, why do our many minds all construct one and the same Nature? Why, in brief, do we all see the same sun, moon and stars?

I would suggest that physics itself may provide a possible although very conjectural clue. The old particle-picture, which lay within the limits of space and time, broke matter up into a crowd of distinct particles, and radiation into a shower of distinct photons. The newer and more accurate wave-picture, which transcends the framework of space and time, recombines the photons into a single beam of light and the shower of parallel-moving electrons into a continuous electric current. Atomicity and division into individual existences are fundamental in the restricted space-time picture, but disappear in the wider, and as far as we know more truthful, picture which transcends space and time. In this, atomicity is replaced by what General Smuts would describe as 'holism'—the photons are no longer distinct individuals each going its own way, but members of a single organisation or whole—a beam of light. The same is true, *mutatis mutandis*, of the electrons of a parallel-moving shower. The biologists are beginning to tell us, although not very unanimously, that the same may be true of the cells of our bodies. And is it not conceivable that what is true of the objects perceived may be true also of the perceiving minds? When we view ourselves in space and time we are quite obviously distinct individuals; when we pass beyond space and time we may perhaps form ingredients of a continuous stream of life. It is only a step from this to a solution of the problem which would have commended itself to many philosophers, from Plato to Berkeley, and is, I think, directly in line with the new world-picture of modern physics.

Scientific Progress and Civilisation

I have left but little time to discuss affairs of a more concrete nature. We meet in a year which has to some extent seen science arraigned before the bar of public opinion; there are many who attribute most of our present national woes—including unemployment in industry and the danger of war—to the recent rapid advance in scientific knowledge.

Even if their most lurid suspicions were justified, it is not clear what we could do. For it is obvious that the country which called a halt to scientific progress would soon fall behind in every other respect as well—in its industry, in its economic position, in its naval and military defences, and, not least important, in its culture. Those who sigh for an Arcadia in which all machinery would be scrapped and all invention proclaimed a crime, as it was in Erewhon, forget that the Erewhonians had neither to compete with highly organised scientific competitors for the trade of the world nor to protect themselves against possible bomb-dropping, blockade or invasion.

But can we admit that the suspicions of our critics are justified? If science has made the attack more deadly in war, it has also made the defence more efficient; in the long run it shows no partiality in the age-long race between weapons of attack and defence. This being so, it would, I think, be hard to maintain in cold blood that its activities are likely to make wars either more frequent or more prolonged. It is at least arguable that the more deadly a war is likely to be, the less likely it is to occur.

Still it may occur. We cannot ignore the tragic fact that, as our President of two years ago told us, science has given man control over Nature before he has gained control over himself. The tragedy does not lie in man having so much scientific control over Nature, but in his having so little moral control over himself. Yet it is only one chapter of a long story—human nature changes very slowly, and so for ever lags behind human knowledge, which accumulates very rapidly. The plays of Æschylus and Sophocles still thrill us with their vital human interest, but the scientific writings of Aristarchus and Ptolemy are dead—mere historical curiosities which leave us cold. Scientific knowledge is transmitted from one generation to another, while acquired characteristics are not. Thus in respect of knowledge each generation stands on the shoulders of its predecessor, but in respect of human nature both stand on the same ground.

These are hard facts which we cannot hope to alter, and which—we may as well admit—may wreck civilisation. If there is an avenue of escape, it does not, as I see it, lie in the direction of less science, but of more science—psychology, which holds out hopes that for the first time in his long history, man may be enabled to obey the command 'Know thyself'; to which I, for one, would like to see adjoined a morality and if possible even a religion, consistent with our new psychological knowledge and the established facts of science; scientific and constructive measures of eugenics and birth control; scientific research in agriculture and industry, sufficient at least to defeat the gloomy prophecies of Malthus and enable ever larger populations to live in comfort and contentment on the same limited area of land. In such ways we may hope to restrain the pressure of population and the urge for expansion which, to my mind, are far more likely to drive the people of a nation to war than the knowledge that they—and also the enemies they will have to fight—are armed with the deadliest weapons which science can devise.

This last brings us to the thorny problem of economic depression and unemployment. No doubt a large part of this results from the War, national rivalries, tariff barriers, and various causes which have nothing to do with science, but a residue must be traced to scientific research; this produces labour-saving devices which in times of depression are only too likely to be welcomed as wage-saving devices, and to put men out of work. The scientific robot in *Punch's* cartoon boasted that he could do the work of 100 men, but gave no answer to the question—"Who will find work for the displaced 99 ?" He might, I think, have answered—"The pure scientist, in part at least." For scientific research has two products of industrial importance—the labour-saving inventions which displace labour, and the more fundamental discoveries which originate as pure science, but may ultimately lead to new industries and new popular demands providing employment for vast armies of labour.

Both are rich gifts from science to the community. The labour-saving devices lead to emancipation from soul-destroying toil and routine work, to greater leisure and better opportunities for its enjoyment. The new inventions add to the comfort and pleasure, health and wealth of the community. If a perfect balance could be maintained between the two, there would be employment for all, with a continual increase in the comfort and dignity of life. But, as I see it, troubles are bound to arise if the balance is not maintained, and a steady flow of labour-saving devices with no accompanying steady flow of new industries to absorb the labour they displace, cannot but lead to unemployment and chaos in the field of labour.

At present we have a want of balance resulting in unemployment, so that our great need at the moment is for industry-making discoveries. Let us remember Faraday's electromagnetic induction, Maxwell's Hertzian waves, and the Otto cycle—each of which has provided employment for millions of men ; and, although it is an old story, let us also remember that the economic value of the work of one scientist alone, Edison, has been estimated at three thousand million pounds.

Unhappily, no amount of planning can arrange a perfect balance. For as the wind bloweth where it listeth, so no one can control the direction in which science will advance ; the investigator in pure science does not know himself whether his researches will result in a mere labour-saving device or a new industry. He only knows that if all science were throttled down, neither would result ; the community would become crystallised in its present state, with nothing to do but watch its population increase, and shiver as it waited for the famine, pestilence or war which must inevitably come to restore the balance between food and mouths, land and population.

Is it not better to press on in our efforts to secure more wealth and leisure and dignity of life for our own and future generations, even though we risk a glorious failure, rather than accept inglorious failure by perpetuating our present conditions, in which these advantages are the exception rather than the rule ? Shall we not risk the fate of that over-ambitious scientist Icarus, rather than resign ourselves without an effort to the fate which has befallen the bees and ants ? Such are the questions I would put to those who maintain that science is harmful to the race.

Summaries of Addresses of Presidents of Sections*

Theories of Light

In his presidential address to Section A (Mathematical and Physical Sciences), Prof. H. M. Macdonald discusses the development of theories of light. From early times, theories of light appear to have taken two forms ; emission theories which ascribe the phenomena of light to emanations from the objects seen, and undulatory theories which ascribe the phenomena to undulations or pulsations proceeding from the object to the eye. With the revival of learning in the fifteenth and sixteenth centuries, both types of theory reappeared. The form of emission theory which was adopted ultimately was that due to Newton, known as the corpuscular theory of light ; in it the emanations consist of small particles of matter emitted from the body. The form of undulatory theory adopted was that due to Huygens ; this theory postulates an elastic medium which pervades all space, and light is assumed to be due to undulations propagated in this medium. At the beginning of last century, the corpuscular theory of light was the theory which was accepted almost universally, but the application of the principle of interference due to Young and Fresnel removed what had been until then regarded as an insuperable objection to an undulatory theory, its supposed inability to account for shadows.

Fresnel's principle of transversality, which was suggested or confirmed by the discovery that light polarised in perpendicular planes did not interfere, led to the relations between the amplitudes of the incident, reflected and transmitted waves of light passing from one isotropic medium to another, and also to the laws of propagation of light in crystalline media.

The development of mathematical analysis made it possible to submit the theory that light is due to undulations in an elastic medium to mathematical treatment. This was effected independently by Cauchy and by Green : Green's "Memoir on the Reflection and Refraction of Light" is specially noteworthy as being the first case of the application of Lagrange's dynamical method of treating a physical problem. Somewhat later, both writers discussed the case of crystalline media, with the result that an elastic medium which was self-contained did not give results which accorded with Fresnel's relations.

The next important stage in the development of theories of light is the hypothesis advanced by Faraday in his memoir on the rotation of the plane of polarisation by a magnetic field, that the phenomena of light, electricity and magnetism have a common origin. In 1865, Maxwell applied the Ampère-Faraday laws to the propagation of a magnetic disturbance in a non-conducting medium and showed that, on certain assumptions as to the nature of the medium, the electric and magnetic forces are in the wave front and the velocity of propagation in free space is the number of electrostatic units in an electromagnetic unit of electricity.

Starting from Faraday's hypothesis that light, electricity and magnetism have a common origin, the propagation of an electrical disturbance in free space will be subject to Fresnel's law of transversality ; if this is combined with the Ampère-Faraday laws which give the relations between electric current and magnetic force and between magnetic current and electric force, it follows that an electrical disturbance is propagated in free space with a velocity equal to the velocity by which an electric charge expressed in electromagnetic units must be multiplied to convert it into electrostatic units.

On the above hypothesis, the effect of the presence of matter can be represented by a distribution of electric and magnetic currents throughout the space occupied by the matter. When no disturbance is being propagated, the states of motion corresponding to the currents which represent the effect of the matter will be steady, and if the effect of the disturbance is to set up oscillations about these steady states of motion, the material medium can be regarded as being transparent to the disturbance. Fresnel's results for isotropic and for crystalline media follow, and also Faraday's result for the rotation of the plane of polarisation by a magnetic field.

Physical Methods in Chemistry

Prof. T. M. Lowry, in his presidential address to Section B (Chemistry), points out that, after a period of dangerous separation, the interpenetration of chemistry and physics, as illustrated by the work of Aston in the Cavendish Laboratory and of Lennard-Jones in the Chemical Laboratory at Cambridge, is now an important factor in the development of both sciences.

The principal contributions of physics to chemical science in recent years have been based upon the discovery of atomic numbers, since this has provided a secure basis both for the classification of the elements and for the theory of valency. Isotopes and radioactivity also find a natural place in the system thus developed. Recent work on nuclear structure

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and disintegration is of less immediate importance to chemists, but is obviously more fundamental than work on the electrons which envelop the nucleus.

Nearly forty years ago, observations of optical rotatory power led to the discovery of *mutarotation* in freshly prepared solutions of nitrocamphor in a large range of non-aqueous solvents, and to the interpretation of this phenomenon as an example of *dynamic isomerism*. The discovery of the arrest of mutarotation in chloroform showed that the isomeric change of nitrocamphor is not spontaneous, and later observations showed that an amphoteric solvent is required to promote the migration of a hydrogen atom in the prototropic change, for example, of the reducing sugars. Mutarotation is thus linked to the conception of acids and bases as donors and acceptors of a proton which was put forward by Lowry and then by Brönsted in 1923.

Measurements over a wide range of wavelengths have shown that the normal rotatory dispersion of many organic compounds can be expressed by one term of Drude's equation, whilst anomalous rotatory dispersion, for example, in ethyl tartrate, can be expressed by two terms of opposite sign. The classification as *simple* of those dispersions which can be represented by one term, and as *complex* of those which require more than one term, is an important step in the analysis of optical rotatory power. Rotatory dispersion in absorbing media is a more complicated phenomenon, but an important simplification occurs in tetra-acetyl-μ-arabinose and in penta-acetyl-μ-fructose, where the partial rotations due to the asymmetric carbon atoms appear to cancel out, so that the whole of the rotatory power is due to the induced dissymmetry of the carbonyl group, the partial rotation of which is thus automatically isolated in the region of absorption, where the Cotton phenomena are observed, as well as in the region of transparency.

Recent work on the prediction of the sign and magnitude of optical rotations is discussed in the final section of the address.

Plant Life and the Philosophy of Geology

In the opening of his presidential address to Section C (Geology) Prof. W. T. Gordon directs attention to the tendency in science for the effects of discovery to be hidden by the further results that have accrued from the application of that self-same discovery. This is particularly true of the study of fossil plants. At present there is a feeling amongst geologists that such studies are not particularly important to them, and one has to admit the truth of that contention from some viewpoints. But there is a wider aspect, and some of the general principles of geology, now accepted as axiomatic and even affecting the general philosophy of the times, are directly or indirectly established through the medium of fossil plants.

In following out this idea, Prof. Gordon notes the attitude of classical authors, so far as can be ascertained, towards geological phenomena, and mentions the great dearth of works on geology throughout the period of the Christian dispensation until the beginning of last century. Yet during the latter part of that period, the principle that fossils, in the modern sense, had once formed parts of plants or animals had been established, and the earlier works of Hooke and La Hire on the microscopic structure of fossil wood had materially assisted in this. Workers prior to their time had certainly accepted fossils as of organic origin, but the position was not generally conceded.

One stumbling-block was the occurrence of fossils far removed from their normal habitat and deeply buried in mines, and animals, rather than plants, were employed in advocating a great universal deluge in explanation of this phenomenon. But, accepting such a view, several authors in the late seventeenth and eighteenth centuries, Woodward, Scheuchzer, Parsons, among others, attempted to fix the season of the year in which the deluge had occurred by arguments based on fossil plants, and unconsciously showed the inadequacy of the theory in a most glaring fashion. The hypothesis had to be abandoned and was replaced by another, again largely established by means of fossil plants, namely, that fossils had existed under conditions quite different from the present. Although the notion had been taught in rather earlier days, it was the publication of works on fossil plants that first placed it before the general public. Consequently Brongniart was quite accurate when he stated that the study of fossil plants had saved the science from some of its more fantastic ideas.

Continuing, Prof. Gordon shows how several distinct floras have been delimited and used in the determination of the age of the rocks containing them, though the extent of the zones is wider than can be ascertained by animal types. In special cases plants alone can be employed, however, and recent research is giving indications along more than one line, that there are possibilities of employing plants as stratigraphical indexes in the future.

Finally, Prof. Gordon deals briefly with the question of fossil plants in relation to climatic differentiation. There is great need of closer co-operation among those interested to secure adequate mutual understanding and criticism in order that any theories advocated may be both necessary and sufficient. For the purpose of discussions on past climates, plants alone appear to be of much value, though animals can be used in certain cases. The big trees of America have been examined to discover changes in climate during the recent past, and a careful selection of the type of tree to be used as an 'index' has been shown to be necessary; but, having made such a selection, consistent results have been obtained. While, at present, only a few thousand years can be covered by this line of research, the future may show that the determination of influences producing rhythmic changes in the growth rings of fossil trees is possible.

The Study of Behaviour

In his presidential address to Section D (Zoology), Dr. E. S. Russell points out that the study of animal behaviour has been somewhat neglected in Great Britain; it has become largely divorced from zoology and handed over to the physiologist and the psychologist, neither of whom is as a rule sufficient of a naturalist to appreciate fully the biological significance of the behaviour observed in the laboratory. The study of behaviour has accordingly not taken its rightful place as an essential part of zoology, either in research or in teaching.

One main cause of this unsatisfactory state of affairs is the continued influence on biology of the classical doctrine of materialism, with its absolute separation of matter and mind, which we owe primarily to Descartes. The living thing is regarded as a mechanism; its behaviour is a subject for the physiologist to study from his analytical point of view; under the influence of this metaphysical theory, he must regard behaviour as the causally determined outcome of the working of the animal machine, actuated by external and internal stimuli. The physiologist as such can have nothing to do with mind, and hands over its study to the psychologist, who finds that he can know nothing directly about the minds of animals.

Dr. Russell puts forward the view that both matter and mind are highly abstract notions, and should be replaced for the purposes of biology by the more concrete concept of organism. Like other natural units, the organism is a system, but it is distinguished from inorganic systems in that it shows the activities of maintenance, development and reproduction, bound up in one continuous life-cycle. A static concept of organism is inadequate; time must enter into the definition; the organism is essentially a "dynamic pattern in time" (Coghill).

All the activities of the organism are, objectively considered, directed towards an end, which is the completion of the normal life-cycle. Behaviour is simply one form of the general directive activity of the organism—that phase of it which is concerned with the relations of the organism to its external world. From this point of view, there is no need to separate life from mind; the relation of behavioural or 'psychological' activities to physiological may be regarded, not as the relation of mental to physical happenings, but, for the practical purposes of study, as the relation of a whole directive activity to its parts.

Dr. Russell then applies this organismal method, which in many ways approaches the Aristotelian, to the practical study of animal behaviour. He lays stress upon the importance of determining exactly what it is to which animals respond, and adduces evidence that response may be to patterns or relations or images, rather than to a simple summation of physico-chemical stimuli. Much of animal behaviour is not determined by external stimulation at all, but is a response to needs or deviations from the normal state.

Co-operative Research in Geography

Current geographical generalisation in regard to a large proportion of the earth's land surface necessarily derives from somewhat scanty data, often still representing the observations of the primary explorers. Prof. A. G. Ogilvie, in his presidential address to Section E (Geography), entitled "Co-operative Research in Geography; with an African Example", suggests a way of accelerating the process of gathering the type of information needed for the composition of geographical syntheses at least fuller and better than those which exist. In respect of the geography of man in such regions, this may be accomplished by utilising to the full the special local knowledge of European or other educated inhabitants of the regions. It is admitted that little help can be anticipated from this source where the fundamental facts of physical geography are concerned, for these must be established by observers trained in the various natural sciences. But, on the other hand, the requisite facts of human geography can be recorded effectively by untrained local observers, if they can be enabled to appreciate the kind of data that are needed. Even here, however, the success of any systematic inquiry depends partly upon the existence of reliable topographic maps. For this reason, the colonies and dependencies of the more advanced nations offer perhaps the most fruitful field for geographical research in the near future, in view of the justifiable hope of rapid extension of regular surveys in such countries.

