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# Science and the Community

CENTURIES of tradition and experience have given us, as Prof. A. N. Whitehead has pointed out, a tradition that each generation will live substantially amid the conditions governing the lives of its fathers and transmit those conditions to the succeeding generation. In his words, "we are living in the first period of human history for which this assumption is false". The time span of important change no longer exceeds considerably the normal span of human life, and we have now to meet change as the normal—not the exceptional—experience.

This necessity for change has at least two aspects. It involves the modification of man's nature to meet the new conditions, a re-adaptation to his environment. It also involves the modification of his existing social, economic, political and industrial organization and institutions to meet the requirements of an era of power production and rapid change, or the evolution of new forms of organization where the old prove inadequate and incapable of development.

The seriousness of the present international situation, no less than our economic difficulties, is largely due to the failure to face change and adapt institutions to meet it. In the Fascist and totalitarian State there are deliberate attempts to put back the clock and return to a simpler order of society, creative thought and adaptability being repressed in an attempt to maintain institutions evolved in a pre-industrial era. Simultaneously, in the assumed defence of the State, the full resources of a power production era are being marshalled for destructive purposes.

On the scientific side, even though in the training of the man of science there is still no concern with the social consequences of his work, scientific workers are to an ever-increasing extent turning their attention to such matters. In the five years since, in his presidential address to the British Association, General Smuts directed attention to the dangers arising out of rapid scientific advance as opposed to a stationary ethical condition, the relations between science and society have been considered on an increasing scale at the British Association meetings both in the presidential addresses and in sectional meetings. Two years ago, the Council suggested in a memorandum to the organizing committees of the various sections that discussions, papers or symposia should be included in their programmes bearing upon the relations between the advance of science and the life of the community.

The attention given to this subject in the programme of the present meeting is fully as great as in previous years. Discussions on chemistry and the community, cultural and social values of science, national nutrition and British agriculture, the psychology of mass entertainment, the reform of the examination system, the poultry industry, traffic safety, chemistry and food science, the strain of modern civilization, and addresses on the engineer and the nation, soil science in the twentieth century, etc., indicate over how wide a field scientific workers are seeking the solution of problems of social well-being and the interpretation of the results to the general community.

It is not on this account alone, however, that the impact of science upon society forms most appropriately the main theme of this year's presidential address. While more scientific effort than ever before is probably being devoted to the elucidation of social problems and the interpretation of the results to the community, there has never been more general alarm about the possibilities of the application of the results of scientific discovery or greater willingness to endorse the late Sir Alfred Ewing's words: "The command of Nature has been put into man's hand before he knows how to command himself."

For this uneasiness the rapid deterioration in international relations during the past year, the weakening of international co-operation and the grim menace of re-armament have been largely responsible. In the growing effort being devoted to preparation for warfare, it is easy for the possibilities of a higher standard of living which science has placed within our grasp to be overlooked, and for the scientific worker to be associated rather with the perversion of his knowledge for destructive purposes. Again, the intensification of preparation for self-defence has tended to strengthen the fetters on freedom of investigation and exposition which dictatorships in many countries have already riveted on industrial and academic workers alike.

The growing impatience of the scientific worker at the extent to which his knowledge is made to serve inhuman ends finds admirable expression in Prof. J. C. Philip's presidential address to Section B (Chemistry) and is paralleled by the alarm at the continued threat to academic freedom and scientific research itself which, as the University Grants Committee pointed out in its report, lays a heavy responsibility on the universities of Great Britain if the Greek tradition of candid and intrepid thinking about the fundamental issues of life is to be preserved for mankind.

Sir Josiah Stamp, in his presidential address to the Association, which appears elsewhere in this issue (p. 435), has thrown down a challenge to creative thought on the impact of science upon society and the technique of change it involves, which comes at an opportune moment. The development of economic planning on a larger scale has made it painfully evident how the full effects of the wisest schemes may be neutralized by factors outside their control. Only by the widest co-ordination can the fullest benefits be secured, whether within the limits of an industry or of a national unit. The resistance of institutions to change not only increases the friction and makes change more difficult and the application of science less profitable and less readily accepted; it also tends to throw out of ratio what Sir Josiah Stamp has termed the scientific, industrial and political periods of gestation.

The present tendency is for the period of scientific gestation, or the interval between the first concept of the idea and its publication in substantially the form in which it is ultimately used extensively, to contract. It is even more demonstrable that industrial gestation, or the subsequent interval between this point and the time when the innovation becomes effective in an economic or industrial sense, has shortened materially and at greater social cost. This contraction is attributed to the greater amenability of the industrial community to scientific research and to our entering on an epoch of concerted industrial research in the last twenty years.

It is to the third question, that of political gestation, that Sir Josiah Stamp directs particular attention. Formerly, the normal span of life of man and machinery provided a phase to which scientific advance could be adjusted for a completely smooth social advance. Technical changes now occur so rapidly that political institutions work far too slowly to make the required adaptation. Political gestation is a function both of human psychology and of social structure, and at present we do not know enough about the way in which ideas permeate, infiltrate or saturate society.

While to prevent disequilibrium it is necessary to evolve some means of contracting the period of political gestation, some of the factors which hitherto have diminished the force of impact on society are losing their previous force. Among such, Sir Josiah Stamp cites the natural increase of population, which is disappearing in all Western industrial countries, and the labour demands of new industries, which offset dislocations caused by labour-saving machinery.

If, therefore, the risk of innovation becomes mechanically rapid, the danger of improvident tardiness is the more acute, and it becomes essential to treat on scientific lines those questions of man's abilities, his affections and his tools which have been brusquely dismissed in the past. With the intensification of scientific effort and the greater subdivision of industry, the possible dislocation becomes more frequent and the way of meeting such change of greater public importance. Impact and change must, in fact, be treated as an area for scientific study, and society must endeavour to regulate the rate of change to an optimum point in the net balance between gain and damage.

No scientific worker can fail to recognize the practical difficulties of economic and political prevision, as involved, for example, in Sir James Irvine's plea for a Ministry of Knowledge for the purpose of predicting the repercussions of new knowledge on all phases of life. None the less, a deliberate attempt may yet have to be made. Moreover, it is clear that the moral and social consequences of innovation, no less than the material, must be taken into account in our calculations, and it may even be desirable to repress the rate of development on the physical side in order to accelerate assimilation on the moral and human aspect. Birth control, for people, may yet demand corresponding measures for their impedimenta.

Sir Josiah Stamp adds one more voice to those which in recent years have pleaded for redistribution of scientific effort and resources. There is not too much effort being devoted to research in physics and chemistry as modifying industry, but there is too much relatively to the research upon the things they affect in physiology, psychology, economics, sociology. Additional financial resources should be applied more to the biological and human sciences than to the applied physical sciences or, if resources are limited, transfers should be made from one to the other.

What is required is not less science but a great extension of the area to which the scientific method is persistently and dispassionately applied. This is no time for a spirit of defeatism but for fuller support of those means of acquiring knowledge on the human and biological side where it is at present deficient. We must achieve an advance in the science of man commensurate with that which we have already secured in the science of matter.

For this task there are two essentials—a time of peace in which the problems can be effectively studied and the adjustments made, and courage and confidence strengthened by the conviction that the human spirit is not doomed to relapse into barbarism, but is fully as capable of emerging from an age of mechanization and standardization to one in which the teeming units of mankind enjoy not merely physical comfort and adequate leisure but also freedom of access to all the rich heritage of civilization. If scientific workers are stimulated by the presidential address and other discussions at the Association's meetings to make more constructive contributions to this question of peace and the impact of science upon society, the Blackpool meetings may well be memorable in annals wider than those of science alone.

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## Geophysics of the Indo-Pacific Region

**Geographie des Indischen und Stillen Ozeans**
Im Auftrage der Deutschen Seewarte verfasst von Prof. Dr. Gerhard Schott. Mit einem Beitrag von Prof. Dr. Ernst Hentschel und Dr. Wolfgang Schott. Pp. xx + 413 + 38 plates. (Hamburg: C. Boysen, 1935.) 36 gold marks.

EVER since Prof. G. Schott, ten years ago, published his great work on the geography of the Atlantic Ocean, geographers and oceanographers have been eagerly awaiting the companion volume on the Indo-Pacific region. In the present work the author has followed the same original plan and, commencing with a historical account of the discovery and exploration of these two oceans, he brings under review the whole sum of our present knowledge, ranging from the geological character of the coasts, through the topography and nature of the sea-floor, the meteorological conditions, the current systems and the physico-chemical character of the sea-water from the surface down to the great depths in the various regions into which these two oceans are divided, to the biological conditions present, including in this latter topic a survey of the anthropology of the whole area.

In his historical account of the great explorers, who opened up for us these wide spaces, Schott mentions the name of Francis Drake in a footnote and in his chart only shows him as having visited the west coast of America, whereas he also sailed the Malay seas, visiting Java and the Moluccas, and was in all probability the first to discover the Giant Robber crab (*Birgus latro*) and to note its habit of living in colonies and of climbing trees.

One great difficulty, which confronts all oceanographers, is the uncertainty of the mode of origin of the great oceans, and this applies especially to the northern part of the Indian Ocean, regarding which one school of geologists holds that it has been formed by the foundering of a great continent, Gondwanaland, while another school believes with Wegener that the oceans have been formed by a gradual drifting apart of the present continental masses. Schott apparently belongs to the former school, and he describes how Africa, Arabia and India are all stable land-masses that are bounded by scarp-faults, where the hypothetical continent of Gondwanaland, that once connected them, has broken off and subsided ; it is to this permanence of these land-masses that Schott attributes the apparent comparative freedom of the Indian Ocean from volcanic islands, though, since we are as yet completely ignorant of the geological nature of the basis on which the Laccadive, Maldive and Chagos archipelagos rest, this freedom may be more apparent than real. Down the whole length of the Indian Ocean and across the south-eastern part of the Pacific Ocean two great submarine ridges have now been traced, the two together forming an almost complete semicircle that runs around nearly half the circumference of the globe ; but wherever these ridges rise above sea-level, or fragments of rock have been obtained from the sea-floor along their length, the rock has been found to be volcanic in origin and is composed of basalt, thus giving no indication of its geological age ; and Schott is thus scarcely justified in claiming that the recent John Murray Expedition, which in 1933–34 mapped a great part of the Carlsberg Ridge and discovered a subsidiary ridge running up towards and probably representing a submarine continuation of the Khirtar Range of India, has thus provided further evidence of the former existence in Permo-carboniferous times of Gondwanaland, or even of its later relic, the isthmus of Lemuria.

In discussing the great 'deeps' that almost invariably lie close to the eastern side of a continental land-mass, Schott reviews the possibility that these have been produced by either faulting or folding, but he makes no mention of the alternative theories of isostatic adjustment or of continental drift.

In his account of the currents, both surface and deep, Schott brings out clearly the enormous importance of the correlated study of the general meteorological conditions ; evaporation and solar radiation produce differences in density of the water, thus inducing sinking of water-masses downwards, while the prevailing winds, by inducing horizontal movement of the surface-water in different directions, cause the zonation of the great oceans into tropical, sub-tropical and polar regions, separated from one another by 'convergence zones', along which one mass of water is driven beneath another and sinks down to a deeper level, thus causing a stratification of the ocean into depth-zones, in which temperature, salinity, oxygen content, etc., are sufficiently different to enable us to trace the course of the deep currents and thus discover the manner in which the deeper waters of the Atlantic and Indian Oceans sweep eastward to the south of the continental masses of Africa and Australia and flow into the Indian and Pacific Oceans respectively. Similarly, the Trade winds, by setting up off-shore currents, cause an up-welling of deep cold water that has a profound influence on the character of the fauna and flora, one notable effect of such up-welling being the absence of coral reefs even in tropical regions, as, for example, on the western coasts of Africa and South America or the south-eastern coast of Arabia and the neighbouring coast of Africa. Yet off the north-western coast of Australia, where the conditions would appear to be favourable to its formation, such up-welling appears to be absent.

The zonation of the surface water has, at any rate in certain regions, a profound influence on the character of the sea-bottom, for, as Schott points out, there is a close agreement between the south polar convergence zone and the change on the sea-floor from the tropical and sub-tropical Globigerina ooze to the polar Diatom ooze, and, to a less degree, the same holds good for the north polar convergence zone. It is, however, difficult to understand how this agreement is brought about, for it is now well known that the polar water, characterized by a profusion of diatom growth, dips at the convergence zone downwards under the sub-polar water and flows northwards towards the equator, and one would have expected this Antarctic Intermediate Current to carry the slowly sinking frustules of the diatoms far to the north ; but for some reason not yet understood the convergence zone appears to mark, not only a change in the surface conditions, but one also in the general character of the plankton at all depths.

Another problem connected with the sea-floor is the mode of formation of the Red Clay that covers vast areas of the north and south Pacific regions and the eastern part of the Indian Ocean. The conditions favouring its formation appear to differ radically in these areas and in the Atlantic, for in this latter ocean the Red Clay is deposited where the Antarctic Bottom Current is strongest, whereas in the Pacific the reverse seems to be the case, and in the Indian Ocean to the north-east of the Carlsberg Ridge there is a patch of this deposit in an enclosed basin, where the bottom current must be at a minimum ; nor in this connexion do we know anything regarding the mode of formation of the manganese nodules that are so characteristic of Red Clay deposits, and even less regarding the original source of the manganese.

Dr. Schott is to be congratulated on the completion of this most valuable work, in which he has rendered available so much information ; but if there is one thing that is brought out most clearly, it is the great need of further investigation in every part of these oceans, which are "by nature left free for all men to deal withal, as very sufficient for all men's use, and large enough for all men's industry". R. B. SEYMOUR SEWELL.

# All Manner of Televiewers

(1) Television Reception:
Construction and Operation of a Cathode Ray Tube Receiver for the Reception of Ultra-Short Wave Television Broadcasting. By Manfred von Ardenne. Translated by O. S. Puckle. Pp. xv + 121 + 43 plates. (London: Chapman and Hall, Ltd., 1936.) 10*s.* 6*d.* net.

(2) Popular Television:
Up-to-date Principles and Practice explained in Simple Language. By H. J. Barton Chapple. Pp. xiii + 112. (London: Sir Isaac Pitman and Sons, Ltd., 1935.) 2*s.* 6*d.* net.

(3) Television
By M. G. Scroggie. (Blackie's "Technique" Series.) Pp. ix + 68 + 7 plates. (London and Glasgow: Blackie and Son, Ltd., 1935.) 3*s.* 6*d.* net.

HE is a wise author who knows his own reader; he is a daring author who writes for more than one reader. The first public demonstrations of high-definition television will have rekindled the enthusiasm of the three main classes of potential televiewer, and these enthusiasts will turn to such books as those now before us for some guidance on how television works. On the criteria suggested, Baron von Ardenne is the wisest, Mr. Barton Chapple the most heroic, of our three authors. Mr. Barton Chapple writes for "the public", Mr. Scroggie, in an attractive preface, explains that he has tried to provide "a fairly comprehensive and unpadded survey for [the wireless amateur] without being unintelligibly concentrated for [the non-technical public]; so that neither is the one exasperated nor the other bewildered". Baron von Ardenne, with his more-than-translator and almost co-author Mr. Puckle, address themselves to the advanced amateur and the engineer. Mr. Scroggie's *via media* proves itself *tutissima* and his book can be recommended to the "wireless amateur who is already familiar with ordinary broadcasting"—and the class is an amazingly large one—as a clear well-balanced account of the present state and immediate possibilities of television, with a sufficient glance at the obsolescent, and a fair-minded scrutiny of the up-to-date. Mr. Barton Chapple does not wholly succeed in his difficult task of speaking to the non-technical public without going beyond its limited vocabulary; there are points at which he probably leaves it bewildered by dropping unconsciously back into the familiar jargon of the wireless amateur and engineer. His book is a good one, but he could make it better in its next edition by forgetting the wireless amateur and writing for one intelligent middle-aged lady who would like to know how she is to see the coronation next year from Croydon.

Baron von Ardenne's important work reveals the magnitude of the self-imposed task which will be undertaken by the many advanced amateurs who decide to build their own receivers for high-definition television. He does not gloss over the economic and technical difficulties and he produces, as he always does, a stimulating book which will certainly, as he hopes, "provide an impulse towards intense activity on the part of amateurs in the newest and perhaps most interesting branch of electrical engineering". He is also fully justified in his "hope that certain paragraphs will bring to the television specialist some fundamentally new ideas".

The book is not easy reading, for it is compressed and occasionally elliptic, but it never goes further in these directions than is compatible with stimulation short of exasperation. The keen amateur will have to stop fairly frequently to think how much has been said and how much the author has assumed it safe to leave unsaid because his selected reader will know already. The "construction and operation of a cathode ray tube receiver for the reception of ultra-short wave television broadcasting" will be made possible, but not disappointingly easy, for the advanced amateur who has the good fortune to read this book—and what fun, what fury and despair, what triumphs it will open up for him! The general treatment is philosophically and scientifically excellent, the book contains technical data not readily available elsewhere, and the detailed "Parts Lists", circuit diagrams, and descriptive material on mains supply units, time bases, filters, picture receivers and sound receivers are clear and satisfactory.

It has already been indicated that the book is more than a translation. Mr. Puckle, who has himself done very notable work in the advance of high-definition television, has introduced into the text a considerable amount of matter designed to help the home-constructor who is to deal with the London as opposed to the Berlin television service. These additions are very valuable, indeed essential, but it would have been better to set clearer boundary marks between the von Ardenne and the Puckle contributions. The joints at present are neither perfect welds nor good clean lap joints. The translation is adequately done, there are no defects in clarity, but Baron von Ardenne's colloquially flexible German takes on an occasionally forbidding aspect in the rigidities of a safe translation.

No one with a serious technical interest in television can afford to be without von Ardenne–Puckle; no one who can read Scroggie's lucid and relatively easy survey will fail to find pleasure and benefit in climbing to the more austere heights with von Ardenne and Puckle.

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# Collected Works of Kepler

Bibliographia Kepleriana: ein Führer durch das gedruckte Schrifttum von Johannes Kepler. Im Auftrag der Bayerischen Akademie der Wissenschaften. Unter Mitarbeit von Ludwig Rothenfelder. Herausgegeben von Max Caspar. Pp. 158+86 plates. (München: C. H. Beck'sche Verlagsbuchhandlung, 1936.) 18.50 gold marks.

