NATURE

SATURDAY, OCTOBER 28, 1933

No. 3339 Vol. 132

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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.
ST. MARTIN'S STREET, LONDON, W.C.2
Telephone Number: WHITEHALL 8831
Telegraphic Address: PHUSIS, LESQUARE, LONDON

Science and Social Problems

WHEN the Council of the British Association meets next month, it is expected to have before it the resolution adopted by the General Committee at the recent Leicester meeting "to request the Council to consider by what means the Association, within the framework of its constitution, may assist towards a better adjustment between the advances of science and social progress, with a view to further discussion at the Aberdeen meeting". The resolution may be regarded as arising from a pronouncement made by Sir Frederick Gowland Hopkins in his presidential address and from an evening discourse by Sir Josiah Stamp on the relation of science to economic progress. The president gave, in the course of his address, an admirable exposition of the importance of biology to social progress and referred to the necessity of bringing into our statesmanship the guidance of biological truth. He also pointed out that the gifts of science and invention to humanity at large are immense enough to outweigh their misuse for purposes of destruction and other evils.

Arising out of these addresses the relationship between science and existing social and economic conditions has been widely discussed in the newspaper Press, particularly the *Daily Herald*, to the columns of which Mr. Ritchie Calder is contributing a series of articles on possible means by which science can help solve some social and ethical problems. In a message to Mr. Calder, published in the *Daily Herald* of October 12, Sir Frederick Hopkins gave his support to the proposed investigation in the following words:

"It is sure that the feeling is widely spread to-day that while scientific research has produced countless gifts for humanity, scientific thought has been too little directed to the problem of removing those hindrances and inhibitions which prevent these gifts from making for human happiness and social progress.

"While it should, doubtless, be realised that the mind of the successful investigator is apt to be highly specialised and that to tempt him from the laboratory into the arena might be neither wise nor profitable, science nevertheless has representatives both qualified and free to give thought to wider issues, and it is perhaps true that they have failed hitherto to realise that it may be for them, rather than for the politician, to solve the problem in question.

"The problem is so difficult that I think most scientific men will agree with you that the time has come for concerted thought and action and

will welcome the investigation which you are to make in the *Daily Herald* to emphasise its urgency and to assist towards a solution."

With the general support thus afforded to a scientific inquiry into the causes of existing social problems, most of us would be in complete agreement, and also that some scientific workers may usefully take part in investigations of this kind, as citizens in a community depending upon scientific work for its position and maintenance. As Sir Frederick is both president of the Royal Society and of the British Association, his pronouncement is of high significance; but it must, of course, be read as a personal view and not as committing either of the bodies of which he is the distinguished head to action upon the subjects involved.

The British Association has had before it on several occasions the question of extending its influence to fields other than those comprehended in its sections. It may be remembered that thirty years ago Sir Norman Lockyer, in his presidential address to the Association on "The Influence of Brain Power on History", showed that scientific developments had a much greater influence upon the progress of events than political action. He hoped that one result of his address would be an extension of the public activities of the Association; and on the day following his address the Conference of Delegates of Corresponding Societies passed a resolution that "it is desirable that scientific workers and persons interested in science be so organised that they may exert permanent influence on public opinion . . . and that the Council be recommended to take steps to promote such organisation". To Lockyer's disappointment, however, the Council decided not to take the action he desired; and it became clear that if his objects were to be achieved a new organisation would have to be formed. The result was the foundation in 1905 of the British Science Guild "to promote the application of scientific methods and results to social problems and public affairs".

Six years ago it was reported at the Leeds meeting of the Association that the Council had considered the possibility of inviting the co-operation of the British Science Guild for the promotion of objects of common interest; and a joint committee of the two bodies prepared a report in which the general methods by which such a fusion might be effected were outlined. When, however, this report came before the General Committee, it was opposed on the grounds that the Association should concern itself with scientific work only, and not with the social consequences, which might be left to other bodies. The result was that the report was referred back, and nothing more was heard of it.

The social implication of science came up again, however, at the meeting of the Association in York last year, when the president, Sir Alfred Ewing, pointed out that man was ethically unprepared for the great bounty of the engineer, and that certain of the results of scientific development had been consequently perverted. Related problems were discussed by Prof. Miles Walker in his address as president of the Engineering Section at the same meeting; and, in addition, he emphasised the contribution which the engineer and man of science could make in economic and social matters, and in the amelioration of the lot of mankind.

As the direct outcome of this address the Engineering Section passed a resolution supporting the views expressed, and urging that the Government should invite the leading scientific societies and institutions to appoint in conference representatives to co-operate with the Government in formulating plans for dealing with social and economic problems associated with progressive science and invention. This resolution was, however, not adopted by the Committee of Recommendations, and was, in consequence, not passed on to the Council for consideration. While, therefore, much attention was given in the public and scientific Press to the pronouncements made by Sir Alfred Ewing and Prof. Walker, the Council did not act on the lines suggested or issue any statement relating to it. As the result, however, of the resolution passed by the General Committee at the Leicester meeting, the Council is now expected to give attention to the subject and to take action upon it.

It may greatly be doubted, however, whether the British Association, either through its Council or the Sections, is competent to undertake the proposed inquiry into the ethical and social consequences of scientific progress. The Association is only in session for a week annually, and though the Council meets several times during the intervening period, and may act independently, the Sections themselves are in being only during the annual meeting. Moreover, while the members of the Council, or of sectional committees, are familiar with their own particular fields of scientific

work, few of them take active interest in other branches of science, and fewer care to concern themselves with ethical or social standards, except as citizens in a civilised community.

A characteristic of the scientific man is not to express an opinion upon a subject outside that of which he has particular knowledge; and if this is accepted as a sound principle, it would surely be a mistake for representatives of physics, chemistry, biology and other branches of natural science to take upon themselves the responsibility of surveying social conditions and offering solutions to ethical problems of modern civilisation as shaped by science. It is true that membership of the British Association is open to any member of the public, without qualification, but it is true also that all the affairs of the Association are managed by members engaged in scientific work, and that the laity is not represented upon its Council or committees. We are not objecting to this limitation but merely using it to suggest that these bodies are not necessarily in contact with the public mind or qualified to give it guidance. Scientific workers would probably resent advice from politicians or social reformers upon the merits of their investigations or the desirability of restricting the range of them; and they might expect a similar reception for their views if they express opinions upon subjects not their own.

If, however, we may judge from past experience, the British Association may hesitate to take up questions outside its own special sphere, and with which its members have no particular qualifications to deal. Social problems will not be solved merely by the advice of the British Association or any other scientific organisation. Advice is one step: the acceptance of advice is another. Before scientific advice is appreciated and accepted there is considerable work to be done. Is it not true that there is a mass of important 'business people' who are suspicious of the pronouncements of persons whose lives are spent in the rare and protected atmosphere of 'science'? Neither the British Association nor even the Royal Society could carry out the educational work needed to make scientific methods understood and their influence effective. They must have the aid of people and organisations in touch with every possible grade of society. As a first step, then, we would suggest the organisation of a somewhat unofficial committee of representatives of such bodies as the British Association, Royal Society, British Science Guild, Federation of British Industries, Association of Teachers in Technical Institutions, Rotary Movement, Workers' Educational Association, British Institute of Adult Education, and others in contact with social and industrial conditions. Such a committee might do much to remove the suspicion with which science is often regarded by so-called practical men of affairs.

Whether it is the function of scientific workers to take an active part in social propaganda, or be influenced by the ethical aspects of their results, may be disputed; and in any event it cannot be taken for granted. The antithesis of science and ethics and the implication that scientific research may be unethical rests on a confusion in thought. The business of science is the pursuit of knowledge and its systematisation when acquired. Hence no body or organisation concerned with the promotion of scientific research, as such, is called upon to pass a moral judgment upon the scientific conclusions of which it has accepted, or is testing, the validity. Such a body is bound to accept the increase of knowledge as ethical, that is, in the long run for the greatest good of the greatest number.

It is understood, of course, that scientific investigations, when applied to human affairs, may be beneficial in certain conditions and in others may be harmful. Thus the present economic dislocation and unemployment are commonly regarded as due to the application of science to the improvement of the technique of production, which has displaced labour and led to over-production. To allow this view to affect the application of the results of scientific research to the problems of industry and to slow down improvement in technique, would be as big a blunder (or even bigger) than it would have been to give way to popular clamour when the introduction of machinery in industry a hundred years ago was opposed on the ground that it displaced labour. There was greater distress and a far higher proportion of unemployed then than there is to-day, and the standards of living were much lower. Science has provided rich treasures, but the community has not made the best use of them. How to adjust social and economic conditions to progressive scientific knowledge is not the function of the British Association or any other body concerned mainly with the promotion of such knowledge. What could undertake such work more appropriately is a council or committee having upon it leading representatives of the social, as well as of the natural, sciences.

William and Caroline Herschel

The Herschel Chronicle: the Life-Story of William Herschel and his Sister Caroline Herschel. Edited by his Granddaughter Constance A. Lubbock. Pp. xi+388+8 plates. (Cambridge: At the University Press, 1933.) 21*s.* net.

IT is somewhat rare to find the bonds of family affection so strong as they were in the Herschel family. Between William and his sister Caroline, who wrote of him as "the best and dearest of brothers", they were particularly strong. The lives of these two members of the family were so intertwined that a biography of either must necessarily be to a large extent a biography of the other also.

In this volume under notice, Lady Lubbock has given an intimate and fascinating picture of the lives of William and Caroline, based upon Caroline's very full "Journals" and the brief autobiographical notes left by William. She has not attempted to give a detailed account of William Herschel's scientific work, though some allusions are necessarily made to his discoveries and theories. It is the human side of their life-story which is presented. The story of the organist, whose interests were gradually diverted from music to astronomy, and who finally became the most famous astronomer of his age, will always have a strong human appeal.

William's early interest in astronomy and philosophy was no doubt due to the influence of his father. Caroline writes: "My Father was a great admirer of astronomy and had some knowledge of the science: for I remember his taking me on a clear frosty night into the street, to make me acquainted with several of the beautiful constellations, after we had been gazing at a comet which was then visible. And I well remember with what delight he used to assist my brother William in his philosophical studies, among which was a neatly turned globe, upon which the equator and the ecliptic were engraved by my brother." When William had settled in England and had successfully established himself in the musical world he spent most of his leisure time in reading mathematical works, such as Smith's "Harmonics" and Maclaurin's "Fluxions". Herschel wrote in a letter to Dr. Hulton: "Many times after a fatiguing day of 14 to 16 hours spent in my vocation, I retired at night with the greatest avidity to unbend the mind (if it may be so called) with a few propositions in Maclaurin's 'Fluxions' or other books of that sort. Among other mathematical subjects, Optics and Astronomy came in turn, and when I read of the many charming discoveries that had been made by means of the telescope, I was so delighted with the subject that I wished to see the heavens and planets with my own eyes thro' one of those instruments".

In 1772, William brought Caroline to England to train her as a public singer. On reaching London, says Caroline, "in the evening, when the shops were lighted up, we went to see all that was to be seen in that part of London: of which I only remember the optician shops, for I do not think we stopt at any other". William was now beginning to take astronomy seriously. He bought some object glasses and made tubes for them, one as long as thirty feet. Finding these long tubes almost impossible to manage, his thoughts turned to reflectors. At first he hired a two-foot Gregorian telescope but soon conceived the idea of making one for himself. "I was informed that there lived in Bath a person who amused himself with repolishing and making reflecting mirrors. Having found him out, he offered to let me have all his tools and some half-finished mirrors, as he did not intend to do any more work of that kind. The 22nd of September, when I bought his apparatus, it was agreed that he should also show me the manner in which he had proceeded with grinding and polishing his mirrors, and going to work with these tools I found no difficulty to do in a few days all what he could show me, his knowledge indeed being very confined." Now began a period of feverish activity in telescope construction, the whole house being given up to it, to Caroline's dismay. She writes: "To my sorrow I saw almost every room turned into a workshop. A cabinet maker making a tube and stands of all descriptions in a handsome furnished drawing-room. Alex putting up a huge turning machine . . . in a bedroom for turning patterns, grinding glasses and turning eyepieces, etc."

At this time, Herschel was fully occupied with his musical engagements but "Every leisure moment was eagerly snatched at for resuming some work which was in progress, without taking time for changing dress, and many a lace ruffle was torn or bespattered by molten pitch. . . . My time was so much taken up with copying music and practising, besides attendance on my Brother when polishing, that by way of keeping him alife I was even obliged to feed him by putting the vitals by bits into his mouth;—this was once

the case when at the finishing of a 7 feet mirror he had not left his hands from it for 16 hours together. And in general he was never unemployed at meals, but always at the same time continuing or making drawings of whatever came into his mind. And generally I was obliged to read to him when at some work which required no thinking; and sometimes lending a hand, I became in time as useful a member of the workshop as a boy might be to his master in the first year of his apprenticeship."

Caroline was gradually becoming indispensable to her brother and had to make up her mind to sacrifice her ambition to earn her own livelihood; coming, as this did, at the time when success seemed within her grasp, her disappointment must have been great. But her devotion to her brother enabled her to bear it uncomplainingly and, thenceforth, she set herself to assist William in his astronomical work. Under his tuition she studied algebra, geometry and trigonometry. Her nephew, afterwards Sir John Herschel, said of her: "She had nothing of mathematical genius, but her extraordinary powers of application in long-continued effort, with her extreme accuracy in all she did, were of as great practical value to my Father as if she had had far greater mathematical knowledge—perhaps more".

Herschel jumped into fame in 1781 by his discovery of Uranus. It was due to the high quality of his mirror and eyepieces that he was able to notice that the comet (as it was at first thought to be) had a larger image than the stars. Messier wrote to him: "It [this discovery] does you the more honour, as nothing could be more difficult than to recognise it, and I cannot conceive how you were able to return several times to this star —or comet—as it was absolutely necessary to observe it several days in succession to perceive that it had motion".

Herschel's statements as to the magnifying powers he had used, 932, 1536, 2010, etc., were regarded by many of his contemporaries as wild exaggeration, being far in excess of the powers then generally used. In a letter to Dr. Watson, Herschel wrote: "I do not suppose there are many persons who could even find a star with my power of 6450, much less keep it, if they had found it. Seeing is in some respect an art, which must be learnt. To make a person see with such a power is nearly the same as if I were asked to make him play one of Handel's fugues upon the organ. Many a night have I been practising to see, and it would be strange if one did not acquire a certain dexterity by such constant practice."

In 1782 Herschel accepted, at some pecuniary sacrifice, an appointment as King's Astronomer at a salary of £200 per year, and moved with his sister to Datchet, near Windsor. He was then forty-three years old and was henceforth able to devote his time entirely to making telescopes and to observing. In both he was very assiduous; he was accustomed to observe the whole night through, whenever it was clear, always in the open air. "When the waters were out round his garden, he used to rub himself all over, face and hands, etc., with a raw onion, to keep off the infection of the ague, which was then prevalent; however, he caught it at the last." Caroline was the assiduous helper, writing down the observations as they were made by William. In 1783, the large 20-foot reflector was finished. The great 40-foot telescope, towards which the King had given £4,000 and £200 per year for maintenance, was completed in 1789. This telescope did not justify Herschel's hopes. It was too large and cumbersome for regular use, requiring the attendance of two workmen to move it during observations. The mirror, moreover, was of such composition that it tarnished very rapidly. Most of Herschel's discoveries were made with the 20-foot telescope.

William's marriage in 1788 was a great blow to Caroline, who later destroyed every page of her "Journal" for the nine years after that event. But gradually the wound healed. The birth of a son, John, completed the reconciliation which her love for her brother and the friendliness of her sister-in-law were inducing. This period was, from the astronomical point of view, the most important in her life. She had discovered her first comet in 1786, during William's absence in Hanover. From 1788 to 1795 she discovered six more and in 1807 an eighth. Thereby she established a reputation as an independent observer.

Systematic sweeping by William Herschel for nebulæ, clusters and double stars ended in 1802, but he continued to observe objects of interest for many subsequent years. His labours by day and by night had gradually enfeebled his constitution. Caroline remained faithful to the last. She writes: "The time required for this purpose, I could only obtain by making use of most of the hours which are generally allotted to rest, as during the day my time was spent in endeavours to support my dear Brother in his decline. And besides the hope that we might continue yet a little longer together

began to forsake me, for my own health and spirits were in that state that I was in dayly expectation of going before". But she lived to attain the age of ninety-seven years, surviving her brother by twenty-five years.

William by his star-gauges, studies of double stars and of nebulæ had completely revolutionised sidereal astronomy. *Cœlorum perrupit claustra* is his most fitting epitaph. The best memorial to Caroline is her share in the labours of William, without which his discoveries would not have been possible.

The volume contains a number of illustrations, including reproductions of the well-known portraits of William Herschel by Abbott, Russell and Artaud. The only portrait of Caroline shows her at the age of ninety-seven; it is to be regretted that a reproduction was not also included of the attractive silhouette, showing her as a young woman.

H. SPENCER JONES.

The Fear of the Dead

The Fear of the Dead in Primitive Religion: Lectures delivered on the William Wyse Foundation at Trinity College, Cambridge, 1932–1933. By Sir James George Frazer. Pp. viii+204. (London: Macmillan and Co., Ltd., 1933.) 10*s*. 6*d*. net.

AGE cannot wither nor custom stale Sir James Frazer's infinite erudition. The veteran of "The Golden Bough" can still charm the reader's way through an arid wilderness of facts with the melody of his silver tongue and with sparks of humour, so that the traveller reaches his journey's end (somewhat abruptly) without fatigue. The unwonted shortness of this work is not a sign of flagging industry, for it is merely an instalment of a bigger work.

The theme Sir James has chosen this time is the fear of the dead which has exercised so potent an influence on mankind. He complains that it "hitherto has hardly attracted the notice it deserves". I should have thought it more accurate to say it is ceasing to attract as much notice as it used to. There was a time when fear, not only of the dead, but also of sex, birth, thunder and lightning, everything, cast its gloom over the whole of savage life. Now neither theorists nor field-workers find it as much as they used to.

Sir James marshals his serried ranks of examples, how men in all parts of the world fear the dead. What his objective is is not quite clear. The impression is that he wishes to prove that this fear is common to the whole human race, is an instinct which lies at the basis of religion. Sir James is, however, inflexibly honest: he does not suppress the truth; he begins magnanimously by enumerating all the people he can find in books who fear the dead but little or not at all; so that by the end of the first lecture we have learnt that this fear is by no means so inevitable as an instinct should be. In fact, he frankly admits, certain customs "exhibit a tender regard for the spirits of the dead which is very different from that fear and scrupulous avoidance which often, if not generally, characterize the attitude of primitive man to the souls of the departed".

In Lecture III we learn that this fear varies not only from people to people, but even in the same individual at different times. The whole state of mind may change in the twinkling of an eye. Sir James, who never blinks a fact, however awkward, bravely quotes Pechuel-Loesche to the effect that in Loango "the relations of the living to the dead are reported to be friendly up to the time when the ceremony of mourning is performed at the grave, or at all events till the moment when the grave is dug, but after the mourning rites have been duly observed, or the body interred, the relations between the living and the dead are said to be decidedly hostile". The same face-about could be observed in Eddystone in the Solomon Islands. When Iranga died, so far from driving away his soul, they took pains to catch it on a ring, which they stuck in the thatch of the house, thus providing it with temporary quarters while his skull was being bleached. I saw it all and there was no trace of fear. When the skull was ready they wrapped it up and carried it with the soul-ring to the cemetery, which was a row of skull-houses. There the brother of the deceased unwrapped the parcel and proceeded to adorn the skull with as much composure as if it had been a living man. The comfortable cheerfulness that pervaded this place of death is one of my pleasant recollections of Eddystone. The brother could not, however, himself put the skull into the skull-house: only one man could safely do so, a foreign slave who had been consecrated so that he was fairly immune, and if he was smitten with disease by the dead in spite of it, he was only a captive. From the time that skull was put into the skull-house, no layman dare

come near it. Fear set in from the time the skull and the soul-ring were put in with the customary burnt-offering.

The same change can be observed in Fiji: no fear while the corpse is in the house; fear after the burial, but even then only at night.

Clearly it is not the dead these people fear, but something the dead people acquire by the burial service. What is it? Here again Sir James supplies the answer without perhaps quite realising it. He quotes Dr. R. H. Codrington as distinguishing in Melanesia "between ghosts of power and ghosts of no account, between those whose help is sought and their wrath deprecated, and those to whom no observance is due". It is not death then that makes one class feared, for both are equally dead; it is power. Codrington continues: "A man's ghost has in greater force the power which a man had in his lifetime." Therefore a man who had power in his lifetime has more after death and so is more feared. If he had none when alive, then zero multiplied remains zero.

Codrington is a most reliable witness, but he was more interested in ideas than in the way they are worked out and in the purpose. He notes this access of power, of *mana*, but does not see the cause. Had he attended to the details of ritual, not only at death, but also on any occasion, he would have found that this increase of supernatural power follows any consecration, not merely the last sacrament. I have seen low-born Fijians bolt at the approach of the 'Lord of Nayau' as fast as if he had been a ghost. Even his own relations, great noblemen, gave him a wide berth, and the explanation was always the same: "We fear him because he has been consecrated as Lord of Nayau." A great change had been wrought in him by the process: before it he only had supernatural power in regard to his younger brothers; afterwards he can bless or blast the whole of his people.