Proof of this contention lies in the success of the effort inaugurated by a committee of the British Association, appointed in 1926 to investigate the state of knowledge of the human geography of Inter-tropical Africa. This committee, which issued to selected persons throughout Africa a *questionnaire* dealing with specific aspects of local environment as affecting the material life of the native, has recently received very full replies to its questions from the District officers of Northern Rhodesia. These reports, voluminous in the aggregate, yield material for the first comprehensive view of the real relationship between the natives and their land in this Protectorate. Prof. Ogilvie, after sketching the physical background of the region, devotes the bulk of his address to a synthetic summary of certain aspects upon which new information is thus available.

The distribution of the population is revealed in relation to those of water and of woodland, upon which the natives are so largely dependent for wood ash as manure. Tsetse areas are defined, and the relative importance of cattle, in the parts remaining free, is made clear. The various staple crops are seen to have a definite relationship, in their distribution, to the soil conditions on one hand and to external influences on the other. These latter vary in degree throughout the country. The approximate volume, direction and character of the annual migration of native labour to European centres may now be appreciated. The annual rhythm of work and occupation as determined by the seasonal rainfall and variation of river flow can be clearly discerned, with its regional differences.

Other African territories will, it is to be hoped, soon yield data as full as these from Northern Rhodesia, and this mode of investigation might usefully be extended to other continents.

Future of Rail Transport

In his presidential address to Section F (Economic Science and Statistics), Prof. H. M. Hallsworth discusses "The Future of Rail Transport". At the present time, the established position of the railways is being assailed. Competition by road has taken on a new form, coastwise traffic has increased, and the air has been opened up as a third competitor. In view of these developments, what is the future position of the railways likely to be ? Are they to be displaced from their position as the chief mode of transport, to which the rest are supplementary, and to be relegated to a position of secondary importance in the transport system of the twentieth century ?

An 'ideal distribution' of traffic would provide for an economically sound division of function between road, rail and other forms of transport and would take into account, not only the price to the consumer and the cost to the operator, but also the ultimate real cost to the community. The difficulties of determining such true costs, however, are very great and especially so in the case of both rail and road transport.

Many railway critics advocate a solution of the problem by an alteration in the present (statutory) system of charging, but a real solution does not seem possible along these lines or by any system of division of road and rail into areas or spheres of function. By the Road and Rail Traffic Act, 1933, the railways are now permitted to make "agreed charges" with individual traders, and the result of a large extension of the system will undoubtedly be still greater competition with road hauliers, much of which would be wasteful to the community. The traders are on the horns of a dilemma. They cannot ask that the railways should be tied to their former methods of charging, while they themselves are free to choose road transport when it suits them to do so or when it is less expensive to use the roads.

The best solution is that the railways should come to be regarded as transport companies, undertaking a given piece of transport by that means or combination of means which appears to them to be the most economic, and at the same time, most suited to meet the real demand of the traveller or trader. It would be in their own interests to effect transit in each case by the most economic method, since otherwise their own net revenue would be diminished. The interests of the community might be safeguarded by the principle of limitation of profits and by the transformation of the Railway Rates Tribunal into a supervisory authority. Despite the development of new forms of transport, railways are likely to remain the backbone of the transport services of Great Britain for many years to come, though to meet modern requirements they need to be supplemented by other means of transport ; this can be done most effectively and economically when the different modes of transport are under one management.

Sources of Cheap Electric Power

The president of Section G (Engineering), Prof. Francis G. Baily, devotes his address to the consideration of sources of cheap electric power.

In the winning of coal, a residue of some six per cent is left, as too poor to be worth carriage to consumers, but if consumed to produce electric power at the pit head, it affords a cheap and effective fuel. Its use will render more advantageous some methods of winning and cleaning which, though low in cost of operating, produce a large proportion of waste. The total amount thus made available is not less than 18,000,000 tons per annum, some fifty per cent more than the entire electric supply industry uses to-day. Formerly, the lack of condensing water has been urged against pit head stations, but higher steam pressures and improved cooling towers have made this disability of small account. Another source of cheap power may be found in the factories which use large quantities of low-pressure steam. If this steam is produced at high pressure and put through turbines, it can be released at a suitable low pressure for factory use, and the electric power is obtained at very low cost.

Hitherto, these sources have been little exploited for general supply, as the pits and factories in Great Britain are not usually centrally placed, and means of distribution from them have not been readily available. The construction of the great network of high-tension wires, known as the grid, allows of all such sources being connected, and it can distribute with very small loss and cost to considerable distances. If a line be drawn some forty miles distant from the edge of the coal areas, nearly the whole of the country south of a line from Montrose to Arrochar in Scotland, and north of a line from Hull to Bournemouth is included, and the area contains two thirds of the population and most of the industries. Hence these sources are well placed for supply, and the grid and subsidiary lines will then form not only a great distributing agent, but also a great collector from all sources. The cost of distribution has been so much reduced that it is considerably cheaper to transmit power electrically than to carry the equivalent coal by rail. Only ship carriage of coal of good quality from pits near the coast to coast towns at a distance can compete with electric transmission.

While the hydro-electric stations in Scotland come into the scheme, for most of them the high cost of construction raises the cost of production, and except in areas distant from the coal fields, it will be difficult for them to compete with pit head stations on remunerative terms.

A substantial part of the cost of production is the heavy assessment for rates on this and other public services, and a reduction of this tax is overdue. With a lower rate charge and cheaper fuel, the domestic heating load will be much increased, and this load has a vast potential magnitude. The lowered cost is also favourable to railway electrification, and the addition of these loads will help to reduce the cost of distribution. The combined effect will bring about a new era of development.

A general scheme of this kind, which unites two industries to their mutual benefit and to the advantage of the public, will require a national board for harmonising all the interests involved, but this is now a recognised method of organisation.

Origin and Use of 'Yerba Maté'

Infusions from vegetable products are common throughout the world; but *yerba maté*, which Capt. T. A. Joyce discusses in his presidential address to Section H (Anthropology), is peculiar to Paraguay and South Brazil; leaves and shoots of a shrub of the *Ilex* family (*Ilex paraguayensis*) are dried by fire, hot water poured on the powder or broken leaf, and, usually throughout the many countries of South America where its use became far-spread from the land of origin, was and is imbibed through a silver or bamboo tube. The drink contains little or no tannin, combines well with a meat diet, taking the place of vegetables and fruit when these are absent, and is a valuable anti-scorbutic.

Its commercial use appears to date from soon after the entry of Jesuits into South America; the first Jesuit mission was established in 1609, the last in 1760; between those dates great establishments of the missionaries spread along the banks of the Paraná River and its affluents, in South Brazil, Paraguay and North-east Argentina. Converts were concentrated in these spots, and the Jesuits, as in other regions, sought a lucrative commerce which should make the mission stations economically independent. The leaf of the ilex provided a means of supplying Spanish colonies in many parts of South America with a drink which formed a substitute for the then often unprocurable wine, and had definitely good medicinal effects. The Jesuits also encouraged the use of the ilex infusion among converts, to replace the fermented drinks to which many races were addicted. When the Jesuits were expelled in 1774, the maté industry was reckoned to yield profits of more than £100,000 annually; the leaf was traded to Buenos Ayres, Uruguay, Chile, Peru, Bolivia and Ecuador; Asunción, on the Paraná, was the greatest depot. Use of the ilex is first mentioned by Nicolás Durán, a missionary writing in the early seventeenth century; among other authorities quoted are Pinelo (1636); del Techo (1649–72); Frézier (1712–14); Juan and Ulloa (1740–1744); J. P. and W. P. Robertson (1811–1830); Demersay (1860); Southey (1817).

The honour of giving a botanical name to the shrub falls to the English botanist A. B. Lambert, who described and illustrated *Ilex paraguayensis* in 1824; the French botanist Bonpland, who went in 1820 to Paraguay, sought it in its native forests, but was imprisoned by the autocrat Francia for many years, and lost the opportunity.

Many attempts were made during Jesuit times to germinate the ilex seed and thus to establish social plantations in convenient regions, to obviate long and arduous journeys to points in the wild forests neighbouring the Paraná; these were eventually successful, but the secret was lost after the ruin of the missions until recent times, when plantations have been created in the old Misiones Territory, North-east Argentina. It is rather remarkable that the first explorers in the country, Ulrich Schmidt (1535–1553) and Cabeza de Vaca (1541–1544) make no mention of the use of the ilex, though they were for the most part travelling through its natural habitat. No mention of its use occurs until after the establishment of the Jesuit missions.

The study of ethno-botany is of high importance; for this reason the subject of a valuable plant was chosen. A short time only elapses before the origins of such plants—with maize as a notable example—are lost during a rapid spread all over the world; stimulants and narcotics share a similar fate. It is therefore suggested that a great opportunity exists for a trained botanist to re-write the fine work of A. de Candolle, the "Origin of Cultivated Plants", a new and up-to-date edition of which is badly needed.

Normal and Abnormal Colour Vision

Prof. H. E. Roaf, president of Section I (Physiology), takes colour vision as the subject of his address.

The study of colour vision is important because it is concerned with one of the most important sensory processes, and a complete understanding of the problems of colour vision would help to explain all other central processes of sensation. The special problem in the study of colour vision is the nature of the receptor organs in the retina.

Analyses of colour sensations show that it is possible to reproduce all colour sensations on the assumption that there are three types of receptors in the retina which are differentially stimulated by the various wave-lengths of light. The above conclusion is the basis of the trichromatic hypothesis advanced by Thomas Young in 1802.

Sensations of white and of yellow are psychologically homogeneous perceptions which can be reproduced by heterogeneous stimuli. The former can be produced by light from two, three or more regions of the spectrum, whilst the latter can be produced by stimulation with one or two regions. Sensations of black are produced not by absence of stimulation but by relatively less stimulation than that of other areas of the retina.

Defective colour vision is usually congenital, and its peculiarity is that the individuals affected by congenital defect in colour vision fail to distinguish 'red' from 'green' but they can distinguish 'blue' from 'not blue'. The normal person can distinguish 'red', 'yellow' and 'green', whilst those with marked defective colour vision can see only one colour corresponding to the above three. This colour is often said to be yellow, but it is more correct to describe it as 'not blue'; it is called yellow as that is the complementary colour to blue. Even if only two types of receptors are present, there must be differences in the degree to which each is stimulated by light close to the 'blue' of the spectrum and that in the 'red' of the same.

Theories of colour vision have been largely influenced by the view of Helmholtz. He elaborated the trichromatic theory of Young by advancing the view that the differential stimulation was due to three substances which were acted upon to varying degrees by the different regions of the spectrum. This view that there are three photosensitive substances in the retina has no support which excludes other interpretations. Up to the present, only one photosensitive substance has been definitely demonstrated.

An alternative view of Max Schultze is worthy of consideration. He points out that the coloured oil globules in the retinæ of birds would give rise to differential action on one photosensitive substance. Colour filters have not been found in the retinæ of mammals above marsupials, so that this view is equally hypothetical with that of Helmholtz. The main difference is that colour filters are easy to demonstrate in birds, etc., but no one has yet proved the presence of more than one photosensitive substance.

Psychology and Social Problems

In his presidential address to Section J (Psychology), Dr. Shepherd Dawson suggests that the problems that arise from living in a community, such as those of supply and demand, capital and labour, law and order, hygiene, transport, etc., are as much mental as material, and that their solution demands some knowledge of the agencies that move men to action, their inborn tendencies, their acquired habits, and the mentality of the groups to which they belong. Such knowledge, to be of real value, must be based, not on casual observation and intuition, but on the systematic, objective and controlled inquiry that characterises scientific method.

Social problems can be approached from the point of view of either the individual or the community, but neither approach can be consistently maintained to the exclusion of the other, for man is not independent of his fellows; his social environment is part of himself, and he is a unit in the social organism. The big social problem is the dual one of fitting the individual into the group and fitting the group to the individual. This is essentially an educational problem in the widest sense, one that concerns the home, the school, the Press, etc.

The development and use of objective methods of studying mind are beginning to provide information of social importance, which, though still scanty, is suggestive. Mental tests have been applied more or less carefully, and in forms more or less satisfactory, to children of all ages, races and grades of society, and the results obtained raise some hope of getting reliable information regarding the distribution of intellect in the population as a whole and in the various professional, social, racial and economic strata, and regarding its connexion with fertility, disease, environment, and other conditions: they offer, too, a method of studying the puzzling problems of mental inheritance.

Distinguishing between capacity and ability, Dr. Dawson insists on the need for care in interpreting the results of attempts to measure them. He briefly indicates some of the results of attempts at mental measurement: in particular, the distribution of intellect in the population, as measured by mental tests, throws some light on certain educational and social problems. It is well known that the educational casualties in post-primary schools are enormous: in Scotland about 44 per cent of the children of age twelve embark on a secondary school course; of these 70 per cent begin the second year work, 43 per cent the third, 22 per cent the fourth, 15 per cent the fifth, and 9 per cent the sixth. Of those who pass to 'advanced divisions' only 14 per cent enter the third-year course. The distribution of intelligence in the population, the curricula and examinations of the schools and the fact that it is usually the duller pupils who fall out first, all suggest that these casualties may be due to an attempt to provide for the few who have the intellect and temperament for professional and administrative work, to the neglect of the majority who are of average or nearly average capacity.

Forest Biology

In his presidential address to Section K (Botany), Prof. A. W. Borthwick discusses "Some Aspects of Forest Biology". The present-day endeavour to grow pure forests involves many problems demanding scientific forest management, with the aim of obtaining the highest yield in the shortest time. In this, the inseparable connexion between botany and forestry becomes all-important.

The climatic factor has an important bearing on forestry. The optimum region where the general balance in climatic factors is the most favourable usually produces the most desirable results with a minimum of trouble and cost. The question of acclimatisation is far from settled, though it is of the utmost importance. Reaction to light intensities and edaphic factors, too, form an important study. Though the tree may react temporarily to certain changes in conditioning factors, there is no evidence that such reaction becomes permanent and hereditary.

In forestry, the long period which must elapse between the establishment of a crop and its final harvesting makes it imperative that a judicious choice of trees best adapted to any given locality be made. Here again, the forester comes into close contact with the botanist. The structure of trees, their reaction to conditioning factors, and, above all, their individual variability must all be taken into consideration during afforestation.

The fundamental biological facts of sylviculture may be grouped according to the three stages of the life of a forest; juvenile, pole or stage of most rapid height growth, and adult stage. In the juvenile stage, clearing and weeding must not be delayed. Thinning out, too, is important. The pole stage is the time of greatest density in the life of the stand. Here the skill of the forester is put to the test, for now is the time to encourage length, form and cleanness of stem. In the adult stage, work should be diverted into obtaining the greatest volume production and quality of timber by controlling diameter increment.

The biology of the large pure stands of timber naturally differs from that of mixed stands. The arrangement of the different species in a mixed stand is a difficult problem. It would seem that the suggestion of Prof. Heinrich Mayer that the forest should be made up of small compartments, each compartment consisting of one species, satisfies most of the requirements of the trees.

Other aspects of the forest as a living community which have not received much attention yet are its biological influences, especially on drainage and water supplies; and its effect on winds in breaking and tempering them. This latter involves the question of a reasonable balance between forest and grazing land, which is one of considerable biological and economic importance.

Science at the Universities

In his presidential address to Section L (Educational Science), Mr. H. T. Tizard refers to the financial responsibilities of universities. The high cost to the public of teaching science at universities makes it necessary to consider seriously whether an increase in numbers of science students can be justified.

The problem of numbers of science students can be regarded from various points of view. Most branches of the chemical industry welcome university graduates as recruits, and do not demand of them a considerable knowledge of the practical problems of industry. Many employers in the engineering industry, however, expect a university graduate of engineering to have a wide acquaintance with practice, and regard him as a misfit if he has not. As a result, there is a constant tendency for university departments of engineering and of the branches of technology to introduce practical instruction of a kind more suited to technical schools. This tendency must be resisted ; and one way to resist it is to restrict the numbers of students. The chief aim of university departments of technology should be to produce the leaders of the technical professions. They must avoid the temptations of mass production. Unfortunately, however, the immediate effect of restricting numbers is to make the financial difficulties of universities greater, for the fee income is reduced, and expenditure cannot be reduced so quickly.

The opportunities for suitable employment open to students of some branches of applied science are limited. Two years ago, a strong Government committee reported that the supply of industrial biologists was not equal to the demand, and attributed the reason for this largely to the neglect of biology as a subject of study in schools. If universities had taken this report seriously, a large number of highly-trained specialists would now be looking vainly for employment. University authorities must form their own judgment about the probable demand for specialists three or four years hence, and must organise their 'schools' accordingly. It is a better policy in the long run to keep the supply of highly-trained specialists short, rather than in excess, of demand.

The neglect of biology at schools is not responsible for an alleged shortage of biologists ; it has certainly not led to a shortage of doctors. The next generation may see a development of the biological sciences comparable with that of the physical sciences, and their applications, in the last thirty years ; but the time is not yet ripe.