A POPULAR version of Kepler's letters was published in 1930 by Messrs. Caspar and von Dyck, and was reviewed in NATURE of November 29, 1930, p. 835. Since then Prof. Walther von Dyck has died. We learn that he never lost an opportunity of pressing the claims of Kepler for a collected edition other than that of Frisch—which is open to many objections—and of collecting and studying any documents by Kepler, of which there are a great many. Before he died he had the satisfaction of seeing the Bavarian Academy of Sciences in Munich, with the co-operation of the Deutsche Forschungsgemeinschaft, consent to become responsible for the work. It has named Prof. Max Caspar as editor, and the Würtemberg State Government has set him free from other work for the purpose. He dedicates this volume to Walther von Dyck, and has been able to use the material collected by Dr. Rothenfelder.

The present volume consists of the bibliography preparatory to this edition. The preparatory work seems to have been very thoroughly done. Many of the manuscripts are at Poulkovo. There are certain known collections, public and private. Besides these, circulars were sent out to some 180 libraries, mostly in the neighbourhood of Kepler's residences, to ask them what editions or manuscripts of Kepler they possessed. Most of them replied. It was not to be expected that this step could lead to a large addition to the known works, but some idea of the distribution of these could be got, and also the practical certainty that if any work was missing, it might be looked for elsewhere in vain. However, it *did* lead to certain finds, though not to very important ones.

Actually what we have in this work is, after a preface, eighteen pages of introduction; then four pages of a facsimile of Kepler's communication to Guldin, giving a list of his works edited up to 1621; then sixty-eight pages of works printed in Kepler's time, carefully collated, and each with a descriptive supplement. Several of the minor works have been sought in vain. As Prof. Caspar remarks, "a bibliographer must know what each individual writing contains, from what view it is treated, what is its relation to the whole. So, only a few works receive mention in this book, that I have not been able to see for myself, and for which I had to content myself with taking them out of catalogues, because I could not inspect the originals. All care was taken to give the titles exactly." There are eighty-six titles under this section, originals or duplicates.

After the formal bibliography comes a description of each work. These are pretty full. For example, we note "51. *Calendarium und Prognosticum auf das Jahr* 1617", which Prof. Caspar has not been able to find. In spite of that, there is half a page upon it. These 'prognostics' Kepler did simply to get bread, because the foolish public would buy them. He condemned bitterly the time spent upon them, as being akin to begging, and scarcely in any way more venial—though he does not seem to have altogether disbelieved them.

After that we have seventy-six entries, or twenty pages, of briefer descriptions of various works of Kepler published afterwards, up to the present day. Then, still more briefly, a list of 224 writings which are about Kepler, or which contain some notable reference to him, also continued up to the present day. Then an alphabetical list (3 pp.) of the works in the first section; then a list (3 pp.) of the libraries quoted, and then four pages devoted to the names referred to. Then, a most valuable section, photographic facsimiles, reduced to fit the page, of all except a few of the title pages contained in the first section. Some of these are in two colours. All this has been done as well as possible, and, of course, costs money. The comparatively low charge to the public is because

Prof. von Dyck was able to allocate funds to this purpose which he had received from the Rhineland industry for investigations relating to Kepler.

Prof. Caspar shows a commendable enthusiasm for his subject, but it seems to us he altogether overrates Kepler as a mathematician. Admitted that Kepler was an outstanding man, a genius in his wild way, and that he had a hard life, and that without courage and strong convictions he would never have discovered 'Kepler's laws'; but because he did so, the world has put him into a niche from which he cannot be displaced. Of course, that happened after his death, when I suppose it did not matter to him how the world treated him. It is no part for this journal to decide whether he was or was not greater than his great contemporaries, Galileo and Tycho Brahe, still less, to step across time and compare him with his predecessor Copernicus and the rest, or his successors, Descartes, Huygens and Newton. But, to take an example—*Harmonices Mundi Libri V*, 1619, contains 'Kepler's third law', which is a very valuable asset; but it also contains a lot of sheer nonsense which no one now thinks of, except to dismiss it, such as the music of the spheres, spelt out in the notes each planet makes, with the remark that the earth utters those notes because misery and famine were found there. No doubt they were; so, too, were the courage and tenacity of a Kepler. Also some things with a less personal point and which we are able to judge impartially, such as the relations of the distances of the planets to the sides of the regular solids. We get no notion at all of this from Prof. Caspar's description. To translate a specimen: "The beginnings of this great work reach back to the earliest adult years, its roots are in the deepest soil of Kepler's thinking. He reveals to us the innermost kernel of his views on Nature and the World, he utters the last word of what he knows how to say of the Cosmos and the position of men. We see here not merely the astronomer . . ." and so forth; all rather rhetorical to our thinking. Although the technical work seems to be well done, this exaggerated language is characteristic. R. A. S.

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# The 'Factor School' in Psychology

**Ability and Knowledge:**
the Standpoint of the London School. By Frank C. Thomas. Pp. xx+338. (London: Macmillan and Co., Ltd., 1935.) 15*s*. net.

THE number and character of contending schools of psychology were well brought out a few years ago in a large volume issued in America under the title "Psychologies of 1930". No fewer than eleven schools came under review, one of them being the "Factor School", created by Prof. C. Spearman, and described by him as a school to end schools. That the other schools still flourish—for there is no one of them which does not contain some portion of the truth—does not prove that Prof. Spearman's expectation, or at least his hope, is entirely disappointed. On the contrary it is probably true to say that his theory of a general factor (the now rather famous *g*) and of a variety of specific factors in ability holds the field more securely than ever; and it is equally true to say that his analysis of the birth and growth of knowledge places the psychological study of cognition on a more scientific footing than has ever existed before. After reading Spearman, one can scarcely resist the conclusion that the time has come when William James's lament that psychology was no science, but only the hope of a science, is no longer justifiable.

Prof. Spearman's large books, however, and his extensive series of contributions to learned journals, make heavy going for many people who are not professional psychologists, but who yet desire a statement, which shall be clear without being superficial, of the steps of his argument. Such readers are numerous, and they include, in particular, workers in the fields of education, vocational guidance, and industrial psychology. For them, Mr. F. C. Thomas has written this excellent handbook.

In this book Mr. Thomas really takes up the position of a teacher who, having mastered his subject, takes a keen interest in presenting its essentials with all the lucidity of which its nature admits. We observe that Prof. Spearman and Prof. F. A. P. Aveling, to both of whom Mr. Thomas acknowledges his indebtedness as their former pupil, are abundantly satisfied as to the accuracy of the book as a statement of their joint position. Further, we believe we can answer for it that the readers whom Mr. Thomas has specially in view will be equally satisfied. He modestly disclaims any but "the most ordinary literary facility". We can certify, however, that the book is so well written that not once have we been compelled to re-read a sentence in order to be sure of its meaning.

**(1) Bird-Lovers' Manuals**
How to Know British Birds. By Norman H. Joy. Pp. 136+40 plates. Birds of the Green Belt and the Country around London. By R. M. Lockley. Pp. xix+236+4 plates. 5*s.* net each.

**(2) The Birds of the Firth of Clyde :**
including Ayrshire, Renfrewshire, Buteshire, Dumbartonshire and South Argyllshire. By John Morell McWilliam. Pp. 164+10 plates. 12*s.* 6*d.* net.
(London : H. F. and G. Witherby, 1936.)

THE house of Witherby, under the direction of a distinguished ornithologist, is justly renowned for its bird-books, both technical and popular. Two of the works named above belong to a new series of "Bird Lovers' Manuals" which seem likely to have a wide appeal.

(1) Dr. Joy's volume is a handy work of reference, intended primarily as an aid to identification. To this purpose it is admirably suited. Emphasis is laid on distinguishing characters rather than on general descriptions, and the value of song and call-notes in this respect is recognized. The numerous illustrations are well designed for their particular aim, and make the book very good value indeed for its modest price. Mr. Lockley's volume is a guide to bird haunts in the neighbourhood of London. Each chapter deals with a particular type of habitat, ranging from chalk country to salt marsh, from orchard and park to heather and pines, and pleasantly describes its characteristic bird-life. Actual localities are named, even means of getting there being indicated, and the book should prove very helpful to many who wish to explore the home counties in search of birds.

(2) Mr. McWilliam's book fills a gap among the local faunistic studies of its kind. It gives a straightforward and useful account of the occurrence of different species in the Firth of Clyde and the counties bordering it : the area, of course, includes the great sea-bird nursery of Ailsa Craig.

**Das Zooplankton der Binnengewässer :**
Einführung in die Systematik und Ökologie des tierischen Limnoplanktons mit besonderer Berücksichtigung der Gewässer Mitteleuropas. Von Prof. Dr. W. M. Rylov. (Die Binnengewässer : Einzeldarstellungen aus der Limnologie und ihren Nachbargebieten, herausgegeben von Prof. Dr. August Thienemann. Band 15). Pp. x+272+30 plates. (Stuttgart : E. Schweizerbart'sche Verlagsbuchhandlung (Erwin Nägele) G.m.b.H., 1935.) 30 gold marks.

THIS work should perhaps have been entitled "Introduction to the Study of the Zooplankton". It is essentially a book for the student or one about to embark upon some limnological problem, and in these cases it should prove of the greatest value.

In the general introductory chapter, as well as in the sections dealing with the main groups of planktonic animals, there will be found in outline the present-day knowledge of such problems as reproduction, food, adaptations and vertical and horizontal distribution of the freshwater zooplankton. There is given, too, a brief introduction to the question of seasonal form variation and to the hypotheses of Wesenberg-Lund, Ostwald and Woltereck. References to a full literature list enable any particular aspect to be pursued in greater detail. Finally, the diagnostic keys, descriptions and plates of only those animals most likely to be encountered will greatly facilitate the task of sorting and identifying collections made in the field.

For the more advanced worker the book is naturally of less value, since the greater part is devoted to systematic descriptions of the commoner Rotifera, Cladocera and Copepoda of the plankton. The list of synonyms (pp. 221–224) is of service to those whose interests are only secondarily systematic. From it they will learn, surely with regret, that the genus *Keratella* disguises such characteristic rotifers as *Anuræa cochlearis* and *An. aculeata*, and that the latter now becomes *K. quadrata*.

**General Chemistry :**
an Elementary Survey ; emphasizing Industrial Applications of Fundamental Principles. By Prof. Horace G. Deming. Fourth edition, rewritten and revised. Pp. xiii+774. (New York : John Wiley and Sons, Inc. ; London : Chapman and Hall, Ltd., 1935.) 17*s.* 6*d.* net.

PROF. DEMING's popular text-book has been extensively revised in its new edition, and many new sections have been added. It now contains brief, but accurate, accounts of numerous modern physico-chemical topics, such as photochemistry, the Raman effect, atomic structure and valency (Chapter xxiii), activity theory of electrolytes and *p*H values. The industrial sections have also been revised and amplified to take account of modern practice.

Although the interest and value of the book have been greatly increased, its appeal to the more elementary student is lessened. The reviewer is not altogether in sympathy with the plan of introducing unbalanced equations in the earlier part of the book, as this will encourage a habit which teachers find it hard enough as it is to eradicate among students. Balancing equations should be taught as soon as they are used.

Prof. Deming's book, although it does not fit in with any English course, will be found very interesting and suggestive by teachers.

**The Self in Psychology :**
a Study in the Foundations of Personality. By A. H. B. Allen. (Psyche Monographs, No. 5.) Pp. 282. (London: Kegan Paul and Co., Ltd., 1935.) 10*s.* 6*d.* net.

MR. ALLEN, with whom we are familiar as the author of "Pleasure and Instinct", gives us his views on the relation of the self to psychology. Many of the moderns will find it difficult to accept his definition of psychology as the natural history of the *conscious* experience of *men*. Are the rest of the animal kingdom to be denied any consideration under the caption psychology ? That the study of subjective experiences is the sole province of psychology, and that those phenomena which are only open to inspection by another observer are not to be included seems to us an alarming doctrine, to say the least of it.

# Indian Conjuring

By Lieut.-Colonel R. H. Elliot, late I.M.S.

THERE is a widespread belief among British people who have not visited the East that India is the 'home of mystery'. I have come across not a few men and women in high and responsible positions who share this erroneous idea. In 'the dim red dawn of man' every strange natural phenomenon was ascribed to the supernatural. Slowly but surely knowledge grew, explanations displaced superstition, and reason, greatly daring, trespassed more and more on the once undisputed domains of the gods, with the result that one mystery after another was resolved by the onward march of common sense. The area of the 'supernormal' has steadily shrunk, and is daily still shrinking. The discovery of facts has always preceded the explanation of their causal origin. There are many things which still puzzle us ; we have no valid explanation for them ; we freely admit our ignorance and wait for the advance of the tide of knowledge which we believe will sweep on irresistible and ever progressive, washing out as it goes the ripples on the sands of ignorance.

In the early days of our colonization of the East, men watched with wonder the fearlessness with which the Indian snake-man handled his dangerous pets. They saw 'the mango trick', the disappearance of the girl from the basket which was stabbed in every direction by a sword, and the speedy return of the young woman unharmed at the bidding of her master. Then there was the duck, which bobbed at every word of command, answering by the number of its bobs the questions of the performer, and so on. At first the European looked on at these and at a number of other wonders of the same kind, and following the line of least resistance, ascribed the phenomena to mysterious causes which were beyond finding out. As time went on, men who had been imbued with an interest in conjuring before they left 'home', started to study the 'tricks' which had obtained so wide a fame. To their surprise they soon found that conjuring as practised in the East was dependent on the very same factors which governed the art they had learnt at home.

The veil of mystery which had shrouded the Orient was little by little lifted to expose trickery, misdirection and humbug. There was, however, one great difference. In the West, the performer made no bones about the fact that he was deceiving his audience, whilst the Eastern always claimed supernatural powers for himself. Around all his doings he threw a veil of mystery ; he was and is a past-master in the art of humbugging his clientele ; he never allowed one of his tricks to be taken as a laughing matter ; his whole technique was that of the 'priest of mystery' ; the matter was a very serious one, no matter how trivial the 'experiment'—he would not have it called a trick for anything—might be.

Step by step our people unravelled the mysteries, dragged them into light and saw them in all their pitiful fraudulence, until it became clear that the fact that a man has a brown, black or yellow skin, and lives in far-away parts of the earth little known to the majority of us, gives him no claim whatever to mystery. Man is man wherever you may find him ; his powers are as limited in China as in Chiswick, in Tibet as in Tooting. Nearly 2000 years ago Tacitus coined the phrase "omne ignotum pro magnifico", a dictum which has pricked the bubble of many a mystery. The wonderful 'mango trick' is based on such barefaced deception that were a performer to present it before the "Magic Circle" at one of our monthly meetings, he would be laughed off the stage. The marvellous nodding duck is dependent on a principle so elementary that my grandson of eleven years of age—a budding magician—would hesitate to use it, unless it were combined with other methods which would help to conceal the fraud. The earthenware medallion, on which the Christian is invited to inscribe the symbol of his faith, with the result that though the disk is ground to powder beneath his foot, the cross is found imprinted on his hand, suffices at first to astonish the subject of the experiment, until he has had time—provided he has the intellect—to solve the very simple device which led him astray. The wonderful seer who reads your fortune in the sand tells you things which seem supernatural in their source, unless you realize that your personal servant has been impanelled to help deceive you. Your conversation has been listened to, your letters read and the information so gained has been handed to the 'holy man' in exchange for the receipt of a small coin of the realm. One might go on with a number of other 'tricks' ; and please note that 'tricks' they are, nothing more and nothing less.

At the present time, most sensible people know all about the majority of these wonders of the East, but two remain to puzzle and disconcert a number of our fellow-countrymen, even including some who have spent the best years of their lives in the East. I refer to the 'Rope Trick' and to 'Levitation'. The Occult Committee of the Magic Circle, a Committee of which I have the honour to be chairman, spent a great deal of time sifting the evidence in favour of the former performance, for which supernatural origin has been so freely claimed. At a meeting held in London on April 30, 1934, with the late Lord Ampthill, a former acting-Viceroy of India, in the chair, we submitted a résumé of the evidence which we had collected. Lord Ampthill said that during his viceroyalty he had tried hard to see the 'rope trick', but in vain. Similar evidence had been sent us by letter from the late Viceroy, Lord Irwin. Lord Meston, the Right Rev. the Bishop Welldon (formerly Metropolitan of India), Sir Michael O'Dwyer and others supported Lord Ampthill, whilst the last-named mentioned that he had asked the Nizam of Hyderabad if he could help him, but though probably the most powerful prince in India, His Highness could not do so. Those who are interested in the subject will find it fully discussed in the second and third chapters of my book "The Myth of the Mystic East" (Blackwood).

No better illustration could be given of the way in which evidence in favour of this trick has been adduced than the statement made by a correspondent in the *Western Morning News* of November 29, 1934, who wrote as follows: "According to a correspondent, the Indian Rope Trick was performed before several hundreds of men who landed in India from Her Majesty's troopship Malabar. It was performed several times a day, not in bad light or when it was dark, but in the full light of the Indian sun. The Duke of Connaught watched the performance sitting on his horse and seemed highly interested." This story, so circumstantially told, seemed as if it must be true, but I had the privilege of being able to submit it to His Royal Highness, through the kindness of a member of his staff, and this is the reply I received: "With reference to the enclosed letter from Colonel Elliot, I sent it to the Duke. Quoting from his letter, he says: 'After these many years I am unable to remember small events of that time, but I have no recollection of ever having seen the rope trick during my service in India, or even heard of it.' " It is impossible to believe that His Royal Highness would ever have forgotten such a supernormal happening. I am greatly in His Royal Highness's debt for so graciously answering my question. It serves to show the way in which the names of our Royal Family are used behind their backs, in a manner which it is very difficult for them to resent. Their outstanding popularity carries great weight with the public, and leads many people to accept stories as ridiculous as this.

There are two recent incidents which deserve a brief mention. The first of these was the so-called 'Cheltenham Rope Trick'. A gentleman who styled himself "Professor" declared that he had discovered how to perform the 'Indian Rope Trick', and had actually done it before a meeting of a society of conjurers. This statement was widely advertised in the Press, and a local photographer stated that he had photographed a girl "as she reached the top of the rope—but when he developed the film, to his amazement, no trace of the girl was to be seen. The rope was bare". I took some trouble to run this story to earth, and was in communication with officials of the society, and with a gentleman of undoubted honesty who was present at the meeting in question. What did it all amount to? It was just a joke at the expense of the local press-man. A wire had been suspended between the tops of two tall trees, a rope was hung from this, care being taken so to arrange the light that the wire was not visible, and the dupe was told that just before his arrival a girl had ascended the rope and disappeared. The members of the society were much annoyed at the publicity that this trick had attracted and were very unwilling that more publicity should be given to it than they could help. I had to fall in with their wishes. Measures had been taken to prevent any further absurd claims being made. All the same, from time to time notices appeared in the Press, dealing with this incident as if it were worthy of credence instead of being the joke—perhaps not in the best of taste—that it was. My son sent me a copy of it from an Indian paper in which it was taken seriously.