A log of wood or a lump of clay can be kicked about the sculptor's workshop. Consecrate it and it becomes an idol to be approached with fear or trembling, because it can help or hurt.

If we confine our range in space and make up for it by intensity, if we dissect a few specimens only, but do it minutely, we arrive at an explanation. Sir James's method of enumeration can never lead to positive results, but we have to thank him for a negative one: he has definitely proved that man is not by nature afraid of the dead.

A. M. Hocart.

Television for the Amateur Constructor

(1) *Experimental Television: a Series of Simple Experiments with Television Apparatus; also How to Make a Complete Home Television Transmitter and Television Receiver.* By A. Frederick Collins. Pp. xxi+313. 10*s*. 6*d*. net.

(2) *Television: for the Amateur Constructor.* By H. J. Barton Chapple. Pp. xx+233+46 plates. 12*s*. 6*d*. net.
(London: Sir Isaac Pitman and Sons, Ltd., 1933.)

NO really good book on television—such as is now available in German—has yet appeared in either language of the English group. The two before us are both from the same publisher, and both are written expressly for the home experimenter.

(1) Mr. Collins intersperses his diffuse and uneven description of experiments, ranging from bell-ringing to line television, with patches of partial erudition which are at once misplaced and misleading, since they frequently go wrong at a critical point in the physics. Where there is so much to condemn it is scarcely necessary to cite specimens, but his list of six advantages for cathode ray television is a fine example of a good case wrecked by bad advocacy. The book is dedicated to "Hollis S. Baird, America's Television Genius", and the author seems to have overlooked the confusion that may be caused by his references to "Baird Television" without sufficient distinction between "America's Television Genius" and another worker who is qualified only twice in the volume as "Baird, of London".

(2) Mr. Barton Chapple has an infectious enthusiasm which does not lead him into any concealment, though it may lead to some slight underestimate, of the difficulties and defects of the system which he describes. His detailed and accurate instructions, with plentiful illustrations and circuit diagrams, will ensure that the amateur who is wise enough to take him as a guide will be capable of producing a workmanlike television receiver of the mechanical type, with its associated radio receiver and mains' apparatus.

The discussion centres round the methods bearing the name of "Baird, of London", and carries the reader as far as the new receiver which embodies the mirror drum and the "Baird Grid Cell", utilising the Kerr effect. The author ought not to commend acid soldering flux, even to the

amateur; he understates the case for cathode ray television; and he is definitely unfair when he says that "the avariciousness of the authorities controlling sound broadcasting has left few available frequency channels for television transmissions of this very high standard." He does not explain why, in a book dated February 1933, the performance of the Baird system is represented only by a 1928 image, nor why this is accompanied by a "cathode ray effort" of about the same date. It is probable that Baird images have improved since 1928; it is certain that cathode ray images have done so. The book deserves well of a wide public.

Short Reviews

Allgemeine Chemie der Enzyme. Von Prof. J. B. S. Haldane und Dr. Kurt G. Stern. (Wissenschaftliche Forschungsberichte, Naturwissenschaftliche Reihe, herausgegeben von Dr. Raphael Ed. Liesegang, Band 28.) Pp. xii+367. (Dresden und Leipzig: Theodor Steinkopff, 1932.) 22 gold marks.

THIS is something more than a translation of Prof. Haldane's English monograph on enzymes, which has been already noticed in NATURE (127, 354, March 7, 1931); additions have been made both by the author and by the translator, particularly in the more descriptive part of the book.

At bottom, the enzymes are considered through the eyes of a mathematician rather than by a biologist; they are, as it were, confined, forced to conform to equations with several variables. It is true that recognition is given to their specificity, but the mathematical treatment prevails. It is possible that this book will mark the high tide of such treatment, for there is abundant evidence of a return to the experimental study of the enzymes as biological catalysts acting at, and in virtue of, their surfaces. These substances are once more in the forefront of interest and it is becoming appreciated that much more work is required on the chemical side to elucidate their behaviour.

The enzyme literature is so vast, so much of it relates to experimental work that is careless and inaccurate, that a selection of the literature must be largely a matter of sentiment unless a very highly critical attitude is observed. Prof. Haldane would probably have been well advised to pay more attention to some of the earlier work in which a simpler and more comprehensive view of the subject is taken. On the whole, we prefer the English original to the translation.

Physical Chemistry: for Students of Biology and Medicine. By Prof. D. I. Hitchcock. Pp. xi+182. (London: Baillière, Tindall and Cox, 1932.) 15*s.* 6*d.*

THE topics discussed in this book have been "offered during the past five years to medical and graduate students in Yale University as a part of the course in physiology". The lectures have been delivered, therefore, outside the department of chemistry. They were accompanied by a course of laboratory experiments, detailed directions for which have, very wisely, been omitted from the book. The author's course is confined in the main to topics of special interest to students of biology, and he has produced a well-written and well-documented volume—a bibliography of about a hundred entries affording an opportunity for wider reading on certain selected topics.

The twelve chapters of the book deal with the more important fundamental properties of liquids and gases, solutions, electrolytes and mass actions, hydrogen ions (indicators and buffers), galvanic cells, the colloidal state, membrane equilibria and equilibria in blood, reaction velocity and enzyme action, oxidation-reduction and phase boundary potentials, and the transformations of energy.

Each chapter is followed by a short set of numerical examples, and an interesting feature of a useful little book is seen in the short biographies of eminent chemists which are scattered as footnotes throughout the volume. A. F.

Competitive Design of Steel Structures. By Peter Russell and George Dowell. Pp. xxii+426. (London: Chapman and Hall, Ltd., 1933.) 21*s.* net.

WHETHER it is legitimate to give a book a generic title when, in point of fact, it is confined to a consideration of two types, or species, only, is perhaps open to question. Out of the whole range of steel, or mainly steel, structures, the authors of this treatise have selected a gantry building and a cinema building for the full extent of their purview. This criticism apart, however, a high meed of approval can be expressed at the completeness of the analysis of design and calculation in the two cases dealt with.

The book will be a most helpful desk companion to the draughtsman engaged on these special classes of work. The structural details are worked out with a thoroughness which is not, and for obvious reasons cannot be, a feature of ordinary textbooks on structural design. Much practical advice and hints on economical expedients are incorporated in the text, which consists largely of calculations, concise and to the point. The diagrams, moreover, are good and the type clear.

Taking it as a whole, the book is an admirable production for its purpose, which is "to meet the needs of both the detailer and the young draughtsman who are assumed to have at least a fair knowledge of mathematics, mechanics, strength of materials and graphic statics." B. C.

The Mechanical View of Life*

By DR. J. GRAY, F.R.S.

ALTHOUGH it is impracticable to review, even in the most general terms, the progress of zoology as a whole, it is perhaps possible to take stock of one particular branch of the subject and to discuss its contributions towards problems which are of some general scientific and human interest. To an increasing extent, experimental zoologists are borrowing the weapons of physical chemistry, and possibly the time has come to consider the general point of view which underlies this type of attack on zoological problems. What is our conception of the essential nature of the living organism? Do we believe that the activity of living matter and its potentiality for change can be expressed adequately in terms of physical units? Do we incline to the belief that living animals have been evolved from inanimate matter?

When, as biologists, we are asked to define our conception of the nature or origin of living matter, we must confine ourselves to views which are based on the facts of observation. The more accurate and extensive are our observational data, the more precise and the more satisfying will be our conclusions. The material with which the biologist must deal is of extreme diversity and complexity, and we naturally turn to the physical world for standards of measurement which will help us to arrange our material and to place our observations in a reasonable relationship to each other.

As I understand it, the age-long discussion between the mechanistic and vitalist schools of thought turns on how far we believe—on the basis of observation—that the facts of biology can be sorted out into a harmonious and satisfying series, without invoking conceptions which are found to be unnecessary in dealing with the facts of observation within the physical world. The centre of gravity of the problem shifts from time to time; but for many years two concepts appear to have influenced the discussion to a marked extent.

First, the synthesis of organic compounds from inorganic material suggests that there is no fundamental difference between the type of substances found in, or made by, living organisms and those which are found in, or formed by, purely inorganic systems. Secondly, the inferences drawn from the theories of organic and terrestrial evolution suggest that these two processes are fundamentally similar and involve the operation of fundamentally comparable forces. Not a few biologists have, in fact, maintained that living matter "owes its origin to causes similar in character to those which have been instrumental in producing all other forms of matter in the Universe" (Sharpey-Schafer, 1911). This was the view of Ray Lankester, who elaborated a series of intermediate steps whereby the first type of living organism was evolved from inanimate matter. I imagine that not a few modern zoologists would tolerate, if not actually accept, a similar view. From this it is often, but not always, implied that there is a fundamental continuity in the properties of all matter and that the only properties which a living organism can possess are those which can be defined in physico-chemical terms.

Opposition to such a view has not been wanting. In 1912, Sir Oliver Lodge replied to the views set forth by Sir Edward Sharpey-Schafer and stressed the existence in organisms of a principle, not easy to define, which is absent from the world of physics and chemistry. From time to time the battle has been renewed, and both biologists and physicists have taken an active part. It is a curious but pertinent fact that the most far-reaching mechanistic views have been and are being put forward by biologists; the more cautious views or the vitalistic views are held by physicists and chemists.

The exponents of the mechanistic view have been curiously indefinite in the exposition of their opinions. I confess that a study of the more popular works on physical science leads me no nearer to an understanding of those "causes" which, according to Sir Edward Sharpey-Schafer, "have been instrumental in producing all other forms of matter in the Universe"; nor have such chemists as I have had the good fortune to meet been very familiar with the concept of "co-ordinated series of self-regulating and self-propagating chemical reactions", such as are described by Prof. Lancelot Hogben. According to Prof. Hogben, we may look for a complete solution to the nature of life within a mechanistic framework, fortified by the conviction that "The mechanist has a cheerful attitude to knowledge and refuses to capitulate to the fear of the Unknown: the vitalist, a sadder but not necessarily a wiser type, finds balm in the limitations and failures of human effort". So far as I have been able to observe, it is by no means obvious to note in the writings of Dr. J. S. Haldane, Prof. A. V. Hill or the Bishop of Birmingham those signs which are usually associated with a contemplation of the failures of the human intellect.

The mechanistic view of life seems to imply that if, at any instant of time, we were to know the precise distribution of the matter and energy which are present in an organism, we would have a complete understanding of all its properties. In other words, the behaviour of living systems can be completely defined in terms of laws which are fundamentally similar to those which describe the behaviour of inanimate systems. It is of interest to consider how far this conception is based on

* From the presidential address before Section D (Zoology) of the British Association, delivered at Leicester on September 7.

the results of observation, and how far it rests on a rather indefinite foundation of intuitive belief.

Let us look for a moment at the theory of the evolution of animate from inanimate matter. From a biological point of view it seems at first sight reasonable—it seems to be the natural conclusion to draw from the process of evolution which characterises the world of living organisms and the universe as a whole. The theory gives us a comfortable feeling of continuity of thought. Let us look at the position from a physical point of view. As a physical phenomenon it is undoubtedly *possible* for a living organism to have been evolved spontaneously from inanimate matter. It is also possible for a stone to leap spontaneously from the surface of the earth. These things are possible, but are they probable ?

It is *possible* for all the particles in a suspension of Indian ink to move simultaneously in one direction. It is also possible for all the molecules of a pebble to perform the same feat—but in view of the very large number of other possibilities, the *probability* of simultaneous co-ordinated movement is very, very small unless we are dealing with very small numbers of molecules. The degree of smallness can be judged by putting ten black and ten white balls into a box and drawing them out at random in lots of ten. The probability that we will draw ten white or ten black balls is five times in one million. If we increase the numbers and draw one hundred balls, the probability of drawing balls all of one colour is so small that we say that anybody who expected it to occur must be slightly demented. In practice we sum all this up by saying that so long as we are dealing with reasonably large numbers of molecules, the events which we observe are the most probable events, and we assume that the improbable events do not in fact occur. On this arbitrary but effective basis rest most, if not all, the laws of physics and chemistry which we apply to the study of living matter.

The organisation of the simplest living organism is clearly more complex than that of a stone or of a motor-car, and it carries out processes which are infinitely more complex than the sorting out of black from white particles. What, in fact, is the probability that any chance distribution of molecules should lead spontaneously to the dynamically active mechanism of the living organism ? Would any serious credence be given to the suggestion that a motor-car or even a footprint on the sands came spontaneously into existence without the intervention of directive forces ? Why, then, should we accept the spontaneous origin of living matter ? It is possible, but it is so improbable that, if considered as an observable phenomenon, in any other sphere of human thought it would be discarded as a figment of a deranged brain.

Left to himself, the chemist does not seriously consider the *spontaneous* origin of proteins from carbon dioxide, water and simple salts, nor does the physicist admit the spontaneous origin of organised machines. Biology itself provides not one shred of observational evidence to support the spontaneous origin of living matter in the world to-day, and yet not a few biologists are prepared to postulate the spontaneous origin of intermediate stages between the living and the inanimate worlds—to my mind, the spontaneous origins of these stages represent physical events which are so improbable that we cannot describe them in terms of 'laws' which only apply to events of an entirely different order of probability : if these intermediate stages actually occurred they must be classified as miracles, not as 'natural' events. We may be told that in past ages, events which are now very improbable were, in fact, of quite frequent occurrence. As men of science, we cannot accept this statement without some assurance as to what were the nature of the conditions which made the origin of life inevitable or even probable. The distribution of energy and of matter in past epochs may have been different ; but if such conditions produced the living organism, is it not strange that every attempt to reproduce them in the laboratory has completely failed ?

We can put the facts in another way. Within the physical world all systems appear to move towards the state of greatest probability, and the events which take place within a dynamic system are those which tend to destroy structure and not those which elaborate it. Is there any evidence which suggests that, within the physical world, a dynamic machine has spontaneously come into existence ? That such an event might happen is true, but has it, in point of fact, ever occurred under the observation of mankind ? Unless a positive answer can be given to this question, the belief in the spontaneous origin of living matter seems to be a negation of the principles which underlie scientific thought.

If we decline to accept the spontaneous origin of living from non-living matter, there is no particular reason why we should hope to express all the properties of an organism in terms of physical laws ; we might just as reasonably try to express physical phenomena in terms of biological conceptions. It seems more logical to accept the existence of matter in two states (the animate and the inanimate) as an initial assumption. Some properties are naturally common to matter in either state, and it is therefore legitimate to study the so-called physical properties of living matter ; but just as the fundamental concepts of physics are based on observational facts, so those of biology must conform to the same conditions. The physicist is not concerned with the origin of inanimate matter ; he is content to investigate it as he finds it. The biologist must likewise accept the living state as he finds it and not allow his science to rest on theories, however spectacular or attractive.

It is not easy to define life, but in practice most people will admit that matter in the living state possesses characteristics which are fundamentally

different from those of inanimate objects. The central characteristic of living matter is its state of organised dynamic structure.

If we base our conception of the structure of protoplasm on the facts revealed by physical methods we must imagine a system, of great chemical complexity and of great potentiality for self-differentiation, within a fluid framework. So far as we know, specific chemical reactions are seldom restricted to localised regions of the cell; on the contrary, substantial mechanical disturbances can often be induced in the cytoplasm without affecting its biological or chemical activities. We can, however, look upon a mass of protoplasm as a very fine emulsion, the fundamental units of which are extremely small. If we assume that the properties of the system as a whole are essentially those of each individual unit, then we have no great difficulty in seeing how mass disturbances fail to affect the properties of the whole system. The displacement of the particles by diffusion, or other causes, throughout the mass of the system will not influence the fundamental properties of the cell or nucleus if these properties are essentially those of the small individual units.

The conception of the living cell as an aggregation of a very large number of fundamental units is in keeping with the fact that small fragments of egg cells retain some, at least, of the properties of the whole system. It is also in keeping with the very small dimensions (as in viruses) within which living phenomena have been observed. There is some evidence to support the view that single differentiated cells also represent aggregates of very small living units. For example, a suspension of the spermatozoa of the sea-urchin *Echinus* in sea-water, after a period of maximal activity, enters a phase of declining mechanical and respiratory activity. If we consider a single spermatozoon during this period of senescence, we find that the intensity of its mechanical and respiratory activity declines in a way which is characteristic of a population of units which differ from each other in their viability—the single cell behaves, in fact, as though it represented a large population of much smaller units of activity.

If we accept the view that the fundamental unit of life is extremely small, we can see that mechanical disturbances throughout a suspension of such units may induce no very far-reaching results. The conception of protoplasm as an emulsion of small vital units suspended in a fluid system is perhaps the most satisfactory picture we can derive from available facts; but it breaks down when we try to think of the mechanism whereby the cell differentiates itself as a whole—for here we must postulate some form of co-ordinated relationship between individual units. If, however, we shelve this difficulty for the moment and accept the general conception that 'vital' properties are associated with very small units of structure, a variable number of which are normally aggregated together as a suspension to form a single cell—it is obvious that we must exercise very great caution in the application of the statistical laws of physics in describing the properties of the fundamental units of life. The only legitimate laws are those applicable to the behaviour of single units of activity.

So far as I can form an opinion, such determinate laws have not yet been forthcoming. I am inclined to think that the intrinsic properties of living matter are as mysterious and as fundamental as the intrinsic properties of the molecule of a radioactive substance: when the physicist can tell us why one particular molecule explodes and why another goes on existing, I venture to think that we can begin to consider the possibility of defining the fundamental properties of living protoplasm in physical terms. At present, however, the physicist seems more inclined to define physical phenomena in terms of biological conceptions, for, according to M. Poincaré and others, "modern physics is presenting us with apparent examples of spontaneity and foresight". For the moment, however, we must conclude that although physical methods have provided important facts concerning the state of living material, they have not as yet thrown much light on its fundamental properties.

After cell division has been in progress for a very short period, the cells which are formed by an egg of a sea-urchin begin to show a marked difference in arrangement from those of a polychæte worm. At the end of the third cleavage cycle, the cleavage pattern of a sea-urchin is seen to be orthoradial—the cleavage furrows between the upper quartet of cells lie immediately over the furrows of the lower quartet. In the polychæte, however, the arrangement is spiral, not orthoradial, for the furrows of the first quartet of smaller cells lie between the furrows of the basal quadrant cells. By experimental means we can force the sea-urchin egg to divide in a way characteristic of the worm. This is done by increasing the centripetal force which tends to press one cell against another, and we can show that the arrangement in the polychæte worm is that assumed by a system of spheres so arranged as to pack together within a minimum volume. The arrangement in the polychæte is essentially the same as in the egg of the mollusc or polyclad turbellarian. The classical interpretation of this fact associates the similarity in the cleavage pattern with a common phylogenetic relationship. From an experimental point of view one is inclined to a totally different view, namely, that the similarity in form is due to a similarity in the intensity of the mechanical forces operating on the cells. In the worm, mollusc, or turbellarian, the centripetal pressure acting on the cells is sufficient to force the cells to occupy a form in which a maximum volume is enclosed by a minimum area of surface. In the sea-urchin this is not the case. The pattern as such plays no essential rôle in determining the fate of the egg. A spirally cleaving sea-urchin egg develops normally; it does not develop into a worm or mollusc. The mechanical view is

peculiarly attractive, but it has one serious objection.

When the dividing cells of a molluscan egg rotate so as to reduce their centripetal pressure to a minimum, a rotation to the left is as effective as a rotation to the right—and on each occasion one would expect an equal number of rotations to the left as to the right. In a few cases this seems to occur, but in others the left-handed or right-handed pattern appears to be due to determinate and not to chance forces—for at any given stage of cleavage all the eggs show a rotation to the right or to the left. That this phenomenon is correlated with mechanical asymmetry is quite probable, and it may be that the nature of this asymmetry will eventually be observed. In the meantime, however, we seem to be faced with the fact that a mechanical condition which is satisfiable in either one of two ways, is, in fact, only effected in one way. Does it not look as though a disturbance has occurred in the probability values of the system ? It is as though we were presented with a bag of black and white balls—and each time we pick out the black balls and reject the whites. Before we attribute a determinate behaviour to the cleaving egg cell we must, of course, make certain that the chance of left- or right-handed cleavage is mechanically of equal probability. Up to the present we can only say that no mechanical difference is apparent—and in the absence of such definite evidence we are free to interpret the facts either as evidence of a deficiency in our knowledge of the mechanics of the system, or to the possibility that there exists in the egg a potentiality which makes certain events more probable than they could be in inanimate systems. One is tempted to suggest that the cells of a molluscan egg turn one way or another for intrinsic reasons : an event starts inside the cells—quite independent of any external influence—just as in the exploding molecule of a radio-active substance. In other words, the cell has an individuality of its own—which is free from the limitations of statistical laws. The field of cell cleavage is full of possibilities for future inquiry, and would well repay more intensive study.

The only laws which physics has provided for an analysis of biological phenomena rest on a statistical basis ; they only apply to systems which contain a large number of participating units and only describe natural phenomena in terms of probability and not of absolute truth. If we accept these laws as a means of describing the behaviour or the structure of an organism, we must accept the conventions attached to the laws, and agree to ignore such events as are improbable although they may conceivably occur. From this point of view, the spontaneous origin of living from inanimate matter must be regarded as a highly improbable event, and as such can be assumed not to have occurred. Similarly, the development of an organism from so-called undifferentiated protoplasm involves processes which are entirely without parallel in inanimate Nature.