The complaint that the general education of a university student of science is defective, and that there is too early specialisation at schools, is also discussed. Mr. Tizard sympathises with the difficulties of schoolmasters, who often have their hands forced by the standard of scholarships set by universities. The Imperial College proposes to award scholarships on a general examination for an experimental period of five years. If university authorities really believe that the standard of general education is too low, the remedy is largely in their own hands. They must revise the matriculation examination, and make it appropriate for the normal age of entry. At the same time, they must not demand so much specialised knowledge from scholarship candidates.

In conclusion, it is argued that universities should now attempt to provide for students who wish to study science as a cultural subject. University education in science and technology is at present primarily designed to produce specialists. There is an urgent need for skilled administrators and men in public life who have a real knowledge of the principles of science. No university is making a serious attempt to meet this need.

Scientific Planning of Rural Life

The subject of Prof. J. A. S. Watson's presidential address to Section M (Agriculture) is "Scientific Progress and Economic Planning in Relation to Agriculture and Rural Life". Ever since the beginning of civilisation, the rate of improvement in agricultural technique has controlled and conditioned, to a considerable degree, the progress of the human race. This progress has been of two kinds—on one hand an increase in numbers and on the other a rise in the material standard of life.

At certain times and places, improvements in farming have failed to keep pace with the potential rate of growth of population, and population has been kept down by the periodic recurrence of famine. The idea that scarcity is a normal occurrence continues, indeed, to colour a great deal of our thought. But in the more advanced countries, during the past fifty or sixty years, the productive capacity of the agriculturist has been rising at an unprecedented rate, which is tending to become ever more rapid. Meanwhile, in these countries as a whole, the rate of increase of population has been slowing down. There is now no doubt that the demand for agricultural produce can be met, in the future, by a diminishing number of agriculturists. The available reserves of land and of other raw materials are so large that there can be no ground for anxiety for many generations to come.

The present crisis in world agriculture has largely arisen out of our failure to realise these broad facts. Land settlement in the new countries has been actively encouraged, while none of the old countries has been prepared to reconcile itself to a less intensive use of its soil. States have, almost without exception, tried to check the natural flow of population out of farming and have even, from time to time, adopted measures designed to drive people back to the land. The result has been that the farmer, while finding it ever easier to produce, has found it ever more difficult to sell. For more than a generation, the farmers of the world have been progressively impoverished and burdened with debts, so that they were in no condition to face a period of financial disorganisation bringing an abrupt fall in the general price level.

During the past few years, there has been a growing realisation that the farmer's economic lot was becoming unendurable, and a variety of expedients have been adopted in the endeavour to ensure something like fair prices for agricultural commodities—compulsory restriction of output; monetary compensation by the State for restrictions voluntarily made; even plans for the destruction of produce judged to be surplus; State subsidies designed to make good the difference between cost of production and market price; export subsidies; tariffs and many more.

The most logical of these schemes are based upon the essentially simple idea that the efficient producer shall be promised, in advance, a reasonable price for a given quantity of produce, and that a system of contract production shall replace that of competitive selling. The translation of this idea into practice is an immense task, but remarkable progress has already been made. There is every hope that economic planning will prove the way that we seek, the way of realising, in terms of human good, the potential benefits arising out of our growing command over Nature.

Scientific Societies and Museums

The ever-increasing share which scientific knowledge and method are taking in both the social life and the industrial activity of the community makes ready access to all kinds of information of primary importance; and in facilitating this, the scientific society, the public library and the museum already play an important part. It seems, however, that by closer co-operation, the services that they can render in this direction can be materially increased. This topic forms the theme of Sir Henry Lyons' presidential address to the Conference of Delegates of Corresponding Societies attending the Aberdeen meeting of the British Association.

At the present day many firms in technical industry are employing to an increasing extent scientifically trained men in their research departments, and to them a ready access to current scientific and technical literature is all-important, not only for study but also to follow up a reference, or to scan in order to see in what direction knowledge in their branch of scientific inquiry is moving.

At the present time, through the facilities afforded by the National Central Library and the Science Library of the Science Museum, London, research workers have ready access to as wide a selection of current scientific and technical periodical literature as any country can offer, but it seems to be comparatively little known and is therefore not nearly so fully utilised as it might be.

Discussion in scientific and technical subjects, which is readily obtainable in London and in the larger cities, may be less easy to arrange elsewhere; and yet such discussion may bring to light methods and equipment already in use in one field of investigation which can be advantageously introduced in others. The International Council of Science Unions at its recent meeting has appointed a committee to promote such co-operation in the international field, at the suggestion of Dr. G. E. Hale, of Mount Wilson Observatory, California, who, in the designing of the new 200-inch telescope and its equipment, has found in other branches of science examples which have been of the greatest value to him and his colleagues. There is no reason why co-operation in more restricted fields should not be equally profitable, and for its promotion local scientific societies are specially well adapted.

Closely related to the provision of information by ready access to published material and by discussion of technical and scientific problems confronting scientific workers in any district, there is the influence which the museum may exercise in similar fields. Such institutions can scarcely aid the scientific worker by bringing to his notice the newest advances in his subject, but now that so many of them are giving attention to the representation of the technical industries which have been established in their vicinity, well-designed and critically selected exhibits of them and their newest advances can be most suggestive and of real value to those whose main interests lie in other fields. Many of these institutions have in the past received their main support and encouragement from those who were interested in archæology and natural history, but science and technology are now finding more ample provision so far as space admits. The establishment of the Municipal Museum of Science and Industry at Newcastle-upon-Tyne a month or two ago is a good example of what can be done in this field; and there, too, is the North East Coast Institution of Engineers and Shipbuilders, a scientific society of high standing and repute, to assist and guide the new Museum in its development.

There is without doubt a wide field of co-operative effort which can be developed with the purpose of facilitating access to the technical and scientific information which exists in Great Britain, but which is not as much utilised as it might be; in this task the society, the library and the museum have their parts to play.

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in amounts which can supply local markets ; others would supply a limited overseas demand ; and still others are capable of supplying a large export market." The species treated of in the pamphlet of the so-called 'Ash Group' are *Eucalyptus regnans, gigantea, obliqua, sieberiana, fastigiata, oreades, fraxinoides* and *consideniana.*

British Breed Standards of Domestic Animals

A BREED standard, well-defined though it may be at the moment, is a fluctuating measure of quality, and Herbert Haseltine has done good work for science as well as for art in creating the sculptures of typical British champions of domestic breeds at the present day. The series of statuettes, nineteen in number, cast in bronze or carved in stones of various hues and textures, chosen to suggest the colours and characteristics of the animals, was exhibited in London and Paris in 1925, and now, thanks to the generosity of Marshall Field, has taken its place as a permanent exhibit in the Field Museum of Natural History in Chicago. A pamphlet (Zoology Leaflet, 13) has just been issued by the Museum, illustrating and describing briefly the models in this unique series, which is a permanent tribute to the skill of the stockbreeders of Great Britain.

Drought and Disease in Lambs

As a result of the prolonged drought of last year, a bad outbreak of 'stomach-worm disease' or 'scouring' developed in lambs during the late part of autumn and early winter, causing heavy losses to sheep in many parts of Great Britain. There can be little doubt that the outbreak was due to deficiency in food, owing to the shortage of grass, for such a condition has been found to lead to a great increase in the numbers of parasitic worms. To prevent severe infestation it is necessary to keep up the condition of the lambs. The weather conditions of the present year in many ways resemble those of last year, and there is danger of a recurrence of stomach-worm disease with its attendant losses. Farmers and others interested are therefore recommended to apply for the account of the life-history of the parasitic worms, with information about their distribution and control, published as Leaflet 75 by the Ministry of Agriculture and Fisheries and issued free of charge.

Oil in Western Canada

THE fact that the second edition of "Oil and Gas in Western Canada" by G. S. Hume (*Canada, Dept. Mines, Econ. Geol.*, Ser. 5, 1933) contains twice as many pages as the first is an indication of the mass of new data of oil and gas prospects in western Canada acquired during the last five years. The author has wisely refrained from amplifying to any marked extent the brief introductory chapter on oil origin and accumulation, but the additional illustrations of various types of structures certainly make his digest more palatable both to the uninitiated and to those familiar with the subject. In view of the rapid advancement of geophysical science and its now widespread application, the chapter on this subject is still too brief and sketchy to be of real technical value. In the first edition, a chapter was devoted to a survey of carbon ratios in relation to known occurrences of oil and gas, emphasis being laid on the fact that favourable structures can be determined by means of these ratios ; it is therefore significant that this section has been omitted in the second edition. The additional information given is wholly relevant to the main issue, and serves as a useful basis of comprehension of the actual descriptions of oil and gas fields. Order and proportion are given to these descriptions, and valuable technical data contained therein made more accessible by division of the region under review into seven districts, namely, the Foothills, Southern, Central, and Northern Plains of Alberta, the Plains of Manitoba and Saskatchewan, Northwest Territories, and British Columbia. Lack of an index, however, to such a large volume is a decided disadvantage.

Safety in Mines Research Board

THE Safety in Mines Research Board has just issued its twelfth annual report ; this report is always looked forward to with a good deal of interest by all connected with coal mining in Great Britain, and this twelfth report is especially interesting because it includes a report on matters that come under the purview of the Health Advisory Committee. The subjects dealt with are exceedingly wide, but all have bearing on the safety of men engaged in any way in coal mining. A number of the detailed reports, which are contained in appendixes to the main report, have already been published, chiefly in the *Transactions of the Institution of Mining Engineers*, and these are exceedingly important. It is also of the greatest interest to find that this Board is co-operating with similar bodies in other countries, and especially with the United States Bureau of Mines, with the French, German, Belgian and other interested bodies.

French Mathematical Tracts

FOR the last six years the well-known Paris publishers Hermann et Cie. have been issuing brief but authoritative accounts of recent research work in many fields under the general title of "Actualités scientifiques et industrielles". Several of the latest additions to this series are of a mathematical nature, and are grouped under various sub-headings such as "Exposés d'Analyse Générale" (which deal with developments of Cantor's theory of aggregates), "Exposés de Géométrie", and "Exposés mathématiques". One of the tracts placed in the third group might very well have been included in the first. The authors include M. Fréchet, Emmy Noether (who writes in German), A. Appert, M. Brelot, J. Dieudonné, L. Godeaux and N. Lusin. Some of these confine themselves to rather special problems investigated by themselves, while others, notably MM. Fréchet and Appert in their "Exposés d'Analyse Générale", give a general account of all the results obtained in the field considered. The number of pages in a tract varies from 11 to 63, and the price from 5 to 14 francs. The style has the clarity and charm which are characteristic of French exposition.

Designs upon Postage Stamps

SLIGHT changes in colour and design have just been made in certain postage stamps for Great Britain, printed for the first time by lithographic process; now the United States of America has notified the appearance of new issues. These are to bear striking scenes from ten of America's National Park areas, such as Yosemite's El Capitan on the one cent stamp, the Grand Canyon on the two cent, Old Faithful Geyser on the five cent, Crater Lake on the seven cent, and, an interesting breakaway from tradition, a prehistoric apartment from the great Mesa Verde 'cliff palace' on the four cent. There is a great deal to be said for the reproduction of features which give a new beauty and interest to each stamp, and at the same time spread a knowledge of the great natural monuments of the country open to traveller and naturalist.

Dissemination of the Brazil Nut

IN his article on the germination of seeds with stony endocarps, printed in NATURE of June 16, Sir Arthur Hill referred to the difficulties of germination in the Brazil nut. Mr. C. Jinarajadasa writes from Belém, Para, that he mentioned this to Dr. Carlos Estevão, director of the Goeldi Museum, Para, Brazil, who stated that two varieties of agouti (*Dasyprocta fulginosa*, Wagl., and *Aguti-Aguti*, L.) are able to break up the hard shell of the Brazil nut with their sharp teeth. After eating a few nuts they bury the remainder in various places, and in this manner Brazil nut seeds are spread and germinate without interference with one another.

New Analytical Balance

WE have had an opportunity of examining the "New Empire" Analytical Balance made by Messrs. Baird and Tatlock (London) Ltd., 14–17 Cross Street, Hatton Gardens, London, E.C.1, and find that it has a number of interesting features. The fittings which are usually of brass are made in stainless steel and other parts are chromium plated. The beam is finished black, which is claimed to be fume and scratch proof, and the top edge is bevelled so that the rider can be accurately placed. The rider scale is white on black, and is easily read. The side and front doors are large and open easily, and the pan hangers are widely spaced so that large flasks may be weighed. Loose bakelite pans are supplied to fit over the metal pans and we found that these were adjusted in weight within two milligrams. The lifting mechanism worked very smoothly, and the period was reasonably short. The sensibility was very good both with small and heavy loads, and the balance is suitable for all accurate work requiring four places of decimals of a gram. The finish of the whole balance is very good, and its appearance compares favourably with that of much more expensive instruments. The agate knife edges and planes are sensibly mounted, and the robust character of the balance makes it very suitable for use by students. The boxes of weights supplied for use with the balance are of gold-plated pieces with fractions in nickel and aluminium, the whole being enclosed in a bakelite block and case which will not warp, the top of the block being covered with velvet. We formed a very favourable opinion of the balance and weights, which represent exceptionally good value for the price charged, and should make a wide appeal to various types of users.

Announcements

PROF. JACOB G. LIPMAN, dean of agriculture in Rutgers University and director of the New Jersey Agricultural Experiment Station, has been awarded the Chandler Medal of Columbia University for 1934, for his work in agricultural chemistry. The Chandler Medal is awarded annually by Columbia University for "conspicuous work in the field of chemistry". Prof. Lipman was president of the First International Congress of Soil Science and is the founder and editor of *Soil Science*.

THE Third International Locust Conference will meet in London on September 11 in the Lord Chairman of Committees' Room, House of Lords, under the presidency of Sir John Chancellor. His Majesty's Government in the United Kingdom will be represented by Sir Guy A. K. Marshall, director of the Imperial Institute of Entomology; Mr. B. P. Uvarov, senior assistant, Imperial Institute of Entomology; Mr. H. B. Johnston, chief locust investigator of the Institute; Mr. G. F. Seel of the Colonial Office; and Mr. M. C. Mossop, nominated by the Government of Southern Rhodesia. The meetings will be open to the public. Cards of admission may be obtained from Mr. Francis Hemming, Secretary-General to the Conference, 2, Whitehall Gardens, S.W.1.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A technical officer at the Admiralty Technical Pool—The Secretary of the Admiralty (C.E. Branch), Whitehall, London, S.W.1 (Sept. 12). An assistant agricultural organiser to the Nottinghamshire Education Committee—The Director of Education, Shire Hall, Nottingham (Sept. 12). An assistant at the Fuel Research Station, East Greenwich—The Establishment Officer, Department of Scientific and Industrial Research, 16, Old Queen Street, Westminster, S.W.1 (Sept. 15). A chemist in the Department of the Government Chemist—The Government Chemist, Clement's Inn Passage, Strand, W.C.2 (Sept. 15). Assistant civil engineers in the Civil Engineer-in-Chief's Department, Admiralty and H.M. Naval Establishments—The Civil Engineer-in-Chief, Admiralty, London, S.W.1 (Sept. 15). An assistant plant pathologist in the Department of Agriculture and Lands, Salisbury, Southern Rhodesia—The Official Secretary, Office of the High Commissioner for Southern Rhodesia, Crown House, Aldwych, London, W.C.2 (Sept. 15). A superintendent of forests in the Department of Agriculture and Forests, Sudan Government—The Controller, Sudan Government, London Office, Wellington House, Buckingham Gate, S.W.1 (Sept. 20).

Letters to the Editor

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

Radioactivity of Potassium

SOME time ago one of us attacked the problem of the radioactivity of potassium by carrying out a partial separation of its isotopes and determining the atomic weight and the radioactivity of the 'heavy' fraction obtained. The fact that the 'heavy' fraction was found to be more active than the normal potassium proved that the activity is not due to the main isotope 39 but to a heavier one. By comparing on one hand the activities of these two samples and their atomic weights on the other, it is possible to determine the mass of the radioactive isotope.

While the comparison of the radioactivity[1] could be carried out with the necessary accuracy, the comparison of the atomic weights with sufficient accuracy involves some difficulties. Hönigschmid, some years ago, and Sachtleben recently in his laboratory, found for the difference between the atomic weight of the normal and of our 'heavy' potassium exactly the same value, and their figure is only compatible with the assumption that the activity of potassium is due to an isotope of mass 41 or possibly 42, while Baxter's determination leads to a lower value (40). Another line of attack is to search for the disintegration product of potassium. The emission of a β-particle changes the atom of potassium into an isotope of calcium. We therefore extracted the calcium from very old Norwegian biotite rich in potassium (6 per cent) but containing only about 0·05 per cent calcium, kindly given us by Prof. V. M. Goldschmidt. All chemicals used were most carefully purified from calcium to avoid contamination of the calcium present in the biotite. The investigation by Aston[2] of the sample obtained did not, however, reveal any difference from common calcium.

Some time ago we investigated in a magnetic field the radiation emitted by potassium to search for the possible presence of positrons. The search led to a negative result. At the same time we studied the effect of the variation of the magnetic field on the number of β-particles registered by the point counter. In view of the small intensity of the potassium radiation, the investigation of the magnetic spectrum involves great difficulties; however, the accuracy is sufficient clearly to indicate the presence of two strong components, having the energy of about 3×10^5 and 7×10^5 e.v., the former having the greater intensity. It is of interest to note that measurements carried out by an entirely different method by Bocciarelli[3] led to a similar result.