There remains the 'Plymouth Demonstration of the Rope Trick' by Karachi, who, by the way, in private life was a Mr. Arthur Darby. There can be no doubt that a number of honest witnesses, who, however, had not had the benefit of a training in conjuring, were taken in by Karachi, who was simply performing a conjuring trick, which some people have thought very clever, but which to those of us who have studied conjuring was a very cheap form of deception. Mr. Harry Price exposed it in the *Listener* (January 16, 1935), and there was a lot of correspondence on the subject, much of which called to mind Carlyle's bitter dictum on the subject of the intelligence of the population of Great Britain.

The other much disputed topic is that of the power of Oriental fakirs to practise 'levitation'. Many years ago, Messrs. Maskelyne put on a show in which a girl was apparently suspended in mid-air lying horizontally. Hoops were passed round her in various directions to show that there were no mechanical aids to her flotation. It need scarcely be said that it was simply a clever piece of illusion. The Eastern magician presents a similar trick, and much has been made of it in a recent issue of the *Illustrated London News*. Many Europeans have seen this clever performance, but some at least of those who have described it have not been very skilled observers. What actually occurs is substantially as follows: The girl lies on the ground and is covered up; a sort of tent is built round her; then under cover of it she is raised up; the tent is gradually taken away bit by bit, until she is seen lying suspended as it were above the ground, but with some of her coverings dropping down to the ground near her head end in what appears a very innocent way. The spectator is not allowed to go up and examine this drapery or he would find out that it conceals an iron post driven into the ground. Were he allowed further license, he would soon discover the secret of the trick, which indeed is very similar to the device used by Maskelyne long ago. An Indian civilian who occupied a high position in the country recently wrote to me describing how he had this trick performed in his compound at a garden-party. Among his guests was a well-known bishop who was greatly troubled by what he took for a satanic manifestation, until the Commissioner asked him how the man described his performance. "As a trick," replied the bishop. "Well, if he only claimed for it that it was a trick you may be sure it was nothing more. He would certainly not err on the side of modesty in his claims."

In reading of, or in listening to descriptions of this trick as given by men who have not had a training in conjuring—the art of suggestion and misdirection—I would urge readers to be very sceptical. They are often misled to think that events happened far differently from what they actually did. Time after time I have heard people describe what they thought they saw, and knowing how the trick was done I have been astonished that they can have been so hopelessly misled as to the real facts. The success of any and every conjuring show depends on this factor of deception.

We read and hear wonderful descriptions of *yogis* buried alive and being none the worse for it. In those cases in which expert conjurers have witnessed such experiments, it has been quite clear that the actual conditions were not those claimed by the performer. By means well known to expert magicians—I use the term without prejudice—the suffocation of the subject was easily avoided, though doubtless the experience was sufficiently unpleasant. I know the wonderful claims that have been put forward, but I have so often had the opportunity of checking such claims by careful observation and discovering their worthlessness that I am very far from being convinced.

Once again I would urge readers to look always for a natural explanation of any phenomenon, and when one is not forthcoming, to await the advent of more knowledge, confident that a normal and not a supernormal explanation is always forthcoming, provided that we have the requisite knowledge.

# American Early Tertiary Mammals

THE White River formation of western North America contains numerous well-preserved fossil skeletons of mammals which date back to Oligocene times when some present-day families were beginning to flourish. The rocks seem to have been formed by floods on a very extensive plain, where the carcases of animals which lived under varied conditions were washed together repeatedly during a long period. The fossils therefore give a very good idea of the mammals which were living on the North American continent during a particularly interesting episode in the evolution of mammalian life. They have already been described in numerous scattered works and papers, but modern methods of collecting have provided so many more satisfactory specimens that there is now an opportunity for a comprehensive review of the whole fauna.

Such a review is being undertaken by Prof. W. B. Scott and Prof. G. L. Jepsen, of Princeton University, who have just published the first part of their work dealing with the Insectivora and Carnivora*. None of the Insectivora has the vacuities in the bony palate and the incompleteness of the zygomatic arches which characterize some existing Insectivora, so that these must be regarded as degenerate, not primitive features. Of the Creodonta or earliest Carnivora, only some Hyænodontidæ survive in the American Oligocene, but very fine skeletons have been obtained from the White River formation. The authors are as much puzzled as previous investigators to explain the use of the long passage above the palate of

* The Mammalian Fauna of the White River Oligocene. Part I. Insectivora and Carnivora. *Trans. Amer. Phil. Soc.*, N.S., 28, Part 1. Pp. ii+153+22 pl. (Philadelphia: American Philosophical Society; London: Oxford University Press, 1936.)

*Hyænodon* by which the internal nostrils are displaced as far backwards as those of a crocodile. They remark that "there is no other feature in the teeth or skeleton of the hyænodonts to suggest amphibious habits". They also point out that *Hyænodon* cannot have fed on ants like the existing ant bear (*Myrmecophaga*), which exhibits a nearly similar arrangement of the palate.

The beautifully preserved skeletons of Canidæ or dogs are especially interesting, because they show that in Oligocene times the family was not so completely distinguished from other Carnivora as it is at present, while one genus, *Daphœnus*, seems to be the common ancestor of at least three distinct groups of modern Canidæ. The smaller Oligocene dogs must have looked much like civets.

There are very few Mustelidæ in the White River formation. This family seems to have been much more characteristic of the Old World than of the New World during Oligocene times. Of the Felidæ, no true cats have been found in North America before the Pliocene, but the sabre-tooth cats or Machairodontinæ are well represented in the White River formation. They are all much smaller than the familiar 'sabre-toothed tiger' of later date, but it is interesting to observe that the articulation of the lower jaw in the Oligocene genera is as completely adapted for the wide opening of the mouth as it is in the latest Pleistocene genera. There is no doubt that the sabre-shaped canines were used for stabbing ; and one skull of *Nimravus* in the museum of the Dakota State School of Mines exhibits a large gash in the brain-case that was evidently made by such a stab.

From this brief summary it is clear that Prof. Scott and Prof. Jepsen are doing much more than providing technical descriptions of the fossils. They are publishing an illuminating treatise on Oligocene mammals, of which the succeeding parts will be eagerly awaited. A. S. W.

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# Daniel Gabriel Fahrenheit (1686-1736)

AMONG the many improvers of the thermometer in the eighteenth century, none laboured more assiduously or successfully than Daniel Gabriel Fahrenheit, the German natural philosopher and instrument maker who died in Holland at the early age of fifty years on September 16, 1736. His work was done at a time when the physical and medical sciences were making rapid advances, and there was great need for thermometers of good construction and furnished with a standard scale which could be used for comparisons. It was this need that Fahrenheit met. He was not the first to make thermometers, the first to use alcohol or mercury, or to devise scales with fixed points, but his improvements were such as to make his thermometers known all the world over, and though to-day it is generally recognized that the universal use of the centigrade scale would be a great advantage, the Fahrenheit thermometer seems likely to remain in use for many years yet.

For nearly a century before Fahrenheit's time, men of science had been using thermoscopes and thermometers, and a grand array of names is associated with their early history. Galileo, Boyle, Huygens, Hooke, Halley and others all contributed to the progress of thermometry. Doctors were especially interested in thermometers by which the temperature of human beings and animals could be taken, while natural philosophers required thermometers as much as barometers. The term 'thermometer' is first mentioned by the French Jesuit, Father Leurechon (1591–1670), in his "Récréation mathematique" published in 1624. The early instruments were subject to changes in atmospheric pressure and were really 'baro-thermoscopes'. Ferdinand II, Grand Duke of Tuscany (1610–70), founder of the Accademia del Cimento at Florence, was the first to produce a thermometer unaffected by atmospheric pressure.

There were all sorts of ideas regarding the graduation of thermometers. In 1665 Boyle suggested the freezing point of aniseed oil, and Huygens in the same year suggested as fixed points the freezing point and boiling point of water. Snow in very cold weather, the greatest heat in summer and melting butter were also proposed for definite temperatures. There were also many suggestions regarding scales, about a score of scales being used in the eighteenth century, of which, however, those due to Fahrenheit, Réaumur and Celsuis, or perhaps more correctly Martin Strömer, alone survived.

It is well known that Fahrenheit was the first to bring the mercurial thermometer into general use, that he devised his well-known scale about 1714, and that he described his method of making thermometers in five short papers in Latin to the Royal Society in 1724, but it is not generally known how he came to be an instrument maker. The bicentenary of his death, however, has led to the publication of a biographical memoir in the *Transactions of the Royal Academy of Sciences of*

*Amsterdam*, the authors of which, E. Cohen and W. A. T. Cohen-de Meester, add a great deal to our knowledge of Fahrenheit's personal history. This memoir shows Fahrenheit in a most pleasing light, gleaning information from many sources, writing and lecturing on such things as hydrostatics, optics and chemistry, and consorting with some of the most learned men of his time. Of special interest in this memoir are the references to some letters not long ago discovered in Leningrad. In one of these, written on April 17, 1729, to the famous physician Boerhaave, Fahrenheit tells of a visit in 1708 to the Danish astronomer Römer, whom he found placing thermometers in a mixture of ice and water and in blood-warm water. Inspired by his contact with Römer, Fahrenheit began to read about barometers and thermometers and studied the memoirs of Maraldi, de La Hire and Amontons in the publications of the Paris Academy of Sciences. Of the writings of British physicists, he knew only of Boyle's works, so far as they had been translated into Latin, as it was not until his visit to England and his election into the Royal Society in 1724 that he studied English.

Born in Dantzig on May 24, 1686, Fahrenheit was the eldest of a family of three boys and two girls, who were left orphans in August 1701 by the accidental death of both father and mother. He was sent by his guardian to Amsterdam to a merchant's house to learn business, and as a young man made journeys into Denmark, Sweden, Germany and Russia, probably settling finally in 1715 in Amsterdam, where by his lectures he stimulated the study of physical science and where he constructed the thermometers for which he will always be remembered. In 1736 he secured a patent for a mill for draining purposes but did not live to reap any benefit therefrom. His death took place at The Hague, and four days later he was buried in the Kloster kirke, the register of which contains the entry "Am 20 September 1736 am Tage begraben in dem Gewölbe unter dem Chor Daniel Gabriel Fahrenheit. Für Miete des Grabes und zwei Läuten 18 Gulden".

The memoir on Fahrenheit to which reference has been made above contains portraits of several of his most celebrated contemporaries, including Boerhaave, Römer, s'Gravesande, Musschenbroek and Nieuwentyt, but none of Fahrenheit himself.

# Obituary

## Mr. William Rintoul, O.B.E.

MR. WILLIAM RINTOUL died at the age of sixty-six years at his home in Ardrossan, Ayrshire, on August 25, after nearly a year's illness. His career had been a remarkable one, and began in Glasgow, where he was educated and received in Anderson's College his scientific training. In the late 'eighties there were (as there are even now) few schools of analytical chemistry, so that Mr. R. R. Tatlock not only filled the post of city analyst but also himself lectured and had a staff of lecturers on chemistry and physics to students many of whom afterwards became his assistants and later occupied important positions in the chemical profession. Ramsay was one of them.

After a short time as an assistant, Rintoul lectured to Tatlock's students until in 1891 a post of chemist offered in a paint manufacturer's near London, where he got chemical and works experience. After three years there he went in 1894 to the Royal Gunpowder Factory as a chemist in the laboratory, later becoming chemist-in-charge of the manufacture of nitroglycerine, and for two years before he resigned he was chief chemist in the laboratory.

At this time the Royal Gunpowder Factory under Sir Frederic Nathan as superintendent and Mr. James Thomson as manager led the explosives industry in Great Britain in organization, in safety precautions and in the invention of new processes and plant. Rintoul, naturally inventive and of remarkable manual skill, did his full share, of which the displacement process for the manufacture of nitroglycerine is an example. This process improved the manufacture of that explosive economically in that no high buildings were required to house the plant and also from the point of view of safety, as the nitroglycerine was removed (by upward displacement) from its acid mixture as soon as it had been formed and was sent at once for its preliminary washing, instead of being left to separate in bulk in an acid, and more or less dangerous, state. At this time also he was co-inventor with Robertson of a process and plant for the recovery of acetone, the solvent used in the manufacture of cordite.

Accompanying Sir Frederic Nathan to Nobel's Explosives Company (now part of Imperial Chemical Industries, Ltd.) at Ardeer in Ayrshire in 1909 as chief chemist, he became research manager there and devoted himself to the organization of the laboratories and erection of many new ones. His policy had several features which have been commended by others in like position, as for example, the provision that all chemists, whether destined for research or plant, should first undergo a thorough training in analytical chemical methods, the insistence on a good system of documentation of reports and of published work, the installation of physical methods of testing explosives and close contact with the universities.

While at Ardeer he was associated with a number of patents chiefly on stabilizers for explosives, and developed a keen interest in biochemical investigations, some of which are described (with Raistrick) in the *Philosophical Transactions of the Royal Society*.

About ten years ago Rintoul was brought up to the headquarters of Imperial Chemical Industries, Ltd., as a director of its research organization, from which he maintained an active and sympathetic contact with all the company's laboratories, and came into close touch with many prominent scientific men who were working directly or indirectly in the company's interests, for it was part of his duty to administer the support given by the company to widespread scientific activities. In these matters he gained the respect and affection of everyone with whom he came in contact, and as representative of his firm was well known abroad, where he attended many conferences.

Rintoul was made an O.B.E. for his work in the Great War, and assisted on many committees such as the Councils of the Chemical Society and Institute of Chemistry, the Safety in Mines Research Board, the Chemistry Research Board (D.S.I.R.), the Research Committee of the Midland Railway and the British Standards Institution. When he died he was president of the Faraday Society, in the discussions of which he took much interest.

Rintoul married twice: first Lottie Edwards, by whom he had two sons and a daughter, and secondly, two years ago, Jess Isabel Robertson.

R. ROBERTSON.

## Dr. N. A. F. Moos

To those interested in terrestrial magnetism and in Indian science, the name of Dr. Nanabhai Ardesher Framji Moos is well known, and they will learn with regret from *Current Science* for June of his death on March 12 last. Born in 1859, he graduated in engineering at the Poona College of Science in 1878, and after some years of teaching there entered the University of Edinburgh, taking the B.Sc. degree with distinction in 1886. On his return to India he held a series of appointments, including that of professor of physics at the Elphinstone College, Bombay.

At that time the observatory at Colaba, Bombay, was in charge of Mr. C. Chambers; and on his death, in 1896, Moos was appointed director, soon having the responsibility of overcoming the disturbances produced in the magnetic records by electric traction in the city. He shifted the magnetic work to a new observatory at Alibag, where he was most successful in handling the architectural difficulties of a constant-temperature room.

Moos had all the faithful conscientiousness that is found in Indian officers, and to that he added much of the Parsee energy and enterprise. His training in engineering, as well as in physics, gave him considerable interest in instrumental design, so that he loved to work out new patterns in seismometers. But his outstanding feature was his devotion to the observatory. He was ever on the look-out for new apparatus, and was determined that, if he could bring it about, the equipment of Bombay should not be inferior to that of any observatory in the world. For the financial difficulties of those in administrative charge, his sympathy was, not unnaturally, somewhat restricted; but in spite of an occasional disappointment his loyalty to his work never flagged.

Moos's great opportunity came with the plan for putting together and discussing the complete series of observations of the old Bombay Observatory; and the two volumes of "Colaba Magnetic Data, 1846–1905" are a monument of conscientious and successful labour. They form an indispensable part of the equipment of a magnetic library.

Moos had always taken a keen interest in the university life of Bombay, and after his official retirement in 1919 his active participation was kept up until the end.

G. T. W.

## Mr. J. L. Hodgson

MR. JOHN L. HODGSON died on August 14 at his home near Leighton Buzzard, at the early age of fifty-five years. Born at Lincoln and receiving his technical training at Nottingham University College, he leaves a life record of very valuable work in the engineering world. On the practical side, he served with Messrs. William Walker, the Gedling Colliery, Yarrow and Co., where he was associated with the late Sir Alfred Yarrow in research work on speed ships and destroyer design. About 1910 he was appointed to the staff of George Kent Ltd., of London, and became the technical adviser on all matters connected with the metering and control of air, gas and steam. It was he who designed the first Venturi air meters, which were installed by the Victoria Falls Power Co. He was also intimately concerned with the ventilation arrangements of the Mersey Tunnel. For one of his papers dealing with the use of the orifice for the measurement of fluid he was awarded the Telford Medal by the Institution of Civil Engineers.

Throughout his life, Hodgson abhorred waste in all forms, believing that scientific discovery and invention should be used for the service of man, and not for his destruction. He was one of the founders of the Engineers' Study Group, which was formed to study how and why there is "poverty amidst plenty" in our age. His death will be a severe loss to many friends.

WE regret to announce the following deaths:

Dr. Alexander Anderson, formerly president of University College, Galway, on September 5, aged seventy-eight years.

Mr. E. R. Deacon, O.B.E., head of the high explosives branch of the Directorate of Explosives Research, Woolwich, on August 29, aged fifty-four years.

Lord Moynihan, emeritus professor of surgery in the University of Leeds, and president in 1926–32 of the Royal College of Surgeons of England, on September 7, aged seventy years.

# News and Views

## The British Association and Social Science

THE Report of the Council of the British Association, adopted by the General Committee on September 9 at Blackpool, included two matters of particular interest relating to the development of the activities of the Association in the field of the social sciences. During the year covered by the Report, the Council appointed a Committee to consider how the Association might indicate the importance which it attaches to the development of the social sciences, either by the appointment of a third general secretary or by other appropriate means. As a result, this year's programme includes in a separate section the titles of addresses, papers, and discussions having a special bearing upon the relations between science and the interests of the community. Communications appropriate to this group may be suggested by organizing sectional committees or by sectional presidents. At least one discussion in each annual programme is to deal with the application of science to social problems, and at least one of the evening discourses. By these developments, it is intended to provide the evidence which public opinion now demands that the Association shall carry out one of its original aims, namely, that of "obtaining a more general interest for the objects of science".