So long as this state of our knowledge persists, it is dangerous to assume that the statistical laws of physics can satisfactorily describe all biological events. Our knowledge of the physical and biological properties of living matter suggests that the fundamental unit of structure is extremely small, and that it contains potentialities for change which are unique in the universe. These properties we must accept as fundamental axioms of our science which may or may not prove (in the future) to have their parallel in the physical world. It may seem presumptuous for the biologist to set up postulates peculiar to his own sphere ; it would be more fitting perhaps for him to accept, with medieval humility, the assumptions of his physical brethren. One wonders, however, at times whether the concepts of intrinsic organisation and of emergent evolution are entirely absent from modern physics. Even if this is not the case, we can fortify ourselves by the knowledge that physics has from time to time changed its fundamental assumptions with advantage to itself and to the world.

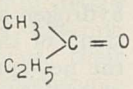
Those biologists who are inclined to accept the views I have ventured to put forward may be encouraged by a recent remark of Prof. Niels Bohr (NATURE, 131, 458, April 1, 1933) : "The existence of life must be considered as an elementary fact that cannot be explained, but must be taken as a starting-point in biology, in a similar way as the quantum of action, which appears as an irrational element from the point of view of classical mechanical physics, taken together with the existence of the elementary particles, forms the foundation of atomic physics."

Not infrequently the physiologist can restrict his interest to the physical properties of isolated organs—the origin of which does not concern him. The zoologist, on the other hand, knows that the beautifully adapted mechanism known as an 'organ' was evolved from a system unlike itself and may, in turn, initiate something new. For this reason, he cannot afford to forget what may be called the 'intrinsic potentiality of the living organism'. He may or may not be able to use this conception as a guide to more adequate observations, but it should be constantly in his mind.

Experimental zoology can be divided into two types of study : (1) the investigation of the physical and the chemical properties of living organisms ; (2) a study of the intrinsic potentialities of living matter, revealing as it does a co-ordination of events which is without inanimate parallel. In the first type of work we must use each new weapon which the physicist can give us. In the second type of work, however, biology must be the mistress and not the servant of physics or of chemistry—she must make her own foundations, and build on them fearlessly, prepared to change her views, if need be, but not prepared to force the wine of life into bottles which were designed for use in the simpler and less intoxicating fields of chemical science.

Free Radicals

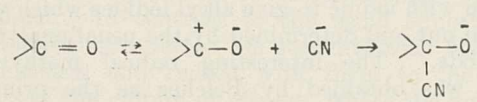
THE General Discussion on "Free Radicals" held by the Faraday Society at Cambridge on September 28–30 was noteworthy for the large attendance of distinguished foreign visitors as well as for the number and range of the papers presented. It is impossible to do justice to all the contributions in a short review; what follows must be regarded as a personal impression of the more salient features of the discussion.



The definition of a free radical presents some difficulty. Probably the best 'working specification' is that of Wieland, quoted by Prof. T. M. Lowry in his opening paper. "Free radicals are complexes of abnormal valency which possess additive properties, but do not carry an electric charge and are not ions." This definition, like most of the others which have been attempted, is open to criticism; in particular, charged free radicals, for example, CH_2^+, which contain an odd number of electrons, are familiar in positive ray work and were discussed later in the meeting.

In the opening paper, Prof. Lowry laid stress on the significance of free radicals for theories of valency and of the mechanism of organic reactions. In terms of the electronic theory, the splitting of a covalent link may be thought of as taking place unsymmetrically, giving two ions of opposite sign, or the link may be broken symmetrically so that each fragment of the molecule retains one of the electrons of the link and is a free radical. In the early days of the electronic theory of valency, it was thought that stable molecules might contain covalent linkages with any degree of polarity from a neutral bond like that between the carbon atoms in ethane to the polar bond in NaCl. There is now a considerable body of physical evidence which indicates that the two types of linkage are fairly sharply marked off from one another. It is true that dipole moment determinations show that a single covalency can exhibit some degree of polarity, but this is always far short of the moment to be expected for the transference of an electron from one atom to another. The accumulating data on crystal structure and Raman spectra also give an experimental distinction between ionic and covalent linkages.

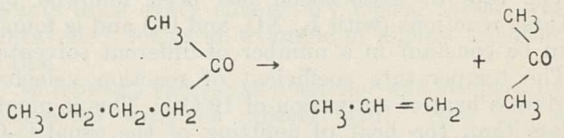
It follows that two main types of mechanism must be considered for organic reactions. Lapworth has shown that the formation of cyanhydrins is essentially an ionic reaction, and Lowry formulates it thus



with an intermediate polarisation of the double bond. On the other hand, the thermal decomposition of hydrocarbons and many photochemical changes cannot be formulated as ionic reactions. Thus Norrish has found that the photochemical decomposition of methyl ethyl ketone follows the course:

The ultimate products are carbon monoxide and an equivalent mixture of nearly equal parts of ethane, propane and butane. It is evident that these products are most readily accounted for by the intermediate formation of the free radicals methyl and ethyl.

It is convenient here to mention a remarkable result obtained by Norrish for higher ketones. With methyl butyl ketone the products of photochemical decomposition are acetone and propylene.

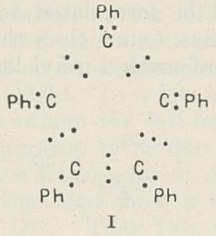


Since the radiation used is that absorbed by the carbonyl group, this reaction presents an interesting problem in molecular mechanics. It can be shown that nearly all the energy absorbed by the carbonyl group reappears as the energy of disruption of a bond in another part of the molecule.

Most of the free radicals met with in organic chemistry have one unsatisfied valency and therefore contain an odd number of electrons. These odd molecules should exhibit the paramagnetism due to an unbalanced electronic spin; this has been verified experimentally for inorganic free radicals, such as NO_2, ClO_2, etc., and more recently by Sugden for the typical organic free radicals, the ketyls (R_2C–O–K). These substances have a high degree of stability and can be kept for an indefinite time; on the other hand, Paneth estimates the average life of a methyl radical as a few thousandths of a second. Free radicals thus fall into two groups, the stable type with a long life, and the evanescent type with a very short average life.

Many organic radicals of the first type have been prepared since Gomberg, in 1900, discovered triphenylmethyl. A valuable review of this series of compounds was given by Prof. Ziegler. The factors which favour the dissociation of the hexaaryl ethane molecule appear to be the unsaturation and the volume of the substituents, and of these, volume appears to be more important. Thus pentaphenyl ethyl and pentaphenyl cyclopentadienyl appear to exist entirely as the free radical. For the latter substance an interesting symmetrical electronic formula (I) has been suggested by Löwenbein in which a ring is formed by five

three electron links. The introduction of substituents containing triple bonds appears to have little effect in promoting the dissociation of the ethane linkage.



I

The number of radicals of the triphenyl methyl type now known is very large and progress is to be expected rather in the accurate physico-chemical study of known complexes than in the preparation of new substances. Ziegler and his co-workers have already developed accurate methods for determining the energy changes which accompany the dissociation of hexa-aryl ethanes; these have so far only been applied to hexaphenyl ethane. The rate of dissociation has been followed by three reactions (with I_2, NO, and O_2) and is found to be constant in a number of different solvents. The temperature coefficient of reaction velocity gives a heat of activation of 19 Cal. This is much less than the heat of splitting of the usual C–C bond, namely, c. 70 Cal. Ziegler has also worked out an accurate optical method of determining the degree of dissociation of hexaphenyl ethane in various solvents. The temperature coefficient of the dissociation constant gives a heat of dissociation of about 11 Cal.

These measurements are of interest in connexion with a quantum mechanical theory of triphenyl methyls contributed by Prof. E. Hückel. In Hückel's theory of benzene the stability and planar configuration of the ring are ascribed to resonances between six electrons, one from each carbon atom, which are designated p_h electrons. In hexaphenyl ethane the aromatic nuclei must, on stereochemical grounds, be arranged at or near tetrahedral angles around the central carbon atoms, and with this arrangement it is not possible to have interaction between the p_h electrons of one aromatic nucleus and another. In triphenyl methyl, however, the three phenyl groups can approach a planar configuration with links to the central carbon atom at 120°. A marked interaction between the electrons of the three nuclei can then occur which stabilises the free radical. This energy of stabilisation must be subtracted from the heat of rupture of the C–C bond to give the heat of activation of the hexaphenyl ethane molecule. Hückel terms the energy of stabilisation the "static bond strain", and computes its value approximately for typical substituted ethanes. With six aromatic substituents the static bond strain is 55 Cal., in fair agreement with Ziegler's experimental results. The strain decreases rapidly with the number of aromatic substituents; for one phenyl group in the molecule it is only 12 Cal.

Another discussion of free radicals in terms of quantum mechanics was contributed by Prof. J. E. Lennard-Jones, who applied the method of molecular orbitals to investigate the structure of the CH_3, CH_2, and CH radicals. Particular interest attaches to the structure of CH_2, which has a singlet normal state and not, as might have been expected, a triplet state. The production of CH_2 from CH_3 involves not only the removal of a hydrogen atom but also an "energy of reorganisation" of the electrons in the CH_2 residue so that the net spin becomes zero. A rather cruder way of expressing this result (since it refers to a particular atom and not to the molecule as a whole) is to state that whilst CH_3 contains quadrivalent carbon, CH_2 contains bivalent carbon. This energy must play an important part in many chemical and photochemical changes. Thus carbon monoxide is known from spectroscopic evidence to be $^1\Sigma$ with bivalent carbon, whilst the carbonyl group in ketones may be regarded as containing quadrivalent carbon. Hence the photochemical change studied by Norrish in which carbon monoxide is formed from the lower ketones must involve an energy of reorganisation.

A number of papers were contributed on the chemical reactions of radicals of short life. The simplest of all free radicals is, of course, atomic hydrogen, which can be produced in high concentrations by a discharge through hydrogen at pressures of less than 1 mm. This radical has the comparatively long life of about one second, and some recent work on its chemical properties and those of atomic oxygen was described by Hartek. At low temperatures (liquid air or hydrogen) some very striking results have been obtained. With oxygen, atomic hydrogen gave high yields of hydrogen peroxide, with mercury a solid product containing 70 per cent of HgH, and with ethylene ethane was formed. In the last reaction, the apparatus was capable of producing 500 c.c. of ethane, measured at atmospheric pressure, in 15 minutes.

The use of free methyl and ethyl to synthesise organometallic compounds was described by Paneth. Amongst the compounds isolated was the long sought for antimony analogue of cacodyl, $(CH_3)_2Sb.Sb(CH_3)_2$. This substance is spontaneously inflammable in air and melts at 17·5° C. In the liquid state and in solution it is nearly colourless, but on solidification becomes bright red. Horn, Polanyi and Style described experiments showing that methyl and ethyl are formed by the action of sodium on alkyl halides at 200°–300° C. The radicals were detected in two ways: (*a*) by using them to initiate the chain reaction between hydrogen and chlorine; and (*b*) by interaction with iodine to give alkyl iodides which were frozen out and determined by the usual analytical methods. The interesting radical methylene, CH_2, was obtained by Belchez as the primary product of the thermal decomposition of methane on a platinum surface at 1,100° C. and 0·1 mm. pressure. The radical was identified by reaction

with an iodine mirror and the subsequent formation of the additive compound $CH_2I_2Hg_2$ of melting point 230° C.

Finally, a number of papers were devoted to the study of free radicals in electric discharges by spectroscopic or positive ray methods. Of these there is only space to mention the important report by Mecke on "Free Radicals and Spectroscopy". Spectroscopic methods not only detect the presence of free radicals but also for diatomic radicals give exact information about their dimensions and the strength of the interatomic linkage. It is true that polyatomic radicals and molecules give spectra of such complexity that a full analysis is difficult, but Mecke pointed out that there is a good deal of evidence for regarding simple radicals as the bricks from which larger molecules are built up. Their dimensions show little change when they form part of a larger molecule, and similar linkages have similar binding energies in diatomic radicals and in larger collections of atoms. Thus the accurate spectroscopic data for diatomic radicals and molecules can be applied with little modification to the discussion of the dimensions and strength of linkages in more complex systems. S. S.

Obituary

PROF. P. EHRENFEST

THEORETICAL physics has lost one of its ablest and most enthusiastic exponents through the death on September 25 last of Paul Ehrenfest, professor of theoretical physics in the University of Leyden. Born in Vienna in 1880, he studied first under Boltzmann. From Vienna he went to Göttingen; there he made the acquaintance of his future wife (Mrs. T. Ehrenfest-Afanashewa). In collaboration with Mrs. Ehrenfest, he undertook a thorough critical investigation of the principles underlying the kinetic theory of matter, a problem which had fascinated him ever since his Vienna days. The elucidation of certain paradoxes in Boltzmann's *H*-theorem (1907) and the extensive article on statistical mechanics in the "Enzyklopädie der mathematischen Wissenschaften" (1912) testify to the fertility of their combined activity. The latter work was written in Russia, where the Ehrenfests lived for several years.

In 1912, Ehrenfest was called to Leyden to take the chair of theoretical physics on the retirement of H. A. Lorentz. With the exception of minor interruptions (lecturing trips to the United States and Russia) he worked and taught at Leyden until his death. Of his scientific work of this period we may mention his prediction of the interference patterns produced by X-rays travelling through a diatomic gas (1915), his work on the adiabatic hypothesis in the quantum theory (1916; his own delightful survey of this topic in *Die Naturwissenschaften*, 1923, should be consulted) and his theorem on the propagation of wave packets in quantum mechanics (1927).

Ehrenfest's intellectual enthusiasm and his innate desire to communicate to others (especially the younger workers) everything he understood and also every question which he felt unable to answer, was a novel experience to the phlegmatic sons of Holland. In contrast to the usual educational principles, he infected his students with his own enthusiasm and rushed with them to the outposts of the empire of physics, where the fighting against the great unknown—relativity and quantum theory—was going on. But at the same time, he did not forget to take them to an occasional tower, from which he could show and explain to them in his masterly way the domains already conquered. Finally, he taught them the importance of careful attention to details; his own love for detail and his perseverance in following up minor points until every elementary logical thread was unravelled, set us an example of highest scientific value.

Ehrenfest's success as a teacher was inseparably connected with his critical vein. How can a teacher expound what he does not himself fully understand? In harmony with his ideals, he maintained, throughout his life, that the obvious rules of scientific communication should be kept, namely, that a lecturer or author should understand what he says or writes and should be understandable by his audience. Readers of NATURE who have not had the privilege of meeting Ehrenfest may deem such an ideal quixotic; those who have will remember that, besides his honesty and his seriousness, he had a ready wit and boyish laughter at his disposal. Lectures where the audience was expected not to interrupt were, as a rule, a bore to him, especially if he was himself the lecturer.

Those who came in personal contact with Ehrenfest were struck by the richness of his personality, every domain of true spiritual culture being dear to him. The profoundly human and altruistic sentiment, which was always in the background of his thoughts and actions, made him a valued friend to many and also brought him many devoted friends who—in his later years—would have liked to see him happy more often.

H. A. KRAMERS.

WE regret to announce the following deaths:

Mr. David Miller Muir, a well-known radiologist of Exeter, who worked under Sir J. J. Thomson at the Cavendish Laboratory, Cambridge, before taking up the medical aspects of his subject, on October 18, aged forty-six years.

Dr. Christine Murrell, a member of the Council of the British Medical Association and first woman member of the General Medical Council, on October 18, aged fifty-nine years.

News and Views

Prof. T. H. Morgan, For.Mem.R.S.

THE Nobel prize in medicine for 1933 has been awarded to Prof. Thomas Hunt Morgan, of the California Institute of Technology. This award is a recognition of the importance of investigations of heredity for the advance of medicine. Prof. Morgan's earlier work in experimental zoology, of which he was professor at Columbia University from 1904 until 1928, was widely recognised, and dealt with fundamental problems of embryological development. About 1910 he took up the study of the mutations in *Drosophila*, and developed a school of genetics which achieved world-wide recognition. The theory of crossing-over which he developed is still the subject of much active investigation, and his law that the number of linkage groups of genes corresponds with the number of chromosome pairs has since been confirmed in plants, these and related discoveries having substantially proved the chromosome theory of inheritance. Although his work has been entirely with animals, the importance of these investigations in their application to human genetics is well recognised. Prof. Morgan is a past president of the U.S. National Academy of Science and of the American Association for the Advancement of Science. He was elected a foreign member of the Royal Society in 1919, and received the Darwin medal in 1924. He was president of the Sixth International Congress of Genetics, held at Ithaca, New York, in August 1932.

Parliamentary Science Committee

THROUGHOUT the post-War era, there have been endeavours to establish some organisation which would serve as a liaison body between science and Parliament, and those endeavours have received consistent support in these columns. During the past two years, the British Science Guild and the Association of Scientific Workers have bestirred themselves to bring such an organisation into being, and have received promises of support from the following societies (arranged in order of date): Joint Council of Qualified Opticians, Pharmaceutical Society of Great Britain, Institute of Physics, Royal Institute of British Architects, Society of Engineers, Institution of Professional Civil Servants, Institution of Mechanical Engineers, South-Eastern Union of Scientific Societies, Institution of Naval Architects, Oil and Colour Chemists' Association and Institute of Metals. It is satisfactory to learn that the suggested liaison organisation has been definitely formed; and now that it is an established fact, other representative scientific bodies will no doubt wish to be represented in the important work to be done.

AT meetings held in London during the week ending October 21, the British Science Guild and the Association of Scientific Workers decided to join forces (so far as the Parliamentary activities of the two bodies are concerned) to form a Parliamentary Science Committee. Each organisation has representation on the Committee, to which will be added representatives of other bodies concerned. The headquarters of the Committee will be at the offices of the British Science Guild, 6, John Street, Adelphi, W.C.2 (Telephone, Temple Bar 2789). The chairman of the Executive Committee is Commdr. L. C. Bernacchi, the vice-chairman Prof. B. W. Holman, and the joint hon. secretaries are Mr. A. Howard and Mr. H. W. J. Stone. The new Committee proposes to confine itself for the present to exploring and forwarding the subjects actually under preparation for Parliament by its constituent bodies; and announcements as to what these activities are will be made from time to time as they mature. Meanwhile, the Committee will continue the periodical issue to its supporters of *Science in Parliament*, a summary collated from *Hansard* of all Parliamentary proceedings affecting science. This is a compilation which started with the opening of the 1932–33 session and will be adequately indexed.

"Modern Man" in East Africa

DR. L. S. B. LEAKEY'S report on the Kanam jaw and the reconstructed Kanjera skulls, which was presented at the meeting of the Royal Anthropological Institute on October 20, has afforded material, as was indicated by the observations of Sir Arthur Smith Woodward and Dr. W. L. H. Duckworth in the discussion which followed, to which anthropologists and palæontologists will have to devote consideration for some time to come. As the result of comparative study of his material, and more particularly in view of the results of an X-ray examination of the roots of the molars and premolars of the Kanam jaw, Dr. Leakey concludes that this fossil represents a new species of man of Lower Pleistocene, or even Pliocene, age, contemporary with *Pithecanthropus*, *Sinanthropus*, and *Eoanthropus*. Unlike these examples of early man, however, Kanam man is sufficiently close in his resemblances to *Homo sapiens* to warrant inclusion in the same genus as modern man. The jaw possesses a pronounced chin and the arrangement of the teeth in the dental arch, as well as their size, resembles that of modern man. Kanam man may, therefore, it is concluded, be taken to be a form ancestral to modern man, for which the name *Homo kanamensis* is proposed. The anatomical characters of the jaw have thus been shown to be more nearly congruous with the geological and palæontological evidence of a very high antiquity than seemed possible when it was thought that 'modern man' had appeared at this early date; while the construction of an entirely new species upon the evidence of a single specimen may seem less hazardous in so variable a creature as man, when it is remembered that the original identification of *Sinanthropus* as a new genus rested on the evidence of a single tooth alone. Dr. Duckworth, indeed, deprecated Dr. Leakey's modesty in creating a new species only.

DR. LEAKEY'S interpretation of the evidence afforded by the reconstructed Kanjera skulls is in

conformity with his conclusions on the character of the Kanam jaw, and should remove any hesitation such as was felt in accepting the antiquity claimed for Oldoway man. The Kanjera skulls, although larger and thicker than the average skull of modern man, and lower in relation to length, are regarded as a generalised, and rather primitive, example of *Homo sapiens* of Middle Pleistocene age. They represent a distinct advance on the Kanam race; and in the absence of the prominent eyebrow ridges are differentiated from the early types of man other than *H. sapiens*. The portion of a femur associated with the fragments of skull suggested, as might have been expected, great muscular development, and, more important, indicated that Kanjera man walked with an upright gait. Prof. Elliot Smith, who was in the chair, pointed out that both the brain cast of *Sinanthropus* and the skulls of Kanjera man show signs of the gradual increase in man of the organs of visual discrimination. A point of peculiar interest at the moment which emerged in Dr. Leakey's report bears upon the development and distribution of the industries of the Stone age. He very pertinently stressed the importance of the association of pebble and hand-axe industries with the Kanam and Kanjera remains, in view of the arguments for the association of core industries and early *H. sapiens*, a relation towards which archæological speculation is now tending, in the attempt to explain the distribution of the two types of industry, the core and the flake, and to assign them respectively to *H. sapiens* and Neanderthal man. Dr. Leakey indeed went further, and in view of the complete developmental series found in East Africa, favoured the view that the area is near the centre of development of the hand-axe culture, if not indeed itself the actual centre. His specimens are on exhibition at the British Museum, where they will remain until November 21.