If we assume that these two components are due to β-particles originating in the nucleus of the same potassium atom, the transformation of the latter must lead to the formation of an isotope of scandium, a conclusion which can be tested. In searching for a calcium isotope of short life as a result of the emission of the first β-particle, we precipitated calcium oxalate from a solution of potassium chloride and tested with a Geiger counter the activity of the precipitate within 30 seconds, reckoned from the beginning of the chemical operation. The result was, however, a negative one. The failure of Aston to detect a calcium isotope produced by the decay of potassium is possibly due to the fact that the decay leads to the formation of a calcium isotope having a very short life, and a stable scandium isotope.

Another possible explanation was put forward by Gamow[4]. He assumes that potassium emits α-rays not yet detected, and that the β-radiation observed is due to a chlorine isotope produced by the decaying potassium nucleus. Gamow calculates the ranges of the hypothetical α-radiation of potassium and of rubidium to be 0·24 cm. and 0·63 cm. respectively. By using Geiger's multiplication method we were unable to find any indication of the presence of α-particles in the radiation emitted by potassium or rubidium. We then tried to obtain α-tracks from rubidium by cloud chamber photographs. 1,400 exposures were taken at a pressure of 23 cm., the surface—covered by a rubidium compound—being 55 cm.². Not a single track could be observed, though experiments carried out with α-radiation cut down to a small residual range have shown that particles having a range as short as 0·1 cm. could still be detected. A negative result was also obtained when investigating with the point counter precipitates of silver bromide, obtained from solutions containing potassium and rubidium nitrate, within 20 sec. reckoned from the start of the chemical operation.

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M. PAHL.
R. HOSEMANN.

Institute of Physical Chemistry,
University of Freiburg/Br.

[1] G. v. Hevesy, W. Seith and M. Pahl, *Z. phys. Chem.*, Bodensteinfestbd., p. 309, 1931.
[2] F. W. Aston, NATURE, **133**, 869, June 9, 1934.
[3] D. Bocciarelli, *Atti. R. Accad. Lincei*, (6), **17**, 830; 1933.
[4] G. Gamow, NATURE, **133**, 744, May 19, 1934.

Catalytic Interchange of Hydrogen between Water and Ethylene and between Water and Benzene

IT is known that, in the presence of a platinum catalyst, there is an interchange of hydrogen atoms between gaseous hydrogen and water[1]. Recent observations have proved that nickel can also act as a catalyst of this reaction. On the other hand, A. Farkas, L. Farkas and E. K. Rideal[2] have shown that the hydrogenation of ethylene on a nickel catalyst is preceded by an interchange between the hydrogen atoms of the ethylene and the hydrogen used for hydrogenation. Afterwards it was found by the authors in collaboration with G. Ogden[3] that a metallic catalyst causes a rapid exchange of hydrogen atoms between benzene and gaseous hydrogen at ordinary temperatures, while at the same time hydrogenation is very slow.

We have now found that these two sets of experiments can be combined into a new process: a metallic catalyst is capable of bringing about an exchange of hydrogen between ethylene and water, and also between benzene and water.

A series of experiments for ethylene and water were carried out as follows. About 35 c.c. at N.T.P. of ethylene was enclosed with 100 mgm. water containing 3 atomic per cent of heavy hydrogen, in a sealed tube of 140 c.c. capacity, and after adding 1·5 gm. of a nickel catalyst the mixture was kept at 80° C. After 7 hours, the hydrogen of the ethylene was found to contain 0·6 per cent of D. Tests made after 24 and 48 hours showed a constant 1·3 per cent of heavy hydrogen in the hydrogen of the ethylene. Assuming that at this value equilibrium was attained, we obtain for the distribution coefficient of heavy hydrogen between water and ethylene (that is, per cent heavy hydrogen in the hydrogen of the water phase compared with per cent heavy hydrogen in the hydrogen of the ethylene phase) a value of $1 : 0{\cdot}58 = 1{\cdot}7$.

The interchange of hydrogen between benzene and water was obtained in a similar way: 0·16 gm. of benzene was heated with 0·135 gm. of water containing 3 per cent of heavy water in a sealed tube of 50 c.c. capacity, in presence of 1·45 gm. of the nickel catalyst. After 2 hours, the heavy hydrogen content of the hydrogen in the benzene was 1·5 per cent and the same value was found after 6 and 12 hours. These data give for the partition coefficient of heavy hydrogen between water and benzene (at 200°) a value of 1·05.

The above processes seem to provide a convenient method for the replacement of H by D in organic compounds containing double bonds or aromatic rings.

J. HORIUTI.
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University,
Manchester.
Aug. 20.

[1] J. Horiuti and M. Polanyi, NATURE, **132**, 819, 931; 1933. *Manch. Lit. Phil. Soc.*, **78**, 47; 1934.
[2] *Chem. and Ind.*, **53**, 489; 1934. E. K. Rideal, *Chem. and Ind.*, **53**, 610; 1934.
[3] *Trans. Far. Soc.*, **30**, 663; 1934.

Interferometer Patterns of the Hydrogen Isotopes

IT has been suggested to me that the accompanying photographs (Fig. 1) showing the Fabry-Perot patterns of the red Balmer line for ordinary hydrogen and for a mixture containing an appreciable amount of the heavier isotope, might be of interest to readers of NATURE. They were taken by Dr. E. Gwynne Jones with the arrangement used by him and by Dr. S. Tolansky for their fine-structure researches, in order to estimate the percentage of heavy hydrogen in this mixture, which was being used by Dr. R. W. B. Pearse and me for other purposes. Originally the gas was supplied to Prof. F. Paneth by Dr. P. Harteck.

The tube used as a source of light was excited by a high-frequency discharge, with external electrodes, and exposures were made at or above room temperature. With an étalon gap of 3 mm. the fringes for

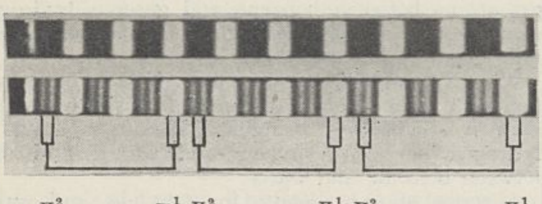

FIG. 1. Fabry-Perot fringes of H_α. Ordinary hydrogen (top); mixture containing 10–15 per cent of the heavy isotope (bottom).

the heavier isotope (which show the doublet structure of H^2_α so clearly) were separated from those of the lighter by some 2½ orders as indicated in Fig. 1.

I have recently shown that this method affords a ready means of estimating quantitatively the relative amounts of the two isotopes in a mixture. In Fig. 2, fringes are shown for three different tubes prepared by Prof. Paneth. The way in which the concentration

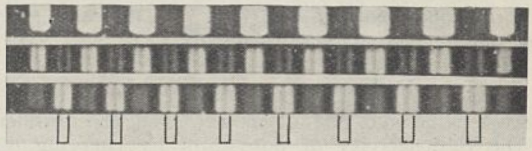

FIG. 2. Patterns for mixtures containing 10 per cent (top), 33 per cent (middle), and 75–80 per cent (bottom) of heavy hydrogen. The position of the heavy isotope doublet is marked.

of diplogen is increased from 10 to more than 75 per cent by continued electrolysis of water is well shown in the photographs.

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Anomaly in the Specific Heat of Ferrous Chloride at the Curie Point

THE susceptibility of ferro-magnetic metals above the Curie point depends on temperature according to the law $\chi\ (T - \theta) = C$. A similar relation holds for the anhydrous salts $FeCl_2$, $CoCl_2$, $CrCl_3$ and $NiCl_2$, θ varying from 20° to 67° K. It appears natural to assume that at temperatures below θ, these bodies become ferro-magnetic.

Measurements made at Leyden[1] show that at temperatures below θ the magnetic susceptibility of all these bodies depends on the field-strength; it can, however, by no means be said that they become ferromagnetic in the ordinary sense.

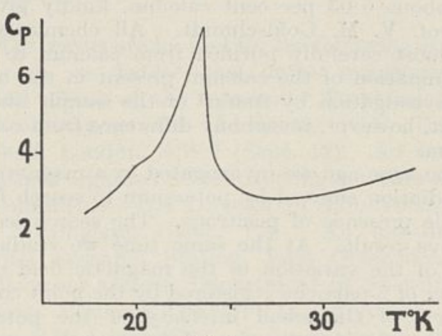

FIG. 1.

In order to clear up the nature of this anomaly we have measured the specific heat as a function of temperature, since this relation should show whether the anomaly is connected with the appearance of a molecular field or not. This is all the more interesting, inasmuch as Landau's[2] theory would lead us to expect peculiar ferromagnetic phenomena in some of these salts. The first body to be investigated was $FeCl_2$, the specific heat of which (C_p for 1 gm.-mol.) is plotted as a function of temperature on Fig. 1. The experiments show a large jump in the specific heat at 23·5° K., the shape of the anomaly being similar to that found in ferromagnetic metals. Hence we conclude that the anomaly in the specific heat, and also that in the susceptibility, of $FeCl_2$ is connected with the appearance of a molecular field at a well-defined temperature, which, in analogy to ferromagnetic bodies, we shall call the Curie point.

It is characteristic that, in accordance with Landau's theory, the Curie point 23·5° is higher than the value of $\theta = 20{\cdot}4°$ found by Woltjer and Wiersma by extrapolating the law of Curie-Weiss.

The specific heat curve below the Curie point is not completely smooth; a hump is clearly discernible. We are at present not in a position to decide whether this hump is due to the properties of ferrous chloride or to some secondary fact, such as impurities or the presence of helium adsorbed on the powder in the calorimeter.

It is interesting to note that preliminary measurements of the specific heats of $NiCl_2$ between 20° and 80° K. ($\theta = 67°$) do not point to the existence of any marked anomaly. At present we are engaged in measuring the specific heat of $CrCl_3$, in which the results obtained with $FeCl_2$ would lead us to expect an anomalous behaviour.

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L. W. SHUBNIKOW.
Ukrainian Physico-Technical Institute,
Kharkov. July 6.

[1] Woltjer, *Leiden Comm.*, 173b. Woltjer and Wiersma, *Leiden Comm.*, 201a.
[2] L. Landau, *Sov. Phys.*, 4, 675; 1933.

Ionospheric Investigations

IN a recent letter[1], Mr. R. Naismith gave a brief description of equipment used for ionospheric investigations by the Radio Research Board as a part of the Polar Year programme. The equipment described made it possible to record the relation between the radio frequency of the pulse signals used and the virtual height reached by them in the ionosphere. Records of this type give a measure of the maximum density of ionisation.

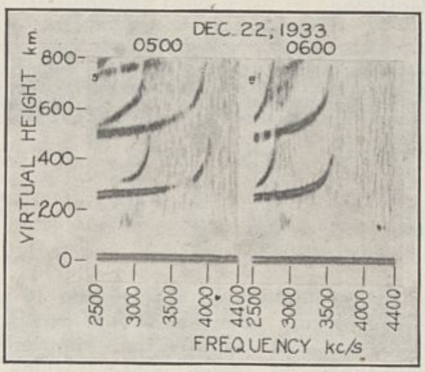

FIG. 1.

Similar equipment was developed at the U.S. National Bureau of Standards[2,3] in 1932, and records extending from April 1933 to date are at hand. Of particular interest are the records obtained at night showing the critical penetration frequencies for the ordinary and extraordinary rays in the *F* region. Fig. 1 shows records obtained at 0500 and 0600 E.S.T. on December 22, 1933. Each record gives the virtual height for the band 2500–4400 kc./s. The frequency is changed at a uniform rate of 200 kc./s. per minute, thus requiring $9\frac{1}{2}$ minutes to pass through the band. Although accurate determination of the actual separation between critical frequencies will await a more nearly simultaneous determination of the two values, the separation is very nearly 800 kc./s. when the ordinary ray critical frequency is at 2500 kc./s.

The greater portion of the critical frequencies obtained at night in this band were for the extraordinary ray. The diagram in Fig. 2 has been plotted from monthly averages of this critical frequency and represents about 1,900 hourly determinations of the

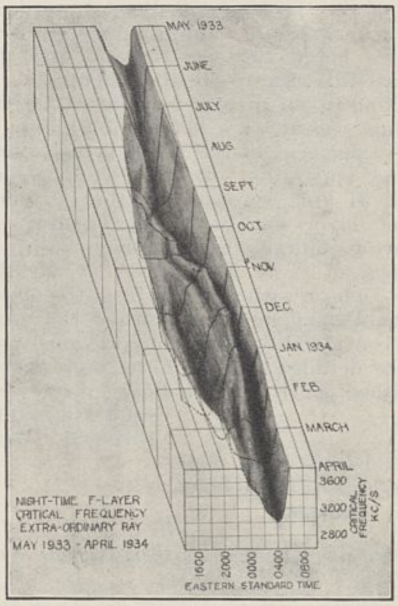

FIG. 2.

type shown in Fig. 1. Calculations from these curves indicate that the two minima in December occurring at 2200 and 0600 represent respectively ionisation densities approximately 1·14 and 2·05 times as great as the minimum value at 0400 in June. The maximum in December at 0430 represents a density 2·65 times as great as the June minimum. The maxima in November and January are slightly higher than that in December.

Work is in progress on the replacement of the preliminary equipment by permanent equipment which will record over a frequency range from 500 to about 12,000 kc./s. The apparatus is arranged to cover this range in four bands. In order to maintain the receiving set accurately in tune with the transmitter, the latter is provided with two oscillators, one variable and the other fixed. The fixed oscillator is set at a value equal to the intermediate frequency of the superheterodyne receiving set. The output from the antenna is either the sum or the difference frequency depending on which band is being used. The variable oscillator of the transmitter serves also as the oscillator for the receiving set. Thus only the detector of the receiving set is required to be tuned, and this tuning is not critical.

Department of Commerce, T. R. GILLILAND.
Bureau of Standards,
Washington.
June 12.

[1] R. Naismith, NATURE, 133, 66, Jan. 13, 1934.
[2] Gilliland, *Bureau of Standards Journal of Research*, 11, 561–566, Oct. 1933. *Proc. I.R.E.*, 22, No. 2, 236, Feb. 1934.
[3] NATURE, 133, 57, Jan. 13, 1934.

Ultra-Violet Solar Spectrum and Ozone in the Stratosphere

ON June 26, July 7 and 31, we succeeded in sending up registering balloons into the stratosphere, to heights of 21, 20 and 31 km. respectively, with an automatic quartz spectrograph. The plate registering the spectra was moved every few minutes; simultaneously, two barographs and a thermograph recorded pressure and temperature on the photographic plate. In order to avoid the permanent position of the spectrograph direct towards the sun, a plate of magnesium oxide (MgO) was fixed about 1·5 metres below the spectrograph and the latter was directed downwards to the MgO plate.

According to our present calculations, we find that at the first ascent, at a height of 21 km., approximately 40 per cent of the whole layer of ozone was below the apparatus. At the third ascent, at a height of 31 km., we calculate that 70 per cent of the ozone layer was below the apparatus. These results are remarkable because they confirm the new calculations of F. W. P. Götz, A. R. Meetham and G. M. B. Dobson[1], who deduce from the observations of the zenith sky light a height of the ozone layer which is considerably lower than previously supposed.

A more detailed report of the investigations will be published shortly in the *Physikalische Zeitschrift.*

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[1] Götz, Meetham and Dobson, NATURE, **133**, 281, Aug. 19, 1933. *Proc. Roy. Soc.*, A, **145**, 416; 1934.

Nuclear Magnetic Moments and the Properties of the Neutron

IN a recent letter to NATURE, S. Tolansky[1] has discussed the "negative nuclear spins" of nuclei containing an odd number N of neutrons and an even number Z of protons. Nuclei of this group may have both positive and negative magnetic moments (that is, Landé's g-factor of these nuclei may be both positive and negative), whereas if N is even and Z odd, the magnetic moment is always positive.

Without entering into criticism of theoretical considerations raised by Dr. Tolansky (I can agree with Dr. Tolansky in the view that there may exist in Nature two kinds of neutrons—but scarcely of the structure proposed by him—but not in his further inferences), I should like to point out that his statement that "Tamm and Altschuler . . . have attempted to explain the difficulty of negative spins by assuming that several neutrons [as opposed to a single neutron] can contribute to the spin properties" is not altogether correct. In the note cited by Tolansky[2], Mr. Altschuler and I have shown that from the simple fact that the *orbital* motion of the neutron does not contribute to its magnetic moment, and from the generalised Landé formula for the g-factor, it follows immediately that the sign of the g-factor of a neutron, supposed to be moving in a spherically symmetrical field of the rest of the nucleus, depends on the state of the neutron, positive and negative signs being about equally frequent.

This result is independent of any assumption as to the relative direction of the magnetic moment and of the spin of a free neutron, and also holds when several neutrons contribute to the angular and the magnetic moments of the nucleus, as well as when a single neutron is concerned. Thus the facts considered by Dr. Tolansky may be easily explained without special assumptions. In fact, we made the assumption mentioned by Tolansky not to explain the 'negative spins', but only in order to obtain a consistent explanation of *numerical* values of the measured g-factors.