## Incorporation of the British Science Guild

IN the same spirit, the General Committee accepted the recommendation of the Council for the incorporation of the British Science Guild in the Association. It will be remembered that the Guild was the outcome of Sir Norman Lockyer's presidential address to the Association, at the Southport meeting thirty-three years ago, on "Influence of Brain Power on History". The stated object of the Guild is "to promote the application of scientific method and results to social problems and public affairs". As is pointed out in the Report adopted at Blackpool, the same object is implicit in the aims of the Association; and the programmes of recent meetings have given evidence of a greater concern for these problems than was commonly exhibited in former years. The terms of the incorporation of the Guild in the Association include the transfer of the capital funds of the Guild to the Association, together with contingent bequests from Lady Lockyer and Sir Albert Howard. The Council of the Association will appoint a committee, to be called the British Science Guild Committee, which will be entrusted with arrangements for lectures already initiated by the Guild and for any similar lectures approved by the Council. The Norman Lockyer Lecture is to continue to be delivered annually and to have particular reference to the relations between science and the welfare of the community; and the Alexander Pedler Lecture is to be offered annually to one of the corresponding societies of the Association, or be delivered at a centre outside London. The amalgamation of the two bodies was greatly to be desired, and we are glad that it has now been accomplished. Though, when the Guild was founded, few men of science took active interest in the application of scientific methods to the investigation of social problems, there is now a decided change of attitude in this respect and the columns of NATURE have afforded abundant evidence of such repercussions. The Association has responded to this extended influence, and has thus shown itself to possess the progressive spirit which should be characteristic of every scientific institution.

## Jean-Sylvain Bailly (1736-93)

THE bicentenary of the birth of the French astronomer Jean-Sylvain Bailly, who was born in Paris on September 15, 1736, and perished on the scaffold at the age of fifty-seven years, recalls a career of great interest, for Bailly was not only a cultivated and distinguished man of science, but he was also one of the enthusiastic philanthropists who at the coming of the French Revolution adopted with ardour the popular cause and endeavoured to secure for the people sound constitutional reforms. The son of a keeper of the King's pictures, it was intended that he should follow in his father's footsteps as a painter, but literature proved more attractive than art, and science more alluring than either. It was his acquaintance with Lacaille that led him to astronomy, and one of his earliest labours was the reduction of Lacaille's observations on zodiacal stars. He also became known for his researches on Jupiter's satellites, but his greatest work was his "Histoire de l'Astronomie", a work full of animated description, luminous narrative and interesting detail. The correspondent of Voltaire and Buffon, the contemporary of D'Alembert and Diderot, Bailly's versatility was recognized by the unusual honour of his being elected a member of the Academy of Sciences, the French Academy and the Académie des Inscriptions et Belles Lettres.

ALL accounts of Bailly describe him as a man of the highest integrity, generous, courageous and liberal-minded. The popularity he enjoyed led to his election in 1789 as a deputy to the Tiers-Etat and to his being chosen president of the National Assembly. In his capacity of president he dictated to the members the oath taken in the Tennis Court at Versailles on June 20, 1789, "to resist tyrants and tyranny, and never to separate till they had obtained a free constitution". About a month after this, the Bastille fell, and on July 17, when Lafayette was made commander-in-chief of the new National Guard, Bailly was made Mayor of Paris. For two fateful years Bailly held his difficult posts, endeavouring amidst the rising tide of republicanism to serve both King and country. Then came his fall. On July 17, 1791, the demonstration took place in the Champ-des-Mars to secure signatures for a petition demanding the dethronement of the King. There was disorder and violence, Bailly gave the order for the crowd to be dispersed by force, fire was opened, some forty people killed and with the "massacre of the Champ-des-Mars" Bailly's popularity waned. A few months later, he resigned his posts and retired to Nantes. Two more years passed and against advice he visited Laplace at Melun. He was recognized and denounced, and was sent to Paris, where he was tried on November 10, 1793; on the next day he was condemned, and on November 12—a bitterly cold wet day—was taken in an open cart to the ill-fated Champ-des-Mars and there guillotined amidst the execrations of the people he had done his best to serve. Save for Lavoisier, who fell on the scaffold six months later, Bailly was the most distinguished man of science who fell a victim to the Revolution. He had, however, played a conspicuous and honourable part, and to-day his statue stands in the gardens of the Luxembourg.

### Vitamin $B_1$

THE structure of vitamin $B_1$ was made certain by its synthesis, recently announced from the laboratory of Prof. Williams of Columbia University (see NATURE, Aug. 29, p. 372), and this has now been repeated elsewhere. Grewe (*Hoppe-Seyler's Zeitschrift für physiologische Chemie*, 242, 89; 1936), working in Windaus's laboratory at Göttingen, describes the preparation of the pyrimidine half of the molecule, and completely confirms the latest formula put forward by Williams, though mention is only made of Williams's earlier suggestions which he himself has now modified. Grewe goes on to state that he had intended to work out a synthesis of the vitamin from the new pyrimidine derivative when he learned, through Prof. Windaus, that Andersag and Westphal had already accomplished this in the scientific laboratories of the I.G. at Elberfeld, and that patent protection had been sought. Prof. Williams's work was carried out with the collaboration of Merck and Co., Inc., Rahway, N.J.; it seems, therefore, on the cards that there may be some interesting developments in the patent field, should the synthesis of vitamin $B_1$ become practicable on a commercial scale.

### Half-Castes and World Peace

A NOVEL view of the problem of the half-caste and of the role which might be played by communities of mixed origin in the promotion of world peace is taken by Mr. Cedric Dover in a memorandum which he presented to the International Peace Congress held on September 3–6. In a cursory survey of the figures, he points out that not only are half-castes more numerous than is realized generally, but that they form an appreciable proportion of the populations of the modern world. Mr. Dover, however, does not rely on the mere weight of number. He goes on to argue that half-caste communities, consisting of 'marginal' men, who represent two cultures, and exist under conditions of 'imperialism', owing to the presence of a dominant white population, present parallelisms, due to a common ethnic element derived from their white blood, a common language (English), a common religious belief, and common social and economic conditions. It is suggested, therefore, that the continued growth of ethnic relations and mixed populations should be accepted as part of the machinery of human evolution, of which advantage should be taken to promote the greater ethnic unity and cultural uniformity, which would afford an efficient counter to an aggressive spirit of nationalism, while the creation of a united front of marginal communities would lead inevitably to better international understanding.

IF Mr. Dover's suggestions to this end tend to a more rational attitude towards the half-caste, they will have accomplished much. Miscegenation, however, has not been overlooked as a possible ultimate solution of the colour question; but the world, it would seem, is not yet prepared, on present evidence of the effects of the crossing of widely diverse strains, to foster it deliberately or even to countenance it. The organization of a world-wide front of sufficient strength to make its weight felt demands resources and machinery, of which at present there seems little expectation. Quite possibly local loyalties would prove obstacles stronger than the communal parallelism upon which Mr. Dover would rely.

### Roman Leicester

A FURTHER stage in the proceedings which will determine the future of Roman Leicester (see NATURE of August 29, p. 356) was reached on September 3, when an inquiry was held in the city by the Ministry of Health to examine the application of the Leicester Corporation to borrow £135,000 for the purpose of erecting baths on the site adjacent to the Jewry Wall, upon which archæological investigations are being conducted by Miss Kathleen Kenyon. The application was opposed by the Leicester Archæological Society, the Leicester Literary and Philosophical Society and the Leicester Civic Society, bodies co-operating in the excavation. They were represented by Mr. Macgregor Clarkson; and Mr. P. K. Baillie Reynolds, Inspector of Ancient Monuments, was also present, representing the Office of Works. In the course of his evidence, Mr. Clarkson stressed the unique position which the site conferred on Leicester. The recent discoveries, he urged, made it possible to point to the civic centre of the city in three historic periods—the Town Hall of Roman times, the Guildhall of the Middle Ages, and the modern Town Hall. Miss Kenyon's evidence dealt with the important archæological features of the site added by her investigations, including part of the Forum and the ten feet depth added to the Jewry Wall, part of the Roman Town Hall, which, now standing at 35 ft. in total height, is one of the largest Roman walls in Britain. This wall is scheduled as an ancient monument.

THE suggestion put forward by Mr. McEvoy, the Town Clerk, in stating the case for the application, was that excavation should proceed under skilled archæological supervision, the cost entailed over and above the normal cost of excavation to be borne by a local committee representing those interested in ancient remains. Against this, Mr. Colin D. R. Elles, the chairman of the excavation committee, handed in a petition, which had been signed by 3,235 persons in four days only, asking that the remains should be preserved; while Mr. Baillie Reynolds not only stated that his department would look with great favour on any scheme to preserve the remains, but also intimated that the Office of Works would co-operate in laying them out to advantage.

### Forensic Medicine

THE Advisory Committee on the Scientific Investigation of Crime, under the chairmanship of Lord Trenchard, recently issued its report (London : H.M. Stationery Office, 1936. 2*d.* net), from which it would appear that the teaching of forensic medicine in London is in an extremely backward condition as compared with the teaching of that subject in most of the capitals of Europe, and well behind the standard set in Scotland. As the Committee points out, this is not confined to the restricted sphere of criminal investigation and police practice, but extends to the study of many problems connected with social medicine and to the whole question of medico-legal practice. The Committee recommends the establishment of a medico-legal institute which would act as a training centre for medico-legal experts and as a centre for special pathological research, and it also suggests that facilities should be given for courses of instruction for students of law, coroners and other persons who are associated with medico-legal work.

As to the question of police laboratories, though in certain circumstances it is no doubt advisable to have laboratory facilities under the direction of the police, the proper place for extensive medico-legal investigations is in connexion with departments of universities. If the investigating authorities are to have the facility of obtaining advice on all kinds of scientific subjects, as they must, there is no possibility of so doing if they are restricted to police laboratories. Such advice and assistance can be obtained only through the universities. It is, however, impossible for the police authorities to know what departments to consult, and therefore a department of forensic medicine within the university offers the only means by which full use of the latest advances in science may be obtained. On considering the whole matter, it would appear to be advisable for the authorities in London to concentrate their efforts in founding a Department of Forensic Medicine in connexion with the University of London, and to make the necessary arrangements for the ample material, which is at present largely wasted, to be utilized in the teaching of elementary forensic medicine to medical students and to offer facilities for post-graduate study and research to those who desire to specialize in this subject.

### Technical College Equipment

WE have received from an Advisory Committee on Technical College Equipment, British Industries House, Marble Arch, London, W.1, a memorandum on a scheme in progress for setting up an exhibition at British Industries House showing the equipment necessary for technical institutions. This movement is designed to help those responsible for expenditure on these centres in view of the very large outlay anticipated during the next few years by the Board of Education. The Committee represents the three associations concerned with technical teaching and also the Institution of Production Engineers, and hence is an authoritative body. It is pointed out that the present method of deciding on a design, that of visiting recent buildings and utilizing the composite information obtained, wastes time and is unsatisfactory. Technical education in Great Britain is lamentably behind that on the Continent in the matter of material equipment and buildings, hence this scheme is to be commended. The relationships of the pieces of mechanism will no doubt be an important part of the Committee's work, though this must be to some extent subservient to the configuration of the floor space. More difficult will be the presentation of the structural features and service supplies essential as the basis of the equipment. It is stated that the object is to enable full information to be obtained for getting out estimates for building, extending, and equipping institutions. So far as the two former functions are concerned, it seems difficult to see how the exhibition can supply any detailed information, from the province of trained professional advisers and necessarily varying with local conditions; such advisers, however, should be able to learn much from the exhibition.

### Geological Survey and Museum: New Activities

A NEW publications stall, where the public may purchase the official guides and geological memoirs, including the series of handbooks on British Regional Geology referred to in NATURE of September 5 (p. 389), has been opened in the entrance hall of the new Geological Museum at South Kensington. The Museum has also published an extensive series of excellent photographic postcards, price 1*d.* each, which are likely to be of value to teachers of geology and physical geography. The postcards include reproductions of general views of the Museum, with dioramas and other interesting exhibits; and photographs of British localities of geological interest, with explanatory text, illustrating marine erosion and sea coasts, rock-weathering and denudation, vulcanism, glaciation, and similar subjects. A list is obtainable from the Museum. An experimental series of free public lantern lectures and lecture tours on the geology and scenery of various regions of Great Britain was given last month. The lectures were well attended, and will be continued throughout the winter. Facilities for special parties can be arranged. Recent additions to the exhibited collections include a series of specimens from H.M. Office of Works, illustrating the weathering of the building stone

(Anston stone) of the Houses of Parliament; and a suite of ores illustrating the occurrence of copper at Kilembe, presented by the Geological Survey of Uganda. This occurrence, which is in granulitic rocks, is remarkable for the presence of the cobalt ore linnæite, although arsenic and antimony are absent. Among the donations recently received by the petrographical department there is a valuable series of rock-specimens from the Pre-Cambrian of the Adirondacks, New York State, collected and presented by Dr. A. F. Buddington of Princeton University; and a second fine collection from the Charnwood Forest and Nuneaton areas, presented by Mr. H. H. Gregory of the Leicester Museum.

### Empire Fauna at Home and Abroad

THE August number of the *Journal of the Society for the Preservation of the Fauna of the Empire* presents some interesting contrasts in its varied accounts of wild life in different British territories. Capt. C. R. S. Pitman, to whose reports as Game Warden of the Uganda Protectorate NATURE has referred on previous occasions, in a lecture to the Society, explained why organized control of the 21,000 elephants of the Protectorate became necessary. The devastation caused by such great numbers in a limited area (of some 80,000 square miles), where the native population averages forty to the square mile, became intolerable, and yet under organized control, and in spite of the fact that 17,000 elephants have been slain in twelve years, the estimated number remains as it was in 1924. Capt. Pitman is of opinion that organized control is the finest insurance for the adequate perpetuation of the African elephant. From wild Africa we turn to the home of animal protection—and read Miss Frances Pitt's article upon the polecat and pine-marten in Great Britain. The elephants are over-numerous, do serious harm, are deliberately slaughtered, and yet their continued existence is secured; the polecat and pine-marten are rare, are two of the most interesting members of the primitive fauna which survive in Britain, they do no particular harm in any serious degree, and yet—the first is extinct in Scotland and England, and survives only on the Welsh border, and the latter is apparently extinct, or all but extinct, throughout the whole country except in the north-west of Scotland; and almost all because these creatures are liable to find their way into traps set for vermin. It is ironical that while we concern ourselves with the fauna of the Empire abroad, these two creatures should be disappearing in *our* own land under our eyes. Can no step be taken to ensure their adequate perpetuation, as the adequate perpetuation of destructive elephants in Uganda is ensured?

### Marine Biology at Cullercoats

THE Report for the year ending July 31, 1935, of Armstrong College Dove Marine Laboratory, Cullercoats, Northumberland, drawn up by the director, Prof. A. D. Hobson, and published by the Marine Laboratory Committee of Armstrong College, shows a successful period in the history of the Laboratory. Further alterations in the building have given more working space and the library has been extended, with most satisfactory results. Herring observations have been continued in accordance with those of previous years, also salmon investigations, the results of the latter work having been published in the Annual Report of the Tyne Salmon Conservancy Board. Interesting results have been obtained by Dr. Bull in his experiments on conditioned responses in fishes in connexion with changes of salinity, and he has also continued his observations on pollution in the Tyne estuary. Faunistic work, which has been made a speciality of the Laboratory researches, is progressing rapidly, many new additions have been made to the fauna, and a reference collection is in process of formation which will be of great value to future workers. A mussel survey of the Northumberland beds has been completed, and a report prepared and submitted to the Northumberland Sea Fisheries Committee. This report appears in the present publication, showing that the Holy Island and Budle Bay beds are the only areas of importance for bait supplies. Papers on the herring investigations by B. Storrow and Dorothy Cowan, on conditioned responses in fishes (Part 6) by H. O. Bull, and on heterogonic growth in the abdomen of *Carcinus mœnas* by J. H. Day (see NATURE, April 18, 1936, p. 669) are also included.

### Weed Problems in Australia

As in some other parts of the world, noxious weeds are proving a serious source of trouble in Australia. The problem has been under the consideration of the Standing Committee of Agriculture and independently by several of the bodies represented on it. An arrangement was made in 1934 that as a preliminary to further work an officer of the Council for Scientific and Industrial Research should undertake a survey of the problem, the economic importance of different weeds, methods of control which had been already tried and their results, and so forth; his report to include recommendations for further co-operative work. The survey was undertaken by Mr. G. A. Currie, of the Division of Economic Entomology, assisted in certain aspects by Mr. J. Calvert, of the Division of Plant Industry. The report has been recently drawn up by Mr. Currie, and the more important portions of it are published by the Council for Scientific and Industrial Research of Australia in Pamphlet No. 60, "A Report on a Survey of Weed Problems in Australia" (Melbourne: Government Printer, 1936). Apart from the study made of past records of the activities and damage resulting from weeds, the weed legislation of each State was studied and the methods of administration ascertained. The pamphlet outlines the losses incurred from weeds, and the existing methods of control and the relation of dangerous weed growth to various primary industries. There is much in this pamphlet which could be studied with advantage in Great Britain. Among the sixteen weeds selected as being the most important in Australia are such well-known ones as bracken, stinkwort, thistles, blackberry, St. John's wort, lantana, ragwort, convolvulus and wild turnip.

(*Continued on p.* 459.)

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# The Impact of Science upon Society*

By Sir Josiah Stamp, G.C.B., G.B.E., F.B.A., President of the British Association

DURING the past year we have had to mourn the loss of our patron, King George V, but to rejoice in the honour done us by His Majesty King Edward VIII, himself our most illustrious past-president, in taking that office.

Since the beginning of this century the British Association has, till now, added only one new place of meeting in Great Britain to its list. Blackpool can certainly do for science in the North all that Bournemouth achieved in the South: give our record new vigour, and itself a new friend.