150th Anniversary of the Royal Asiatic Society

IN 1783, Sir William Jones landed at Calcutta, and on January 15 of the following year, he convened a meeting of some thirty prominent members of the European community of the city to discuss the "Institution of a Society for enquiring into the History, civil and natural, the Antiquities, Arts, Sciences, and Literature of Asia". As a result of this gathering the Asiatick Society was formed, under the presidency of Sir Robert Chambers, and Sir Warren Hastings, the Governor-General, and members of the Council of Fort William, Bengal, were invited and agreed to be patrons. In due course the title of Asiatic Society of Bengal was adopted, and on January 15, 1934, the Society will celebrate its hundred and fiftieth anniversary. Few aspects of scientific development in India during the past century have not been associated with the Society. Geology and mineralogy early received much attention, and it is a happy coincidence that Dr. L. L. Fermor, director of the Geological Survey of India, should be president of the Society at the forthcoming celebrations. In its early days the Society also accumulated valuable collections, which led in due course to the foundation of the Indian Museum, from which, in 1916, arose the Zoological Survey of India. The historical and antiquarian memoirs published by the Society are widely known. Indeed, its fellows may look back on a long and distinguished record of service to India and to the world.

Frazer Lecture, 1934

IN accordance with the inter-university rotation established under the rules of the foundation, the Frazer lecture for 1934 will be delivered in the University of Oxford. The lecture was founded in honour of Sir James Frazer and is delivered annually in the Universities of Oxford, Cambridge, Liverpool and Glasgow in succession, Sir James having been connected with each of these universities at some period of his life. The Committee for Anthropology of the University of Oxford announces that it has elected Herbert Jenkins Rose, professor of Greek in the United College of St. Salvator and St. Leonard in the University of St. Andrews, to be the lecturer for this occasion. Prof. Rose went to Balliol College, Oxford, as a Canadian Rhodes scholar, was fellow and tutor of Exeter College, Oxford, and before his appointment to a chair at Glasgow held the chair of Latin in the University of Aberystwyth. He is president of the Folk-lore Society and is the first occupant of the presidential chair in the recently formed Scottish Anthropological Society. He has contributed a number of papers in classical and folk-lore studies to the journals of learned societies and is the author of "Primitive Culture in Greece" (1925), "Primitive Culture in Italy" (1926) and other works.

Scientific Workers and Disarmament

A PAMPHLET entitled "Patriotism Ltd.: an Exposure of the War Machine" which has recently been published by the Union of Democratic Control, 34 Victoria Street, London, S.W.1 (6*d*.), not only directs attention to the activities of the armament firms towards nullifying the work of the Disarmament Conference which at least in part inspired Beverley Nichols's latest book "Cry Havoc", but also raises a number of ethical or moral questions for scientific workers in particular. Two chapters of the pamphlet describing the perfecting of warlike preparations in Great Britain and the prostitution of science involved in what is euphemistically described as national defence, raise the question as to what terms, if any, should induce a scientific worker to devote his energies to such research. Many of the developments in the aircraft industry relate to devices for the carrying or release of bombs or for aircraft gun-mountings which, like developments in the submarine or in the light tank, as in poison gas, can only be regarded as essentially offensive weapons. The question almost inevitably arises whether the scientific opinion in the world could not put a term to such destructive developments if it had sufficient moral solidarity and courage. It is also stated that research required by the fighting services is financed by the Department of Scientific and Industrial Research. This, we

believe, is incorrect. The fighting services have their own research departments. Possibly the fact that some of the industrial research work carried out at the National Physical Laboratory and the Chemical Research Laboratory, and by various research associations, may be applicable to naval or military purposes as well as to industrial purposes, has led to this misconception.

The International Mind

IN a recent article entitled "The International Mind" (NATURE, Sept. 30) dealing with the work of the League of Nations in the field of international intellectual co-operation, it was suggested that the League should concentrate mainly on education and the Press, and that, in regard to the many other forms of co-operation in science, art, letters, politics, etc., it should content itself in the main with collecting data on the present position. A correspondent has pointed out that a compendium of information on this latter sphere of activity has in fact been issued by the League of Nations, in its "Handbook of International Organisations", and in its quarterly bulletins on the same subject, published by Messrs. Allen and Unwin, Ltd. The "Handbook" for 1929 is priced at 10*s*., and runs to 348 pages. Moreover, the League of Nations, as a complete list of its publications further indicates, has by no means overlooked the power of the Press, as a cultural or intellectual factor. A conference of "Press Experts" was held in 1927; also a European Conference on Transport of Newspapers; and its publicity methods are described in a pamphlet on "The League of Nations and the Press" published in connexion with the International Press Exhibition, Cologne, 1928.

Statistical Methods in Technical Problems

DURING recent years there have been considerable developments in the application of modern statistical methods to the technical problems of industry and agriculture. The Council of the Royal Statistical Society considers that the time is now opportune for the formal provision of facilities which will stimulate discussion of such problems. It has therefore been decided to form a special section of the Society for the purpose of promoting the application of methods of statistical analysis to industrial and agricultural problems. This new development of the Society's activities should certainly meet a real need, since in the research department of a large industrial firm or at an agricultural research institute, special investigations are frequently undertaken which involve careful planning and experiment before the most suitable statistical procedure is obtained, while in the ordinary course of day-to-day production and selling, there often arise problems of sampling and testing, or questions as to whether measurements taken are used to the best advantage, and how far they are adequate for the purpose intended or even the extent to which some of them may be redundant. The facilities provided by the Section will be twofold: (1) the holding of regular meetings; and (2) the publication of a supplement to the *Journal of the Royal Statistical Society*, devoted entirely to this aspect of statistical science. The first meeting will be held on Thursday, November 23, at the Hall of the Royal Society of Arts, John Street, Adelphi, London, W.C.2, at 5.30 p.m.

"Research is the Door of To-morrow"

THE motto quoted above is engraved over the porch of the new Post Office research station at Dollis Hill, which was opened by Mr. Ramsay MacDonald on October 23. The results of the work carried out in many of the laboratories fully justify this saying, so far as telephony and telegraphy are concerned. It was stated that the annual saving to the Post Office effected by 14 out of the 511 investigations carried out last year was £190,000. The station possesses very complete workshops so that all the apparatus required for research purposes can be at once constructed. The researches carried out are generally very thorough. For example, when testing automatic telephone apparatus, all the component parts, such as telephone dials, selector switches and relays are continuously operated to failure or destruction. This enables an accurate forecast to be made of the performance of new types of equipment under working conditions. In the physics laboratory, investigations are made of the properties of the various materials used in the construction of communication apparatus. The apparatus for the production of the high voltages necessary for testing new types of lightning arresters and safety valves is carefully screened off from the rest of the laboratory. A special laboratory is devoted to improving the speeding up of the trunk telephone service. It has led to the provision of new facilities for signalling over trunk telephone lines by means of voice frequency currents. The introduction of the teleprinter has greatly increased the work of the telegraph research laboratory. The results obtained by operating this instrument under various conditions are being carefully investigated.

THE metallurgical department of the Dollis Hill station is devoted to the examination of the microstructure of metals. It is used mainly for diagnosing the cause of failure in all types of engineering plant. The analysis of small amounts of metals either in the form of alloy or impurity is carried out by the spectrograph. The methods developed have had important applications in connexion with the analysis of the lead alloys used for making the sheaths of underground and submarine cables. The laboratory for testing telephone instruments can deal with them at the rate of a thousand a day and this speed enables every new and repaired instrument to be tested as it comes from the contractors. The apparatus developed as a primary standard of telephone efficiency gives a high quality transmission and reproduction of speech at definite and constant levels. Similar standards have been made by the larger telephone administrations of the world and form an international standard of reference. There are also acoustic and cable research laboratories which are carrying out useful work. In addition to

the research work carried out at the Dollis Hill station, technical training is given to many of the young assistants in the various departments of the Post Office. During the current year, 1,700 students will receive instruction. Correspondence classes have also been started for the benefit of provincial students.

Telephone Statistics of the World

THE American Telephone and Telegraph Company has published statistics in *Electrical Communication* for July of the telephone development of the world on January 1, 1932. Assuming the population of London to be 8,900,000, it is calculated that there are 8·7 telephones for every hundred people. This is the maximum density of the telephones of the cities in Great Britain. In France, Paris has a density of 14·2, and in Germany, Berlin leads with 11·6. San Francisco has the greatest telephone density of any city in the world, there being 39·1 telephones per 100 inhabitants. Other cities where the density exceeds 30 are Stockholm, Washington, Seattle and Denver. When countries are considered, we find that the United States has 15·8 telephones per hundred of the population, Canada has 13·1, Denmark 10·1, Sweden 9·1, Norway 7·0, Germany 4·8, Great Britain 4·5 and France 2·9. When telephone conversations and telegrams are considered for the year 1931, Canada heads the list with 250·3 per person, the United States comes next with 223·5, New Zealand with 200·4, and Germany with 36·9, Great Britain with 35·4 and France with 20·9 are near the bottom of the list. The figures show that 56 per cent of all the world's telephone numbers are listed in the United States. They also show that more than 50 per cent of the 12·5 million automatic or 'dial' telephones in the world are in the United States. The usefulness of the telephone increases according to the number of telephones in use. Even in the United States, the numbers per hundred persons are increasing every year and the saturation point still seems some distance away. The mechanical convenience of the telephone makes a strong appeal to them.

International Congress on Glass and Ceramics

THERE is very clear and encouraging evidence of the permeating of industry by scientific methods when two industries like those dealing with glass and ceramics, traditionally secretive, get to the stage of arranging an international congress. That happy consummation was reached by the holding on September 17–26 of the First International Congress at Milan, Venice, Faenza and Florence. The organisation of the Congress had been carried out by the Federazioni Nazionali Fasciste delle Industrie del Vetro e Della Ceramica and was presided over by the Hon. B. Donzelli, with Signor Luciano Scotti as vice-president. The proceedings consisted of five sessions held in Milan for the reading of scientific and technical papers, and the transaction of business, visits to ceramic refractories and glass works in the neighbourhood of Milan, Venice, Faenza and Florence, and there was a good deal of generous hospitality at all these centres.

No less than forty-four papers on glass and thirty-one on ceramics were contributed to the technical sessions by authors from the United States, Czechoslovakia, England, France, Germany, Russia, as well as Italy. The members of the Society of Glass Technology from England contributed fifteen of the papers on glass. The English Ceramic Society and the Glass Research Delegacy, the Deutsche Keramische Gesellschaft, the Deutsche Glastechnische Gesellschaft, and the American Ceramic Society were also all officially represented. This first Congress was undoubtedly a success and it was determined that others should follow in series. It is possible that, following suggestions made by the English delegates interested in glass, the second congress may be held in England in 1936. Something was done also to make provision for maintaining contact between scientific workers and glass technologists in the various countries, by setting up an International Commission for Glass, with representation of the United States, England, France, Germany, Italy, Spain and other countries, and Prof. W. E. S. Turner, of Sheffield, was elected president. A similar Commission for Ceramics is under discussion.

Physics in Industry

IMMANENT in to-day's technological developments is an increasing recognition of 'physics'. In the past, to the man in the street, a scientific worker in industry has always been a 'chemist' or, if not, has been regarded vaguely as some kind of second-rate chemist; but that is now changing. The Institute of Physics is playing no small part in bringing about the change, and its series of lectures on "Physics in Industry" has covered a wide variety of interests, while the industrial research associations also, of course, exercise an ever-extending influence in the same direction. Symptomatic of the movement is the fact that for the first time, Section A of the British Association had a sub-section on industrial physics at the recent Leicester meeting. It is earnestly hoped by many physicists engaged in industry that this innovation will become a regular feature and that more time will be allotted in the future to its important discussions.

DR. EZER GRIFFITHS presided at the Leicester meetings of the sub-section and the subjects were chosen for their local interest in the city of Leicester. Mr. H. Bradley, who recently delivered an Institute of Physics lecture on "Physics in the Boot and Shoe Industry" (NATURE, May 27, p. 756), contributed two papers; one dealing with physics of industrial drying with special reference to the removal of moisture from leather and from shoes; the other concerned with the testing of flexible sheet materials, like leathers and textile fabrics, by inflation under hydrostatic or pneumatic pressure. Dr. S. G. Barker, of the Wool Industries Research Association, emphasised the importance of the subjects in rela-

tion to textiles. Dr. C. H. Spiers, who is himself a chemist, read a paper entitled "Some Physical Problems of Leather Manufacture" in an effort to show how tremendously wide is the scope for the application of physics in relation to tannery problems; his paper is printed in full in the *Leather Trades' Review* for October 4.

Archæological Finds in the Crimea

A JOINT expedition of the University Museum, Philadelphia, and the Leningrad Academy for the History of Material Culture has been engaged in the exploration of an ancient fortress site at Esski-Kermen in the Crimea under the direction of Prof. P. L. Schmidt, representing the Leningrad Academy. According to a communication issued by the S.C.R., a large amount of archæological material obtained from interments, consisting of pottery, bones and ornaments, has already reached Leningrad, where it awaits examination. In the slopes of the plateau on which the fortress stands, thirty-three catacomb burials were discovered. These date from the fifth to seventh centuries A.D. Inside the fortress were a number of communal burial chambers, cut from the solid rock. These contained human skeletal remains, which had evidently been deposited there after having first been interred elsewhere. They closely resemble burial chambers discovered at Mengap-Kale. These remains are believed to belong to the people previously known only from the 'dolmen' burials. It is hoped to establish their cultural affinities and chronological relations by the present excavations. Four large dolmens and eight cist burials were also examined and yielded three unbroken skulls, the first to be found in this region. Archæological investigation in the Crimea has demonstrated a succession of five occupations, of which the best known is that of the bronze age Scyths, whose art, characterised by the free use of animal motives, is known from widely distributed burials, and extended as far as China. It is anticipated that the present excavations will at least establish certain fixed points in the chronology of the at present obscure prehistory of the Crimea.

Amani Agricultural Research Station

THE fifth annual report (1932–1933) of the Amani Agricultural Research Station has been issued by the Colonial Office (London: H.M. Stationery Office. 1*s*. net), and in a covering letter attention is directed to the fact that this is "the first report since the Station has really got going and stood upon its own feet". Definite advances have been made along many lines of investigation, and although a programme of long-range research has been followed, some important results capable of immediate application have been obtained. An intensive study of the root system of coffee has revealed the fact that a close correlation exists between root distribution and the acidity gradient of the soil profile. Where the reaction is approximately neutral, a uniform dispersal of roots is found throughout the soil, but should a mildly acid or neutral layer overlie an acid subsoil, the roots will be restricted to the upper layer. This behaviour suggests an explanation of many long-standing problems with regard to coffee-growing. The sisal industry has hitherto been chiefly devoted to the manufacture of binder twine, but an extension of the uses of the fibre is now taking place which affords an opportunity to develop special lines to serve particular purposes. This has necessitated a systematic examination of sisal seedlings and seedling hybrids, in the course of which a hitherto undescribed species has been discovered. The latter shows marked superiority to sisal, the rate of growth being greater, and its fibre being both softer, finer, and with a greater tensile strength. There seems no reason to doubt that this species will either replace sisal to a considerable extent, or supplement it and facilitate the extension of its present uses. An account of the Amani Agricultural Research Station was given by its director, Mr. William Nowell, before the Royal Society of Arts on October 24.

Broadcast Reception and Electrical Interference

THE Institution of Electrical Engineers has recently set up a Committee to consider the various problems involved in interference with the reception of broadcasting caused by electrical machinery and apparatus. This Committee, which is representative of the various interests involved in the matter, has been considering the means which might be adopted to render future plant and appliances non-interfering, in addition to the possible methods for dealing with the interference apart from suppression at the source. With the assistance of four sub-committees, the disturbance due to such items as lifts, trolley omnibuses, domestic appliances and other apparatus have been investigated; and it would appear that in many cases devices for the suppression of the interference could be incorporated in future designs at a reasonable cost. In order to facilitate progress in this direction, it has been decided to seek the co-operation of the manufacturers and other interests affected; while the possibility of international action on the question of electrical equipment embodying suppression devices will receive consideration by a British National Committee to be set up for the purpose. Further investigation appears to be necessary on some of the larger items of plant, and quantitative tests on these are being carried out by the British Electrical and Allied Industries Research Association.

Cinematograph Films for Teaching

REFERENCE was made in NATURE of December 17, 1932, p. 921, to the cinematograph films of cyclic phenomena produced by Messrs. Dance-Kaufmann, 18 Upper Stanhope Street, Liverpool, 8. We have now received a new list of films available. Before referring to the subjects dealt with, some features of these films may be emphasised. As Messrs. Dance-Kaufmann point out, their films are definitely for teaching purposes, preferably in the class-room, and not for entertainment. All are safety films and they are supplied for 35 mm., 16 mm. and 9·5 mm. projectors at one uniform price. The only adaptation

to standard projectors required is a loop absorber, for all the films are in the form of loops so that the phenomena illustrated can be repeated indefinitely. The subjects included in the present list include the production of mathematical curves, combination of harmonic motions (including harmonics), wave motion, light, electrostatics and elementary electricity, theory of alternating currents and of the induction motor, electric valves, mechanisms, heat engines, pumps, etc. Most of the films are produced from cartoons, but the engineering subjects include several films in 'half-tone' of models or full-scale apparatus. Messrs. Dance-Kaufmann are prepared to advise on suitable apparatus for showing their films.

Science and Wheat-Growing

THE issue of the *Journal of the Society of Chemical Industry* for August 4 contains an informative article, entitled "How Science can help to improve the Nation's Food Supply—Wheat", by Dr. E. A. Fischer, director of the Research Association of British Flour-Millers. Until comparatively recently, the main object of the wheat grower was to obtain a good yield per acre, the milling and baking qualities of the product being disregarded. Dr. Fisher outlines the history of the wheat-growing and milling industries during the past sixty years and shows how it explains the apathy and ignorance concerning wheat quality formerly prevalent in Great Britain. The first important step in enhancing the quality of English wheats was Biffen's achievement in producing the Yeoman wheats. These are, however, not suitable for all soils or all districts, and much further improvement is necessary if the output of home-grown wheat is to be increased materially. The directions in which such improvement may be accomplished may be summarised as follows: development and extended use of wheat-drying machinery on the farm; development of new varieties of wheat of higher protein content and better gluten quality, and suitable for all wheat-growing districts; development in the mills of flour-conditioning processes by which the baking characters of flours may be improved. The fate of the English wheat-grower is closely linked to that of the country miller, and his aim should be the production of wheats which may be ground and consumed where grown, with little or no admixed foreign wheat, heavy transport charges being thus saved.

Science for Citizenship

IN connexion with the article in NATURE of October 14, p. 581, under this title, a correspondent recalls an opinion on the general subject expressed by Sir Horace Lamb, in 1925, when he occupied the presidential chair at the meeting of the British Association at Southampton. Sir Horace said, "The habit of sober and accurate analysis which scientific pursuits tend to promote is not always favourable to social and economic theories, which rest mainly on an emotional, if very national basis. There is, I think, a certain dumb hostility, which, without venturing on open attack, looks coldly on scientific work, except so far as it is directed to purposes of obvious and immediate practical utility".

Announcements

PROF. SYDNEY CHAPMAN, professor of mathematics in the Imperial College of Science, will deliver a lecture on "The Sun's Magnetism" before the Institution of Professional Civil Servants at the Royal Society of Arts, John Street, Adelphi, London, W.C.2, on November 24 at 5.30 p.m. The lecture will be open to the public.

MR. C. T. P. ULM, together with his assistant pilots, Messrs. G. U. Allen and P. G. Taylor, landed in Derby, Western Australia on October 20 at 12.15 a.m. (local time), thus completing the flight from England in 6 days 17 hours and 56 minutes. This beats the record set up by Sir Charles Kingsford Smith in his recent solo flight by 10 hours 54 minutes. The machine used was an Avro Ten, fitted with three Wright Whirlwind engines.

THE Ramsay Memorial Fellowship Trustees have made the following awards of new fellowships for the year 1933–34: Dr. A. G. Winn, a British fellowship of £300, tenable for two years, at University College, London; Dr. N. W. H. Addink, a Netherland fellowship of £300, at the University of Cambridge; Dr. J. Smittenberg, a Netherland fellowship of £300, at the University of Bristol. The Trustees have renewed the following fellowships for the year 1933–34: Dr. J. M. Albareda (Spanish fellow), Rothamsted Experimental Station, Harpenden, Herts; Dr. Walter Cawood (British fellow), University of Leeds; Dr. C. Kawassiades (Greek fellow), University College, London; Dr. Mario Liguori (Italian fellow), University of Oxford; Dr. John MacArthur (Glasgow fellow), Royal Institution, London.