IG. TAMM.

Teberda,
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July 24.

[1] NATURE, **134**, 26, July 7, 1934.
[2] *C.R. Acad. Sci. U.R.S.S.*, **1**, 455; 1934.

Solubility of Gluten

THE tenacious mass obtained when the starch is washed from a dough of wheat flour is termed 'gluten', and is commonly held to contain two distinct proteins, glutenin and gliadin. Glutenin is defined in current textbooks as insoluble in all neutral solvents, but soluble in dilute acid and alkali. Gliadin is also defined as insoluble in neutral solvents, but is distinguishable from glutenin by its solubility in 60–80 per cent alcohol.

It has already been shown by Cook and Alsberg[1] that gluten can be dispersed completely in 30 per cent urea solution, while only partial dispersion is obtained in concentrated solutions of the lyotropic salts, potassium iodide and potassium thiocyanate. Later studies[2] of gluten dispersions in 30 per cent urea led to the conclusion that, although fractions resembling glutenin and gliadin could be obtained from such dispersions, there was no clear-cut distinction between the solubilities of these two proteins. Whole gluten was therefore used in subsequent investigations.

Sodium salicylate. Grams per 100 c.c. solution.	Gluten nitrogen extracted as percentage total gluten nitrogen.	Urea. Grams per 100 c.c. solution.	Gluten nitrogen extracted as percentage total gluten nitrogen.
7·0	92·0	18·0	85·4
8·0	99·2	21·0	94·6
9·0	99·3	24·0	99·7
10·0	99·1	27·0	99·5
12·0	99·9		

Recently we have found that 10 and 12 per cent solutions of sodium salicylate would disperse gluten completely and more rapidly than solutions of the same substances at higher concentrations. Both urea and sodium salicylate are known to exert a denaturing action on albumins, and presumably the rate of denaturation increases with the concentration of reagent. This probably accounts for the lower rate of dispersion of gluten observed in sodium salicylate solutions of high concentration. An attempt was then made to determine more accurately the minimum concentration of urea and sodium salicylate required to disperse gluten. For this determination a tough, tenacious gluten obtained from a high-quality Canadian-grown wheat was employed, since concentrations capable of dispersing such material should disperse less tenacious glutens quite readily. The method consisted of shaking the gluten obtained from 5 gm. of flour with 100 c.c. of various concentrations of the two solvents for six hours at room temperature, filtering and analysing both the filtrate and solid for protein. The results given in the accompanying table show that 8 per cent sodium salicylate and 24 per cent urea are the minimum concentrations that will cause complete dispersion. Increasing the amount of solvent, or the time of extraction, had little effect on the amount dispersed.

The lower concentration of sodium salicylate required for dispersion, together with the fact that it does not contain nitrogen, favours this reagent over urea as a neutral solvent for gluten. The use of these neutral solvents for dispersing gluten is subject to criticism since they are known to denature other proteins, but it will be shown in papers to be published shortly in the *Canadian Journal of Research* that these reagents have a less drastic action on gluten than the classical solvents, dilute acid and alkali.

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[1] Cook and Alsberg, *Can. J. Res.*, **5**, 355; 1931.
[2] Cook, *Can. J. Res.*, **5**, 389; 1931.

Shape of the Dibenzyl Molecule

SOME time ago, I completed an X-ray analysis of the crystal structure of dibenzyl[1], and showed that the results could best be explained by a three-dimensional model of the molecule, in which the planes of the benzene rings were at right angles to the plane containing the zig-zag of the connecting CH_2 groups, as shown in Fig. 1. The structure is thus an interesting contrast to those aromatic compounds like naphthalene and durene in which all the carbon atoms of the molecule are found to lie in one plane.

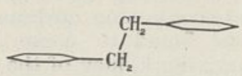

FIG. 1.

More recently, however, Dhar[2] has published the results of an independent investigation of dibenzyl, and his conclusions differ materially from mine. He assigns to the molecule the form shown in Fig. 2,

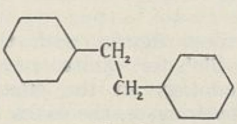

FIG. 2.

with the modification that one benzene ring and its contiguous CH_2 group are depressed below the plane of the paper by 0·12 A. while the remainder is raised above the mean plane by a similar amount. His structure is thus only slightly distorted from the planar form.

To determine the exact shape of the molecule is obviously a matter of some difficulty, because the orientation with respect to the crystal axes is rather complicated. It is quite possible to place each of the above models in a position which makes the projections of the two structures in at least one direction very similar. The matter can only be settled by an exhaustive study of the reflections from several different zones in the crystal.

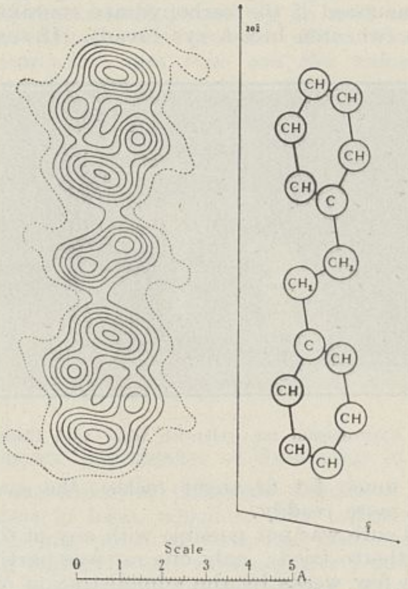

FIG. 3. Dibenzyl, projected along the *b* axis. Each contour line represents a density increment of one electron per square A.

I have now completed a double Fourier analysis of the structure factors for three such zones of reflections, and the results confirm my previous conclusions. The orientation given before is only slightly modified, and the shape of the molecule is verified. Calculations based on the Fourier analysis show that the planes of the benzene rings cannot be turned by more than about 8° from the three-dimensional position of Fig. 1.

A contoured map of the electron density for one of the projections (along the *b* axis) is given in Fig. 3, and it will be seen that six of the fourteen carbon atoms are clearly resolved. The remainder are resolved in other projections, so that nearly all the co-ordinates can be estimated directly from these maps. The regularity of the benzene ring is a rather striking feature of this particular map. It was obtained by summing a double Fourier series of about fifty terms at 450 separate points taken over the asymmetric unit (half the molecule).

The possibility that Dhar has examined a different crystal modification from the one dealt with by me must not be overlooked. My crystals melted sharply at 52°, and corresponded in every respect with the standard description.

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July 27.

[1] *Proc. Roy. Soc.*, A, 1934, in the press.
[2] *Current Science*, 2, 480, June 1934.

Dietary Depigmentation of Young Rats

WHEN black (or hooded) young rats are given a ration containing much carbohydrate and also the vitamins B_1 (acid clay standard), B_2 (egg-white or horse-flesh), A and D (standardised cod liver oil), McCollum's salt mixture and the necessary amino acids (casein, egg-white or horse-flesh), they are liable to show symptoms of yellowish depigmentation of the fur after about two months. Symptoms are less pronounced if the carbohydrate contains much cellulose (wheaten bread, rye bread). If such diets

FIG. 1. Experimental rat, yellowish white with black sides.

contain much fat or sugar (cake), the symptoms develop more readily.

Rapid cure was not possible with any of the food-stuffs hitherto tried; only one rat was partly cured within a few weeks by the administration of lemon juice; two other rats exhibited a small improvement during the same period. Addition of whole, dried yeast, on the other hand, resulted at best in a very slow cure; the sides of the body improved first (Fig. 1), finally after two months the fur got back its original black colour. When the yeast was omitted afterwards, the rat showed symptoms of depig-

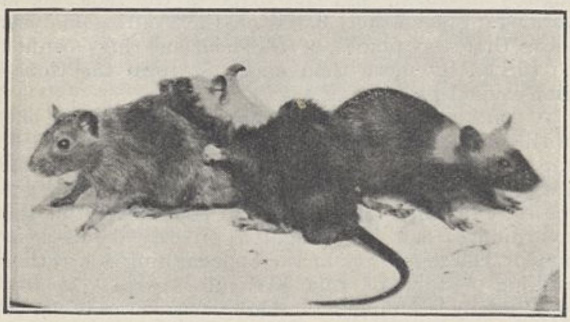

FIG. 2. Animal on left, yellowish grey; those on right black with bald head and neck.

mentation again simultaneously all over the body (Fig. 2, left animal). Sometimes there was loss of fur on the head, neck and back during this period of depigmentation (Fig. 2, two animals on right); the new hairs which appeared on neck and trunk before the cure started were more obviously yellow-tipped than the remaining old hairs which began slightly to turn pale by that time.

The symmetrical distribution of the returning pigment reminds one of the hyperpigmentation in pellagra of man (Lavinder[1]); the diet which causes depigmentation is probably deficient in the pellagra-preventive factor B_6 (György[2]) or the growth-promoting factor Y (Chick and Copping[3]); on the other hand, the alleged relation between pellagra and diets rich in sugar (Leader[4]) is in some measure corroborated by the above mentioned results. After all, the fact that lemon juice was active too suggests that vitamin C or some other active principle in lemon juice may play some part, although vitamin C itself is generally assumed to have no effect on the rat. One should take into account here the beneficial results obtained by Morawitz[5] with lemon juice as regards hyperpigmentation and scurvy of a human patient.

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Delft.
Aug. 13.

[1] Lavinder, "Avitaminosen und verwandte Krankheitszustande", p. 684, Springer, Berlin, 1927.
[2] György, NATURE, **133**, 498, March 31, 1934.
[3] Chick and Copping, *Biochem J.*, **24**, 1764; 1930.
[4] Leader, *Biochem. J.*, **24**, 1172; 1930.
[5] Morawitz, *Klin. Wochenschr.*, **13**, No. 9; 1934.

Acceleration of Respiration of Normal and Tumour Tissue by Thionine (Lauth's Violet)

THE defective oxidation of carbohydrate by tumour tissue (Dickens and Šimer)[1] causes experiments directed towards its restoration to be of interest. It is now known that at least two types of reagent are able to function as catalysts in increasing directly the oxygen consumption of body-cells: (*a*) certain reversibly oxidisable systems, particularly methylene blue[2,3] and pyocyanine[4]; (*b*) the dinitrophenols, particularly dinitro-*o*-cresol, found by Dodds and Greville[5,6] to increase the respiration of surviving kidney and tumour tissue.

In the course of investigations of the action of reversibly oxidisable systems on the metabolism of normal and tumour tissue, I have found that this action of dinitro-*o*-cresol on the respiration of kidney tissue is apparently not a special property of the nitrophenols, but is shown also by the dyestuff thionine (Lauth's violet). Measurements were made in the Haldane-Barcroft-Warburg apparatus, and those of respiratory quotient in bicarbonate media by the method of Dickens and Šimer[7]. Thionine added to a lactate-containing medium in 5×10^{-5} M. concentration was found to cause an increase of respiration of surviving kidney of the rat amounting up to 90 per cent in phosphate- and up to 59 per cent in bicarbonate-Ringer solution; an example follows:

	R.Q.	Q_{O_2}	$Q^{O_2}_{CO_2}$	Extra oxygen	Extra carbon dioxide
Control	0·83	−27·5	−6·05		
With thionine 5×10^{-5}M.	0·92	−42·8	−10·6	15·2	16·0

Comparison of these figures with those given by Dodds and Greville[5] for dinitro-*o*-cresol shows an almost perfect analogy in the effect of the two substances. In both cases, the extra oxygen is used for the combustion of metabolite at or near *R.Q.* unity, and the increase itself is of the same order of magnitude. Thus a link is provided between the hitherto obscure action of the nitrophenols (or perhaps of products formed from these in the tissues) and that of the reversibly oxidisable dyestuffs. The respiration of kidney in presence of glucose is also increased by thionine.

The respiration of tumour tissue is increased by thionine in similar concentration. With Jensen rat sarcoma, increases of 48–146 per cent were observed in phosphate- and in bicarbonate-media containing glucose; in lactate, contrary to Dodds and Greville's experience with dinitro-*o*-cresol, both thionine and pyocyanine cause a fall.

A marked difference also exists between the behaviour of these three reagents towards the aerobic lactic acid formation in tumours; this is accelerated by dinitro-*o*-cresol[6], diminished by pyocyanine[4] whilst with thionine I find that it is possible to increase the tumour respiration by 146 per cent with little or no effect on the aerobic glycolysis. It may be mentioned that methylene blue in solution of high bicarbonate concentration at *p*H 7·6 caused an increase of respiration of the tumour, accompanied by a slight increase of aerobic glycolysis in some experiments. On the other hand, the more positive system, toluylene blue, in higher concentration, has been found, like ferricyanide[8], to lessen aerobic acid formation. These experiments are being continued and extended to other oxidation-reduction systems.

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Aug. 13.

[1] F. Dickens and F. Šimer, *Biochem. J.*, **24**, 1301; 1930.
[2] E. S. G. Barron, *J. Exp. Med.*, **42**, 447; 1930.
[3] L. J. Soffer, *Bull. Johns Hopkins Hosp.*, **49**, 320; 1931.
[4] E. A. H. Friedheim, *Biochem. J.*, **28**, 173; 1934.
[5] E. C. Dodds and G. D. Greville, NATURE, **132**, 966, Dec. 23, 1933.
[6] E. C. Dodds and G. D. Greville, *Lancet*, **1**, 398; 1934.
[7] F. Dickens and F. Šimer, *Biochem. J.*, **25**, 973; 1931.
[8] B. Mendel, *Angew. Chem.*, **46**, 52; 1933.

Glutathione and Vitamin C in the Crystalline Lens

IN a recent letter, Evans[1] disagrees with our observation that a considerable part of the iodine-reducing substance in the crystalline lens is ascorbic acid[2].

In support of the view that the lens contains an insignificant amount of ascorbic acid, Evans refers to a biological test in which she added crystalline lens to the scurvy-producing basal diet of a group of guinea-pigs, and states that the experimental animals survived no longer than the negative controls, which "indicates that the lens contains only small amounts of ascorbic acid". On account of the present interest of these observations, we wish to point out that in a paper[3] not referred to by Evans we reported a demonstration of the presence of ascorbic acid in the lens of the ox by means of a biological method. It was observed at the time that the curative biological test gave no evidence of the presence of ascorbic acid in the lens, because the experimental animals died before the negative controls, presumably owing to a toxic action of the lens. The same objection holds against the prophylactic method which was apparently used by Evans.

In our final test, therefore, the tooth structure method was used, and the results indicated the presence of a considerable amount of ascorbic acid in the lens. It should be noted that the lens was given to the animals in doses calculated from the 2-6-dichlorophenolindophenol titre to contain 2·7 mgm. of ascorbic acid. Ground desiccated tissue was used and suspended in water for dosing from a pipette. If the lens is added to the diet (as in Evans's experiment), a serious error may be introduced by the oxidation of the ascorbic acid present.

Evans suggests that the Okuda iodine titration method is fairly accurate for estimating the glutathione content of crystalline lens, but also reaches the contradictory conclusion that the lens possibly contains another iodine-reducing substance apart from glutathione or ascorbic acid. In this connexion it may be observed that the rapid reduction of 2-6-dichlorophenolindophenol by an acid extract of the lens indicates the presence of a substance or substances *which ipso facto can also reduce iodine.* Therefore the iodine titration of the lens extract gives a measure not of the content of glutathione alone, but also of the glutathione and the indophenol-reducing substances together.

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W. J. DANN.

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University of Cambridge and
Medical Research Council.
Aug. 11.

[1] NATURE, **134**, 180, August 4, 1934.
[2] NATURE, **131**, 469, April 1, 1933.
[3] *Biochem. J.*, **28**, 638; 1934.

Hormonal Interruption of Broodiness in Hens

THE separation of particular hormones effecting broodiness in hens, which is very important from the economic point of view, has been studied by Hertwig and Schwarz[1] with negative results: menformon in quantities of 500 mouse units had no influence upon the interruption of broodiness.

In these experiments four groups of brooding hens and those which had discontinued their broodiness and yet were not laying eggs were used. Different hormones were administered, for a period of ten days. Prolan A, pituitrin and distilled water were administered subcutaneously and the thyroid gland by mouth. Prolan A was given in increasing doses up to a total of 1,600 mouse units; the second group was given dried cattle thyroid gland (0·5 gm. daily) and the third group, pituitrin (Dr. Heisler, Chrast, Czechoslovakia, 0·5–1·0 c.c.) amounting in all to 8 c.c., that is, 48 pigeon units. The fourth group, serving as control, received the same amount of distilled water.

The results show that: (1) the hormones in the amounts given had no influence upon the interruption of broodiness during the experimental period and seven days afterwards. (2) Thyroid gland produced heavy moulting on the fifth day of the experiment and this was continued for a period of seven days. However, the same quantity of thyroid substance had no effect upon the moulting of the breeding hens. (3) The hen from the prolan group, which was not broody but was not yet laying eggs, started to lay five days earlier than the others. (4) The pituitrin administered to hens in such large doses, which were large enough for a man, had no effect upon health, broodiness, or laying.

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[1] *Arch. Geflügelkunde*, **8**, 3; 1934.