The reactions of society to science have haunted our presidential addresses with various misgivings for some years past. In his great centenary address General Smuts, answering the question "What sort of a world picture is science leading to?", declared that one of the great tasks before the human race is to link up science with ethical values and thus remove grave dangers threatening our future. For rapid scientific advance confronts a stationary ethical development, and science itself must find its most difficult task in closing a gap which threatens disruption of our civilization, and must become the most effective drive towards ethical values. In the following year a great engineer spoke as a disillusioned man, who watched the sweeping pageant of discovery and invention in which he used to take unbounded delight, and concluded by deploring the risk of losing that inestimable blessing, the necessity of toil and the joy of craftsmanship, declaring that spiritual betterment was necessary to balance the world. Then came the president of the Royal Society, a supreme biochemist, on the perils of a leisure made by science for a world unready for it, and the necessity for planning future adjustment in social reconstructions. Followed the astronomer, deploring man's lack of moral self-control; in knowledge man stands on the shoulders of his predecessor, whereas in moral nature they are on the same ground. The wreck of civilization is to be avoided by more and not by less science. Lastly, the geologist gloried in the greatest marvel of millions of centuries of development, the brain of man, with a cost in time and energy that shows us to be far from the end of a mighty purpose, and looking forward confidently to that further advance which alone can justify the design and skill lavished on such a task. So the geologist pleads then for scientific attention to man's mind. He has the same faith in the permanence of man's mind through the infinite range of years

> "That oft hath swept the toiling race of men
> And all their laboured monuments away",

that is shown at the Grand Canyon, where, at the point exposing, in one single view, over a billion and a half years of the world's geological history, a tablet is put to the memory of Stephen Tyng

* Presidential Address delivered at Blackpool on September 9.

Mather, the founder of the National Park Service, bearing what is surely the most astonishing scientific expression of faith ever so inscribed :

"There will *never come an end* to the good that he has done".

We have been pleading then in turn for ethical values, for spiritual betterment, for right leisure, for moral advance, and for mental development, to co-ordinate change in man himself with every degree of advance in natural science in such a harmony that we may at last call it 'progress'. This extension of our deeper concern beyond our main concern is not really new, but it has taken a new direction. I find that exactly one hundred years ago there was a full discussion on the moral aspects, a protest that physical science was not indeed, as many alleged, taking up so much of the attention of the public as to arrest its study of the mind, of literature and the arts ; and a round declaration that by rescuing scientists from the narrowness of mind which is the consequence of limiting themselves to the details of a single science, the Association was rendering "the prevailing taste of the time more subservient to mental culture". A study of these early addresses shows that we are more diffident to-day in displaying the emotions and ideals by which I do not doubt we are all still really moved. But they also show that we are preoccupied to-day with some of the results of scientific discovery of which they were certainly then only dimly conscious. A part of that field, which ought itself to become scientific, is my theme to-day.

### Impact as the Point of Continuous Change

What do we mean by impact ? My subject is *not* the influence or effect of science upon society —too vast, varied and indeterminate for such an occasion. We may consider the position of the average man, along a line of change we call 'progress', at the beginning of a certain interval of time and at its end. We might then analyse how much is due to a change in the average man himself, his innate physical and mental powers, and how much to other influences, and particularly to science. We may debate whether the distance covered is great or small by some assumed standard, and whether progress has been rapid. We might ask whether the direction has been right, whether he is happier or better—judged again by some accepted standard. But our concern here is with none of these questions. I ask whether the transition has been difficult and distressing, in painful jerks and uprootings, costly, unwilling, or unjust ; or whether it has been easy, natural, and undisturbing. Does society make heavy weather of these changes, or does it, as the policeman would say, 'come quietly' ?

The attitude of mind of our order may be either that change is an interruption of rest and stability, or that rest and stability are a mere pause in a constant process of change. But these alternatives make all the difference to its accommodating mechanisms. In one case there will be well-developed tentacles, grappling irons, anchorages, and all the apparatus of security. In the other, society will put on casters and roller bearings, cushions, and all the aids to painless transition. The *impact* of science will be surprising and painful in one case, and smooth and undamaging in the other. Whatever may be the verdict of the past, is society and its institutions now learning that change is to be a continuous function, and that meeting it requires the development of a technique of its own ?

Science itself has usually no immediate impact upon institutions, constitutions, and philosophies of government and social relations. But its *effects* on people's numbers, location and habits soon have ; and the resistance and repugnance shown by these institutions and constitutions to the changed needs may rebound or react through those effects upon scientific enterprise itself, and make it more precarious or more difficult. Thus the effect of applications of electricity and transport improvements is clearly to make the original areal extent of city or provincial Governments quite inappropriate, and the division of functions and methods of administration archaic. If these resist change unduly, they make it more difficult and frictional, and the applications of science less profitable and less readily acceptable. Time makes ancient good uncouth. When two bodies are violent or ungainly in impact, both may be damaged. If the written constitution of the United States, devised for the 'horse and buggy' days, still proves not to be amenable to adjustment for such demands, it will be difficult to overstate the repercussion upon economic developments and the scientific enterprise that originates them. Let any Supreme Court decision of unconstitutionality on the Tennessee Valley experiment in large-scale applied science to natural problems on a co-ordinated plan bear witness. Such unnecessary resistance may be responsible for much of what has been aptly called 'the frustration of science'.

Avoidable friction in the reception given to scientific discovery not only deprives the community of advantages it might otherwise have enjoyed much earlier, or creates a heavy balance of cost on their adoption ; it may also discourage applied science itself, making it a less attractive and worthwhile pursuit. In that sense we are considering also the impact of society upon science. This, too, is not new. The Association had as one of its first objects "to obtain a more general attention to the objects of Science, and a removal of any disadvantages of a public kind which impede its progress". The first address ever offered affirmed that the most effectual method of promoting science was the removal of the obstacles opposing its progress, and the president instanced the very serious obstacles in the science of optics due to the regulations relating to the manufacture of glass. To-day, perhaps the scientist places more stress upon the failure of Governments to encourage than upon their tendency to discourage. So much then for the *idea* of impact. Is the scientist or inventor responsible for impact, and if not, who is ?

## The Question of Responsibility

Elsewhere I have retouched Jeremy Bentham's poignant picture of the inventor of over a century ago, plans and cap in hand, on the doorstep of the rich or influential, waiting for someone to believe in him. From this type of external 'sport' amongst engineers and scientists came much or most industrial innovation, external to the processes of business. To-day, in the older and applied sciences affecting industry, the solo scientist is the exception and, with the large research departments of particular businesses and trade research associations, the picture is quite different—the expenditure higher, but the results much more rapid and numerous, even if for a time they may be kept secret. Although records of finished work may be available over the civilized world, there is much overlapping of current work, but the price of this as a whole is a far smaller fraction of the total result, if we omit from our consideration the first-magnitude discoveries of epoch-making influence. The industrial community is now far more amenable than hitherto to scientific influence ; indeed it is often the instigator in the mass of minor advances.

The new epoch of concerted industrial research dates really from the end of the Great War. During all that time I have held some middle position of responsibility between the research laboratories and institutes on one hand, and the costing and profit and loss accounts on the other, and my impression is that the proportion of work in which the initiation comes from the business end is steadily increasing. In studies of the periods of scientific and industrial gestation respectively, I have elsewhere defined *scientific gestation* as the time elapsing between the first concept of the idea and its public presentation to society in a form substantially that in which it ultimately finds extensive use without important modification ; and *industrial gestation* as the period elapsing from this point to the date when in an economic or industrial sense the innovation is effective. Both periods are difficult to determine exactly in practice, but on a broad view, the period of industrial gestation, with which alone I am here concerned, appears to me certainly to have shortened materially, though possibly at greater social cost. It would obviously be so if industry is actively encouraging research. "Faraday's discoveries came at the beginning of the great steam era, and for fifty years there would have been no difference in transport, even if those discoveries had not been made", for the telegraph was the only material influence upon it, and practical lighting was delayed until 1900.

In nearly every scientific field there is subdivision of labour, and it is rare that the worker who digs out new truth 'at the face', so to speak, is also responsible for bringing it to the surface for the public use, still less for distributing the new scientific apparatus or ideas broadly, and even less for the profitable exploitation of the whole process. These functions are nearly always distinct, even though they are embraced under one general popular description : chemist, engineer, etc. But in few cases is it any part of the professional training in the subject itself, to study how new products or processes affect the structure or welfare of society. I have questioned many scientific workers, and find them, of course, keenly alive to the positive and direct beneficial effects of their work, but they have rarely any quantitative ideas as to negative, indirect and disturbing consequences.

All these discoveries, these scientific infants, duly born and left on the doorstep of society, get taken in and variously cared for, but on no known principle, and with no directions from the progenitors. Nor do the economists usually acknowledge any duty to study this phase, to indicate any series of tests of their value to society, or even of methods and regulation of the optimum rate of introduction of novelty. These things just 'happen' generally under the urge of profit, and of consumers' desire, in free competition, regardless of the worthiness of new desires against old, or of the shifts of production and, therefore, employment, with their social consequences. The economist rightly studies these when they happen, but he is not dogmatic about them not being allowed to happen at all in just that way on account of the social disturbance or degradation of non-economic values which they may involve. It is truly a 'no-man's-land', for it is rarely that the functions of government begin until a vested problem exists. Especially in Britain we do not anticipate—"Don't worry,—it may never happen".

Problems with us are usually called 'academic' until we are 'going down for the third time'. It is a maxim of political expediency not to look too far ahead, for it is declared that one will always provide for the wrong contingency. The national foresight over wireless was exceptional, and it has to be contrasted with the opportunist treatment of the internal combustion engine. In reply, it can, of course, be urged that no one can foresee just how a scientific idea will develop until it is tried out, rough and tumble, in economic society, and to make anticipatory rules may even hinder its development.

## The Scientific Worker in the Wider Field

It is rightly stated that the training of the scientist includes no awareness of the social consequences of his work, and the training of the statesman and administrator no preparation for the potentiality of rapid scientific advance and drastic adjustment due to it, no prevision of the technical forces which are shaping the society in which he lives. The crucial impact is nobody's business.

When the research worker lifts his attention from his immediate pursuit and contemplates its hinterland, he has three possible areas of thought. He may dwell upon its practical applications and seek to make them as immediate and realistic as possible ; moved by the desire not to be merely academic, he may return to his task, to focus his attention primarily on what is likely to be of practical utility, rather than on what is intellectually intriguing. Or he may think of its ultimate social consequences, and speculate on the shifts in demand, the unemployment, the loss of capital, the ultimate raising of the standard of life that may result—in other words, he may engage in economic prevision and social and political planning for the results of his efforts. Or, in the third place, he may listen and watch for hints from other fields of scientific study which may react upon his own, and suggest or solve his problems. I do not attempt to give these priority. Economic and political prevision is the most difficult and precarious, because it needs a technique different from his own, and is not given by the light of Nature.

Specialist scientists have no particular gifts for understanding the institutional processes of social life, and the psychology of multiple and mass decisions. It is a tortuous and baffling art to transmute their exact findings into the wills and lives of unscientific millions. But quite a number engage in the pursuit, and have not much greater aptitude as amateur ministers of foresight than statesmen would have in planning research. Fewer are skilled, however, in what should be the most appropriate auxiliary to their work—the synthesizing of scientific knowledge. The more penetrating they are in their main pursuits, the less may they absorb through analogy or plain intimation from outside. We constantly hear that the average clinical application lags much farther behind the new resources of diagnosis from the laboratory than circumstances compel. But it may be the other way round. The strongest hint of the presence of a particular factor—a positive element in beriberi—was given by the clinician to the biochemist, who relied entirely on the *absence* of a particular factor, a negative element, no less than fifteen years before the biochemist took serious notice, looked for it, and found it. Bacteriology and chemistry await the advance of the biochemist before they come effectively to each other's assistance. The cause and prevention of the obstinate degree of maternal mortality are objects pursued *ad hoc*, with scarcely a casual glance at the direct appeal of the eugenist to observe the natural consequences of an improvement in female infant mortality two decades earlier.

I do not then pretend to dogmatize as to how far the scientist should become a social reformer. One physicist welcomes the growing sense of social responsibility, among some scientists at least, for the world the labours of their order have so largely created, though he deplores that in this field they are still utterly unscientific. Then another great authority, Sir Henry Dale, declares that it is the scientists' job to develop their science without consideration of the social uses to which their work might be put.

I have long watched the processes by which the scientific specialist 'makes up his mind' in fields of inquiry outside his own. It seems still a matter for investigation whether the development of a specialist's thinking, on balance, impairs or improves the powers of general thinking compared with what they might otherwise have been. We do not know the kind or degree of truth that may rest in Anatole France's aphorism : "The worst of science is, it stops you thinking". Perhaps this was more subtly expressed in the simpler words of the darkie mother : "If you haven't an education, you've jest *got* to use yoh brains".

My own experience is that when the attempt to deal with social consequences is made, we quickly find ourselves either in the field of larger politics debating the merits of the three prevalent forms of State government, or else performing miracles with fancy currencies and their blue prints reminiscent of the chemical engineer.

### Human Aspects of Changing Industry

There are, however, some essential features of the impact which must be dealt with under any form of society and government, and with any machinery for regulating values. They involve man's abilities, his affections, and his tools, all of which have been brusquely treated in the past, and might be scientifically treated in the future. An industrial civilization is unthinkable without division, and, therefore, specialization, of labour, and without tools and capital instruments. Then life itself is not much worth living without social ties and the allegiances of place and kin. These three indispensable elements of the good life bring out defensive mechanisms for their protection. No one likes to see a man, highly trained for a special service or specially fitted by natural aptitudes, cut off from opportunity to use his powers and reduced to the level of an unskilled biped. No one likes to see the results of abstinence and specially directed labour which is embodied in a great machine or factory rendered impotent long before it has given its life's usefulness. Waste of skill and of capital are alike grave faults by which we should judge and condemn an industrial organization. Since man does not live by bread alone, if a ruthless industrial organization continually tears up the family from its roots, transferring it without choice to new surroundings, destroying the ties of kin, home and social life, of educational and recreational environments, it is far from ideal. Human labour can never be indefinitely fluid and transferable in a society that has a soul above consumption of mere commodities.

These three obstructions to change are not final and rigid limitations upon it. Men die, their skill and home associations with them. Plant and equipment wear out. Their successor presents a natural opportunity in each of the three cases for the introduction of change in position, in aptitude, in purpose or design, without waste or human distress. The length of working life and the durability of materials mark the natural phase or periodicity of a smoothly changing society —its quanta, so to speak. But the impetus for change or the irritant has no such intervals. It proceeds from various causes : varying harvests, changes in natural forces ; changing human desires and fashions ; differences in the rate of growth of population in its different parts ; the collective psychological errors of optimism and pessimism in business in an individualistic society ; variations in gold supplies and credit policies based thereon. All or any of these, without invoking any disturbances from the impact of scientific discovery, would serve to make adjustments necessary outside the natural phases to which I have referred, in a society with parts that are interdependent through division of labour, and localization of industry, joined by foreign trade and convenient transport. These alone would bring about a changing world with incomplete adaptations, loss of capital, and so-called frictional unemployment.

It is easy to exaggerate the adjustment necessary for the addition of invention and science to these causes of change. But with the intensification of scientific effort, and the greater sub-division of industry, the possible dislocation becomes more frequent, and the ways of meeting such change of greater public importance. This field of inquiry includes widely diverse questions, for example, patent laws, invention clearing, obsolescence accountancy and costing regulation, taxation adjustments, local rating pooling, trade union regulations, price controls, technical education, age and other discriminations in unemployment relief, transfer bonuses, pension rights, housing facilities, and more selective direction of financial support of intensive scientific research. In this neutral field the specialist scientist and the politician are both amateurs. It is to be covered by each extending his studies, and by specialists who treat impact and change as an area of scientific study.

I do not propose to go over all the ground, so old, so constantly renewed, as to the effect of machinery upon employment. It is known as a historical induction that, in the long run, it makes more employment than it destroys, in providing work in making the machinery, in reducing price so that far greater quantities of the commodity concerned may be consumed, and in enabling purchasing power to be diverted to increase other productions. It has even facilitated the creation of a larger population, which in turn has provided the new markets to work off the additional potentiality of the machinery. It does all this in 'the long run' ; but man has to live in the 'short run', and at any given moment there may be such an aggregation of unadjusted 'short runs' as to amount to a real social hardship. Moreover, it comes in this generation to a people made self-conscious by statistical data, repeated widespread at frequent intervals, and to a people socially much more sensitive to all individual hardship and vicissitude which is brought about by communal advance.

### The 'Balance of Innovation' and Population

There are two important aspects of the change induced by science which are insufficiently realized, and which make a profound difference to the direction of thought and inquiry. The first I will call the 'balance of innovation' and the second the 'safety valve' of population.

The changes brought by science in economic life may be broadly classified as the 'work creators' and the 'work savers'. The latter save time, work and money by enabling the existing supply of particular commodities to be produced more easily, and therefore at lower cost, and finally at lower prices. People can spend as much money as before upon them and get larger quantities, or they can continue to buy their existing requirements at a lower cost. In this second event they 'save money' and their purchasing power is released for other purposes. By a parallel process, producing or labouring power is released through unemployment. The released working force and released purchasing power can come together again in an *increased* demand for other products which, to this extent, have not been hitherto within effective demand. The supply of this increase may go part or all of the way to absorb the displaced labour. But this process takes time, and the labour displaced is not at once of the right kind or in the right place. More important, however, is the invention of quite new objects of public demand, which may be desired in addition to the supply of old ones. This brings together released labour and released purchasing power in the most decisive way.

The most orderly and least disturbing phases of progress will be found when these two types of innovation are reasonably balanced. Of course, few new objects of purchasing ambition are entirely additive ; most of them displace some other existing supplies. Artificial silk displaces some cotton consumption, radio may displace some types of musical instruments. Recently the German production of pianos and guitars has been at a very low percentage of capacity, and part of this has been made good by the demand for radio sets. The dislocations caused by labour-saving machinery can most easily be made good by a due *balance* of new labour-creating commodities.

A natural increase of population is the best shock absorber that the community can possess, especially if accompanied by an extension of territory such as the United States enjoyed in the constant westward movement of the frontier in the nineteenth century, or Britain in the period of overseas emigration. A moment's reflection will show why this is the case. Assume that 1,000,000 units of a commodity are made by 100,000 men, and that there is an increase of population of 2 per cent per annum, so that in five years 1,100,000 units will be consumed and employ 110,000 men. Now assume the introduction of a new invention which enables 1,100,000 units to be made by 100,000 men. There will be no displacement of existing labour, but only a redirection of new and potential labour from that industry to other fields. Again, a considerable reduction in demand *per head* can be sustained without dislocation, if the actual aggregate of production demanded is maintained by increasing numbers. The affected industry can remain static and need not become derelict. New entrants to industry will be directed to those points where purchasing power, released through labour-saving devices, is creating new opportunity with new products. New capital is also naturally directed into the new channels, instead of into additions to the old industry.