AT the annual statutory meeting of the Royal Society of Edinburgh held on October 23, the following Council was elected:—*President:* Sir E. A. Sharpey-Schafer; *Vice-Presidents:* Dr. J. B. Clark, Prof. James Ritchie, Sir Thomas H. Holland, the Hon. Lord Sands, Prof. C. G. Darwin, Prof. R. A. Sampson; *General Secretary:* Prof. J. H. Ashworth; *Secretaries to Ordinary Meetings:* Prof. F. A. E. Crew and Prof. James P. Kendall; *Treasurer:* Dr. James Watt; *Curator of Library and Museum:* Prof. D'Arcy W. Thompson; *Councillors:* Prof. P. T. Herring, Prof. T. M. MacRobert, Prof. Godfrey H. Thomson, Dr. Malcolm Wilson, Prof. E. B. Bailey, Prof. J. C. Brash, Prof. A. J. Clark, Prof. A. G. Ogilvie, Prof. E. M. Wedderburn, Lieut.-Col. A. G. M'Kendrick, Prof. James MacKinnon and Prof. W. Peddie.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A lecturer in biology at the Leicester College of Technology—The Director of Education (Oct. 30). A professor of education, and a professor of dental science, in the University of Melbourne—The Agent-General for Victoria, Melbourne Place, Strand, London, W.C.2.

Letters to the Editor

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

Germinating Coconuts on a New Volcanic Island, Krakatoa

IN connexion with the notes which were published in NATURE of July 27 and October 5, 1929, with reference to the original home and mode of dispersal of the coconut, the accompanying letter which I have recently received from Dr. Docters van Leeuwen, lately Director of the Botanic Gardens, Buitenzorg, Java, is of interest. The letter gives a very interesting account of the four new Krakatoa Islands which have arisen during the last few years and also of the germination of coconuts washed up on the beach of the last-formed island.

ARTHUR HILL.

Royal Botanic Gardens,
Kew, Surrey.
Sept. 22.

AFTER being quiescent for more than forty-three years, the Krakatoa volcano renewed its activity in December 1927. Heavy eruptions started from a submarine crater situated in the centre of the basin, between the three islands of the Krakatoa group, and the ejected volcanic materials formed a cone which in January 1928 appeared above the surface of the sea, and formed an island which was 175 metres long and 3 metres high. In the following months activity was most severe and a cone 200 metres high was built up having a volume of about twenty-five million cubic metres! This island was soon destroyed by the sea waves and eventually disappeared. This was Anak* Krakatoa I.

Activity started again on March 25, 1928, but it was not until January 1929 that a second new island rose above the waves. At the end of February the island was about 40 metres high and 275 metres long. In the early days of July this island, Anak Krakatoa II, also was washed away.

Anak Krakatoa III was born on June 3, 1930, and it was destroyed by the sea on August 8. The submarine cone, however, was now so firmly constructed that three days later the fourth child of Krakatoa appeared, which was a healthy baby, and grew in a short time into a big island, Anak Krakatoa IV.

In the month of January 1932, one of the officials of the volcanological service, who paid a visit to the new island, brought me some seedlings, picked up by him on the beach, and I had myself an opportunity of visiting the island in the month of May of the same year. It was then 40 metres high and comprised an eccentric hot crater lake and some solfataras on its margin. The wall of this lake was on one side 40 metres high and very steep, and sloped on the other side gently to the beach, which was more than 1 km. long.

On this beach, which consisted of black sand, a great quantity of pumice and logs was washed ashore and many plant seeds had already germinated. I found many seedlings of common drift plants and of plants of the *Barringtonia* association. The following seedlings were found: *Pandanus tectorum*, *Canavalia rosea*, *Ipomoea pes-caprœ*, *Barringtonia speciosa*, *Terminalia Catappa*, *Xylocarpus granatum*, *Pongamia pinnata*, and 41 germinating coconuts.

This last find was of special interest, as in this case there could be no question at all whether the nuts had been planted or not. No native, with the exception of the coolies of the volcanological service, had dared to land on this still active and treacherous crater, nor was there anything for them to find there. Moreover, the coconuts lay on the beach and were mostly unburied, lying between the pumice and the logs in the same disorderly manner as the seedlings

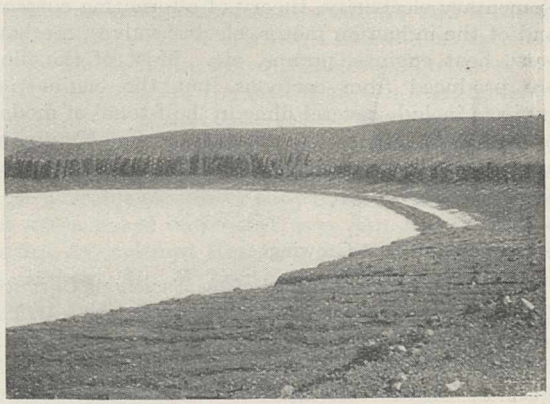


FIG. 1. The crater lake of Anak Krakatoa IV, May 1932.

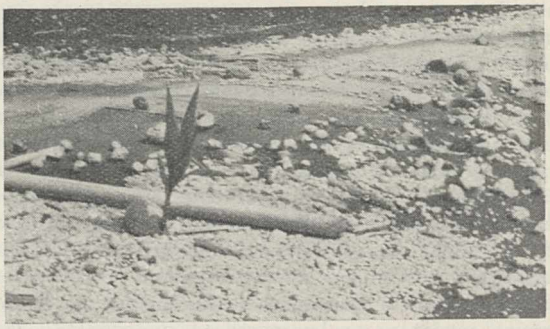


FIG. 2. Young coconut on the beach of Anak Krakatoa IV, May 1932.

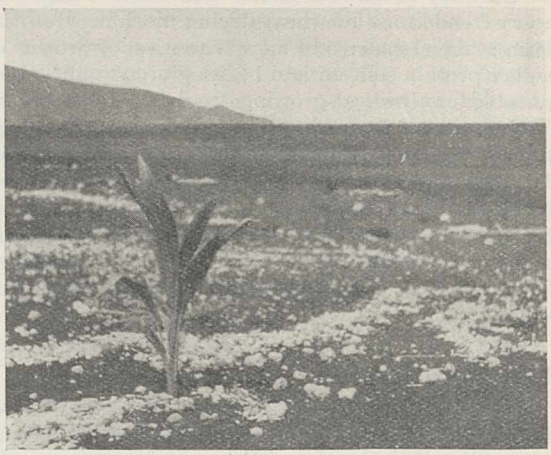


FIG. 3. Firmly rooted coconut on the beach.

* Anak is the Malay word for child.

of the other plants, as to which no one questions their distribution by the sea. Some coconuts were just beginning to sprout; others had already formed a bunch of leaves and were rooted firmly in the soil. They were here in exceptionally good condition, as the crabs, which often ruin the germinating nuts, were not present on the beach. We thus find on this new island a strong proof of the ability of the coconut, when washed ashore, to establish itself on the beach without human aid.

After a rest of some months, the crater again started into activity in November and the poorly-developed vegetation was covered over by the ejected volcanic material.

W. DOCTERS VAN LEEUWEN.

Leersum,
Bergweg, 188.

Heavy Hydrogen in Contact with Normal Water

OWING to the impossibility of identifying individual molecules of a gas, very little is known about the possibility of an exchange between molecules of a gas (for example, hydrogen) and the same molecules as constituents of a liquid (for example, water) in contact with the gas. In connexion with work on the disintegration of lithium by ions of the heavy isotope of hydrogen[1], we prepared mixtures of the hydrogen with pure helium and stored these over water in an aspirator. As first prepared, these contained approximately 1 per cent and 7 per cent of the heavy isotope respectively. After the lapse of about six weeks we observed a loss of activity as a disintegrating agent, and measurement of the concentration of the heavy isotope by the method outlined in our paper[1] showed that less than one-twentieth of the original hydrogen was present in each case, but that the total hydrogen content was approximately the same.

Tests extending over six weeks with the apparatus filled with mixtures of ordinary hydrogen and helium showed no change of volume, thus eliminating leakage or solution as the mode by which the heavy hydrogen was lost. It is probable that the molecules of the heavy hydrogen underwent a process of exchange with the molecules of hydrogen in the water, and that the final state of the system would be one in which the concentration of heavy hydrogen was the same in the liquid as in the gas. A similar process of exchange has been reported by Lewis and Macdonald[2], who showed that there was a rapid equilibrium established between the hydrogen of ammonia and that of heavy water in which it was dissolved. It is evident that the observations suggest the use of the heavy isotope in experiments with hydrogen in much the same way as the radioactive isotopes of heavy elements have been used as 'indicators' for those heavy elements in the past.

M. L. OLIPHANT.

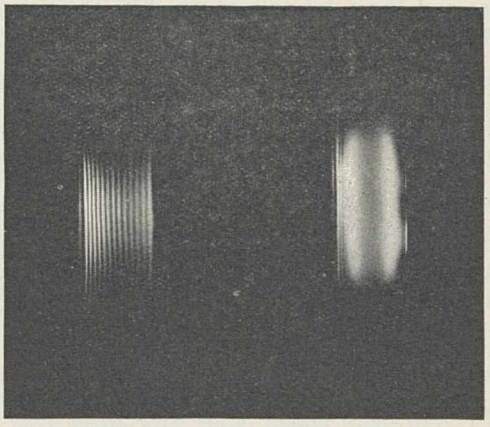
Cavendish Laboratory,
Cambridge.
Oct. 16.

[1] *Proc. Roy. Soc.*, A., **141**, 722; 1933.
[2] *J. Amer. Chem. Soc.*, **55**, 3502; 1933.

High-Frequency Glow Discharge

IT is a well-known fact that it is possible to maintain high-frequency glow discharges at very low voltages. A discharge tube having as internal electrodes two discs at a distance of one or two centimetres and containing neon at a pressure of a few millimetres of mercury, shows the lowest values of the maintaining potential if the frequency is about 10^8 cycles. Values between 10 and 15 volts (peak-value) are readily obtained. At lower frequencies the minimum maintaining potential increases until at frequencies of the order of 10^6 cycles more normal values are reached, which do not differ much from the values obtained with direct current and low frequencies.

Experiments to be described elsewhere with a modified form of the Langmuir collector method showed that in general there exist in high-frequency discharges considerable space potentials. The existence of such space potentials can be interpreted as a result of the very great difference in inertia between the electrons and the positive ions, both under the influence of an oscillating E.M.F. of high frequency. While the amplitude of the oscillating ions is practically zero, the amplitude of the electrons can exceed by many times the electrode distance, in which case a great part of the electrons will reach the electrodes in each half period, thus being removed



(*a*) (*b*)

FIG. 1. (*a*) Direct current discharge through neon; pressure 45 mm., current 8 micro-amp., maintaining potential 256 volt. (*b*) High frequency discharge in the same tube, maintaining potential about 50 volt, frequency 3×10^6 cycles.

from the discharge. The result is a positive space charge and therefore a potential gradient in certain parts of the discharge.

At the highest frequencies, however, the amplitude of the electrons, too, can be smaller than the electrode distance, and so one may expect that at the highest frequencies the space potential will not reach the same high values as in the case of moderate frequencies, for example, between 10^6 and 10^7 cycles.

Experiments have been performed in order to measure the space potential and the maintaining potential at the same time in a glow discharge in the region of the very high frequencies. For that purpose a small collector wire was placed in the middle between the two electrodes. Dimensions of the discharge tube: electrode distance 20 mm.; neon at a pressure of 5 mm. At the frequency of 6×10^7 cycles the following results were obtained: maintaining voltage 13·6 volts, space potential 21 volts positive compared to the electrodes.

A simple calculation shows that the maximum energy which an electron can obtain in the alternating field of 6·8 volts/cm. at the frequency of 6×10^7 cycles is only 1·15 volt, which value is much

lower than the lowest excitation potential of neon (16·6 volts). Therefore the hypothesis seems to be justified that the acceleration of the electrons occurs for the greater part by the steady field, due to the differences in space potential.

A recently observed experimental fact relating to the distribution of the space potential may throw light on the observations. When a high-frequency glow in a neon discharge tube of the type already described above is operated in the region of the moderate frequencies, say, 3×10^6 cycles, sometimes there are present near each of the two electrodes a series of two or three luminous layers, divided one from the other by darker spaces; the space between the electrode and the first layer is perfectly dark.

The appearance of these layers is very similar to that of the luminous layers in the case of a direct current discharge in neon at small currents, as first described by Holst and Oosterhuis[1].

Fig. 1 (*a*) is a photograph of the layers in the case of a direct current of 8 micro-amperes. The electrodes are coated with a cæsium film on cæsium oxide, the pressure of the neon is about 45 mm. As there were from cathode to anode 13 luminous layers and the total voltage was 256, the potential difference between two layers is about 20 volts. Fig. 1 (*b*) shows a high-frequency discharge in the same tube. In front of the two electrodes three luminous layers are visible, which fact leads to the conclusion that there is a potential drop of about 80 volts near the electrodes.

A. C. VAN DORSTEN.

Laboratorium voor Technische Physica,
Delft.
Sept. 26.

[1] G. Holst and E. Oosterhuis, *Physica*, **1**, 78; 1921. *Phil. Mag.*, **46**, 1117; 1923. See also M. J. Druyvesteyn, *Z. Phys.*, **73**, 33; 1932.

Ionisation of the Ionosphere

IN a recent letter[1] to NATURE, L. Tonks has suggested that the relation between ionisation density N and critical frequency f should be

$$N = (\pi m/e^2)f^2,$$

rather than

$$N = (3/2)\,(\pi m/e^2)f^2,$$

which has been used in some recent papers. This appears to be correct; for the radio application, the matter may be presented in the following way.

Following Lorentz, we may express the field inside an ionised medium as

$$\bar{E} = \bar{E}_1 + \tfrac{1}{3}\bar{P} + \bar{E}_2,$$

where $\bar{E}_1 + \frac{1}{3}\bar{P}$ is the portion of the field due to all the charges outside a small sphere Δr of radius large compared to the average spacing of the charges and $\bar{E}_2$ is the field due to the charges inside the Δr sphere. The difficulty in evaluating $\bar{E}$ is evidently that of evaluating $\bar{E}_2$, since $\bar{E}_1$ may be evaluated by the usual potential theory. However, for the radio case it is sufficient to know the value of the space average field $\bar{E}^0$ which may be defined as

$$\bar{E}^0 = \frac{1}{\Delta r}\int_{\Delta r} \bar{E}\, dr.$$

For any distribution of charges, it may be shown that $\bar{E}_2^0 = -\frac{1}{3}\bar{P}$ so that $\bar{E}^0 = \bar{E}_1^0$.

We may assume for the sake of illustration that we are concerned with the E layer and a frequency of 3,000 kc./s. The mean thermal velocity of the electrons $\simeq 10^7$ cm./sec., so that the electron on which the force is to be calculated moves in a random direction about 3 cm. during a single period of the radio wave. Since the average electron spacing in the upper atmosphere is about 10^{-2} cm., it is thus evident that the space average field is the one which applies to the present problem. Using the space average field we arrive at the value

$$N = (\pi m/e^2)f^2.$$

As an alternative way of viewing the problem, consider the time average field for a period short compared to that of the radio wave. Such a time average field will be sufficient for this problem. During 1/30 of the period of the radio wave, the electron moves in a random direction about 10^{-1} cm. and since the electron spacing is about 10^{-2} cm., the ionised medium over this short period of time becomes essentially continuous, so that we can derive the expression for the field rigorously from potential theory, obtaining as before $\bar{E} = \bar{E}_1$.

K. A. NORTON.

Bureau of Standards,
Washington, D.C.
Sept. 21.

[1] NATURE, **131**, 101, July 15, 1933.

Linear Transformations of Hierarchical Systems

As is well known, each of a number of variables which constitute a hierarchical system can be expressed as a linear function of a single general factor g and a specific factor. Each of these specific factors is independent of each of the other specific factors and of g. According to Prof. Spearman's theory of the single general factor, the same g ought to be the general factor of the scores in each of two or more series of mental tests, when the scores in each case tend to constitute a hierarchical system.

But E. B. Wilson has claimed[1] that if a new set of variables is created by linear transformation—"a system of weighting which leads to new scores"—"we can, while keeping to hierarchical systems, do pretty much what we want with g"; or, as he put it in a later paper, g was "relative to the set-up". If that were the whole story, Prof. Spearman's theory would be in serious trouble.

I have recently investigated this matter, with the following results:

(1) There is but an infinitely small chance that a linear transformation (made at random) of a hierarchical system would itself be hierarchical: no new general factor will turn up by accident.

(2) It is nevertheless possible to design linear transformations of a hierarchical system so as to produce new systems which are themselves hierarchical.

(3) It is even possible to make such new systems conserve g or, in other words, to make the new hierarchical system have a general factor which has the same correlations as the original g with the new variables.

(4) It is not possible to conserve g except (*a*) by using some negative weights in the transformation, or (*b*) by using so many zero weights that, in the linear expressions for the new scores in terms of the original, the product of any two coefficients of the same original variable is zero.

As regards (*a*), I understand that negative weights would never be employed by psychologists in handling scores made in mental tests. On the other hand, (*b*) is satisfied when tests are pooled or, in other

words, when one of the new variables is a linear function of m out of the n original variables, when the next $m-1$ new variables are all zero, and when the remaining $n-m$ new variables are respectively identical with the last $n-m$ original variables. Such a pooling of tests will therefore always result in the conservation of g as defined above.

I conclude that Spearman's theory is not impaired by Wilson's discovery.

MAXWELL GARNETT.

21, Well Walk,
Hampstead, N.W.3.
Oct. 10.

[1] *Proc. Nat. Acad. Sci.*, **14**, 286; 1928.

The Two-Factor Theory of Intelligence

IT is one of the objections to the Spearman two-factor theory[1] that the measure of general intelligence, g, is not necessarily invariant for linear transformations of the test scores. I have not followed the discussion on this point at all closely, but a remark interpolated during the joint discussion at Leicester of Sections A* and J of the British Association is perhaps worth repeating here, if only to be answered.

The psychologist chooses his tests carefully to avoid overlap, by which I take him to mean that if the first test produces a score x_1, then the score x_2 in a second test should measure no specific ability already wholly or partly measured in x_1. Now a general linear transformation will produce a new set of scores, of which the first will be $y_1 = w_{11}x_1 + w_{12}x_2 +$ etc., while the others will be similar linear combinations of the x's, with different combining weights. The mathematical desideratum that g should be invariant for such transformation, if it is to have any value at all for the purpose of measuring general intelligence, would then seem to be irrelevant, for the new tests will all overlap one another, since there will be a bit of x_1 in every one of the new tests, and similarly for x_2, x_3, etc.

Since such overlapping tests are expressly ruled out by the psychologist, he need not concern himself with the mathematical consequences of the transformation. It was stated by Wilson that g is "relative to the set-up", but evidently the set-up is so conditioned by the experimental technique that g can take care of itself.

JOHN WISHART.

School of Agriculture,
Cambridge.
Sept. 23.

[1] Wilson, *Science*, **67**, 244; 1928.

Paper Hygrometers

I WAS much interested to read[1] that Mr. K. Mellanby has found paper to be such a convenient hygrometer, as I myself have been using it for this purpose for some time past.

The object of my experiments was to determine the stretch and shrinkage of paper under varying conditions of humidity, and the only reliable means of finding accurately the moisture content of the paper used was to weigh the paper itself after it had attained equilibrium with the surrounding atmosphere. I used strips of about the same area as those described by Mr. Mellanby, but I found that 5 minutes was ample time to ensure that the necessary equilibrium was obtained. In fact, so quickly does the paper respond to a change in the humidity of its environment that it has always been found necessary to transfer the strip to a small stoppered tube in which it is weighed.

Different papers vary in their response as hygrometers. Good writing papers containing rag are usually tub sized (that is, the made paper passed through a bath of gelatine) and these would tend to resist absorption of water and, consequently, would attain equilibrium slowly. If Mr. Mellanby used such a paper, this might account for the period of 10–15 minutes he finds to be necessary, and also for the fact that he observed no loss in weight on transferring the test piece to the balance. Thin filter paper or a good ashless cigarette paper should give a much more rapid response.

It is not generally realised what excellent practical hygrometers can be made from paper by taking advantage of the fact that it absorbs water so readily, and expands rapidly on so doing. As printers and paper makers know to their cost, this expansion may attain 4·5 per cent (in the direction at right angles to the wire mark) on transferring a paper from air to water, and paper hygrometers depending on this principle are actually on the market.

As a matter of interest, I may mention that I have found that the relation between water content and change in length is not linear between values of the latter which vary according to the paper from 5 to 10 per cent, and it seems that there is here a critical point at which there is a sudden loss of power of expansion. Another interesting point is the fact that curves obtained on plotting the water content against the expansion on wetting and the contraction on subsequent drying do not quite coincide, the rate of shrinkage being always less for a given water content. This indicates that paper may lose its powers of response to humidity changes.

I have dealt with these points more fully in the discussion of a paper by Mr. Prior which will appear in a forthcoming issue of the *Proceedings* of the Technical Section of the Paper Makers' Association.

JULIUS GRANT.

The Laboratories,
Croxley Mills.
Oct. 9.

[1] NATURE, **132**, 66, July 8, 1933.