Research Items

Roman Remains at Ipswich. A Roman villa at Castle Hill, Ipswich and a Roman cemetery in Messrs. Bolton's brickfield, Ipswich, are described by Messrs. J. Reid Moir and Guy Maynard in the *Proceedings of the Suffolk Institute of Archæology and Natural History*, 21, pt. 3. Ipswich and its immediate neighbourhood are poor in Roman remains, and, so far as is known, Castle Hill is the only habitation site of the period in the district. The remains uncovered were of considerable extent. The house faced south, overlooking the Gipping-Orwell valley. The shape is difficult to visualise. It may have been of an L shape. Most of the relics found on Castle Hill belong in date to the later half of the Roman occupation, and the evidence from the cemetery points to the same conclusion. On the Castle Hill site in two places there appeared evidence of two Roman levels, which, however, may not have been separated by any great length of time. Two somewhat extensive areas of tesselated pavement were uncovered, one a passage-way and room of plain red tesseræ and the other a room showing a simple form of decoration in black, red and white tesseræ. In a rubbish pit were two cooking pots of black ware, which had been used as cremation jars, a somewhat surprising occurrence for a period when cremation was not generally in vogue. The brickfield cemetery, judging by the pottery and other grave furniture, served the people of Castle Hill, as the remains are comparable in age, but the poor character of the material suggests that it was used only for those of small social importance. The graves were placed more or less in rows with the bodies orientated feet to west. They were in the extended position with the head on a pillow or surface soil, and the hands over the pelvis. In six instances (all females) the skull lay between the feet. Evidently they had been decapitated ; while in two, humanly fashioned flints lay on the pelvic region.

Early Glass. All known examples of glass which can be dated to a period earlier than 1500 B.C. are enumerated by Mr. H. C. Beck in *Ancient Egypt and the East*, 1934, pt. 1. Glass, glaze and faience are all made of similar materials and have to be distinguished. Glaze has been made extensively from the Badarian period in Egypt, the Jemdet Nasr period in Mesopotamia, and from an early date in the Ægean, while faience is found in the pre-dynastic period at least as early as 4000 B.C. Glass was occasionally made before 1500 B.C., but specimens are very rare. There are twenty-eight reputed examples cited here ; but some are not glass, others are of a more recent date, while others are doubtful. The most important piece of evidence is a block of glass from Abu Shahrein, in Mesopotamia, discovered by the late Dr. H. R. Hall, for which a date of 2700–2600 B.C. is claimed. It may have been intended for carving or remoulding. As a worker's piece, it is the earliest evidence pointing to the existence of a factory. A glass cylinder found by Dr. Frankfort at Tell Asmar, Mesopotamia, dated at about 2600 B.C., is of a pale blue-green colour. With the exception of a bead in the Berlin Museum, it is the earliest piece of clear glass known. These two pieces point very strongly to Mesopotamia as the country where glass originated. Two Egyptian specimens, though not the earliest, are the most beautiful of the early examples. One, a small lion head now in the British Museum, is a masterpiece of carving ; the other, a rod with a cartouche, dated 2050–2000 B.C., is the only piece of glass mosaic, with the exception of the bull from Dahshur (xiith dynasty) of which the character of the material is disputed, that can be attributed to this early period. As a rule this technique was not employed until 1,500 years later.

Nest Mortality of Birds. The extent to which the elimination of individuals at different stages of their life-history takes place is involved in any theory of natural selection, but has not been sufficiently studied in terms of numbers. A contribution by S. Baron of the nest mortality of twelve common and diverse species of British birds is, therefore, of unusual interest (*British Birds*, Aug. 1934, p. 77). Summing up his results, he found that, in 74 nests, 287 eggs were laid. Of these, 77 were destroyed by human agency, 30 by natural causes. Of the 180 which hatched, 6 chicks were destroyed by human agency, 30 by natural causes, so that, from the 287 eggs which were laid, only 144 young birds reached the stage of leaving the nests as fledglings. The greatest mortality took place amongst blackbirds (32 fledged out of 91 eggs in 24 nests), magpies (5 out of 12 in 3 nests), and song-thrushes (29 out of 62 in 16 nests). The most successful hatchings occurred in long-eared owl (4 out of 5 eggs in 2 nests), wood-pigeon (6 out of 8 in 4 nests), and mistle-thrush (13 out of 17 in 5 nests). In those birds in which the greatest mortality occurred the larger part of the destruction was due to human agency. It would be interesting to know whether this was attributable to school-boy raiders or to deliberate means taken for the protection of crops or stock.

Scottish Marine Fauna. In a paper published last year, Mr. A. C. Stephen described the natural faunistic divisions of the floor of the Northern North Sea as illustrated by the distribution of the lamellibranch molluscs. By major differences in their density and in the identity of the dominant species Mr. Stephen was able to divide the sea floor into four well-marked zones. These are (1) the Littoral Zone—from high-water mark down to 2 fathoms ; (2) the Coastal Zone —2–20 fathoms ; (3) the Off-Shore Zone—lying beyond ; and (4) the *Thyasira-Foraminifera* Zone—occupying the deep north-eastern portion of the Northern North Sea. In a recent paper ("Studies on the Scottish Marine Fauna : Quantitative Distribution of the Echinoderms and the Natural Faunistic Divisions of the North Sea. *Trans. Roy. Soc. Edin.*, 57, Pt. 3, No. 32 ; 1934) this author records the results of a similar study of the echinoderm population of the North Sea. He finds that these do not show groupings by density of population into zones, as do the lamellibranchs, but that the species of genera represented (mainly *Ophiura*, *Amphiura*, and *Echinocardium*) occur in the greatest numbers in the lamellibranch off-shore zone. It is suggested, therefore, that the echinoderm population might be used to subdivide this zone. In both of the above-mentioned papers the view is put forward—we believe with justification—that, in the North Sea at least, the distribution of the fauna of the sea floor is best regarded and described in terms of zones. The animal community concept, as evolved by Petersen, though probably the more useful in shallow or enclosed waters, is held to be largely inapplicable to the bottom fauna of the North Sea.

Sponges and Cumacea from East Greenland. The zoological results of the Norwegian scientific expeditions to East Greenland (*Skrifter om Svalbard og Ishavet*, Nr. 61. Oslo, 1934) include reports on the sponges by Maurice Burton and on Cumacea by C. Zimmer. The study of the sponges gathered during expeditions in 1930, 1931 and 1932 by Paul Loyning has afforded the opportunity of making a preliminary survey of the distribution of arctic sponges generally, deep-sea and shallow-water species following different lines. The author states that it will be essential in the future, before any comprehensive work on the zoogeography of sponges generally can be begun, for more attention to be paid to the bathymetric distribution. The collections show that there is a remarkable connexion between the arctic fauna and that of the Indo-Pacific and sub-antarctic regions, for there is a number of species common to Greenland and Africa, Australia and the Antarctic; 15 are confined to the arctic region, 54 species in all being recorded, of which one is new to science and 26 new to the fauna of Greenland; 43 are recorded from the area north of lat. 71° 30′ N. for the first time. Most of those not confined to the Arctic suggest a line of distribution extending southwards along the west coast of Europe and Africa, around the southern extremity of the African continent, through the Southern Ocean to Australia (and perhaps to New Zealand). The line may extend to the Antarctic. *Stylocardyla borealis*, with four sub-species, has a peculiar distribution, sub-species *typica* occurring in the Arctic, Western Europe, along the eastern coast of North and South America as far south as Bahia, off Japan and between Marian and Crozet Islands. Probably it is equally distributed throughout the Atlantic. The distribution of the other three sub-species is more like the shallow water forms. It is suggested that these four sub-species are of recent origin, *acuta* still spreading and *irregularis* restricted, and probably the last to arrive.

Pairing in Starfishes. H. Ohshima and H. Ikeda (*Proc. Imp. Acad., Tokyo*, 10, No. 2; 1934) record observations made in July 1933 on the tropical starfish *Archaster typicus*, which occurs in hundreds on the shore of Ishigaki Island. The superposition of a male starfish on a female, first noticed by Boschma (1924) and confirmed by Mortensen (1931), was found to occur here. With the receding of the tide, the starfish crept about in search of his mate, and when the sandy bottom became exposed the starfish were found in couples on the sand; as the sand became nearly dry the mating couples hid themselves under the sand. When the tide rose and the sea bottom was again flooded with water the upper starfish detached itself from the lower one and crept away. Microscopic examination of the gonads showed that in more than 180 couples the underlying starfish was female and the upper one male. A few exceptions were observed—8 examples of superposition of male on male and 3 of female on male. No case of female on female was found. Other unusual cases were 12 sets of three superposed individuals and 4 sets of four superposed individuals; in each set only the lowest specimen was female. It seems probable that the act of superposition is repeated at each high tide, and eventually the spawning takes place on some stimulus. The close association of male and female will make the fertilisation of the eggs certain. The authors recall the few known cases of pairing in Echinoderms.

Movement of Sap in Trees. Prof. George J. Peirce, of Leland Stanford University, made this the subject of his presidential address to the Botanical Society of America at its meeting in Boston in December 1933 (*Amer. J. Bot.*, 21, 211–227, May 1934). Prof. Peirce has used starch suspension and other fine suspensions in injection experiments with trees, and he attaches considerable importance to the fact that it is frequently possible to inject the tracheal systems of the tree to a very considerable extent. He has thus been led to the view that the movement of water in these tracheal systems may take place very largely in hollow tubes of water in the tracheæ, rapid movement being possibly either in such films of water or in the vapour within. He dissociates himself from the classical view of Sachs that water movement takes place through the wall, but at the same time points out some of the difficulties in the way of the current assumption that movement is taking place in continuous columns of liquid that fill the tracheæ. Prof. Peirce's address maintains the contact between the physico-chemical problems involved and the biology of the living tree. His view that the anatomy of the tree may have direct relation to the possibility of maintaining the supply of water to the crown of foliage under adverse conditions should certainly stimulate further inquiry and discussion.

Acceleration of Flower and Fruit Formation. In continuation of the work on flower and fruit formation referred to in NATURE of August 18, p. 257, it may be mentioned that a preliminary notice by R. Harder and I. Störmer has recently been published ("Blütenentfaltung und Hormonwirkung", *Nachr. Gesell. Wissenschaft. Göttingen, Math. physik. Klasse, Fachgruppe* 6, *Biologie*, N.S., 1, No. 3). The detailed paper will appear in the "Jahrbuch für wissenschaftliche Botanik". In this notice, the authors give a short account of a large number of experiments with flowering plants, including those used by Schoeller and Goebel and others made in order to repeat Schoeller's investigations. But in no case did they get any positive result. They experimented with about 1,300 individual plants, and their investigations seem to have been carried out with the utmost care, but the conclusion is that the hormone has no influence at all. It is emphasised that such experiments can only give trustworthy results when the number of individual plants subjected to treatment and also the number of controls are very great; otherwise it is not possible to know how far the deviation from the mean goes in plants which have not been submitted to treatment.

Evolution of Coal and Oil. In two recent papers (*Proc. Roy. Soc. Edin.*, pp. 115–120 and 121–134; 1934) Prof. H. Briggs sets forth (*a*) the considerations leading to the conclusion that both coal and petroleum probably have a common origin in vegetable matter of a peat-like character; and (*b*) the divergent courses of chemical development responsible for the production of two contrasted series of products. He presents evidence that coal up to the semi-bituminous rank is produced by chemical processes that involve the expulsion of carbon dioxide, methane and water.

During the further change to anthracite, however, water is consumed, the hydrogen being expelled as methane and the oxygen as carbon dioxide. This recalls the statement by Prestwich that: "While it requires a red heat to convert coal into coke, its conversion into anthracite is effected in presence of moisture at much lower temperatures". In the natural evolution of graphite from peat of average composition, the amount of graphite produced is estimated to be 29 per cent by weight of the original peat. The generation of oil from peat involves the consumption of water throughout the evolutionary range. Again carbon dioxide and methane are expelled. It is presumed that pressure and warmth assist the reactions.

Preparation of Protoactinium. Protoactinium (element 91) has a halving period of about 32,000 years, and may therefore be obtained in weighable quantity. G. Graue and H. Käding, working in Hahn's laboratory, have prepared nearly pure protoactinium potassium fluoride containing half a gram of the element (*Naturwiss.*, 22, 386; 1934). 5½ tons of Joachimstal radium residues were worked up. The protoactinium was precipitated with zirconium as phosphate in the earlier stages, partly freed from zirconium by fractional crystallisation and precipitated together with tantalum. The final stages yielded a protoactinium compound which gave no X-ray spectrum of foreign element. 5 mgm. of this protoactinium has been used by H. Schüler and H. Gollnow (*Naturwiss.*, 22, 551; 1934) to investigate the hyperfine structure of the spectrum of the element. This is the first determination of the nuclear spin of an element belonging to a radioactive series, and the nuclear moment was found to be 3/2. The existence of hyperfine structure has always been found to be associated with an *odd* atomic weight, and since protoactinium loses six α-particles in changing to lead, the atomic weight of the lead isotope produced must be 207 (the only odd isotope) and that of the protoactinium must be 231.

The Cryoscopy of Milk. The detection of added-water in milk is one of the most important and difficult problems confronting the public analyst. Genuine samples may fall below the legal limit of 8·5 per cent solids-not-fat, and samples may be above this minimum standard and yet have added-water. Freezing-point determinations, however, give results of real value with practically all milks, but have the disadvantage of requiring considerable skill and experience. Attempts have, therefore, been made from time to time to devise methods by which the freezing-point (or the osmotic pressure on which it depends) can be calculated from the analytical data. J. J. Ryan and G. T. Pyne suggest a molecular constant for this purpose, calculated from the combined values of three variables—refractive index of the milk serum, and content of chloride and of soluble phosphate—and give full details for their determination (*Sci. Proc. Roy. Dublin Soc.*, 21, p. 113; 1934). The formula used is $W = 100 \times (33 \cdot 1 - (K\triangle))/K\triangle$, where W is the percentage of added-water, $K\triangle$ the molecular constant found, and 33·1 its average value for genuine milks. Genuine milks were found by this method to vary from the constant by not more than 3·5 per cent, and to compensate for this variation a deduction is made of 3 per cent from the added-water found. For five milk samples to which 5, 10, 10, 15 and 20 per cent of water had been added, the amounts found by this method were 6·4, 11·1, 11·2, 16·3, and 20·6 respectively, a very satisfactory agreement. The results in their present form apply only to fresh milk samples.

Phthalocyanines. R. P. Linstead and collaborators (*J. Chem. Soc.*, 1016; 1934) have investigated a new class of coloured organic compounds which comprises a parent substance, phthalocyanine, and a number of complex metallic derivatives, having a new structural type. The parent substance has four C_8 units in the molecule and is regarded as a fusion of four *iso*indole rings with extra cyclic nitrogen atoms. The first compound, crude iron phthalocyanine, was accidentally obtained in the works of Scottish Dyes, Ltd., in 1928. The reaction between cyanobenzamide and magnesium gave a crystalline magnesium phthalocyanine, $(C_8H_4N_2)_4Mg, 2H_2O$, which was also obtained from phthalimide, magnesium and ammonia. Many metals and metallic derivatives also react with phthalonitrile to yield compounds of the phthalocyanine type. The copper phthalocyanine is obtained as a bright blue compound by treating copper with phthalonitrile, the formula being $(C_8H_4N_2)_4Cu$. This compound is very stable, resists fused potash and boiling hydrochloric acid, and may be sublimed at about 580° at low pressure in an inert atmosphere. The molecular weight of the magnesium compound was determined in naphthalene by the ebullioscopic method as 538–565, the value for $C_{32}H_{20}O_2N_8Mg$ being 572. The close similarity between phthalocyanines and porphyrins, which form the basis of many important natural colouring matters, is pointed out, including the order of stability of the metal derivatives.

Structures of Halogen Compounds of Non-Metals. From time to time, certain halogen compounds of non-metals have been represented as polar compounds; for example, phenyl dichloroiodide, sulphur tetrachloride, phosphorus pentachloride, iodine trichloride and similar compounds: $[C_6H_5I\,Cl]^+\,Cl^-$; $[Cl_3S]^+\,Cl^-$; $[Cl_4P]^+\,Cl^-$; $[Cl_2I]^+\,Cl^-$. The evidence in favour of these formulæ is largely theoretical, and considerable doubt has been thrown on such representations by investigations of Zappi and Cortelezzi (*Bull. Soc. Chim.*, 1, 509; 1934). These authors find that solutions of phenyl dichloroiodide in carefully purified nitrobenzene and phosphorus oxychloride show a very feeble electrical conductivity, whilst the cryoscopic molecular weight is low. The interpretation suggested is that the dissociation is not electrolytic but follows the equation $C_6H_5ICl_2 \rightleftharpoons C_6H_5I + Cl_2$. A critical examination of the data for the other compounds shows that the cryoscopic dissociation is also probably molecular and not ionic. The feeble conductivities observed are more rationally explained as due to the dissociation of complexes formed with the solvent. The conductivity of iodine in liquid hydrogen sulphide is similarly explained by the equation

$$SH_2 + I_2 \rightleftharpoons H_2 = S = I_2 \rightleftharpoons (SH_2I)^+ + I^- \rightleftharpoons (SH_2I)^- + I^+.$$

The measurements indicating a conductivity of phosphorus pentachloride in nitrobenzene are regarded as subject to large errors, and the fused pentachloride, according to Voigt and Biltz, is entirely non-conducting. The polar formulæ are, therefore, in complete disaccord with actual electrochemical measurements, and should be abandoned.