Now the problem before all Western industrial countries is the fact that their populations are shortly becoming stationary (and then will begin to decline noticeably) and this safety valve of increasing population will no longer be available. Every transfer of *per capita* purchasing power to new directions must then be a definite deduction from the old directions, no longer made good by the steady increase in the numbers demanding less per head from those old sources. The impact of science upon a stationary population is likely, *ceteris paribus*, to be much more severely felt than upon a growing population, because the changes of direction cannot be absorbed by the newly directed workers. Of course, the effects of a static population can be mitigated if the *per capita* income is increasing, because a new direction of demand can be satisfied out of the additional purchasing power without disturbing the original directions of demand provided by the original purchasing power.

The change from a growing to a static or declining population is only one type of difficulty. While the aggregate is altering but slowly, the parts may be changing rapidly. Thus, in Great Britain, 40·4 millions in 1937 becomes 40·6 in 1942, 40 in 1947, 39·8 millions in 1952, 38·9 in 1957 and 37·5 in 1962. But the children aged sixteen years—which I take because of its influence on schools, teaching and industrial entry—have been estimated, taking those in 1937 as 100, to be 85 in 1942, 73 in 1952 and 62 in 1962. A fall of this magnitude means that industries and institutions dependent upon the present numbers must not be merely static but actually regressive. On the other hand, the old people from sixty-five to seventy-four years will increase in this ratio—100, 113, 127, and 133. These problems of static populations at home are accentuated by the possibility of a similar tendency abroad, and need thought in advance. The Australian farmer is more affected by the British conditions of population than by his own.

We have thus the first difficulty, that of a static total demand, the second, that the safety valve of new industrial entrants is becoming smaller, but a third difficulty comes from the present tendency of that class. A stationary elderly population must be very inflexible to change, but a stream of new young life, even if it is to be smaller, would give the opportunity for just that change of direction, in training and mobility, which society needs. But unfortunately, in practice this does not now seem to be very adaptable. For we learn from certain Unemployment Insurance areas that while the older people will willingly take jobs at wages a few shillings in excess of the unemployment relief, the younger men are more difficult. For every one that will accept training under good conditions to suit them for eligible work, ten may refuse, and the number who will not go any distance to take work at good wages is also in excess of those who do. Attachment to place for older people is understandable, and has been accentuated by housing difficulties—one learns of miners unemployed in a village where the prospects of the pit reopening are negligible, while at the same time, only twenty miles away, new miners are being created by attraction from agriculture to more extended workings in their area. The very social machinery which is set up to facilitate change or to soften dislocation aggravates the evil. The first two difficulties are unalterable. This third difficulty is a subject for scientific examination.

### Industrial Disequilibrium

So much for the effect of change of any kind upon employment. Now let us narrow this to scientific changes. At any given moment the impact of science is always causing some unemployment, but at that same time the constructive additional employment following upon past expired impacts is being enjoyed. But it is easy to exaggerate the amount of the balance of net technological unemployment. For industrial disequilibrium arises in many ways, having nothing whatever to do with science. Changes of fashion, exhaustion of resources, differential growth in population, changing customs and tariffs, the psychological booms and depressions of trade through monetary and other causes, all disturb equilibrium, and, therefore, contract and expand employment in particular places.

Our analytical knowledge of unemployment is bringing home the fact that, like capital accumulation, it is the result of many forces. A recent official report indicated that a quite unexpected amount or percentage of unemployment would be present even in boom times. We know already that there may be a shortage of required labour in a district where there is an 8 or 10 per cent figure of unemployment. So, in Great Britain there may well be a million unemployed in what we should call good times—it is part of the price we pay for the high standard of life secured by those who retain employment. For a level of real wage may be high enough to prevent every one being employable at that wage—though that is by no means the whole economic story of unemployment. Of this number, probably 200,000 would be practically unemployable on any ordinary basis—the 'hard core' as it is called. Perhaps seven or eight hundred thousand form the perpetual body, changing incessantly as to its unit composition, and consisting of workers undergoing transition from job to job, from place to place, from industry to industry, with seasonal occupations—the elements of 'frictional' unemployment through different causes. Out of this number, I should hazard that not more than 250,000 would be unemployed through the particular disturbing element of net scientific innovation.

This is the maximum charge that should be laid at the door of science, except in special times, such as after a war, when the ordinary application of new scientific ideas day by day has been delayed, and all the postponed changes tend to come with a rush. At any given moment, of course, the technological unemployment that could be computed from the potentiality of new processes over displaced ones appears to be much greater. But such figures are *gross*, and from them must be deducted all recent employment in producing new things or larger production of old things, due to science. If we are presenting science with part of the responsible account of frictional unemployment at any moment, it will be the total technological reduction due to new processes and displacement due to altered directions of demand, less the total new employment created by new objects of demand. This has to be remembered when we are being frightened by the new machine that does with one man what formerly engaged ten. Perhaps birth control for people demands ultimately birth control for their impedimenta.

The rate of introduction of new methods and the consequent impact upon employment may depend upon the size and character of the business unit. If all the producing plants for a particular market were under one control, or under a co-ordinated arrangement, the rate of introduction of a new labour-saving device will be governed by a simple consideration. It can be introduced with each renewal programme for each replacement of an obsolete unit, and therefore without waste of capital through premature obsolescence. But this applies only to small advantages. If the advantages are large, the difference in working costs for a given production between the old and the new types may be so considerable that it will meet not only all charges for the new capital, but also amortize the wasted life of the assets displaced before they are worn out. In neither case then is there any waste of capital, and the absorption of the new idea is orderly in time. But it is quite otherwise if the units are in different ownerships. Excess capacity can quickly result from new ideas. A new ship or hotel or vehicle with the latest attractions of scientific invention, quite marginal in their character, may obtain the bulk of the custom, and render half empty and, therefore, half obsolete, a unit built only a year before. The old unit has to compete by lower prices, and make smaller profits. The newer unit is called upon to bear no burdens in aid of the reduced capital values of the old. It may be that the enhanced profits of the one added to the reduced profits of the other make an average return upon capital not far different from the average that would result in a community where orderly introduction on a renewal basis is the rule. Or perhaps the community gets some of its novelties rather earlier under competitive conditions, and pays a higher rate of interest for them as a net cover for the risks of obsolescence. Waste of capital would be at a minimum if the 'physical' life before wearing out were as short as the 'social' life of the machine. To make a thing so well that it will last 'for ever' is nothing to boast about if it will be out of fashion in a few years.

Scientists often look at the problem of practical application as if getting it as rapidly as possible were the only factor to be considered in social advantage, and this difference in the position of monopoly or single management in their ability to 'hold up' new ideas is treated as a frustration in itself. Thus it has been said "the danger of obsolescence is a great preventative of fundamental applications to science. Large firms tend to be excessively rigid in the structures of production". Supposing that the obsolescence in question is a real factor of cost, it would fall to be reckoned with in the computation for transition, whatever the form of society, and even if the personal 'profit' incentive were inoperative. It cannot be spirited away. A customary or compulsory loading of costs for short-life obsolescence would retard uneconomically rapid competition of novelties and could be scientifically explored.

### The Charge for Displaced Labour

Now let us look at displaced labour and the costs of it. If the effect of diversion of demand through invention is to reduce the scope or output of particular industries or concerns in private management, they have no option but to reduce staff. If the pressure is not too great, or the change too rapid, this does not necessarily result in dismissals, for the contraction of numbers may be made by not filling up, with young people, the vacancies caused by natural wastage, through death and retirement. But where dismissals are inevitable, re-engagements may take place quickly in the competing industries, otherwise unemployment ensues. Any resulting burden does not fall upon the contracting and unprofitable industry —it has troubles enough of its own already. Nor is it put upon the new and rising industry, which is attracting to itself the transferred profits. In the abstract, it might be deemed proper that before the net gains of such an industry are computed or enjoyed it should bear the burdens of the social dislocation it causes by its intrusion into society. In practice, it would be difficult to assess its liability under this head, and in fact even if it could be determined, new industries have so many pioneer efforts and losses, so many failures, so many superseded beginnings, that it might well be bad social policy to put this burden upon them, for they would be discouraged from starting at all, if they had to face the prospect of such an overhead cost whatever their results.

It would, of course, be theoretically possible to put a special levy on those new industries that turned out to be profitable, and to use it to relieve the social charges of dislocation of labour. But much the same argument could be used for the relief of obsoletism of capital. The distinction would, however, be that in the case of the capital it could be urged that the investor should have been wide enough awake to see the possibilities of the rival, whereas the worker, induced to take up employment in such a superseded industry, was a victim, and could not be expected to avoid it by prevision. In any event, the prevailing sentiment is rather to encourage developing industries, than to put special burdens upon them, in order that the fruits of science may be effectively enjoyed by society with as little delay as possible.

In the upshot, therefore, the injuries to labour, though not to capital, are regarded as equitably a charge to be borne by society in general through taxation, and to be put upon neither the causing nor the suffering business unit.

It may well be assumed that, taken throughout, the gains of society as a whole from the rapid advance are ample enough to cover a charge for consequential damages. But society is not consciously doing anything to regulate the rate of change to an optimum point in the net balance between gain and damage.

The willingness of society to accept this burden is probably mainly due to the difficulty of fairly placing it, for we find that when it *can* actually be isolated and the community happens fortuitously to have a control, or the workers a power to induce, it will be thrown, not upon the attacking industry, if I may so call it, but upon the defender. Thus in the United States recently, the price of consent to co-ordinating schemes made for the railroads to reduce operating expenses has been an agreement on this very point. If staff is dismissed, as it was on a large scale in the depression, because of fewer operations and less stock in consequence of reduced carriage through the smaller volume of trade, or through road and sea competition, no attempt was made to put any of the social cost upon the railroads, and the dismissed staff become part of the general unemployed. But if the self-defence of the companies against competition takes the form of co-operation with each other to reduce operations and stock and, therefore, costs, any resultant dismissals are made a first charge upon them.

The agreement is elaborate, and has the effect of preventing any adjustments which an ordinary business might readily make when it throws the burden on society, unless those adjustments yield a margin of advantage large enough to pay for their particular special effects. Thus the rapidity of adjustment to new conditions, not to meet the case of higher profits to be made at the expense of workers, but rather to obviate losses through new competition, is materially affected, and a brake is put upon the mechanism of equilibrium in this industry which does not exist in its rivals, or in any others where the power exists to throw it upon the community. A similar provision exists in the Argentine, and it is imposed by Act of Parliament in Canada, but as one of the concerns is nationally owned, and the current losses fall upon the national budget, its charge is really socially borne in the end.

In Great Britain such provisions were part of the amalgamation project of 1923, and of the formation of a single transport authority in London in 1933, and, therefore, did not arise through steps taken to meet new factors of competition. But the opportunity for their imposition came when rights to road powers and rights to pooling arrangements were sought by the railways —both of them adjusting mechanisms to minimize the losses due to the impact of new invention— and this was clearly a specialized case of keeping the burdens off society. In the case of the electricity supply amalgamation of 1933, brought about for positive advantages rather than in defence against competition, similar provision was made, and parliamentary powers for transfers to gas and water undertakings, also not defensive against innovation, have been accompanied by this obligation. In the case of such uncontrolled businesses as Imperial Chemicals and Shell Mex, rationalizing to secure greater profits, rather than fighting rearguard actions to prevent losses, obligations to deal with redundancies have been voluntarily assumed. In such cases the public obloquy of big business operations inimical to society can be a negative inducement, but some freedom from radical competition in prices provides a positive power to assume the burden initially, and pass it forward through price to consumers, rather than back against shareholders. The third case, however, of making it a net charge on the improved profits, is quite an adequate outlet. If the principle of putting this particular obstacle in the way of adjustments to meet new competition (as distinct from increasing profits) is socially and ethically correct, it is doubtful whether it is wisely confined to cases where there is quite fortuitously a strategic control by public will.

It will be clear that the difference between the introduction by purely competitive elements involving premature obsolescence and unemployment, and by delayed action, is a cost to society for a greater promptness of accessibility to novelty. The two elements of capital and labour put out of action would have supplied society with an extra quantity of existing classes of goods, but society prefers to forgo that for the privilege of an earlier anticipation of new things. I estimate this price to be of the order of 3 per cent of the annual national income. But when we speak of social advantage, on balance, outweighing social cost, we dare not be so simple in practice. If the aggregate individual advantage of adopting some novelty is $100x$ and the social cost in sustaining the consequential unemployed is $90x$, it does not follow that it is a justifiable bargain for society. The money cost is based on an economic minimum for important reasons of social repercussions. But the moral effects of unemployment upon the character and happiness of the individual escape this equation altogether, and are so great that we must pause upon the figures. What shall it profit a civilization if it gain the whole world of innovation and its victims lose their souls ?

So far I have treated the problem of innovation as one of uneconomic rapidity. But there is another side—that of improvident tardiness. Enormous potentialities are seen by scientists waiting for adoption for human benefit, under a form of society quicker to realize their advantage, readier to raise the capital required, readier to pay any price for dislocation, and to adjust the framework of society accordingly. A formidable list of these potentialities can be prepared, and there is little doubt that with a mentality adjusted for change, society could advance much more rapidly. But there is a real distinction between the methods of adopting whatever it is decided to adopt, and the larger question of a more thoroughgoing adoption.

In proportion as we can improve the impact of the present amount of innovation, we can face the problem of a larger amount or faster rate. Unless most scientific discoveries happen to come within the scope of the profit motive, and it is worth someone's while to supply them to the community, or unless the community can be made sufficiently scientifically minded to include this particular demand among their general commercial demands, or in substitution for others, nothing happens—the potential never becomes actual. It has been computed that a benevolent dictator could at a relatively small expense, by applying our modern knowledge of diet, add some two inches to the average stature, and seven or eight pounds to the average weight of the general population, besides enormously increasing their resistance to disease. But dictators have disadvantages, and most people prefer to govern their own lives indifferently, rather than to be ideal mammals under orders. To raise their own standard of scientific appreciation of facts is the better course, if it is not Utopian. It has been clear for long enough that a diversion of part of the average family budget expenditure from alcohol to milk would be of great advantage. But it has not happened. If the individual realized the fact, it certainly might happen. It is ironically remarked that the giving of free milk to necessitous children, with all the net social gain that it may bring about, has not been a considered social action for its own sake, but only the by-product emergency of commercial pressure—not done at the instance of the Ministry of Health or the Board of Education, but to please the Milk Marketing Board by reducing the surplus stocks of milk in the interests of the producer!

### Planning and its Limitations

Scientists see very clearly how, if politicians were more intelligent, if business men were more disinterested, and had more social responsibility, if Governments were more fearless, far-sighted, and flexible, our knowledge could be more fully and quickly used to the great advantage of the standard of life and health—the long lag could be avoided, and we should work for social ends. It means, says Dr. Julian Huxley, "the replacement of the present socially irresponsible financial control by socially responsible planning bodies". Also, it obviously involves very considerable alterations in the structure and objectives of society, and in the occupations and pre-occupations of its individuals.

Now a careful study of the literature of planning shows that it deals mainly with planning the known, and scarcely at all with planning for changes in the known. Although it contemplates 'planned' research, it does not generally provide for introducing the results of new research into the plan, and for dealing with the actual *impact*—the unemployment, redirection of skill, and location, and the breaking of sentimental ties that distinguish men from robots. It seems to have not many more expedients for this human problem than our quasi-individualist society with its alleged irresponsibility. It also tends to assume that we can tell in advance what will succeed in public demand and what will be superseded. There is nothing more difficult, and the attempt to judge correctly under the intellectual stimulus of high profits and risk of great losses is at least as likely to succeed as the less personally vital decision on a committee. Would a planning committee, for example, planning a new hotel in 1904, have known any better than capitalist prevision that the fifteen bathrooms then considered adequate for social demand ought really to have been ten times that number if the hotel was not to be considered obsolete thirty years later? Prevision thought of in terms of hindsight is easy, and few scientists have enjoyed the responsibility of making practical decisions as to what the public will want far ahead. They, therefore, tend to think of prevision in terms of knowledge and appreciation of particular scientific possibilities, whereas it involves unknown demand schedules, the unceasing baffling principle of substitution, the inertia of institutions, the crusts of tradition and the queer incalculability of mass mind. Of course, in a world where people go where they are told, when they are told, do what they are instructed to do, accept the reward they are allotted, consume what is provided for them, and what is manifestly so scientifically 'good for them', these difficulties need not arise. The human problem will then be the 'impact of planning'.

I am not here examining the economics of planning as such, but only indicating that it does not provide automatically the secret of correct prevision in scientific innovation. When correct prevision is possible, a committee can aim at planning with a minimum disturbance and wastage (and has the advantage over individuals acting competitively), but for such innovation as proves to be necessary it does not obviate the human disturbance or radically change its character. The parts of human life are co-ordinated and some are more capable of quick alteration than others, while all are mutually involved. One may consider the analogy of a railway system which has evolved, partly empirically and partly consciously, as a co-ordinated whole. Suddenly the customary speed is radically changed, and then it may be that all the factors are inappropriate—distance between signals, braking power, radius of curves, camber or super-elevation, angles of crossings, bridge stresses. The harmony has been destroyed. Especially may this be the case if the new factor applies to some units only, and not to all, when the potential density of traffic may be actually lessened. The analogy for the social system is obvious, and its form of government matters little for the presence of the problem, though it may be important in the handling of it.

I have spoken as though the normal span of life of men and machinery themselves provides a phase to which scientific advance might be adjusted for a completely smooth social advance. But this would be to ignore customs and institutions, even as we see in Federal America, Australia and Canada, constitutions which lengthen that phase and make it less amenable as a natural transition. At one time we relied on these to bring about the economic adjustment necessary. But technical changes take place so rapidly that such forces work far too slowly to make the required adaptation. Habits and customs are too resistant to change in most national societies to bring about radical institutional changes with rapidity, and we patch with new institutions and rules to alleviate the effects rather than remove the causes of maladjustments. The twenty mile speed limit long outstayed its fitness, and old building restrictions remained to hamper progress. Edison is reported to have said that it takes twenty-five years to get an idea into the American mind. The Webbs have given me a modal period of nineteen years from the time when an idea comes up as a practical proposition from a 'dangerous' left wing to the date when it is effectively enacted by the moderate or 'safe' progressive party. This period of political gestation may be a function of human psychology or of social structure. We do not know how ideas from a point of entry permeate, infiltrate or saturate society, following the analogues of conduction, convection, or lines of magnetic force.

Our attitude of mind is still to regard change as the exceptional, and rest as the normal. This comes from centuries of tradition and experience, which have given us a tradition that each generation will substantially live amid the conditions governing the lives of its fathers, and transmit those conditions to the succeeding generation. As Whitehead says : "we are living in the first period of human history for which this assumption is false". As the time span of important change was considerably longer than that of a single human life, we enjoyed the illusion of fixed conditions. Now the time span is much shorter, and we must learn to experience change ourselves.