A Simple High Resistance

HIGH resistances to carry small currents, as in grid leaks and electrostatic work, can be very simply made by smoking a rod of silky quartz. A piece of this rod in its ordinary condition is wiped clean and fitted with end metal connexions of closely fitting metal tubes or of copper wire wound round and twisted tight; connecting wires are soldered on or left over from the winding; the dimensions of the quartz rod may be chosen as desired, for 10^{10} ohms 6 cm. length has been used, for 10^{14} ohms 10 cm.; the diameter has been 4 mm. The metal-quartz junction is then well covered with india-ink and dried by warming, the quartz surface being kept free from handling. The whole is now smoked over a small smoky gas flame given by burning, at the end of a glass tube, coal gas that has been led through

petrol; a good dense deposit is made round the india-ink junctions, and over the rest of the quartz a fairly even deposit not too dense is formed. After the rod is allowed to cool, the resistance is measured and can then be very easily and quickly adjusted in value by evenly wiping off some of the deposit with clean dry cotton wool or by adding a little more soot. The resistance may then be sealed into a clean quartz tube or left bare or coated with paraffin wax, of good white quality, by simple dipping.

A bare 10^{14} ohm resistance of this type has been used satisfactorily for five months, and two wax-covered 10^{10} ohm resistances have functioned well for two months as coupling resistances in counter apparatus. The dipping in molten paraffin wax alters the resistance, usually increasing it considerably, but there is little difficulty in allowing for this and in making a resistance of the approximate desired value. The method of construction obviously gives the possibility of a considerable range of resistance and carrying capacity and it is intended to investigate the properties of the resistance at a later date. The good results so far obtained combined with the ease of adjustment and the cheapness of the construction would seem to warrant the present note.

P. W. BURBIDGE.

Cavendish Laboratory,
Cambridge.

The Origin of Tektites

IN his contributions to NATURE on the "Origin of Tektites" Dr. L. J. Spencer[1] has put forward the view "that tektites are not meteoric, though they are connected with the fall of large meteoric masses, but that they have resulted from the fusion of terrestrial rocks, especially in sandy deserts, by the heat so developed".

The radioactivity of eight specimens of tektites and of some pieces of glass of different kinds was determined with the view of deciding whether they were meteoric or terrestrial in origin. I am obliged to Dr. H. Michel of the Natural History Museum of Vienna, and to the Trustees of the British Museum, for these specimens. The problem was suggested by Prof. H. Mache, of the Technical High School of Vienna, and the work was carried out in his laboratory. The results of determinations are given in the accompanying table.

		Ra $\times 10^{-12}$ per gm.	Th $\times 10^{-5}$ per gm.
1.	Moldavite	1·07	1·08
2.	Moldavite (Habří, Bohemia)	1·02	1·60
3.	Moldavite (Probsch)	0·78	1·60
4.	Moldavite (Radomolice, Bohemia)	0·99	1·86
5.	Billitonite	0·96	0·96
6.	Australite (Lake Eyre district)	0·96	0·50
7.	Australite (Victoria)	0·85	1·84
8.	Darwin glass (Tasmania)	0·50	1·13
9.	Glass (Old beads)	0·48	

These results show that the radium content of all the tektites except Darwin glass falls between $0{\cdot}9 \times 10^{-12}$ and $1{\cdot}00 \times 10^{-12}$. A difference of $0{\cdot}1 \times 10^{-12}$ is found even in different parts of the same rock and has no significance.

This constancy in the radioactive contents of tektites coming from such distant parts of the world as Europe, Asia and Australia clearly suggests some kind of genetic relationship. It is difficult to imagine that glass formed in three different continents from different raw materials should have the same radium content.

The radioactive contents of several kinds of glass, including glass beads of prehistoric age, was determined, but the values found were low and very different, the highest being $0{\cdot}48 \times 10^{-12}$ per gm. There is no possibility of these tektites deriving their radioactive contents from iron meteorites in any way, as these meteorites are very poor in radium, the amount being of the order of 10^{-14}.

The radioactivity of Darwin glass differs from all other tektites considerably and agrees more with glass than with tektites. In this connexion the similarity of silica glass from Wabar and Henbury to the Darwin glass as observed by Dr. Spencer is noteworthy.

The value $1{\cdot}00 \times 10^{-12}$ per gm. found for the tektites seems fairly in accord with several such determinations made for granites, which represent the salic part of the earth's crust[2], and show a similar chemical composition. This strongly suggests that these tektites are derived from some mass which agrees in chemical composition as well as in radioactivity with the granitic layer of the earth.

It will be interesting to determine the radioactive content of the tektites recently discovered in French Indo-China and described by Prof. Lacroix, and of those discovered in the Philippine Islands[1]. The determination of the radioactivity of the glasses discovered at Rub' al Khali in Arabia, and at Henbury in Central Australia, will throw further light on the origin of tektites.

V. S. DUBEY.

Department of Geology,
Benares Hindu University.

[1] L. J. Spencer, "Origin of Tektites", NATURE, **131**, 117, Jan. 28; 876, June 17, 1933.
[2] C. S. Piggot, *Amer. J. Sci.*, 5, **21**, 35, January 1931.

WITH reference to Dr. L. J. Spencer's letter in NATURE of October 7, p. 571, on the origin of tektites, the strongest argument against his suggestion that they were formed by the fusion of terrestrial material in meteorite craters is that no tektite has yet been described, so far as I am aware, containing partially fused rock or sand. A further possible objection that no tektite hitherto described contains so many vesicles as glass from meteorite craters is discounted by Prof. A. Lacroix's description of 95 kgm. of tektites from the island of Hainan and the neighbouring mainland, among which glass that originally enclosed vesicles of more than a decimetre in diameter is of frequent occurrence ("Les Tectites de l'Indochine", Paris, 1932, appendix following p. 235). On the other hand, Dr. Spencer's suggestion finds support in the presence of metallic spheres, resembling those of the Wabar glass, in Darwin glass and in tektites from Indo-China, as described in his letter; and also in the presence of nickel in three Malayan tektites, proved by analyses by Mr. J. C. Shenton. As Dr. Spencer remarks, the evidence for tektites being meteoric is entirely negative; and although his suggestion cannot yet be accepted unreservedly, it appeals to me as the best yet proposed for the origin of these bodies.

J. B. SCRIVENOR.

68 Chaucer Road,
Bedford.
Oct. 9.

Chemical Detection of Artificial Transmutation of Elements

IN NATURE of May 6, p. 652, a communication by Prof. F. A. Paneth and P. L. Günther was published on the application of chemical analysis to the study of processes of artificial transmutation of elements.

Similar work has been carried on by us in Moscow since 1931. Appropriate technique was developed and necessary apparatus was devised which made it possible to analyse the gaseous products of atomic disintegration, even when a single α-particle out of 2,000,000 resulted in destruction of the atom. Such a high precision was attained through isolation of helium arising from α-rays, generated by the process of disintegration of the radioactive material. Preliminary reports on this work were made by one of us at the Moscow House of Scientists in January and June, 1932.

The study of the disintegration of aluminium by α-rays which was conducted by the gas-detection method, has revealed the formation of greater quantities of hydrogen than those formed by the scintillation method. Preparations of very strong α-rays have been used in these experiments.

Experiments involving bombardment with β-rays from very strong radium emission preparations on lithium and sodium iodide have proved the formation of traces of helium in the first case, and that of traces of helium and neon in the second. Similar experiments with potassium iodide gave negative results as to formation of rare gases. In experiments with potassium the emission of small quantities of hydrogen was noticed, even without the action of β-rays; this suggests the possibility that the hydrogen is continually being formed from potassium, and represents the products of its radioactive decomposition. Certain geochemical data may be quoted in support of this suggestion, namely, that natural gases from potassium salt deposits usually contain hydrogen, while all other natural gases do not.

Verification of the results reported above is being carried out.

W. SOKOLOV.
M. GUREVICH.

House of Scientists,
Moscow.
July 12.

Co-operation in Science

I AM glad to see that Mr. Gomme (NATURE, Oct. 14, p. 606) is so nearly in agreement with me. The general adoption of the Universal Decimal Classification by abstracting and indexing services would yield a consolidated index to scientific and technical literature. But it would not suffice to remove existing overlapping and gaps. It would be necessary that each periodical should be indexed completely, instead of extracted for papers on a special subject as now happens.

All the important papers in a periodical would be catalogued. Those coming within the scope of a particular bureau would also be indexed or abstracted by that bureau. The titles of the rest would be sent to the various bureaux specially concerned, or to a clearing house for distribution. Thus each bureau would receive titles of all papers within its field for indexing.

The co-ordination of this work needs a classification, as was recognised by the compilers of the International Catalogue of Scientific Literature.

The U.D.C. is only a means to an end. This end is the full co-operation of scientific workers themselves, not merely that of abstracting journals. Such co-operation can only be achieved through a comprehensive index. The U.D.C. is the most economical system at present known. Its use costs one-twentieth as much as abstracting. Afterwards the preparation of annual indexes can be entrusted to unskilled labour. The material for the annual indexes can be cumulated and used without change for long-period indexes, thus eliminating the huge cost of the compilation of such indexes. Nor does the introduction of decimal numbers interfere in any way with the use or form of abstracts as at present. It would merely make them more useful.

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Oct. 14.

References in Textbooks

IN several recent contributions to NATURE, reviewers have reproved authors because a majority of their references were to works of their compatriots. I submit that such criticisms, standing alone, are apt to be very misleading, except possibly in regard to bibliographies which are not concerned here.

Omissions of subject-matter may, of course, be fitly criticised. In encyclopedias and some works of original learning, where the treatment in the text does not profess to be complete, the omission of a reference may be in effect the omission of subject-matter. But since the gravity of the offence varies greatly with the importance of the matter omitted, criticism on this ground should always be supported by specific examples; nationality is irrelevant. In works of instruction an author is not expected to give references to matter treated fully in the text, because the purpose of his book is to save the reader from going to the original literature. His references should only be to matters treated incompletely in the text; they should be to the most easily accessible sources, which will usually be the work of a compatriot. What reviewers in NATURE have condemned as a fault, they should often laud as a merit.

That these obvious facts are not recognised is due, of course, to the present obsession of scientists with the idea of 'credit'. It is regarded as a misdemeanour to state any fact without mentioning the name of its discoverer, and as a felony to associate the fact with any other name. If the primary object of all scientific writing is the acquirement or proper allocation of 'credit', the reviewers are perfectly right. But it should be recognised that the acceptance of that view must inevitably lead to the suppression of textbook authors, who try to pass the whole of their subject-matter through their own minds, thereby welding it into a coherent whole, devoid of its original particularity, and to the encouragement of those who merely vomit at their public the undigested contents of a mechanically compiled card-index. Is that really what is wanted?

NORMAN R. CAMPBELL.

Research Items

Indian Coracles. Mr. James Hornell contributes to *Man* for October an account of the coracles still extensively in use on the rivers Cauveri, Ghavani and Coleroon in the Coimbatore and Tanjore districts of southern India, and on the Tungabhadra, the boundary between British India and the state of Hyderabad. Within the area of coracle distribution, boats or canoes are not in use. The Indian species differs from that of Iraq, Wales and Ireland. The Indian form is circular in plan; that of Iraq, though circular, has convexly curved sides, so that the diameter at the mouth is less than at the equator; the Welsh and Irish forms are bilaterally symmetric, the Irish being actually boat-shaped. Only in Ireland are coracles used on the open sea. The Indian coracles are of three varietal forms, each characteristic of its separate area. All, however, are fundamentally of the same type, differing only in detail, the differences being due to purpose or the conditions of the environment. The most simple are those of Coimbatore and Tanjore, which are about six feet in diameter and accommodate a single fisherman. They are circular, flat and saucer-shaped and very shallow. The framework is built up of lengths of split bamboo, woven at the bottom into a stout meshwork. The sides are strengthened by a rude gunwale of unsplit bamboo. Ox hide is stretched over the outside of the framework. A stout pole about eighteen inches long, fixed to one side of the bottom, serves as a seat and a support when the coracle is carried. The Tungabhadra coracles are of two varieties, one being lighter than the other. They are used as ferries. They are definitely bowl-shaped and deeper than those of Coimbatore. For the larger forms, curved unsplit bamboo ribs give strength. The Kurnul (lower Tungabhadra) coracles are the largest and finest in India, being from ten to fourteen feet in diameter. The largest are said to be capable of transporting fifty men or forty bags of grain. They are more carefully constructed than either of the other forms. Elaborate ceremonies attend their launching.

Instinctive Emotions as Driving Forces. "The Psychology of Power" (London: Macmillan and Co., Ltd., 1*s*. net) is a new edition of the paper originally contributed by Mr. J. A. Hadfield, to the *Spirit*, 1919. It is interesting to note that at a time when it is the fashion to bemoan the high pace of everyday life Mr. Hadfield says, "The experience of applied psychology, and especially psychotherapy, points towards the conclusion that we are living far below the limits of our possible selves". Problems of energy and fatigue lie at the root of all nervous disorders and high endeavour. He gives instances of feats of extraordinary energy or power produced in moments of stress, and proceeds to show that they were not accompanied by equivalent fatigue, or afterwards equalled by efforts of the conscious will. He argues, contrary to Stoic philosophy, that the will is relatively infirm, and that 'driving-power' is derived from one or other of the instinctive emotions. He discusses fatigue, and the dominating importance of the mental factor, giving illustrations from cases of hypnotic therapy. The greatest fatigue is occasioned by mental conflict (mainly between the instinctive urges themselves, or between them and the will), over-sensitiveness to ordinary physical fatigue, and conviction of weakness caused by lack of confidence. Power comes from the harmonising of the instinctive urges. Religion has a great part to play in attaining this end for the individual. The dynamics of religion are then briefly discussed.

Experiments with Sea-Urchin Larvæ. L. v. Ubisch (*Die Naturwissenschaften*, May 5, 1933) describes experiments in which four micromeres from the 16-cell stage of a sea-urchin were introduced through a slit into the cleavage cavity of the blastula of the same or another species or genus or order of sea-urchin, thus providing two assortments of skeleton-forming cells. The implantation of micromeres of the same species or genus as the blastula results in a normal skeleton, but the combination of different genera or orders results in skeletons intermediate between that of the host (the genus or order providing the blastula) and the donor (the genus or order providing the micromeres). Parts of the skeleton may be purely those of the host, others like those of the donor or of mixed nature. Closer examination shows that the mixture may be either a mosaic of host and donor skeletons or may be composed of skeletal elements of an intermediate form. In the normal gastrula the skeletal forming cells (mesenchyme) form syncytia and within the cytoplasm of these the secretion of the skeleton takes place. After implantation of foreign micromeres the latter multiply and may be present on one side of the host larva, or they may, as is usual, divide into two groups and unite with the corresponding groups of the host larva. The skeletons formed in these cases will accordingly exhibit on one or both sides the characters of the donor skeleton, or there will be a mingling of skeletal elements of donor and host.

Greenland Corals. In his paper "The Godthaab Expedition 1928. Alcyonaria, Antipatharia, and Madreporaria" (*Meddelelser om Grønland udgivne af Kommissionen for videnskabelige Undersøgelser i Grønland* Bd. 79. No. 4. 1932), Dr. P. L. Kramp records thirteen species collected by the expedition, many of which are new to the waters west of Greenland. The Greenland corals have been dealt with by the late Prof. Jungersen, who was preparing also a work on the Northern Alcyonaria for "The Danish Ingolf Expedition". Only the Pennatulacea was published and the Alcyonacea and Gorgonacea were never worked up. Prof. Jungersen before he died had identified all the specimens of northern corals in the Zoological Museum of Copenhagen and Dr. Kramp makes use of these collections in order to map the distribution of the various species in the waters west of Greenland, 22 now being known. He uses the nomenclature proposed by Jungersen and accepted in all essentials by Broch and Kükenthal. No decidedly littoral corals have been found in these waters. There are a few well-marked abyssal forms, but most of the species have a wide bathymetrical distribution. *Radicipes challengeri*, *Distichoptilum gracile*, *Pennatula prolifera* and *Bathypathes arctica* have never been found at a depth of less than 1,100 m. So far as the corals are concerned the author states as a general result that species with

a predominantly Atlantic abyssal or deep-littoral distribution do not cross the submarine ridge off Holstenborg, but remain south of 67° N., even if they are able to live in fairly shallow water, whereas predominantly northern species have an extensive distribution from north to south. Decidedly abyssal arctic corals are not known from West Greenland waters.

A Lily of Formosa. *Lilium philippinense* var. *formosanum* is a garden plant which grows over a wide range of altitude under natural conditions. Mr. Kan Yashiroda of Kagawaken, Japan, gives an account of his field investigations on this species in the *Gardeners' Chronicle* of September 9, p. 200. In Formosa, the plant attains a height of more than 9 ft. at an altitude of 600 ft. above sea-level, but grows only about 20 in. at an altitude of about 7,000 ft. The height of the stem diminishes as the distance above sea-level increases, and it seems fairly certain that there are not really any alpine, intermediate and giant forms of the plant, as was at one time supposed. The upward limit seems to be about 12,000 ft. and the habitat is usually under a bush, in soil well supplied with humus. The author intends to test his theory still further by sending seeds of the different altitude forms to be grown in England.

Successors of the Kwanto Earthquake of 1923. The effects of the great earthquake of September 1, 1923, on the seismicity of the Kwanto district have been studied by Mr. T. Kodaira in an interesting paper (*Earthq. Res. Inst. Bull.*, 11, 350–361; 1933). The numbers of earthquakes felt in the district during each of the years 1924–31 were 504, 247, 187, 176, 221, 168, 213 and 360. Of the total number, the epicentres of 307 earthquakes have been determined from seismographic evidence. Omori had shown that the earthquakes of 1914–21 originated chiefly in three districts: (1) the Boso peninsula, (2) the river basins to the north of Tokyo Bay, and (3) Sagami Bay and the Tanzawa Mountains to the north-west. The after-shocks of September, 1923, affected the same regions. During the next three months, the number declined in the Boso peninsula, while the second region became unusually active. In each of the next eight years, the distribution of the epicentres varied, though on the whole, the most active regions were the northern part of Tokyo Bay and the low plain beyond. The focal depths of 316 earthquakes were determined. The number of shocks for every 10 km. of depth gradually increases with the depth to a maximum of 61 for 40–49 km., after which it decreases, only six earthquakes having focal depths greater than 100 km. In the earthquakes that originated below Tokyo Bay, the depths were usually greater than 50 km., in the river basins to the north about 40 km., in Sagami Bay and the Tanzawa Mountains much less than 30 km. With a few exceptions, the earthquakes originated in a bowl-shaped region in and near the northern part of Tokyo Bay, about 200 km. in diameter and 70 km. in depth. As the region is marked by gravity anomalies, it is suggested that a heterogeneity of structure below 70 km. results in the formation of numerous fissures in the upper layers along which the earthquakes occur. The records studied by Mr. Kodaira are continued for the year 1932 in the *Seismometrical Reports* now issued quarterly by the Research Institute. The number of earthquakes felt in Tokyo during the year was 59, most of which originated between depths of 40 km. and 60 km. below Tokyo Bay and the plain to the north.

Broadcasting Aerial at Breslau for Reduction of Fading. The erection of a special type of aerial at the new Breslau broadcasting station, together with the results of field strength measurements on the radiation from this aerial, are described in the April 1933 issue of *Elektrische Nachrichten-Technik*. A single, self-supporting lattice wooden mast, 140 metres high, has been built and the aerial consists of a vertical bronze cable hanging down its axis. Breslau is a 60 kw. station with a wave-length of 325 metres; the length of the aerial is thus about 43 per cent of the wave-length. At the top of the aerial is a bronze ring nearly 11 metres in diameter, insulated from the mast, to serve as a terminal capacity. This brings the effective length of the antenna to more than a half wave-length, the current node and antinode occurring at heights of 19 m. and 100 m. respectively. A ring transformer was used to measure the current distribution along the aerial and the results, shown graphically in the paper, are in good agreement with theory. The polar diagram of radiation in the vertical plane calculated from this current distribution shows that the energy radiated in directions above the horizontal decreases to practically zero at an angle of elevation of about 65°. At a height of about 80 metres a switch is inserted in the aerial to enable the lower part to be used as a quarter-wave-length antenna. Comparative measurements made on the radiation from this portion and from the complete antenna show that, for the same power, the horizontal radiation is increased by about 26 per cent in the latter case. The net result of the use of the new aerial has thus been to double the service area in which reception is obtained free from fading effects. Records of reception tests at various places distant 80–160 km. are given, and these show that the use of the full antenna results in a considerable reduction of the fading experienced with the quarter-wave antenna only in use.

Analysis of Coal Ash. The ash of coal, apparently a very prosaic subject, receives increasing attention. It was early recognised that physical characteristics, such as fusibility, exercise an influence on the behaviour of coals in combustion and gasification. Fusibility depends on chemical composition. In recent years it has been recognised that ash constituents may influence catalytically the reaction of carbon with carbon dioxide and water, and therefore composition is important in processes of gasification also. With the advent of hydrogenation it now appears that catalytic influence may be exercised even by minor constituents of the rarer elements, and therefore the analytical chemistry of coal ash is acquiring a new interest. The issue of Paper No. 28 of the Physical and Chemical Survey of National Coal Resources by the Department of Scientific and Industrial Research on methods for the quantitative analysis of coal ash (H.M. Stationery Office. 6*d*. net) is therefore timely. It collates tried methods of silicate analysis appropriate to such mixtures and directs attention to special methods of spectrum analysis. Its perusal conveys the impression how unfortunate it is that silicate analysis is so tedious, and how much the science and practice of silicates in various industries is hampered by the need of methods for the rapid analysis of silicate mixtures.