Marconi's Wireless Pilot

By Commander E. C. Shankland

DURING the last two decades, experiments have been made on wireless fog beacons, one of which is known as the revolving beam and another as the rotating loop. Navigators are not fully satisfied with these forms of fog signals, neither do the signals give a direct lead of sufficient reliability into a port. The Marchese Marconi's latest wireless invention recently demonstrated in Italy to a party of guests representing shipping and scientific interests of Britain and Italy definitely supplies this need.

The device consists of a beacon situated on the shore (a promontory 300 ft. above sea-level) and a receiver fitted to the ship. Its intrinsic reliability is also better than the direction-finding apparatus hitherto invented because it is simpler as regards both transmission and receiving. The wave-length used is 60 cm.

To envisage the application of the transmission, one may adopt the analogy of twin searchlights on a single mounting with a dark zone between them in the centre, covering an arc of horizon of 269° with their beams, each beam right and left having a distinctive characteristic. The wireless transmitters send out signals at 500 and 1,500 vibrations per second in exactly opposite phases, producing a 1° zone of silence. This silent zone at 10 miles would subtend a band of silence of about 355 yards.

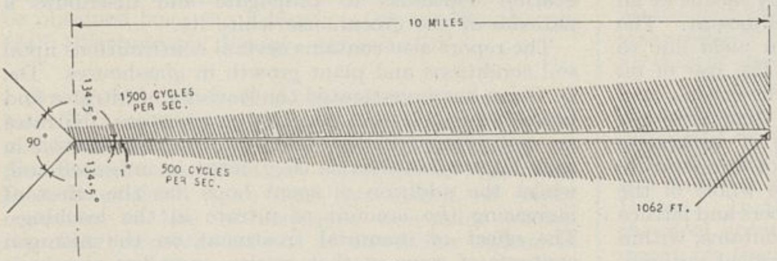

FIG. 1.

To have such a signal fixed in position would be unsatisfactory, as a navigator might assume he was in the silent zone when a breakdown had occurred and the transmitter was not functioning. To guide a ship safely therefore, and also to inspire the confidence produced by positive signals, the system is continuously swung from left to right of the centre line in a similar manner to a searchlight when looking for an object on the water. The amplitude of the swing is small, namely, 6°. When swinging to the left the beacon sounds a high note, when swinging towards the right it sounds a low note. The change of note takes place when the zone of silence coincides with the line of the entrance of the harbour. With this arrangement it is possible to ascertain immediately if the ship is either on the left or right side of the safety line or exactly at it. The rise and fall of the note gives a distinct cadence, to accustom the ear to which requires a certain amount of practice. A principal factor in the sound indication therefore lies in the change of note. If the ship is out of the correct course, the change becomes perceptible, one change of note becoming stronger than the other. It is claimed that this rate of change of tone is given to half a degree of the variation in the course by compass.

Experiments have shown that the apparatus is effective for a distance of 25 miles but the recent tests were conducted over a range of 10 miles, which is the distance between Santa Margarita and the beacon station at Sestri Levante. The strength of the signals varies approximately as the square of the distance from the source.

The transmission apparatus is about 6 ft. high and 4 ft. wide. Two small aerials and reflectors are mounted at right angles to each other on a platform forming the top of a cylindrical base. The platform and the aerial system swings left and right continuously about 2 inches from the centre line. The aerials and reflectors are set for horizontal polarisation of the waves. The small rotating transmitter and the mechanical gear swinging or rotating the beacon platform are both housed in the cylindrical base.

The transmitter is of recent development and has satisfied the conditions of working by operating for five months without attention. It uses two 100 watt special transmitting valves also of a recently perfected type. The remainder of the transmitting station consists of a loud speaker, small motor generators to supply the low- and high-tension to the equipment and to the controlling panels. The latter are housed in the tower. The beacon itself on top of the tower is therefore under remote control.

The receiving equipment consist of two receivers installed on the roof of the navigating house of the *Elettra* at approximately 30 ft. above sea-level. The distance for reception depends considerably on the height of the receivers. These are controlled from the wireless cabin. A repeater device is installed on the navigating bridge together with a microphone with its amplifier. The receivers are about 3 ft. high and only a few inches wide, and in their structure is incorporated an aerial, a small reflector, the tuning circuits and the receiving valves. They are mounted on two separate platforms which may be turned in any desired position. The angle of reception of these receivers is very wide (about 100°), so that it is only necessary to orientate them roughly on the beacon station. With these two receivers the beacon may be received in any position of the ship relative to that of the beacon. The repeater consists of a special milliamperemeter and a loud speaker. One side of the dial of the meter is painted green, the other side is red. In response to the radio signal, the needle oscillates continuously from left to right. When on the exact line of entrance, the change of tone occurs at the same time as the needle occupies its centre position and the deflection of the needle shows the same amplitude on either side. Any deviation from this normal condition indicates that the ship is either too much to the left or right of the line of entrance.

Attached to the system which guides the ship into harbour is a sound-ranging device which gives the distance of the ship from the entrance to the harbour at certain intervals if required. This is done by arranging the modulation of the beacon transmitter in such a way that one change of tone is missed every

15 sec., the next one being sent simultaneously as a radio signal and as an acoustic signal, the latter by means of a loud speaker oriented in the direction of the harbour. By measuring with a stop watch the time elapsing between the radio signals and the sound signal, the distance is known. To render this practical, the ship is equipped with a special microphone tuned to the note sent by the beacon and the head telephones of the observer can be switched over automatically from the radio set to the microphone.

The apparatus is clearly capable of uses other than providing a 'bee' line course for a ship entering harbour in fog. The transmitter may be swung in azimuth to any bearing to provide a silent zone upon which a ship may navigate at right angles if necessary.

Researches on Glasshouse Plants

THE nineteenth annual report (1933) of the Experiment and Research Station established by the Nursery and Market Garden Industries' Development Society, Ltd., at Turner's Hill, Cheshunt, Herts, shows a gratifying co-operation between the glasshouse grower and the scientific worker. The director of the Station, Dr. W. F. Bewley, reports that manurial and variety trials of tomatoes have been prosecuted for some time, and various items of practice, such as planting in trenches, digging in spent hops, chrysanthemum roots and clean straw, have been investigated. A very important experiment relates to heating the soil. This was done by means of hot-water pipes buried in the ground. Circulation of water in the pipes was maintained by means of an electric pump controlled by a soil thermostat. The results show a considerable increase in yield due to the higher temperature of the soil. The use of oil fuel has been investigated through two seasons, and an increased financial return of more than £210 per acre was obtained as against the use of anthracite fuel. This was due to the uniformity of temperature which was maintained throughout the whole of the day and night. Experiments on cucumbers and lettuce find a place in the report, which also contains, within its 115 pages, detailed results of mycological, entomological and physiological investigations by members of the Station staff.

Many short descriptive and research papers of interest to mycologists and entomologists appear in the report. On p. 39, Mr. P. H. Williams writes on leafy gall of the chrysanthemum, discussing its etiology and methods for control. Dr. W. F. Bewley and Mr. O. B. Orchard have a short note on rose diseases, and Mr. H. G. White describes vegetable diseases, including grey mould (*Botrytis* rot or wilt) of lettuce, bean wilt, and a disease of rhubarb. The same author also writes on the sterilisation of lettuce seeds. Messrs. O. B. Orchard and W. H. Read describe the control of leaf mould of tomatoes by fumigation with sulphur or quinone. Several virus diseases form the subject of a contribution by Dr. G. C. Ainsworth, and physiological investigations of mosaic disease of the tomato have been prosecuted by Mr. W. H. Read.

Mr. E. R. Speyer contributes articles on the red spider mite, the tomato-moth caterpillar, parasites of the tomato-moth, thrips and millepedes. Mr. O. B. Orchard writes on the control of wireworms and millepedes, and upon the joint destruction of tomato leaf mould and red spider mite, for which a combined insecticide and fungicide has been suggested. The Station continues to propagate and distribute a parasite of the greenhouse white fly.

The report also contains several contributions upon soil conditions and plant growth in glasshouses. Dr. O. Owen has investigated the leaching of nitrates and potash from soil used for growing tomatoes. Nitrates are not present in the drainage from heated soil in such large quantities as they occur in unheated soil, whilst the addition of spent hops has the effect of increasing the amount of nitrate in the leachings. The effect of manurial treatment on the nitrogen contents of some market garden crops has also been investigated by Dr. Owen. Mr. B. D. Bolas contributes a paper on the influence of light and temperature on the assimilation rate of seedling tomato plants, whilst Mr. R. Melville has studied the effect of water content of the plant upon assimilation. Some aspects of translocation in the seedling tomato plant are described by Mr. I. W. Selman. Messrs. W. H. Read and O. B. Orchard have a paper on plant injury following the burning of sulphur in glasshouses, and Dr. W. F. Bewley and Messrs. Read and Orchard report the results of numerous experiments on conditions which affect the quality of tomatoes.

Heavy Hydrogen and Heavy Water

A SURVEY of the applications of heavy hydrogen in research has been published by H. S. Taylor (*J. Franklin Inst.*, 218, 1 ; 1934). The method of preparation of pure deuterium oxide by electrolysis is described, with full experimental details, and the properties enumerated. The density is found to be $_{25}D^{25}$ 1·1079, in contrast to the value 1·1056 found by G. N. Lewis and Macdonald, whilst the freezing point, + 3·82°, is in good agreement with that found by the latter experimenters.

Pure heavy water is very hygroscopic, and readily absorbs moisture from the air and from containing vessels. Mass-spectrographic results show that the ratio of deuterium to hydrogen in ordinary rain water is 1 : 5000. The ratio of the isotope of mass 3 (H^3 = T) to deuterium (D) in the gas from the electrolysis of the best samples of heavy water is less than 1 : 50,000, and in ordinary water less than $1 : 5 \times 10^8$.

The equilibrium $H_2 + D_2 \rightleftharpoons 2HD$ is of importance in the study of surface catalysis. Glass, mercury, charcoal, etc., are inactive in promoting the reaction, but active nickel and charcoal oxide induce the change even at the temperature of liquid air, the activities of the surfaces being quite specific. A summary of the results on the biochemistry of heavy water is given. The enzyme catalase is only half as active in 85 per cent deuterium oxide as in ordinary water. Bacteria, as contrasted with protozoa and rotifers, are not killed. Compounds of deuterium other than the oxide are known, and a detailed account of the properties of the deuteroammonias, NDH_2, ND_2H and ND_3, is given.

Experiments on the hydrolysis of palmityl chloride and the enzymic hydrolysis of triolein, on the effect of heavy water on the respiration and fermentation of yeast, on xanthin oxidase, and on the cytochrome-indophenol oxidase system, as well as on the swelling of gelatin, have been reported by Rideal, Hughes, Yudkin and Kemp (*J. Chem. Soc.*, 1105; 1934). The results with yeast confirm the result found by Pascu that heavy water possesses toxic properties. No effect on the rate of hydrolysis of palmityl chloride or triolein was found, nor on the activity of xanthin oxidase or cytochrome-indophenol oxidase. The effect on the swelling of gelatin on replacing water by heavy water up to 90 per cent deuterium content was inappreciable.

University and Educational Intelligence

THE handbook of lectures and classes for teachers arranged by the London County Council for the session 1934–35 has recently been issued. Courses are being arranged in most branches of education, and will be given at various centres in London. Copies of the handbook and further information can be obtained from the Education Officer, The County Hall, Westminster Bridge, London, S.E.1.

DR. H. W. CHASE, Chancellor of the University of New York, spoke in his inaugural address on June 13 about the freedom of the individual as a condition of the advance of civilisation—a subject on which confessions of faith have been proclaimed on many occasions of late in American university circles, especially since the advent of the Hitler regime in Germany and the consequent eclipse of *Lehrfreiheit.* While insisting on the necessity for freedom in universities, Dr. Chase reminded his hearers of their obligation to maintain the scientific temper, especially in the fields of the social sciences, now attracting the labour of so many research workers. The address is reproduced in *School and Society* of June 23.

THE Advanced Studies Committee of the University of Oxford has recently published a collection of abstracts of dissertations for the degree of Ph.D. It is vol. 6 of a series of such abstracts and covers the period October 1932–December 1933. Since the institution of this degree in British universities in 1917, there has been no little uncertainty and controversy as to what it does and should imply, and its standard in relation to other post-graduate degrees; and the matter was three years ago considered of such importance and general interest that it was selected as one of the subjects for discussion at the Fourth Congress of the Universities of the Empire. These Oxford abstracts are full enough to give in many cases a fair indication of the standard of the candidate's work, their average length being about two thousand words. They are grouped under the faculty headings: physical sciences (27), biological sciences (3), modern history (6), medieval and modern languages (5), theology (2), *lit. hum.* (1), oriental languages (1) and social studies (1). Several are of wide general interest, notably a study by D. M. Eastwood of Somerville of "The Revival of Pascal in France".

Science News a Century Ago

British Association at Edinburgh

The Edinburgh meeting of the British Association was held on September 8–15, 1834. In the *Analyst* (London) it was stated that a dinner was held on the opening day at 5 p.m., attended by 350 persons, with Sedgwick as chairman. He proposed the health of M. Arago, the Astronomer Royal of France. In reply, "M. Arago dwelt on the advantages that must result from the union of the minds of Europe; he regarded it as the pledge of the peace of the world because intellectual supremacy daily acquires more direct power over the affairs of nations, and when the intellectual rulers are banded in friendship the nations subject to this influence cannot be forced into hostility". These sentiments, we read, produced considerable impression. Following the dinner, the inaugural opening of the meeting took place elsewhere, Sir Thomas Brisbane presiding.

The business of the meeting was dealt with by six sections: (1) Mathematics and Physics; (2) Chemistry and Mineralogy; (3) Geography and Geology; (4) Anatomy and Medicine; (5) Natural History; and (6) Statistics.

The subjects discussed in the Section of Mathematics and Physics ranged from capillary attraction, meteorology, magnetism and optics to engineering. Sir David Brewster described some experiments on reflection from crystals, Rennie submitted a report on hydraulics, and Scott Russell dealt with his observations of the traction of boats in canals. The chair in the Section of Chemistry and Mineralogy was taken by Hope, who was occasionally relieved by Dalton. In this Section there was a discussion on chemical notation, while Daubeny described experiments on thermal waters and the heating power of fuels, and Kemp dealt with the liquefaction of gases. Among those who contributed to the proceedings of the Section of Geology was Agassiz.

The Lord Provost awarded diplomas of the freedom of the City to M. Arago, Dr. John Dalton, and Dr. Robert Brown. Evening lectures were given by Dr. Lardner on Babbage's calculating machine; by Prof. Buckland on fossil reptiles; and by Prof. Whewell on phenomena connected with the tides.

Edinburgh as a Meeting Place

The secretaries for the Edinburgh meeting were Robison and J. D. Forbes. It was largely due to Forbes that the Association met at Edinburgh. A year previous he had written to Sir Thomas Brisbane and to Murchison advocating the claims of Edinburgh as opposed to those of Dublin, Bristol and Liverpool, and in his letter to Murchison he said: "Then as to Bristol, the idea is a new one. Liverpool was spoken of, but as far as I recollect, not the other, nor do I think it a good position. But putting this out of the question, what I object to is your calling Edinburgh a University town, and therefore that it ought not to follow Cambridge. This is quite a mistake. The University gives no character to Edinburgh, and I fear will give little to the meeting. You must be perfectly aware that it is not an academical place, and that the University has nothing to offer. It has no status, no funds, no power. In short, you must never think of the University when you come here, nor compare it in the remotest degree with Oxford and Cambridge. . . ."

Forbes and Vernon Harcourt

During the meeting Forbes entertained Whewell, Peacock and Vernon Harcourt in his house at Greenhill. Of the last he said in a letter : "I learn every year to look with more admiration and affection on that remarkable man ; nor shall I ever cease to look back with peculiar satisfaction on that meeting at York which brought me first into connection with him. . . ." Forbes had every reason to be satisfied with the success of the meeting, for the treasurer, Taylor, was able to announce that whereas the membership at York had been 350, at Oxford 700, and at Cambridge 1,400, the membership at Edinburgh had risen to 2,200.

Exposure of Raingauges

Among the activities initiated by the British Association was the measurement of the quantities of rain falling at different heights above the ground. The observations were carefully made on a pole above the top of York Minster at a height of 212·9 ft., on the top of the Yorkshire Museum at a height of 43·7 ft., and on the ground near by ; the second report on the subject was communicated at Edinburgh. It was clearly established that the recorded amounts decreased with height above the ground, the decrease being greater in winter than in summer. The cause, however, was completely misunderstood, the increased catch near the ground being attributed to the increase in size of the drops as they fell through the lowermost layers of air or, by Luke Howard, to the actual formation of new drops near the ground. The circumstance that the vertical decrease is greater in winter than in summer was attributed to a direct effect of temperature. It is now known that the true cause of the decrease of the catch of rain as the gauge is raised above the ground is the increase of wind velocity with height, the wind forming eddies which sweep the drops past the opening of the gauge. The effect is greater in winter than in summer because the average wind velocity is greater in winter.