### Cultural Lags in a Dynamic Society

I have so far discussed modification of impact to meet the nature of man. Now we must consider modifying the nature of man to meet impact.

Sociologists refer to our 'cultural lags' when some of the phases of our social life change more quickly than others and thus get out of gear and cause maladjustments. Not sufficient harm is done to strike the imagination when the change is a slow one, and all the contexts of law, ethics, economic relations and educational ideals tend towards harmony and co-ordination. We can even tolerate, by our conventions, gaps between them, while preachers and publicists can derive certain amusement and profit from pointing out our inconsistencies. But when things are moving very rapidly, these lags become important ; the concepts of theology and ethics, the tradition of the law, all tend to lag seriously behind changes brought about through science, technical affairs and general economic life. Some hold that part of our present derangement is due to the lack of harmony between these different phases—the law and governmental forms constitutionally clearly lag behind even economic developments as impulsed by scientific discovery. An acute American observer has said that "the causes of the greatest economic evils of to-day are to be found in the recent great multiplication of interferences by Government with the functioning of the markets, under the influence of antiquated doctrines growing out of conditions of far more primitive economic life". It would be, perhaps, truer to say that we are becoming 'stability conscious', and setting greater store, on humanitarian grounds, by the evil effects of instability.

In the United States it would be difficult to find, except theoretically in the President, any actual person, or instrument in the constitution, having any responsibility for looking at the picture of the country as a whole, and there is certainly none for making a co-ordinated plan. Indeed, in democracy, it is difficult to conceive it, because the man in public life is under continual pressure of particular groups, and so long as he has his electoral position to consider, he cannot put the general picture of progress in the forefront. Whitehead declared that when an adequate routine, the aim of every social system, is established, intelligence vanishes and the system is maintained by a co-ordination of conditioned reflexes. Specialized training alone is necessary. No one, from President to miner, need understand the system as a whole.

The price of pace is peace. Man must move by stages in which he enjoys for a space a settled idea, and thus there must always be something which is rather delayed in its introduction, and the source of sectional scientific scorn. If every day is 'moving day', man must live in a constant muddle, and create that very fidget and unrest of mind which is the negation of happiness ; always 'jam to-morrow'—the to-morrow that 'never comes'. If we must have quanta or stages, the question is their optimum length and character, not merely the regulation of industry and innovation to their tempo, but also the education of man and society to pulse in the same rhythmic wave-length or its harmonic.

### The Balance of Physical and Biological Sciences

In some ways we are so obsessed with the delight and advantage of discovery of new things that we have no proportionate regard for the problems of arrangement and absorption of the things discovered. We are like a contractor who has too many men bringing materials on to the site, and not enough men to erect the buildings with them. In other words, if a wise central direction were properly allocating research workers to the greatest marginal advantage, it would make some important transfers. There is not too much being devoted to research in physics and chemistry, as modifying industry ; but there is too much relatively to the research upon the things they affect, in physiology, psychology, economics, sociology. We have not begun to secure an optimum balance. Additional financial resources should be applied more to the biological and human sciences than to the applied physical sciences, or possibly, if resources are limited, a transfer ought to be made from one to the other.

Apart from the superior tone sometimes adopted by 'pure science' towards its own applications, scientific snobbery extends to poor relations. Many of the hard-boiled experimental scientists in the older and so productive fields look askance at the newer borderline sciences of genetics, eugenics and human heredity, psychology, education, and sociology, the terrain of so much serious work but also the happy hunting ground of 'viewey' cranks and faddists. Here the academic soloist is still essential, and he has no great context of concerted work into which to fit his own. But unless progress is made in these fields which is comparable with the golden ages of discovery in physics and chemistry, we are producing progressively more problems for society than we are solving. A committee of population experts has recently found that the expenditure on the natural sciences is some eight to ten times greater than that on social sciences. There is scarcely any money at all available for their programme of research into the immense and vital problems of population in all its qualitative and quantitative bearings. An attack all along the front from politics and education to genetics and human heredity is long overdue. Leisure itself is an almost unexplored field scientifically. For we cannot depend wholly on a hit and miss process of personal adaptation, great though this may be.

There must be optimal lines of change which are scientifically determinable. We have seen in a few years that the human or social temperament has a much wider range of tolerance than we had supposed. We can take several popular examples. The reaction to altered speed is prominent. In the "Creevey Papers", it is recorded that the Knowsley party accomplished 23 miles per hour on the railway, and recorded it as "frightful—impossible to divest yourself of the notion of instant death—it gave me a headache which has not left me yet—some damnable thing must come of it. I am glad to have seen this miracle, but quite satisfied with my first achievement being my last". At the British Association meeting of 1836, an address on railway speeds prophesied that some day 50 miles an hour might be possible. Forty years ago we may remember that a cyclist doing 15–18 miles an hour was a 'scorcher' and a public danger. Twenty-five years ago, 30 miles an hour in motoring was an almost unhealthy and scarcely bearable pace. To-day the fifties and sixties are easily borne, both by passenger and looker-on. Aeroplane speeds are differently judged, but at any rate represent an extension of the tolerance. Direct taxation thirty years ago in relation to its effect on individual effort and action seemed to reach a breaking-point and was regarded as psychologically unbearable at levels which to-day are merely amusing. The copious protection of women's dress then would have looked upon to-day's rationality as suicidal lunacy.

One hesitates to say, therefore, that resistances to scientific changes will be primarily in the difficulty of mental and physical adjustments. But there can be little doubt that with the right applications of experimental psychology and adjusted education, the mind of man would be still more adaptable. Unfortunately, we do not know whether education as an acquired characteristic is in any degree inheritable, and whether increasing educability of the mass is a mere dream, so that we are committed to a Sisyphean task in each generation. Nor do we know whether this aspect is affected by the induced sterility of the age. It may not be a problem of changing the same man in his lifetime, but of making a larger difference between father and son. The latest teachings of geneticists hold out prospects for the future of man which we should like to find within our present grasp, and recent successful experiments with mammals in parthenogenesis and eutelegenesis bear some inscrutable expression which may be either the assurance of new hope for mankind or a devil's grin of decadence.

### The New Economics

What is economics doing in this kaleidoscope ?

The body of doctrine which was a satisfactory analysis of society twenty-five years ago is no longer adequate, for its basic postulates are being rapidly changed. It confined itself then to the actual world it knew and did not elaborate theoretical systems on different bases which might never exist. It is, therefore, now engaged in profoundly modifying the old structures to meet these new conditions. Formerly it assumed, quite properly, a considerable degree of fluid or competitive adjustment in the response of factors of production to the stimulus or operation of price, which was really a theory of value-equilibrium. Wherever equilibrium was disturbed, the disturbance released forces tending to restore it. To-day many of the factors formerly free are relatively fixed, such as wage-levels, prices, market quotas, and when an external impact at some point strikes the organism, instead of the effect being absorbed throughout the system by adjustments of all the parts, it now finds the shock evaded or transmitted by many of them, leaving the effects to be felt most severely at the few remaining points of free movement or accommodation. Unemployment is one of these. The extent to which this fact throws a breaking strain upon those remaining free points is not completely analysed, and the new economics of imperfect competition is not fully written out or absorbed. The delicate mechanism of price adjustment with the so-called law of supply and demand governed the whole movement, but with forcible fixation of certain price elements consequences arise in unexpected and remote quarters. Moreover, the search for a communally planned system to secure freedom from maladjustments involves a new economics in which the central test of price must be superseded by a statistical mechanism and a calculus of costs which has not yet been satisfactorily worked out for a community retaining *some* freedom of individual action and choice.

The old international currency equilibrated world forces and worked its way into internal conditions in order to do so. But the modern attempt to prevent any internal effect of changes in international trade, or to counteract them, and the choice of internal price stability at all costs against variable international economic equations, has set economic science a new structure to build out of old materials. At this moment when elasticity is most wanted, stability leading to rigidity becomes a fetish. The aftermath of war is the impossibility of organizing society for peace.

The impact of economic science upon society to-day is intense and confusing, because, addressing itself to the logic of various sets of conditions as the likely or necessary ones according to its exponents' predilections, it speaks with several voices, and the public are bewildered. Unlike their claims upon physics and mathematics, since it is dealing with money, wages and employment, the things of everyday, they have a natural feeling that it ought to be easily understandable and its truth recognizable. Balfour once said, in reference to Kant, "Most people prefer a problem which they cannot explain, to an explanation which they cannot understand". But in the past twenty years, the business world and the public have become economics-conscious, and dabble daily in index numbers of all kinds, and the paraphernalia of foreign exchange and statistics of economic life. The relativity of economic principle to national psychology baffles the economists themselves, for it can be said truly at one and the same time, for example, that confidence will be best secured by balancing the Budget, and by not balancing it, according to public mentality.

The economics of a community not economically self-conscious are quite different from those of a people who watch every sign and act accordingly. Thus the common notion that economics should be judged by its ability to forecast (especially to a particular date) is quite fallacious, for the prophecy, if 'true' and believed, must destroy itself, inasmuch as the economic conduct involved in the forecast is different after the forecast from what it would have been before. The paradox is just here, for example : if a people are told that the peak of prices in a commodity will actually be on June 10, they will all so act that they anticipate the date and destroy it. Economics, thoroughly comprehended, can well foretell the effects of a tendency, but scarcely ever the precise date or amount of critical events in those effects. The necessity for a concentration upon new theoretical and analytical analysis, and upon realistic research, is very great. But so also is the need for widespread and popular teaching. For a single chemist or engineer may by his discovery affect the lives of millions who enter into it but do not understand it, whereas a conception in economic life, however brilliant, generally requires the conformity of the understanding and wills of a great number before it can be effective.

### The Science of Man

But not alone economics: if the impact of science brings certain evils, they can only be cured by more science. Ordered knowledge and principles are wanted at every point. Let us glance at three only, in widely different fields: man's work, man's health, man's moral responsibility. The initial impact of new science is in the factory itself. The kind of remedy required here is covered by the work of the National Institute of Industrial Psychology. Some of this improves upon past conditions, some creates the conditions of greater production, but much of it combats the evils arising from new conditions created by modern demands, speed, accuracy and intensity. It invokes the aid of many branches of science. It is the very first point of impact. Yet its finance is left to personal advocacy, and commands not 10 per cent of the expenditure on research in artificial silk, without which the world was reasonably happy for some centuries. We can judge of the scope of this by the reports of the Industrial Health Research Board.

Again, the scientific ancillaries of medicine have made immense strides. Clinical medicine as an art makes tardy, unscientific and halting use of them. The public remain as credulous as ever, their range of gullibility widened with every pseudo-scientific approach. (We do not know what proportion of positive cases can create the illusion of a significant majority in mass psychology, but I suspect that it is often as low as twenty per cent.) For a considerable range of troubles inadequately represented in hospitals, the real experience passes through the hands of thousands of practitioners, each with too small a sample to be statistically significant, and is, therefore, wasted from a scientific point of view. Half-verified theories run riot as medical fashions, to peter out gradually in disillusionment. If the scattered cases were all centralized through appropriately drawn case-histories, framed by a more scientifically trained profession, individual idiosyncrasy would cancel out, and mass scrutiny would bring the theories to a critical statistical issue of verification or refutation in a few months. This would be to the advantage of all society, and achieve an even greater boon in suggesting new points for central research.

A suggestion has been made for an inventions clearing house, to "co-operate the scientific, social and industrial phases of Invention, and to reduce the lag between invention and application" managed by a committee of scientists and a committee of industrialists and bankers. The proposal came to me from New York, but London was to be the home of the organization, which was to adopt a code of ethics in the interests of inventors, industry and *social progress*. This brings me to my third example, the field of ethics, which needs the toil of new thought. The systems of to-day, evolving over two thousand years, are rooted in individualism and the relations between individuals. But the relations of society to-day are not predominantly individual, for it is permeated through and through with corporate relations of every kind. Each of these works over some delegated area of the individual's choice of action, and evolves a separate code for the appropriate relationship. The assumption that ethical questions are decided by processes which engage the individual's whole ethical personality is no longer even remotely true. The joint stock company may do something, or refrain from doing something, on behalf of its shareholders, which is a limited field of ethics, and may but faintly resemble what they would individually do with all other considerations added to their financial interests. The whole body of ethics needs to be reworked in the light of modern corporate relations, from Church and company, to cadet corps and the League of Nations.

In no case need we glorify change: but true rest may be only ideally controlled motion. The modern poet says:

"The endless cycle of idea and action,
Endless invention, endless experiment,
Brings knowledge of motion, but not of stillness".

But so long as we are to have change—and it seems inevitable—let us master it. T. S. Eliot goes on:

"Where is the wisdom we have lost in knowledge ?
Where is the knowledge we have lost in information ?"

My predecessors have spoken of the shortcomings of the active world—to me they are but the fallings short of science. Wherever we look we discover that if we are to avoid trouble we must take trouble—scientific trouble. The duality which puts science and man's other activity in contrasted categories with disharmony to be resolved, gaps to be bridged, is unreal. We are simply beholding ever-extending science too rough round the edges as it grows.

What we have learnt concerning the proper impact of science upon society in the past century is trifling, compared with what we have yet to discover and apply. We have spent much and long upon the science of matter, and the greater our success the greater must be our failure, unless we turn also at long last to an equal advance in the science of man.

# Summaries of Addresses of Presidents of Sections*

## Trends in Modern Physics

IN his presidential address to Section A (Mathematical and Physical Sciences), Prof. Allan Ferguson, after referring to the heavy loss which physical science has suffered in the deaths of Sir John McLennan, Sir Richard Glazebrook, Sir Joseph Petavel and Prof. Karl Pearson, discusses those remarkable changes of outlook which have characterized the development of physical science in the twentieth century. The evolution of molar mechanics along Newtonian lines ; the extrapolation of the perceptual facts involved in the behaviour of macroscopic masses down to the dimensions of atomic magnitudes, and the success attendant on this extrapolation ; the wave theory of light, which was so successful in co-ordinating old facts and predicting new ones as to draw from Lord Kelvin a noteworthy expression of his belief in the objective reality of the ether ; these were outstanding contributions of nineteenth century thought to physical science.

Withal, there was considerable simplicity—not to say confusion—attendant on the definition of such a fundamental concept as that of mass.

With the closing years of the century, the discovery of the electron, of radioactivity, and the investigation of the manner of distribution of energy in the spectrum showed the existence of complexities and contradictions beyond the powers of the classical theory to explain or to resolve ; and the last year of the nineteenth century saw the birth of those ideas which have given to our vocabulary a new verb—to *quantize*. The development is sketched of quantum notions as shown in the Rutherford-Bohr atomic model, the vector model of the atom, the dualism of outlook which emphasizes now the wave-aspect, now the particle aspect of matter and of radiation and the resolution of that dualism by the later developments of quantum mechanics.

Discussion of the new concepts introduced by the discoveries of the neutron and positron, and the positing of the neutrino to save conservation processes, leads to consideration in some detail of the development of the doctrine of causality and the definitions of *cause* given by Locke, Hume and Mill, the effect on the doctrine made by the enunciation of the uncertainty principle, and the attempt made by Planck to save the principle of causality.

* The Presidential Address, and addresses by the Sectional Presidents, are being published as "The Advancement of Science, 1936". (Blackpool: B.A. Reception Room. London: Burlington House.) Price 3*s*. 6*d*.

Is it possible for the plain man of science to order his daily work on a rational basis without of necessity becoming a technical metaphysician ? The work of Karl Pearson, amended and extended to meet modern demands, points the way to a possible solution—a solution which, indeed, has some affinities with the endeavour of Prof. Planck to rescue the principle of causality. If the distinction is kept clear between the conceptual model, and the perceptual facts which the model is invented in order to subsume ; if it is realized that the world-model, be it built up of billiard-ball atoms or probability-smears, in Euclidean or some esoteric form of hyper-space, remains a model still, and that, until any part of the model emerges into the region of perception, talk of its reality is rather beside the mark ; if the twentieth century man of science is as ready to discard a worn-out model as ever Maxwell was, he is not likely to steer wide of the mark.

The man of science of to-day is called upon, more insistently than at any other period of history, to remember that he is a social animal. He can no longer continue to offer sacrifices at the shrine of the Idol of Purity ; he must be prepared to consider the social repercussions of his work, whether these repercussions be eugenic or dysgenic. Section A has already initiated the consideration of such implications—it is hoped that the officers of the Section will continue to emphasize and to widen this aspect of the Section's work.

## Training the Chemist for Service to the Community

THE place of the chemist in the present-day community, and the manifold ways in which chemistry is involved in the solution of national and industrial problems, is the topic of the presidential address to Section B (Chemistry) by Prof. J. C. Philip. Any society which is intellectually alive will foster the spirit of inquiry, and the prosecution of research is perhaps the fundamental service which the chemist renders to the community. Mere accumulation of knowledge, however, which does not lead to action directly or indirectly is inadequate and unsatisfying, and it is because in the field of chemistry the academic search for new knowledge has led to such abundant practical achievement in the industry of the nation and the health of its citizens that the science deserves fuller recognition by the public.

It is a commonplace that discoveries at first of a purely scientific character have frequently turned out to have unexpected applications, and it has become clear that, so far as research and discovery in pure chemistry are concerned, a very long view indeed must be taken in assessing their practical value. Further, it must not be forgotten that a solution of even the most ordinary chemical problems on rational lines is possible only because of our accumulated knowledge of natural phenomena and natural laws. Work, therefore, in the field of pure chemistry builds up a reserve of knowledge and technique on which future generations can draw in attacking practical questions.

It is with this background that so much 'directed' research is prosecuted at the present time—research, that is, which aims at the solution of some specific problem of industrial or national significance. During the last twenty years there has been a notable expansion in the amount of directed research, and in this movement the State has taken a prominent share. Apart from the initiation of industrial research associations, the State has itself organized research on certain chemical problems of national importance, such as those connected with the utilization of fuel, the preservation of food, and the pollution of rivers. Many of these questions require the collaboration of men of science other than chemists, and indeed some of the most fruitful scientific investigations are co-operative in character.

Apart from research, very many trained chemists —the general practitioners of the chemical profession—are engaged in work of a more routine, but highly important, character, and their contribution to the smooth running of industry and to healthy living is far greater than most people realize. A study, indeed, of the occupations of chemically trained men shows that, in the industry of the country, the chemist is ubiquitous. This suggests that those who picture him as concerned mainly with explosives and poison gas have an entirely wrong perspective. The use of chemical substances for destructive purposes is a prostitution of knowledge and skill which chemists would like to see eliminated.