The Auroral Spectrum and the Upper Atmosphere*

By PROF. L. VEGARD

THE results of investigations on the auroral spectrum carried out by the writer and his collaborators since 1912 were discussed. The conclusions to be drawn from these results regarding the state of the upper atmosphere when they are seen in relation to other known properties of the polar lights were stated.

Interferometer measurements of the green auroral line have been carried out recently in collaboration with L. Harang. The close agreement with the value of Babcock shows that the green auroral line is identical with that of the night sky. Interferometer pictures taken parallel and perpendicular to the ray streamers give no indication of Doppler effect.

In the region between the limit in the ultra-violet and to about 9000 A. in the infra-red, the auroral spectrum has been fairly thoroughly explored.

During the last few years, special attention has been given to the exploration of long wave-lengths. Up to the present, eighty-five lines and bands have been recorded photographically and measured.

The following important results have been obtained :

(1) Apart from the green line, the spectrum of an ordinary aurora is dominated by negative and positive nitrogen bands.

(2) All the eight infra-red bands as yet observed in collaboration with L. Harang, and a large number of red bands, belong to the first positive group of nitrogen.

(3) The second green line or band has a wave-length of approximately 5240 A., and cannot be identified with oxygen lines or with bands of the negative nitrogen group. It may be referred to the first positive group of nitrogen or the band N_2 of solid nitrogen.

(4) In the ultra-violet we have observed a diffuse band series coinciding with one observed from solid nitrogen.

(5) In the red part, two lines, 6302 and 6365, appear which may be identical with the OI lines, $(^1D_2 - {}^3P_2)$ and $(^1D_2 - {}^3P_1)$ respectively, but no OI lines are found in the infra-red and it is doubtful whether OI lines, other than those attached to the levels $^1S_0$, $^1D_2$ and $^3P_{012}$ appear in the auroral spectrum. This curious fact is explained by assuming that oxygen is mainly excited indirectly by collisions of the second kind with active nitrogen. The energy of active nitrogen available for excitation (9·55 volts) and the energy required for dissociation according to the equation $O_2 = OI + O(^1S_0)$ (9·3 volts) nearly balance, and the probability for the excitation process therefore becomes large on account of a kind of resonance. As shown experimentally by Kaplan, the green OI line can actually be excited by active nitrogen.

(6) Lines of hydrogen and helium are either not present or extremely weak, showing that there is no dominating layer of light gases floating on the top of our atmosphere.

The average energy of the more prominent bands and lines have been measured. The intensity distribution is subject to considerable changes of which the following have been detected and studied :

(*a*) Variations with the auroral type.

(*b*) Lines in the region 6300 are enhanced and produce the red coloured aurora of type *A*. The enhancement is a universal phenomenon and seems to follow the sunspot cycle. In another type, *B*, where the red colour is restricted to a band near the lower limit, the red colouring is explained through the enhancement of the first positive group of nitrogen.

(*c*) The enhancement with increase of altitude of the negative nitrogen bands relative to the green line. This altitude effect detected in 1923 has recently been verified by Størmer and Harang.

The distribution of the negative nitrogen bands gives a method for the determination of the temperature of the emitting molecules. Measurements carried out on the basis of spectra obtained in 1923–24 gave temperatures of about − 30° C.

The results of the spectral analysis, especially the altitude effect, and the temperature determinations seen in relation to the height and luminosity distribution of the auroral streamers, show that nitrogen must be carried to high altitudes through the effect of an electric state set up by the action of solar rays of short wave-length[1].

The resulting state of the extreme upper atmosphere resembles the solar corona and the writer has, on the basis of the formation of the terrestrial corona, developed a theory of the solar corona[2] recently investigated mathematically by Rosseland. The terrestrial corona, being caused by the solar radiation, will reach its highest development towards the sun, and the charged matter will accumulate near the plane of the magnetic equator. This coronal distribution of matter accounts for the fact that the maximum altitude reached by auroral rays increases towards lower latitudes and is greater near sunset than in the middle of the night. The coronal structure also gives a simple explanation of the zodiacal light and accounts for the fact that, in addition to reflected sunlight, the zodiacal light emits a spectrum of the same type as that of the night sky luminescence, as indicated by Slipher's observations. The electrical state of the terrestrial corona as derived from auroral studies is in good agreement with that recently found by radio echo work.

* Substance of a paper read before Section A (Mathematical and Physical Sciences) at the Leicester meeting of the British Association on September 7, 1933.

[1] Compare L. Vegard, *Phil. Mag.*, **46**, 193 ; 1923.
[2] Compare L. Vegard, *Vid. Akad. Oslo*, I, No. 2 ; 1928.

The Sutlej Deodar

"FOR practical use in the field, the deodar itself is the best indication of the quality class of any existing crop, and it is proposed to employ vegetation lists only in the determination of the *site quality class*, where the existing crop is an abnormal one. . . . As the ground flora of deodar crops with a complete canopy consists largely of herbs, it follows that the whole of the ground cover, including herbs, ferns, and grasses as well as shrubs, should be studied in sylvicultural work."

This extract, from "The Sutlej Deodar : Its Ecology and Timber production", by R. Maclagan Gorrie, of the Indian Forest Service (*Ind. For. Records* (*Sylvic. Series*), 17, pt. 4, Calcutta : Govt.

of India Central Pub. Branch, 1933), forms the framework of a valuable piece of work.

The object of the research undertaken by the author was to trace the relationship between the plant associates of the deodar (*Cedrus deodara*) and its value as a timber tree; the species forming the most valuable of the coniferous trees in the north-west Himalaya and the Sutlej region, one of the main sources of the supply of this timber to the markets of northern India.

In his study of the tract of country, Dr. Gorrie is able to show that there are several zones of growth which he divides into three main ones, moist, dry and arid. "The deodar," he says, "occurs in a belt of forest along both sides of the Sutlej Valley stretching from the outer hills of the Lesser Himalaya to the Tibetan border, and it grows under climatic conditions varying from the heavy monsoon of the outer hills to the arid country behind the ranges of the Himalaya whose precipitation consists almost entirely of winter snow fall. The plants associated with the deodar vary greatly between these two extremes, and the correlation of these plants with the varying capacity of the deodar as a timber producer should serve a useful purpose in clarifying our knowledge of Indian sylviculture."

Dr. Gorrie commences by giving some essential data on the subject of the topography, geology, climate and other ecological factors. Under the moist zone belt he discusses the *Pinus longifolia* belt, *Quercus incana* and *Rhododendron* belt, the blue pine (*P. excelsa*)—deodar belt, spruce (*Picea smithiana*)—deodar belt, the broad-leaved species such as horse-chestnut, alder, walnut, poplar, elm, *Acer*, *Pyrus*, etc., (termed 'Thach' forest), the *Quercus semecarpifolia*—silver fir (*A. pindrow* and *spectabilis*) belt, and, lastly, the seral communities of the moist zone. The dry and arid zones are considered together and contain the *Ilex* oak—Neoza pine (*P. Gerardiana*) belt of the dry zone, the Neoza pine mountain formation of the arid zone, the dry zone deodar and the arid zone deodar, the dry zone silver fir—blue pine and arid zone blue pine formations and, lastly, the seral communities of the dry and arid zones (shrubs and herbs). It is of interest to note that of all its tree associates, the blue pine is the only one which accompanies the deodar throughout its range and retreats uphill towards the snow-beds of the inner ranges in a similar manner.

A following chapter discusses the ecological value of the common plants found in the zones, lists of which are given. Graphs of average diameter-age curves, and commercial volume-age curves, are given for the deodar for the three ecological zones; with some remarks on deodar timber production. It is noted that the deodar's capacity as a timber producer alters markedly with climatic changes, and these alterations are correlated by the author with the changes in its plant associates. Some beautiful and informative plates accompany the text.

Chemistry of Muscular Contraction

THE present position of our knowledge of the chemistry of muscular contraction and of the functions of phosphagen in this process has recently been reviewed by P. Eggleton and by E. Baldwin respectively[1]. In the last five years, interest has tended to shift from the part played by lactic acid to that played by phosphagen. Two different phosphagens are at present known. In all vertebrates the phosphagen is a compound containing creatine and phosphoric acid in equimolecular proportions. It is present chiefly in voluntary muscles and white contain more than red. Cardiac muscle contains much less and smooth muscle little, but an increase is observed in the uterus during pregnancy. In the muscles of invertebrates the creatine is replaced by arginine. In only two species have the two compounds been found together, namely in the jaw muscles of the sea-urchin *Strongylo-centrotus lividus* and in the body of the enteropneust *Balanoglossus Salmoneus*. The Cephalopoda appear to contain a phosphagen of which the base is not arginine; Protozoa appear not to contain it but a phosphagen compound is present probably in all Metazoa.

The following have been found to play a part in the maintenance of excitability or in the process of contraction in muscle: glycogen and lactic acid and their intermediate compounds, phosphagen, hexose-monophosphate ('lactacidogen'), adenyl pyrophosphate, potassium and magnesium. Both during rest and activity, oxygen is consumed and carbon dioxide and heat given off. The chemical changes in the resting isolated frog's skeletal muscle in oxygen are too small for measurement, but in nitrogen, in which the rate of heat production is about two-fifths that in oxygen, lactic acid accumulates, with a corresponding decrease in the glycogen, as well as orthophosphoric acid, from decomposition of phosphagen and later of other phosphoric esters.

The chemical changes occurring in a muscle during activity are considered at the present time to be as follow: phosphagen is reversibly hydrolysed into creatine and orthophosphate to provide the energy of contraction, its synthesis being at the expense of the energy derived from the breakdown of adenyl-pyrophosphoric acid into inosinic acid, phosphate and ammonia. The reconstitution of the latter compound depends on the energy obtained from the breakdown of glycogen to lactic acid, the presence of magnesium ions also being necessary: part of the lactic acid—one-fourth only—is then oxidised whilst the remainder disappears and is probably resynthesised again to glycogen. The heat production of the contraction appears in four stages: during contraction and relaxation, the delayed anærobic heat and the oxidative heat. In the actual process of contraction oxygen plays no part, but it is essential for the complete process of recovery. The delayed anærobic heat appears to be the balance between the exothermic delayed lactic acid production and the endothermic anærobic reconstitution of phosphagen.

On stimulation, the reaction of the muscle first shifts towards the alkaline side, but after a few twitches to the acid side, corresponding with the initial hydrolysis of phosphagen and the slightly later appearance of lactic acid respectively. When a muscle is poisoned with iodoacetic acid, the lactic acid mechanism is inhibited and contraction takes place solely at the expense of the phosphagen. In the absence of oxygen no restitution occurs, glycolysis apparently being the only ultimate source of energy: in oxygen, however, energy can be obtained from another source.

Vapour pressure measurements indicate that the rise in osmotic pressure when a muscle is fatigued to exhaustion in nitrogen is considerably larger than can be accounted for by all the known breakdown reactions added together: only about 75 per cent of the observed change is accounted for by lactic acid production and phosphagen breakdown (assuming the latter to be in combination with some colloidal constituent and therefore to exert a negligible osmotic pressure, since it is non-diffusible). As mentioned above, the resting muscle in nitrogen produces heat at the expense of the breakdown of phosphoric esters; the heat production, moreover, remains constant although the rate of phosphate formation decreases. Both these facts suggest the existence of other reactions in muscle which still await discovery.

In invertebrate muscle, arginine phosphate plays the same part as creatine phosphate in vertebrates. *In vitro*, the breakdown of creatine phosphate is accelerated by the presence of molybdate, whilst that of arginine phosphate is retarded to an equal degree.

In conclusion, it may be pointed out that the phosphagen mechanism appears to be peculiar to muscle; it is both quicker and more efficient than the lactic acid mechanism, which appears to be a property common to all animal cells and perhaps represents the fundamental source of energy in animal organisms.

In a recent article in our columns[2] Prof. O. Meyerhof has reviewed our present knowledge of the lactic acid mechanism of muscle. Glycericaldehyde-phosphoric acid and dioxyacetonephosphoric acid are formed from the phosphoric esters originally present, an equilibrium mixture of aldose- and ketose-monophosphoric acid, probably with fructosediphosphoric acid as an intermediate step, and then converted to α-glycerophosphoric acid and glyceric-acid-monophosphoric acid ('phosphoglyceric acid'), from the latter of which pyruvic acid and phosphoric acid are formed. The pyruvic acid reacts with the α-glycerophosphoric acid to form lactic acid and a triosephosphoric acid which then undergoes rearrangement with the formation of glyceric-acid-monophosphoric acid and glycerophosphoric acid. The inhibition of the mechanism by monoiodoacetic acid is due to inhibition of the reaction of pyruvic acid with glycerophosphoric acid. Sodium fluoride inhibits lactic acid formation by preventing the splitting off of phosphoric acid from the phosphoglyceric acid.

[1] *Biol. Rev.*, vol. 8, pp. 46 and 74; 1933.
[2] NATURE, 132, 337 and 373; 1933.

Psycho-physiological Research in Industry

A DISCUSSION arranged by the Department of Industrial Co-operation of Section F (Economic Science and Statistics) of the British Association on September 11 was devoted to the psycho-physiological requirements of modern factory equipment. Sir Henry Fowler presided, and two papers were presented. The first, by Dr. G. P. Crowden, of the London School of Hygiene and Tropical Medicine, dealt with the practical value of physiology to industry. Dr. Crowden referred to the gap which frequently exists between discoveries and knowledge acquired by experimental work in research laboratories and their application for the general comfort, efficiency and health of mankind. Physiology can, to a large extent, define the needs of man which are essential for the maintenance of normal healthy life, and the nature and mode of execution of industrial operations in relation to the capacity for and the efficient performance of muscular work by the human body is a physiological problem. The strain placed on the body when working under extreme conditions of temperature and humidity, the relation of hours of work and the rate of working to the production of normal or excessive fatigue, the intensity and arrangement of lighting which permits the eye to see with maximum efficiency and minimum strain, the effects of noise and vibration on the human body, are all matters falling within the scope of physiology. Equally, the applications of physiology in industry are concerned with the products of industry.

Discussing the physiological factors which must be considered in any industrial problem, Dr. Crowden said that these fall into four groups: the work factor, comprising the study of the muscular effort involved, the environmental factor, the time factor and the personal factor. The latter is largely outside the control of the management and only education, understanding and goodwill between employees and employers can ensure that this factor does not discount the good results achieved by attention to the other factors.

Dr. Crowden described the results of a number of recent investigations on these various factors, including studies of muscular work in industry, the effect of noise and vibration, particularly in connexion with the use of pneumatic tools, and emphasised the necessity of supplementing laboratory work by field work. Close co-operation between physiologists and industrialists is essential. Important investigations are also being carried out on lighting, ventilation and heating, as well as on the efficiency of manufactured products such as the insulation from heat of sun helmets, etc., which has already led to the design of new helmets. A great deal can still be done in this way to improve the conditions of habitation in the tropics and elsewhere with advantage to health and efficiency.

The second paper was contributed by Dr. G. H. Miles and dealt with the human factor in relation to the design of factory equipment and machinery. The interest of modern management, not only in the mechanical results but also in the efficiency with which they can be repeated throughout each working-day, is leading designers of factory equipment and machinery to take into account the limitations of those who use the machinery and equipment. Limitations may be imposed by fatigue caused by badly arranged controls or working positions, unnecessarily heavy muscular effort, harmful posture, etc.; by the rhythm of machinery operations not synchronising with the worker's rhythm; by badly placed working or observation points; by distraction of attention by moving parts or in other ways; or by waste of effort due to bad design in setting up, stripping or cleaning machines.

Defects of this kind are frequently overcome by human effort but at the expense of the quality of work, and the whole unnecessary strain is detrimental to human welfare. The machine should be designed to fit the human being, and when mechanical or process limitations make this difficult, the adjustment should be facilitated by careful selection of the most suitable workers for the machine or process.

University and Educational Intelligence

CAMBRIDGE.—The Appointments Committee of the Faculty of Geography and Geology will shortly proceed to appoint a University lecturer in geography. The duties will commence on January 1, 1934. Particulars as to stipend and duties may be obtained from Prof. F. Debenham at the Department of Geography, to whom applications should be sent on or before November 4.

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

The degree of Master of Arts has been conferred on Dr. Max Born, formerly of Göttingen, University lecturer in mathematics.

OXFORD.—On October 17, Congregation passed the preamble of a statute which will give candidates in the School of Agriculture the opportunity of paying special attention to the scientific aspects of the subject, such as plant and animal genetics, and animal nutrition.

On the same occasion, Congregation voted an annual grant for five years to the British Trust for Ornithology.

AT a meeting on October 13 of the Sixth Annual Conference for the Preservation of the Countryside held at Buxton, the Earl of Crawford and Balcarres being in the chair, Dr. Vaughan Cornish, representing the Geographical Association, proposed, and Mr. Guy Dawber seconded, the following resolution, which was carried unanimously: "That a Committee be appointed to advise the C.P.R.E. in matters of education generally, and in particular to consider proposals for the preparation of a manual relating to the scenic amenity of Britain in Town and Country, based upon geographical principles."

THE Ninth Annual Congress of the International Federation of Intellectual Unions will take place at the University of Budapest on January 4–6, 1934, under the presidency of Count Paul Teleki. The subject to be discussed is "Tradition and Revolution in Europe". Among the distinguished scholars who will discuss various aspects of this question will be Prof. Hans Freyer (Leipzig) and Prof. René Poirier (Algiers), who will deal with the realms of thought and science respectively. Science, literature, art, economics and politics will thus be submitted to a searching criticism with the view of finding whether some common line of thought about present-day problems cannot be developed. The Federation was founded in 1924 by Prince Charles de Rohan in order to provide a platform for discussion among intellectuals throughout Europe and to facilitate personal contacts. The sixteen national unions belonging to the Federation have all their own particular activities, and their annual meetings are well known on the Continent. The late Lord Birkenhead, General Seely and Prof. Alison Phillips of Dublin are among those who have addressed previous congresses of the Federation. Further particulars of the Congress can be obtained from Prince Charles de Rohan, 8 Parkring, Vienna 1.

Calendar of Nature Topics

November Fogs

November is proverbially the month of fogs, a belief which finds expression in Tom Hood's famous poem. In the French Revolutionary Calendar of 1793, the period October 22—November 20 was the month *Brumaire*—'foggy'. Statistics for London compiled by Mr. R. C. Mossman show that this evil reputation is justified, for November is actually the month in which dense fogs are most frequent. In 106 years, Mossman found records of 125 dense fogs in November. Comparative statistics of fog are difficult to obtain, owing to the personal equation of successive observers, but the figures available strongly suggest that dense fogs were infrequent in London until about 1830, averaging only two or three a year, and then became steadily more common until by the end of the century the average had increased to about nine. In recent years, owing to the partial substitution of gas and electricity for raw coal in heating and cooking, the fogginess of London has shown a tendency to decrease.

Russian Freeze-up and the Siberian Winter

Towards the end of October the rivers begin to freeze in the north of Russia, the process extending southwards during November and reaching the Black Sea and the Caspian early in December. This is an important annual event in the life of the people of Russia and Siberia, as the frozen rivers form excellent highways for sledges, and a great deal of travel and traffic takes place during the winter months. The weather is generally fine, and though the air is intensely cold, calms prevail and climate is healthy and invigorating. The greatest drawbacks are the difficulty of maintaining personal cleanliness and the occasional fierce blizzards or 'poorgas', which are dangerous to travellers. The rivers remain frozen for a period ranging from more than eight months in the extreme north of Siberia to two or three months on the north coast of the Black Sea.

"Oct. 15–27, Gossamer fills the Air" (Gilbert White)

The dispersal of spiderlings buoyed by strands of silk, which on calm autumn days produces the familiar 'showers of gossamer' on bushes and hedgerows, is not confined to any one species but occurs commonly among web-spinning, hunting and jumping spiders (Savory, 1928). Among spiders that avoid sunlight, or nocturnal or burrowing species, the habit is not usual. Negative geotropism leads the young spiders to climb up any available support. At the top the head is turned towards the prevailing breeze, the hinder end of the body elevated as much as possible and a minute drop of silk exuded from the spinnerets. The lightest air appears to be enough to extend this drop into a delicate thread or threads. Sufficient wind-pull on the waving streamer results in the spiderling releasing its grip of its support, and an aerial journey begins.

Young spiders thus borne may be carried long distances. A classical case is Darwin's "Voyage of H.M.S. *Beagle*", where on Nov. 1, 1832, the ship's rigging was coated with gossamer and large numbers of spiderlings were observed sixty miles off the River Plate. Savory has suggested that the island of South Trinidad, lying in the course of the south-

east trade winds, may have received its interesting spider population by gossamer-borne migrants coming from long distances.

Rod-fishing for Salmon ends about November 1

The salmon smolt descends to the sea in its second year. It is an interesting question as to what determines its descent at this particular point in its life history. It is a tenable view that Salmonidæ like the brown trout which are now freshwater inhabitants throughout life, became so by a gradual lengthening of the pre-descent period. Is there any evidence of such a trend in the salmon ?