Early Gold Mining in South America

In the course of his excursion in Chile in August and September 1834, Darwin visited both copper and gold mines. On September 13 he says : "we slept at the gold mines of Yaquil, which are worked by Mr. Nixon, an American gentleman to whose kindness I was much indebted during the four days I stayed at his house. . . . When we arrived at the mine, I was struck by the pale appearance of many of the men, and inquired from Mr. Nixon respecting their condition. The mine is 450 feet deep, and each man brings up about 200 pounds weight of stone. With this load they have to climb up the alternate notches cut in the trunks of trees, placed in a zigzag line up the shaft. Even beardless young men, eighteen and twenty years old, with little muscular development of their bodies (they are quite naked excepting drawers), ascend with this great load from nearly the same depth. A strong man, who is not accustomed to this labour perspires most profusely, with merely carrying his own body. With this very severe labour, they live entirely on boiled beans and bread. They would prefer having bread alone ; but their masters, finding that they cannot work so hard upon this, treat them like horses and make them eat the beans. . . ."

Societies and Academies

PARIS

Academy of Sciences, July 16 (*C.R.*, 199, 173–248). J. VINOGRADOV : Some new results in the analytical theory of numbers. EMILE OSTENC : The ergodic principle in Markoff chains with variable elements. SERGE FINIKOFF : Projective deformation of a couple of congruences. M. MURSI : The values of the modulus of $\sigma(z)$ at infinity. ANDRÉ WEIL : A characteristic property of finite groups of substitutions. AUGUSTE LAFAY : The modifications of the Magnus phenomenon determined by the structure of the wind. Study of the effects of an air current on a polished rotating cylinder, with special reference to the existence of eddies in the air current. MME. EDMÉE CHANDON, EDOUARD BOUTY and ANDRÉ GOUGENHEIM : Time determinations obtained with the aid of an equal altitude instrument, with prism and impersonal micrometer. Results obtained using a Baillaud self-recording optical micrometer. Comparison of three instruments. VENCESLAS POSEJPAL : The formation of hydrogen in a vacuum. In a previous communication (*C.R.*, 198, 59) the author shows that certain hypotheses concerning the ether lead to the prediction of the formation of hydrogen in a vacuum. Further experiments are now described giving the effect of any hydrogen pre-existing in the tube. These show that any hydrogen pre-existing in the vacuum tube will not invalidate the interpretation given in the earlier note. MARCEL PAUTHENIER and MME. MARGUERITE MOREAU-HANOT : The study of an electrified space containing material particles. EDMOND GUILLERMET : The electrolysis of the chlorides of zinc and cadmium in methyl alcohol. JEAN SWYNGEDAUW : Study of the anodic depression in the electrolysis of gelatine. PIERRE FLEURY : An addition method for the exact study of the current given by a photoelectric cell as a function of the incident light flux. PIERRE SOUTY : The influence of circularly polarised light on the velocity of mutarotation of some sugars. A solution of a sugar giving mutarotation is divided between two polarimeter tubes and exposed to beams of dextrorotatory and lævorotatory polarised light. It is shown that the photochemical effect is asymmetrical. HORIA HULUBEI : Intense sources of protons applicable to transmutations. The use of palladium charged with hydrogen for the production of the protons necessary for certain transformations markedly simplifies the working method, and gives yields equalling or surpassing other methods The new technique can be extended to the production of deutons. JEAN AMIEL : The preparation and explosion temperature of some complex compounds of copper nitrate, perchlorate and chlorate with ethylenediamine. The chlorates explode with great violence on heating and might prove useful as primers. HENRI PARISELLE and F. CHIRVANI : The emetic of saccharic acid. JAMES BASSET : The synthesis of ammonia under very high pressures, above 1,000 kgm./cm.^{2}. The apparatus described and figured can work for long periods at permanent pressures between atmospheric pressure and 5,000 kgm./cm.^{2}. At pressures of 2,000 kgm./cm.^{2} and higher, the velocity of the reaction is increased to such an extent that the presence of a special catalyst is unnecessary. The presence of impurities in the gas mixture is less material ; thus coal gas may be used as the source of the hydrogen. J. PRAT : The thermal decomposition of the aryltrihydroxyarsonium chlorides. LÉON DENIVELLE : The neutral aryl sulphates. PAUL GAUBERT : Spherolites with helicoidal windings of the allantoins and their artificial coloration. F. DUPRÉ LA TOUR and MLLE. A. RIEDBERGER : The effect of temperature on the crystalline network of certain normal dicarboxylic acids. ANTONIN LANQUINE : The structure of the Provençal chains to the north-west and to the south of the grand canyon of Verdon. AURÉLIAN VLADESCO : Cultural experiments with ferns : the formation of an aposporous prothallus. AUGUSTE and RENÉ SARTORY, JACQUES MEYER and HANS BÄUMLI : The experimental reproduction of the cryptogamic diseases of paper. CH. CHABROLIN : The germination of the seeds of *Thesium humile* requires the intervention of saprophytic fungi. G. BARBIER : Negative absorption in soil, clay and humus. LOUIS GALLIEN : The determinism of the duality of evolution of the larvæ in *Polystomum integerrimum*. ARMAND DEHORNE : The active phagocytosis of the sarcolytes of the longitudinal muscles after the evacuation of the ovules in *Nereis diversicolor*. MLLE. ANDRÉE MICHAUX : The amounts of calcium in the lungs and kidneys of guinea pigs, normal and starved, suffering from acute or chronic scurvy. Observation of certain bladder troubles due to diet deficiencies. MME. MARIE PHISALIX and FÉLIX PASTEUR : The action of short waves on asp poison. KOHN-ABREST : Rapid toxicological examination for the alkyl halides (chloroform, carbon tetrachloride, etc.). Application to the detection of these products in the air. MLLE. LISE EMERIQUE : Vitaminosis A and the chemical composition of the animal. ALEXANDRE SALIMBENI and GEORGES LOISEAU : Concentration of the diphtheria toxin and anatoxin by means of freezing. FRED VLÈS, ANDRÉ DE COULON and ANDRÉ UGO : The statistics of survival in tar cancers of mice after removal of the tumour. Study of the toxic rôle of the latter.

CAPE TOWN

Royal Society of South Africa, April 18. P. W. LAIDLER : The archæology of the prehistoric settlements in the Heilbron area. W. E. ISAAC : Researches on chlorosis in deciduous fruit trees. The experiments were divided into the following five groups : experiments with lime ; experiments with sulphur ; experiments with manganese sulphate ; experiments with manganese sulphate and mineral fertilisers ; experiments with copper sulphate. In about 10 per cent of cases chlorosis tends to pass away. Copper added as copper sulphate solution in a concentration of about 20 p.p.m., seems to cure the chlorotic conditions. There are beneficial effects with lower concentrations. Additions of potash bring about an improvement in the trees. Additions of lime do not exert a beneficial influence, and thus the trouble would not seem to be due to excess of available manganese, aluminium or iron. The trees are not in any way suffering from a deficiency of manganese, and evidence is presented indicating that chlorosis is not due to a deficiency of magnesium. J. GORDON CRAMB : Smithfield implements from a Natal coast site. A. GALLOWAY and L. H. WELLS : (1) Report on human skeletal remains from the Karridene site. (2) A further note on human skeletal remains from the Natal coast.

SYDNEY

Linnean Society of New South Wales, April 18. H. M. R. RUPP : Notes on Australian orchids : a review of the genus *Cymbidium* in Australia. The variation in the number of recognised Australian species, from R. Brown's time to the present, is discussed, and causes for existing difficulties in determining certain species are suggested. A review is given of the variable species *C. canaliculatum*, R. Br., which is divided into five distinct forms in which colour-scheme and colour play the principal part. T. H. JOHNSTON : (1) Remarks on some Australian Cestodaria. Notes are given on the Cestodaria which are known to occur in Australia, namely, *Austramphilina elongata*, Johnston, *Gyrocotyle urna*, Gr. and Wag., and *G. rugosa*, Dies. (2) Notes on some monocotylid trematodes. An amended description of *Monocotyle robusta*, Johnston and Tiegs, is given. The parasite, together with the two species *M. dasybatis* and *M. minima*, is assigned to a new genus. *Monocotyle selachii*, MacCallum, is also placed in a new Merizocotyline genus. A. N. COLEFAX : A preliminary investigation of the natural history of the tiger flathead (*Neoplatycephalus macrodon*) on the south-eastern Australian coast. This is the principal food fish of this coast. Data were collected during a series of cruises, made in 1930 on privately owned trawlers operating from Sydney as a base ; and the records of the trawlers previously controlled by the State in 1918–22 were consulted. A comparison of the years 1918–22 with hauls made in 1930 shows a considerable decrease in the amount of fish taken per hour's trawling. The evidence so far obtained is insufficient to indicate whether this is due to overfishing, to a migration of the flathead to less disturbed surroundings, or to a natural fluctuation.

ROME

Royal National Academy of the Lincei, March 18. T. LEVI-CIVITA : Stationary solutions of Pfaffian systems : the more significant case (2). G. ABETTI : Height of the chromosphere in 1933 and course of the solar cycle. Observations on 89 days during 1933 at Arcetri gave the mean height of the solar chromosphere as 10·68″, an increase over the 1932 results of 0·45″. At Madrid (31 days), the mean value 9·84″ was found, this being less by 0·01″ than the mean for 1932. The difference is probably due to the marked difference between the numbers of observations at the two stations. As in 1932, the height is greatest at the poles and least at low latitudes. The view that the new solar cycle has commenced, mentioned last year, is confirmed. U. BROGGI : An application of Borel's method of summation. F. CONFORTO : Construction of automorphous functions by means of infinite products (2). G. BARBA : Observations on the nuclei of Andreoli and of Evans. G. LAMPARIELLO : A noteworthy class of non-linear differential equations of the second order. (2) Analytical behaviour—resolutive development. R. EINAUDI : Waves of discontinuity combined with superficial elastic vibrations. F. TRICOMI : An intuitive interpretation of the rotor and of the condition of irrotationality. L. SONA : Dynamic actions of a translocirculatory current investing a bilateral lamina (2). M. RENATA FABBRI : A particular solution of the equations of the motion of a heavy solid round a fixed point. A. ROSSI and A. IANDELLI : Crystalline structure of the compounds $LaMg_3$, $CeMg_3$ and $PrMg_3$. These compounds crystallise in the cubic system, the unit cell containing four molecules. B. L. VANZETTI : Structure of olivil and its derivatives. The structures of olivil and of the isomeric iso-olivil are discussed. M. CURZI : A species of *Aspergillus* with stellate ascospores. *Aspergillus stellatus*, isolated from fermenting sansa, is described. V. PUNTONI: Development of *Anopheles* larvæ in the waters of sewers. Contrary to current opinion, these larvæ grow well in sewage, the organic suspensions of which furnish them with suitable nutriment. V. RIVERA: Further considerations on the biological action of metals at a distance. This action cannot be regarded as due to either the vapour pressure of the metals, or the very slight reduction of the penetrating radiation inside metallic containers, or the radioactivity of the metals. It is assumed that the effects observed are determined by secondary phenomena, including ionisation of the air, produced by the penetrating radiation. G. LUCHETTI: Contributions to the knowledge of the causes of 'intoxication' of soil. This is a true 'intoxication', caused by bacterial, fungal and plant metabolism.

VIENNA

Academy of Sciences, June 14. MARIETTA BLAU and HERTHA WAMBACHER: Physical and chemical investigations on the photographic detection of H-rays. Experiments with pinakryptol-yellow show that the desensitising power of a dye depends on the nature of the solvent in which it is used. It varies also with the oxygen content of the surroundings, the dye apparently acting as a catalyst of the oxidation, by atmospheric oxygen, of the silver formed photochemically. HANS PETTERSSON: Ultra-violet spectrum of radium emanation. By means of a special experimental arrangement, a number of new lines in this spectrum have been mapped. FRIEDRICH BÖCK, GUNTHER LOCK and KARL SCHMIDT: Perkin's synthesis of cinnamic acid. The effects of the temperature and time of the reaction, of the proportions between the three reagents, and of various substituent groups on the yield of product obtained by this synthesis, are studied. The view that benzylidene diacetate is an intermediate product in the reaction is shown to be erroneous. WILHELM SCHMIDT and ERNST BREZINA: Experiments on the action of air-suction arrangements in works. The results of small-scale tests bring out various important points, for example, the inadequacy—in almost all cases—of a hood over an open vessel when the vapour emitted is somewhat heavier or cooler than the air. The necessity of testing the air at a number of points in the room is emphasised. K. W. F. KOHLRAUSCH and A. PONGRATZ: Studies on the Raman effect (33). The Raman spectrum of organic compounds—poly-substituted benzenes (34). Benzoyl, α-toluyl and cinnamoyl compounds. The effect of a benzene nucleus on the extent and intensity of the carbonyl frequency and on the frequency of the nitrile group is similar to that of a conjugated C : C double linking. The order of the substituents of the CO group according to their constitutive influence on the CO-frequency is the same as that of the dipole moments. O. PAULSEN: Raman observations on dichloroethylene. Results are given which indicate that it is scarcely justifiable to speak of dichloroethylene as a definite equilibrium mixture. ROBERT WILLHEIM: Carbohydrate metabolism of carcinoma. The co-ferment peculiar to the malignant tumours or a substrate accompanying it causes the characteristic anomalies of the carbohydrate metabolism, and presumably the spreading of this co-ferment into the rest of the organism is responsible for the general disturbance of such metabolism. HANS HELLER and FRITZ F. URBAN: Neutralisation of the poisonous action of pituitrin in the organism. Experiments *in vitro* show that, if the specific adsorptive power of blood towards pituitrin is taken as unity, that of skeletal muscle and brain is 2–4, that of kidneys 10, and that of the liver 100–200. FRIEDRICH MORTON: Results of a journey to Abyssinia, Egypt and the Quarnero Islands in 1931–32. The plant-geographical relationships in these regions were investigated. EDGAR SCHALLY and FERDINAND NAGL: Observation of 'streaking' in chemical investigations (6). Streaking observed when liquids of similar refractive power are mixed. JULIUS PIA: Comparison of the anise Diplopore flora of Bosnia with that of southern Dalmatia. VICTOR F. HESS, H. TH. GRAZIADEI and R. STEINMAURER: Investigations on the changes in intensity of the cosmic ultra-violet radiation on the Hafelekar (2,300 metres). HANS MOTZ: Investigation of rubber by electron deflection.

Forthcoming Events

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (ABERDEEN MEETING)

Monday, September 10

At 10 a.m.—Capt. T. A. Joyce: "The Origin and Uses of Yerba Maté" (Presidential Address to Section H).
Prof. J. A. S. Watson: "Scientific Progress and Economic Planning in Relation to Rural Industry and Country Life" (Presidential Address to Section M).
Prof. H. E. Roaf: "Normal and Abnormal Colour Vision" (Presidential Address to Section I).

At 8.30 p.m.—Prof. W. L. Bragg: "The Exploration of the Mineral World by X-Rays" (Evening Discourse in MacRobert Hall, Gordon's Colleges).

IRON AND STEEL INSTITUTE, September 10–14. Annual meeting to be held in Belgium and Luxemburg.

Official Publications Received

GREAT BRITAIN AND IRELAND

Ministry of Agriculture and Fisheries. Agricultural Statistics, 1933. Vol. 68, Part 1: Report on the Acreage and Production of Crops and Number of Live Stock in England and Wales; with Summaries for Great Britain and the United Kingdom. Pp. 91+3 plates. (London: H.M. Stationery Office.) 1*s*. 6*d*. net.

The North of Scotland College of Agriculture. Calendar, Session 1934–1935. Pp. viii+124. (Aberdeen.)

London School of Hygiene and Tropical Medicine. Classified Catalogue of Books in the Library, including Departmental Libraries. Class B: Natural Science. Pp. iii+31. (London.) Free.

Department of Scientific and Industrial Research. Report of the Food Investigation Board for the Year 1933. Pp. ix+248. (London: H.M. Stationery Office.) 4*s*. net.

OTHER COUNTRIES

Punjab Irrigation Research Institute: Research Publications. Vol. 2, No. 3: A Study of the Flow of Water under Works on Sand Foundations by means of Models. By Dr. E. McKenzie Taylor and Harbans Lal Uppal. Pp. 28+7 plates. 4 annas; 5*d*. Vol. 2, No. 4: A Study of the Flow of Water under Works on Sand Foundations by means of Models, Part 2. By Dr. E. McKenzie Taylor and Harbans Lal Uppal. Pp. 5+3 plates. 3 annas; 5*d*. Vol. 2, No. 5: An Investigation of the Pressures on Works on Sand Foundations, I. By Dr. E. McKenzie Taylor and Harbans Lal Uppal. Pp. 14+8 plates. 1 rupee; 1*s*. 6*d*. Vol. 2, No. 6: An Investigation of the Flow of Water under Khanki Weir and the Pressures on the Floor. By Dr. E. McKenzie Taylor and Harbans Lal Uppal. Pp. 34+18 plates. 1 rupee; 1*s*. 6*d*. Vol. 4, No. 5: The Relation between Exchangeable Sodium and Crop Yield in Punjab Soils and a New Method of Characterising Alkali Soils. By Dr. Amar Nath Puri. Pp. 4+1 plate. 2 annas; 3*d*. Vol. 4, No. 6: A Simple Method for Determining the Reaction and Titration Curves of Soils. By Balmokand Anand and Dr. Amar Nath Puri. Pp. 4+3 plates. 2 annas; 3*d*. Vol. 5, No. 2: The Transmission Coefficient of Water in Natural Silts. By Dr. V. I. Vaidhianathan and Hans Raj Luthra. Pp. 12+3 plates. 5 annas; 7*d*.

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