The early phases of the salmon's existence together with the breeding period of adult life are open to investigation. Of the rest of its pre-adult and adult life much is conjectural. From the nature of the case, this is likely to be so for a long time. At present, ascertained facts are few, and mainly in regard to movements. It seems probable that the salmon's sea range is greater than formerly was considered likely. The records appear to be held by a marked Alaskan salmon taken 1,000 miles away in Asiatic waters in Kamchatka and by a Scottish fish which journeyed from the Spey to the Cumberland Eden.

Regarded biologically, the salmon is a marine fish which has penetrated an adjacent environment, where presumably conditions are more favourable for reproduction—a penetration which has succeeded at the price of a heavy mortality in the spawned adult fish, and without apparent detriment to the freshwater fauna in that the salmon is one of those species which undergo a pre-reproductive fasting period.

Hitherto, investigations on the natural history of the salmon have been carried on mainly as contributory to economic ends. From a scientific point of view, it would appear timely to ask whether marking and scale reading have not contributed now most of their quota to salmon biology by way of indicating the larger happenings in migration and growth; and to suggest the time has arrived when intensive ecological investigation of the salmon in its river environment among the freshwater fauna generally is both appropriate and desirable, and, in the long run, likely to be productive of sound practical results. The need for such a widening of outlook and for the undertaking of an exact field study of the salmon is illustrated by the way in which the deadly disease furunculosis has so far defied control within the rivers where it has occurred. Ecological investigation might go some way towards elucidating how such an infection maintains itself as an enzootic in these rivers.

Hibernation of the Desert Tortoise of Arizona

The desert tortoise (*Testudo agassizi*) is a great wanderer upon the higher parts of the Southern Californian desert and in Arizona, but in late October Prof. Loye-Miller found that it had already retired to its winter burrow, from which it would not emerge until the following March (*Trans. San Diego Soc. Nat. Hist.*, vol. 7, p. 187, Oct. 1932). The burrow is dug into a sandy hillside, is oval in section and two to three feet deep. There seems to be no attempt at filling the tunnel mouth, nor does the tortoise return to a burrow it has once left, although during the heat of the day it becomes quiescent in the shelter of some bush.

In the severe conditions of desert life, the desert tortoise shows several characteristics favourable to survival. Very remarkable is the low evaporation coefficient of the egg, in which even five months after deposition the fluidity of the albumen and size of the 'air bubble' showed no appreciable change. In Nature, the eggs are probably deposited in burrows, for exposure to the direct sunlight of the desert, even for a short time, would prove fatal to eggs or to young tortoises. A second characteristic is the probable conservation of water produced as an end-product in the metabolism of food, and in the product of protein metabolism as uric acid (seen in birds and reptiles) which being almost insoluble, is less toxic, and is voided with the smallest possible loss of water. An equal capacity for hibernation or æstivation gives ability to withstand great climatic changes; slow development and rate of living, low birth rate and high infantile mortality are correlated with long life; and an insatiable urge to travel carries it over long distances and serves a useful end where food is sparsely distributed.

Societies and Academies

CAPE TOWN

Royal Society of South Africa, Aug. 16. ANNE STEPHENSON and T. A. STEPHENSON: The breeding of marine animals. W. MICHAELSEN: The ascidians from the Cape Province. J. L. B. SMITH: The growth-changes of *Pteroplatea natalensis*. The butterfly-ray, *Pteroplataea*, is frequently found in the Knysna estuary, and a graduated series of examples from the embryo up to the adult has been examined. The embryos are triangular in shape, with moderately developed pectoral fins. In the course of growth the pectoral fins become enormously developed, until the transversely oval or lozenge shape of the adult is reached. The hitherto prevailing idea that large and small specimens represented different species is thus erroneous. Other presumed specific characters also vary according to age. K. H. BARNARD: Some abnormal specimens of the panga. The 'pug-head' panga (*Pagrus laniarius*) is well known to the fishermen. Pug-headedness has been recorded in a number of different fishes, but not hitherto in the panga. SIR THOMAS MUIR: (1) Relations between the primary minors of a 3 by 9 array; (2) Note on an overlooked alternant.

SYDNEY

Linnean Society of New South Wales, Aug. 30. ALAN P. DODD: A new genus and species of Australian Proctotrypidæ. Specimens collected at Beech Forest, Victoria, are described. They are braconid-like and possess outstanding characters, particularly in the development of the wing venation. TOM IREDALE and T. C. ROUGHLEY: The scientific name of the commercial oyster of New South Wales. A description is given and a new name proposed for the common commercial oyster of Australia. T. C. ROUGHLEY: The life-history of the Australian oyster (*Ostrea commercialis*). This is the common commercial oyster of Australia for which the specific name *O. cucullata* has usually been adopted. The anatomical relationship of the gonad to the other organs is discussed. The sex-ratio of 3,000 oysters from the principal oyster-bearing grounds of New South Wales was determined. Females were always found to predominate in marketable oysters; they varied from

54 to 88 per cent; the average percentage was females 73, males 27. Practically all the young oysters spawn for the first time as males. The determination of sex does not appear to be influenced by the amount of food available, as has been suggested for other oviparous oysters.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, 19, 641–757, July 15, 1933). DONALD H. MENZEL and CECILIA H. PAYNE: On the interpretation of nova spectra (see NATURE, Sept. 23, p. 487). THOMAS HARPER GOODSPEED: Chromosome number and morphology in *Nicotiana* (6). Chromosome numbers of forty species. The commonest haploid numbers are 12 and 24. Australasian species are not included. W. A. ZISMAN: (1) Young's modulus and Poisson's ratio with reference to geophysical applications. The geophysicist requires to know statical compressibilities of standard rocks at varying hydrostatic pressures and under minute additional stress corresponding to that involved in wave propagation. Rock cores two inches in diameter and about ten inches long were used. The ends of the cylinder were compressed in the jaws of a testing machine and changes in diameter and length between two points on the cylinder were measured on a function of the load. Young's modulus and Poisson's ratio were calculated directly from the changes in length and diameter. The applied stress rarely exceeded a thousand pounds per square inch. (2) Compressibility and anisotropy of rocks at and near the earth's surface. Compressibilities have been measured at 30° C. for pressures up to 840 kgm./cm.^{2} The change in length of the small cylindrical specimens used was measured in a piezometer. The end of the recording lever carries a stretched manganin resistance wire which passes over a fixed contact. The contact and wire form part of a potentiometer circuit from which movements of the recording lever can be determined. Naked rock and specimens enclosed in copper foil were used; the compressibility of the former is always less than that of the latter, due to the liquid compressing medium penetrating pores and resisting compression. Data are given for many rocks. (3) Comparison of the statically and seismologically determined elastic constants of rocks. Differences observed for rocks near the surface are real, being due to small cracks and cavities; the more compact the rock the smaller they are. For porous rocks, seismological or other dynamical methods alone provide useful geophysical data. W. J. TRJITZINSKY: The general case of non-homogeneous linear differential equations. M. S. KNEBELMAN: A canonical form for a set of vectors. W. C. RANDELS: On a theorem of Fejér. HENRY FAIRFIELD OSBORN: Aristogenesis, the observed order of biomechanical evolution. Aristogenesis is defined. It is an orderly creative process from the geneplasm (= germ plasm) of new germinal characters which are potentially better and more adaptive. It is of two kinds: (*a*) aristogenes, governed by germinal potentiality in certain related lines and relatively slow in development; (*b*) allometrons (changes of proportions), not so governed, and relatively rapid in development. DAVID R. BRIGGS: Electrosmosis and anomalous osmosis. Osmotic pressure measurements were made by placing known amounts of the sodium salt of a colloid (purified gum arabic) in small collodion sacs and allowing equilibrium to be attained against a constant pressure applied to the solution inside the sac while immersed in an external solution. Concentration of colloid and distribution of water at equilibrium were determined. The results can be interpreted in terms of the electrosmotic forces existing in the system, and it is suggested that such forces must be considered when the osmotic properties of colloid solutions are being studied. EDWIN C. KEMBLE: Note on the Sturm-Liouville eigenvalue-eigenfunction problem with singular end-points. KENNETH V. THIMANN and FOLKE SKOOG: Studies on the growth hormone of plants. (3) The inhibiting action of the growth substance on bud development. Plants of *Vicia faba*, 4–6 weeks old, were used. Growth substance is found in all developing parts; maximum was in terminal buds, but very little in lateral buds. Lateral buds grow rapidly when seedling is decapitated, but this effect is inhibited by applying an agar block containing growth substance to the cut stem. JAMES BONNER: Studies on the growth hormone of plants. (4) On the mechanism of the action. Sections of *Avena* coleoptiles were grown in solutions of growth substances. Elongation seems to be accompanied by increased respiration, but it is not certain that the hormone alone is responsible. HENRY BORSOOK and GEOFFREY KEIGHLEY: The energy of urea synthesis. (2) The effect of varying hydrogen ion concentration with different metabolites. Experimental results indicate that one molecule of oxygen is used for every molecule of urea synthesised. There seem to be specific mechanisms in the cell transferring energy from specific reactions liberating energy to those absorbing it. T. J. B. STIER: On the temperature-regulatory function of 'spontaneous' activity in the mouse. Total 'spontaneous' activity of two-day albino mice increases as the animal's internal temperature is raised from 16° to 22° C. and then decreases. Some form of temperature regulation at internal temperatures above about 25° C. is suggested. G. PINCUS, G. DEROO STERNE and E. ENZMANN. The development of temperature regulation in the mouse. Rate of cooling of living mice is slower than that of dead mice, and conversely, their rate of warming is faster. Rectal temperature is always above the external temperature, but the difference fluctuates rhythmically about a mean, which increases to a maximum at about 25° C. and then decreases. EDWARD L. THORNDIKE: The influence of use or frequency of occurrence upon the strength of mental connexions. A record, with discussion, of human multiple-choice experiments with punishments and rewards. No distinction between a confirming reaction due to satisfyingness of making *any* choice and a strengthening influence due to use of a connexion is possible from the experiments. J. M. ODIORNE: (1) The effects of the pituitary hormones on the melanophores of fishes. Divergent results obtained by different workers are thought to be due to differences in the preparations used. Different kinds of fishes respond in different ways to pituitary preparations. (2) The occurrence of guanophores in *Fundulus*. Chromatophores which are silvery by reflected light and dull yellowish grey by reflected light and are never iridescent appear in the dermis below the melanophores. They contain guanin and are most numerous on the dorsal surface. Their reaction to stimuli is opposite to that of melanophores. JOHN H. WELSH: Photic stimulation and rhythmical contractions of the mantle flaps of a lamellibranch. The contractions occur in breeding females; they increase with illumination and cease at low light intensities. The movement promotes aeration of the developing glochidia but probably has other functions.

Forthcoming Events

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

Monday, October 30

UNIVERSITY COLLEGE, LONDON, at 5.30.—Prof. C. B. Fawcett: "Geographical Factors in the Study of Man".*

Tuesday, October 31

BRITISH INSTITUTE OF PHILOSOPHY, at 8.15—(at University College, Gower Street, London, W.C.1).—Prof. J. B. S. Haldane: "Materialism".*

BRITISH RADIO INSTITUTION, at 7.30—(at King's College, Strand, London, W.C.2).—Dr. N. W. McLachlan: "The Principles and Behaviour of Modern Loud-speakers".

Wednesday, November 1

INSTITUTE OF PHYSICS, at 5.30—(at the Royal Institution, 21 Albemarle Street, W.1).—Dr. R. E. Stradling: "Physics in the Building Industry".

SOCIETY OF PUBLIC ANALYSTS, at 8—(in the Rooms of the Chemical Society, Burlington House, Piccadilly, W.1).—Discussion on "The Chemical (as distinct from physiological) Tests for Vitamins" (to be opened by A. L. Bacharach).

Thursday, November 2

UNIVERSITY OF LONDON, at 5—(in the rooms of the Royal Society of Medicine).—Prof. H. Burger: "The So-called Associated Paralyses of the Larynx and Pharynx—Multiple Cranial Nerve-Palsy" (Semon Lecture).*

Friday, November 3

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Prof. A. F. C. Pollard: "Kinematic Design in Engineering" (Thomas Hawksley Lecture).

BEDSON CLUB, at 6.30—(at Armstrong College, Newcastle-upon-Tyne).—Prof. R. A. Peters: "Some Recent Aspects of the Vitamin B Complex" (Bedson Lecture).*

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS, at 7.—Prof. F. C. Lea: "Recent Metallurgical Developments and their Significance for Shipbuilding and Marine Engineering" (Andrew Laing Lecture).

ROYAL INSTITUTION, at 9.—Sir Arthur Hill: "The Escape of the Prisoner: Studies in the Germination of Seeds".

Official Publications Received

GREAT BRITAIN AND IRELAND

Journal of the Institute of Actuaries Students' Society. Vol. 4, No. 2. Pp. 93–152. (London: C. and E. Layton, Ltd.) 3*s*.

Birkbeck College (University of London). The Calendar for the Session 1933–34. Pp. 267. (London.)

Ministry of Agriculture and Fisheries: Fisheries—England and Wales. Salmon and Freshwater Fisheries: Report for the Year 1932. Pp. 49+9 plates. (London: H.M. Stationery Office.) 1*s*. 6*d*. net.

Journal of the Chemical Society. September. Pp. iii+1109–1290+viii. (London: Chemical Society.)

University of Cambridge: Department of Agriculture, Farm Economics Branch. Report No. 21: An Economic Survey of Agriculture in the Eastern Counties of England, 1932. Pp. vi+89. (Cambridge: School of Agriculture.) 2*s*. 6*d*. net.

Biological Reviews and Biological Proceedings of the Cambridge Philosophical Society. Edited by H. Munro Fox. Vol. 8, No. 4, October. Pp. 345–481. (London: Cambridge University Press.) 12*s*. 6*d*. net.

The Coventry Libraries. Report of the Committee on the Year's Work, together with the Third Annual Report of the Museum for the Year ended 31st March, 1933. Pp. ii+21+1 plate. (Coventry.)

Scottish National Development Council. Economic Series No. 9: Report of Committee on the Chemical Industry in Scotland. Pp. 80. (Glasgow.) 6*d*. net.

The Journal of the Institute of Metals. Vol. 50: Metallurgical Abstracts and Index to Volumes 48, 49 and 50 of the Journal. Edited by G. Shaw Scott. Pp. vi+962. Vol. 51. Edited by G. Shaw Scott. Pp. 363+28 plates. (London: Institute of Metals.)

OTHER COUNTRIES

Commonwealth of Australia. Report on Aerial Survey Operations in Australia during 1932. By Dr. W. G. Woolnough. Pp. 83. (Canberra: Commonwealth Government Printer.)

The Imperial Council of Agricultural Research. Scientific Monograph No. 4: Life-Histories of Indian Microlepidoptera (Second Series), Cosmopterygidæ to Neopseustidæ. By T. Bainbrigge Fletcher. Pp. 85+77 plates. (Delhi: Manager of Publications.) 4.8 rupees; 7*s*. 6*d*.

The Quarterly Journal of the Geological, Mining and Metallurgical Society of India. Edited by K. K. Sen Gupta. Vol. 5, No. 1, March. Pp. 58+1 plate. 6 rupees. Vol. 5, No. 2, June. Pp. 59–98+4 plates. 6 rupees. (Calcutta.)

Polar-Årboken, 1933. Utgitt av Norsk Polarklubb. Pp. 168. (Oslo: Gyldendal Norsk Forlag.)

Records of the Botanical Survey of India. Vol. 8, No. 5: Flora Arabica, The Botanical Exploration of Arabia. By Ethelbert Blatter. Pp. 451–501. (Delhi: Manager of Publications.) 12 annas; 1*s*. 3*d*.

N.Z. Department of Scientific and Industrial Research. Bulletin No. 43: Report of the Hawke's Bay Earthquake (3rd February, 1931). Pp. 116. (Wellington, N.Z.: Government Printer.) 2*s*.

Nyasaland Protectorate: Geological Survey Department: Colonial Development. Water Supply Investigation: Progress Report (No. 2) for the Year 1932. Pp. ii+21+12 plates. (Zomba: Government Printer.)

Memoirs of the India Meteorological Department. Vol. 26, Part 1: Registration of Earth-Current with Neutral Electrodes. By Dr. Sudhansu Kumar Banerji. Pp. ii+11+4 plates. (Delhi: Manager of Publications.) 1.6 rupees; 2*s*. 3*d*.

Ministry of Public Works, Egypt: Physical Department. The Nile Basin. By Dr. H. E. Hurst and Dr. P. Phillips. Vol. 3: Ten-day Mean and Monthly Mean Gauge Readings of the Nile and its Tributaries. (Physical Department Paper No. 29.) Pp. viii+715+4 plates. 50 P.T.; 10*s*. Vol. 4: Ten-day Mean and Monthly Mean Discharges of the Nile and its Tributaries. (Physical Department Paper No. 30.) Pp. iv+291. 50 P.T.; 10*s*. (Cairo: Government Press.)

Proceedings of the California Academy of Sciences, Fourth Series. Vol. 21, No. 8: The Templeton Crocker Expedition of the California Academy of Sciences, 1932. No. 8: Mosses of the Templeton Crocker Expedition collected by John Thomas Howell, and Lists of the Mosses known from the Galapagos Islands and from Cocos Island. By Edwin B. Bartram. Pp. 75–86. Vol. 21, No. 9: The Templeton Crocker Expedition of the California Academy of Sciences, 1932. No. 9: The Amaranthaceæ of the Galapagos Islands. By John Thomas Howell. Pp. 87–116. (San Francisco.)

Collection des travaux chimiques de Tchécoslovaquie. Rédigée et publiée par E. Votoček et J. Heyrovský. Année 5, No. 7–8, Juillet-Août. Pp. 279–366. (Prague: Regia Societas Scientiarum Bohemica.)

The Science Reports of the Tohoku Imperial University. First Series (Mathematics, Physics, Chemistry), Vol. 22, No. 3, August. Pp. 393–631. (Tokyo and Sendai: Maruzen Co., Ltd.)

Proceedings of the Sugar Cane Investigation Committee. Vol. 4, Part 3, June: Progress Reports for January 1933. Pp. 145–200. (Trinidad: Imperial College of Tropical Agriculture.)

Proceedings of the American Academy of Arts and Sciences. Vol. 68, No. 9: Least Squares and Laws of Population Growth. By Edwin B. Wilson and Ruther R. Puffer. Pp. 285–382. 1.75 dollars. Vol. 68, No. 10: The Application of Methods of Geometrical Inversion to the Solution of certain Problems in Electrical Resonance. By W. G. Cady. Pp. 383–409. 60 cents. (Boston, Mass.)

Ministry of Agriculture, Egypt. Measuring Moisture in Cotton Bales by Electrical Capacitance. By Dr. W. Lawrence Balls. Part 1. Pp. 42+52 plates. (Cairo: Government Press.)

Mamiferos fósiles de la República Argentina por Florentino Ameghino. Dirigida por Alfredo J. Torcelli. Vol. 9: Atlas. Pp. iv+110+98 plates. (La Plata.)

Conseil Permanent International pour l'Exploration de la Mer. Atlas de température et salinité de l'eau de surface de la mer du nord et de la manche. Pp. 32. (Copenhague: Andr. Fred. Høst et fils.) 5.00 kr.

U.S. Department of the Interior: Geological Survey. Professional Paper 175-D: Origin of the Anhydrite Cap Rock of American Salt Domes. By Marcus I. Goldman. (Shorter Contributions to General Geology, 1932–33.) Pp. iii+83–114+plates 24–42. 15 cents. Circular 1: Iron Ore in the Red Mountain Formation in Greasey Cove, Alabama. By Ernest F. Burchard. Pp. iii+49. Circular 2: Copper Deposits in the Squaw Creek and Silver Peak Districts and at the Almeda Mine, Southwestern Oregon; with Notes on the Pennell and Farmer and Banfield Prospects. By Philip J. Shenon. Pp. ii+35+6 plates. (Washington, D.C.: Government Printing Office.)

CATALOGUES

Safety Automatic Stills. Pp. 4. (London: Baird and Tatlock, Ltd.)

Astronomical Instruments: Observatory Domes, Observation Stages, and Rising Floors. (Astro 516e.) Pp. 88. (London: Carl Zeiss (London), Ltd.)

The Nickel Bulletin. Vol. 6, Nos. 8 and 9, August and September. Pp. 111–138. (London: The Mond Nickel Co., Ltd.)

Reference Catalogue of Periodicals, Journals and Transactions of the Learned Societies, Library Editions and Standard Books in General Literature, History, Science and Oriental, English and Foreign. (Catalogue No. 416.) Pp. 154. (Cambridge: W. Heffer and Sons, Ltd.)

Dulau's Natural History Catalogue. (Catalogue No. 213.) Pp. 44. (London: Dulau and Co., Ltd.)

Catalogue of Miscellaneous Books, including a Selected List of General Works on America, Africa, Egypt, India, China and Japan. (N.S., No. 8.) Pp. 57. (London: Wm. Dawson and Sons, Ltd.)

Catalogue de livres anciens et modernes rares ou curieux relatifs à l'Orient. (No. 25.) Pp. 247–306. (Paris: Libr. Adrien-Maisonneuve.)

Catalogue of Optical Projection Apparatus. Part 1: Optical Lanterns, Epidiascopes, etc. Pp. 36. (London: Newton and Co.)