The great variety of the tasks with which the chemical profession is concerned means that the training of the chemist at our universities and colleges must be on broad, fundamental lines. The day, however, has gone by when chemistry could be treated merely as a philosophical discipline ; so far as the service of the community is concerned, it is a practical science. The universities must accept the burden, as they have already done in medicine and engineering, of putting the vocational training of chemists on a broad foundation of scientific knowledge.

## Palæontology and Humanity

THE biological aspect of palæontology forms the topic of Prof. H. L. Hawkins's presidential address to Section C (Geology). The first part of the address is a re-statement of the basic facts about fossils, and is followed by an appraisement of their value in the attempt to decipher the history of life. Comparison of the records of palæontology and human history shows that fossils, for all their incompleteness, give on the whole a surer basis for historical reconstruction than documents or monuments. A corresponding comparison between the principles of taxonomy in palæontology and neontology shows inevitable differences that may lead to confusion if overlooked. Many of the characters of living organisms, rightly regarded as of specific value by neontologists, are quite inaccessible in fossil material ; even when they seem to be recognizable, they cannot be proved to have a truly specific significance. In skeletal structures, differences that would justify taxonomic distinction between fossils can usually be matched with generic or even family differences in living organisms. Hence such terms as 'genus' or 'species' are used in different senses, and should be enclosed in inverted commas when applied to fossils.

Palæontology treats of the history of organic structures, not with that of the organisms themselves. Actually, this proves a distinction with very little difference, since organisms are dependent for their behaviour and welfare on the qualities of their component structures.

Analysis of the time-ranges of fossil groups leads to the conclusion that simplicity of structure, combined with reasonable efficiency, gives hope of longevity ; while complexity of structure, in spite of its possibly greater efficiency, is relatively ephemeral. In the sphere of morphogeny, the meek inherit the earth and pride precedes a fall.

A review of the palæontological evidence of morphogeny shows 'orthogenesis' to be the prime factor in evolution, with environment acting as educator or executioner according to the plasticity of its victim. The impression gained may be summarized by stating that "the way life is lived is the way of evolution, whether it be from the Cambrian to the Holocene or from the cradle to the grave".

Mankind, viewed in palæontological perspective, appears in a dual role. He is a highly specialized member of a highly specialized class, and so seems doomed to a brief career. But his mental specialization seems to give him the all-round efficiency that is associated with generalization and its prospect of longevity. However, the historical record of human institutions has been, to date, an illustration of the transience of the complex—typical in all but its speed. Man, when he plays the animal, submits to the fate normal to animals, and his exaggerated capacity only accelerates his doom.

With the mental acumen that enables mankind to be a supreme animal, there has developed a faculty that is different and unique. This faculty, which may be called 'altruistic', seems in many ways independent of, and perhaps triumphant over, environment. To man, the clever animal, palæontology points, albeit despairingly, to the precipice just ahead ; but to man, the idealist, it has no message, save to welcome a new experiment that may perchance succeed in justifying the nobility of his aspirations.

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## Natural Selection and Evolutionary Progress

THE subject of Prof. Julian S. Huxley's presidential address to Section D (Zoology) is the relationship of natural selection and evolution. On a Mendelian planet, such as ours appears to be, evolution is the joint product of mutation and natural selection. Recent work has altered our views as to the details of the process. The action of a particular gene depends on many other genes which act as modifiers ; thus selection of the genic background is of great importance. By this means, deleterious effects of an otherwise advantageous mutation can be buffered or even abolished. Dominance and recessivity seem to be due to a similar action on recurrent mutations.

Analysis of this kind, however, only takes us a certain way. We must remember that evolution is a heterogeneous process, which will appear very differently to different groups of workers.

The origin of species is but one of the major problems of evolution : the others are the origin of adaptations and the origin and maintenance of long-range trends.

Species, it is now clear, can originate in several different ways. Their origin may be *unilinear*, when one species is wholly transformed into another ; *divergent*, when one species diverges into two or more (as after geographical or physiological isolation) ; *convergent*, when a new species is formed by hybridization between two species (as in *Primula Kewensis*, *Spartina Townsendi*, etc.) ; or *reticulate*, when divergence and convergence combine to give a network of forms (as in roses, willows, and man). Furthermore, it may be either gradual or abrupt. The divergent origin of new forms after isolation appears always to be gradual, while their convergent origin (by allopolyploidy) after hybridization is always abrupt.

From the point of view of natural selection, speciation falls into two sharply distinct categories. When the characters distinguishing species arise abruptly, selection can have no part in deciding their nature : when they arise gradually, for example, after isolation, it can, and probably in large part does do so.

The origin of adaptations must be sought mainly in natural selection. Whenever an adaptation involves a number of steps or separate characters, no other agency but natural selection can have been operative. Thus, in the great majority of cases, pre-adaptation is ruled out. Natural selection is a mechanism by which results that otherwise would be in the highest degree improbable are rendered probable.

The origin and maintenance of long-range trends in all the numerous cases where the trend is towards functional specialization or improvement will be due to natural selection in the same measure as is the origin of adaptation. The directive character of such trends is no evidence of internally-determined orthogenesis, but is to be expected on a selectionist interpretation. Trends such as that of the elephants, in which the functional improvement is continuous, but the structural mechanism adopted is altered during the process, are incapable of orthogenetic explanation. A trend towards specialization will cease when certain biomechanical limits are reached to further advantageous advance.

Evolutionary progress may be defined as all-round advance in control over, and independence of, environment, while most long-range trends are one-sided specializations, and therefore blind alleys. Since it confers advantage, biological progress can equally be ascribed to natural selection.

Many evolutionary phenomena are better understood when it is realized that most genes act by controlling the rates of processes. In particular, many otherwise puzzling phenomena of recapitulation and anti-recapitulation at once become comprehensible. Anti-recapitulatory phenomena due to the slowing of early processes and the consequent removal of previous adult characters from the life-cycle are of great importance in evolution, accounting for neoteny, clandestine evolution, and fœtalization. This last process has been essential for the evolution of man : it is interesting that it could not have occurred in a polytocous form, where slowing of early growth would be prevented by intra-uterine selection.

An analysis of evolutionary progress reveals some interesting facts. In the first place, it appears that it could only have pursued the course that it has actually taken. Conceptual thought could only have arisen in a monotocous mammalian type with an arboreal ancestry. Non-arboreal and polytocous mammals are excluded ; so are birds and other terrestrial vertebrates ; so are insects and all other invertebrate groups. No further biological progress is now possible, except in man. Another feature of progress is that characters essential for one progressive advance may be a handicap for later progress. This must be taken into account in planning further progress—that is, in any eugenic scheme.

## The Mapping of our African Colonies

THERE has been talk and correspondence lately on the backwardness of Ordnance Survey revision. Maps and Plans are not kept up-to-date and a great deal of inconvenience has been caused by this fact. It is becoming evident that town planning, building, road programmes and the like make up-to-date maps a necessity and not a luxury. It is not to be wondered at that similar problems have arisen in the African Colonies, the budgets of which have been just as hard hit as that of England. In his presidential address to Section E (Geography), Brigadier H. S. L. Winterbotham deals with this question.

The Ordnance Survey is strictly domestic. It has no duties outside the area for which our own parliamentary estimates are framed. The first step towards colonial mapping and surveying was taken in 1803, when the War Office formed the "Depôt of Military Knowledge" (maps were generally considered "military" in those days). In 1855 Lord Panmure, Secretary of State for War, arranged for a more energetic campaign, and he and the Secretary of State for the Colonies, working together, relied upon the same body, now called the "Topographical Department", to keep in touch with colonial survey departments and to intervene for their assistance, as often as possible. The colonial survey departments are concerned mainly with those property surveys which correspond to the large-scale plans of the Ordnance Survey, and the Topographical Department supplied officers and men for topographical mapping.

This dual arrangement has succeeded in providing a large area of good mapping, but it has failed in these post-War years to secure a proper and progressive programme of triangulation and mapping.

There is no question that comparatively enormous sums of money were squandered in England early in last century for lack of scientific forethought. The expenditure of two million pounds upon the unchecked and uncorrelated tithe maps is a case in point. The Grand Triangulation should, of course, have come first. In India the question was tackled sensibly and energetically in the correct sequence. In Africa the first essential is an arc of triangulation from Cape Town to Cairo, upon which all other surveys can be hung. Sir David Gill, H.M. Astronomer at the Cape early in this century, made a good beginning, and it was due to his personal foresight and vigour that this arc had reached the southern end of Tanganyika by 1914. Sir Charles Close added a portion in Uganda, and his whole-hearted co-operation as head of the "Geographical Section" (the new title of the Topographical Department) secured the skilled observers for the triangulation, and made it possible to map considerable areas at the same time. Before the Great War, more than 2,000 miles of the arc of triangulation had been finished. In exactly the same period (thirteen years), between 1922 and 1935, only 360 miles were added. In thirteen years before the War, 480,000 square miles were well mapped; in the thirteen years after, no more than 170,000 square miles.

The machinery exists, the problem grows more urgent in proportion as the development of local resources becomes more important. What seems to be lacking is the realization of the ultimate economy and wisdom of tackling the job in the proper sequence. Mapping and development are bound to go hand in hand.

## Problems of Plantation Economy

IN his presidential address to Section F (Economics and Statistics), Dr. C. R. Fay, who has just returned from a visit to the East, discusses the problems of plantation economy with special reference to the tea industry. The evolution of the plantation can be traced from the early tobacco and sugar plantations of North America, through the indigo plantations of nineteenth century India to the tea and rubber plantations of to-day in India, Ceylon and Malaya ; and tea can be compared as a commodity with tobacco, sugar, coffee, rubber and forest produce in order to show the scope and method of the plantation form.

The tea estate usually has upon it a tea factory ; and thus plantation economy presents two classes of production problems : (*a*) cultural problems connected with the growing of the leaf ; and (*b*) industrial problems connected with the processing of the leaf into tea. Growing embraces the clearance and planting of the land, the cultivation of the plant and conservation of the soil, the plucking of the leaf. Processing involves the factory sequence of withering, rolling and breaking, fermenting, firing, sifting and packing. In the main, plantations are financed and managed by

Europeans ; and there are four types of plantation to-day : the proprietary planter (now rare), the small company, the large company and the consumer company. In the last class, the English and Scottish Joint Co-operative Wholesale Society, Ltd., is important. The 'optimum' size of the estate is increasing ; and the productive unit is in process of integration along two lines : (*a*) the combination of estates into 'groups' and (*b*) the association of estates with coastal agency houses, which have functions of buying, selling, technical supervision and financial control.

The tea estate carries an important labour force, and its labour problems are threefold : recruitment, wages, health and housing. These vary according to the district, and the conditions in Assam, South India and Ceylon differ. Ceylon in 1934–35 was visited by a malaria epidemic, which attacked a large section of the tea area and created conditions of famine in villages adjacent to the estates. It was caused by a period of prolonged drought, and the measures by which it was fought are revealed in the official documents of 1935 and 1936.

Since 1933 South India and Ceylon have participated in the international scheme of tea export control. Regulation of export means restriction of production. It presents difficult problems, but it came in an industry which was already accustomed to joint action in other fields—in the regulation of labour, the provision of medical services and the undertaking of technical research, which in Ceylon is conducted at the St. Coombs Research Institute. In effect, the new control regulation is voluntary group effort, endorsed by the State. Tea control (1933) was followed by rubber control (1934), and both schemes are distinguished by the fact that, unlike the post-War rubber scheme, they include the Dutch East Indies.

The nature of regulation in plantation commodities can be compared with that in forest produce, where the problem of conservation is uppermost.

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## The Engineer and the Nation

IN his presidential address to Section G (Engineering), Prof. W. Cramp avoids technical matters, and confines himself to a review of the relationship between the engineer and the nation. The engineer shares with the devotee of pure science the detached pursuit of truth, but his work, like that of the doctor, is practical in its aspect, and entails not only daily contact with humanity, but also an understanding of human desires and of human psychology. This dual role gives him a greater opportunity both for the development and for the loss of character, but it also makes him more balanced and adaptable than his colleague in pure science.

Engineering at its best is the greatest instrument of civilization that the world has ever seen, because it is so largely concerned with the development of means of communication. Its natural tendency is to promote a closer contact between individuals and nations, but when deflected from this path of peace, it may equally become a terrible agent of destruction and death. For these reasons the activities of the engineer and the uses to which they are put are matters of supreme importance. To what extent does the nation recognize its responsibility towards the engineer, and how does the engineer respond ?

The attitude of the nation towards the engineer is reflected in the status, protection and remuneration that are accorded to him. A sharp contrast exists between his position and that of the medical man, whose period of training is only a little longer and whose responsibility is probably less. By means of his professional organization with statutory powers, the doctor has acquired a proper status with perhaps too much protection. At present the engineer has liability, without appropriate status, remuneration or protection.

The responsibilities of the engineer are emphasized by the charges brought against him by pulpit and press. Of these the first is the statement that engineers lend themselves too willingly to works of destruction. The answer is that pure science recognizes no moral distinctions, so that this is a matter of individual conscience in which the engineer is on a par with the rest of mankind The second is the suggestion that a moratorium should be imposed upon scientific development ; to which the answer is that the invention of a machine does not compel its use. The third charge against the engineer is his lack of fertility in producing inventions which might lead to new industries. This is explained by the clumsy, costly and ineffective protection of patentees and by the absence of scientific representatives upon governing bodies in the State and in industry. In both directions reforms are needed.

The attitude of the engineer towards the nation involves professional conduct, both individual and collective. There have been engineers whose opportunities of acquiring a high standard of values were ideal, yet they surrendered integrity to self-interest when temptation arose. Among collective activities, mention may be made of the growth and development of trade associations ; and of the dangers inseparable from powerful monopolies. The action of such groups in developing and maintaining a high standard of quality is gratefully acknowledged, but it is suggested that there is also some evidence of a tendency to exploit the nation for the benefit of a particular industry. This, if not checked, will react to the detriment of the associations themselves.

Conclusions drawn from the whole analysis suggest a number of reforms. These are: (1) The establishment of an engineering body with statutory powers to prevent unqualified persons from jeopardizing life and to check unprofessional conduct; (2) the proper representation of science in State and municipal departments; (3) a drastic revision of patent procedure in the law courts; (4) voluntary renunciation by trade associations of any advantage unfair to the nation; (5) an inquiry by educational experts into the best means of inculcating a higher scale of integrity among members of the profession. Of these reforms, it is suggested that the British Association might lend its aid in connexion with the second, third and fifth.

## Cultures of the Upper Palæolithic

MISS D. A. E. GARROD deals in her presidential address to Section H (Anthropology) with the Upper Palæolithic in the light of recent discovery. The last twelve years have seen a new impetus given to prehistoric studies by the multiplication of researches outside Europe. This has led to a partial revision of the classification of Palæolithic cultures associated with the name of de Mortillet. In particular, it is becoming clear that the old division into Lower, Middle and Upper Palæolithic has a chronological value only, and that for purposes of typology the fundamental division is into hand-axe, flake and blade cultures.

In considering the present state of our knowledge of the blade cultures one point emerges clearly—the diversity of the strains which have hitherto been grouped together under the heading of Aurignacian. This is borne out by Peyrony's researches in the Dordogne and by recent work in the Near East, which lead to a distinction between the industries characterized by the blunted-back blade, formerly classified as Lower and Upper Aurignacian, and the Middle Aurignacian, in which the type-implements are steep and rostrate scrapers. Peyrony suggests that the first group should be labelled Perigordian, and that the old name of Aurignacian should be kept for the second.

A study of recent excavations, more especially in Russia, the Near East and North Africa, suggests that the problem is extremely complex, and a new system is tentatively put forward. The former Lower Aurignacian is named Chatelperronian, the Middle Aurignacian remains as Aurignacian proper, and the former Upper Aurignacian is divided into Lower and Upper Gravettian, corresponding to the La Gravette and Font-Robert levels respectively. The origins of the Chatelperronian can be traced back into the Lower Palæolithic, both in Palestine and East Africa, and it is suggested that its centre of origin lies somewhere in south-west Asia. It may have given rise to the Capsian, by way of the Kenya Aurignacian, and may also have passed northward to develop into the Gravettian, which is abundant in Russia. The Aurignacian proper, on the other hand, shows a remarkable development in the Near East, and the Iranian plateau is suggested as a possible centre of dispersion.

We thus have three major provinces for the blade-cultures: the Capsian in Kenya and Little Africa, and the Gravettian in north-west Asia and eastern Europe, both possibly derived from the earlier Chatelperronian, but cut off from each other by the great Aurignacian province of the Near East. From the Gravettian and Aurignacian centres migrations pour into central and western Europe, and cultures which in their homelands tend to remain distinct succeed and influence each other until at the extreme limit of their journey we get the classic French sequence. The industries which mark the extreme end of the Pleistocene, such as the Magdalenian, etc., appear to be local developments of one or other of these stocks, while the Solutrean is an intrusive element, of Hungarian origin.

## Circulation of the Blood

THE control of the circulation of the blood, which is such an important problem in relation to surgical shock, forms the subject of the presidential address of Prof. R. J. S. McDowall to Section I (Physiology). Only a few years ago the subject consisted of a large amount of little-related data, but gradually this is being pieced together. For example, the well-known and dramatic fact that stimulation of the vagus nerve will slow up or even stop the heart, is now recognized as indicating part of a mechanism by which the normal heart at rest is constantly subjected to restraint, the release of which results in cardiac acceleration such as occurs in exercise.

The requirements of physical exercise probably give the best indication of most of the mechanisms of the circulation. In the active muscles a number of chemical and nervous mechanisms bring about a dilatation of blood-vessels locally. That the sympathetic vasodilators are in part responsible for the dilatation is a recent development. At the same time, largely as a result of psychical activity, blood-vessels are shut down in less active parts such as the alimentary canal and the skin. This has hitherto been considered to be due to the action of the vasoconstrictor nerves, but it is now shown that probably there is a reduction of the general vasodepressor reflexes which arise from the carotid sinus and the cardio-aortic region. The evidence rests on the fact that severance of the reflex arcs results in increased venous flow and cardiac output, while circumstances which reduce vagus activity also reduce the activity of the general vasodepressor reflexes. Thus just as the vagus may be looked upon as determining the range of cardiac activity, so the depressor reflexes determine the amount of blood available for the heart.

Hitherto, it has been considered that these two mechanisms are concerned primarily with the maintenance of a mean arterial pressure, but several facts suggest that in exercise the loss of their sustained activity is of more importance than their maintenance. These are their great variability in different animals and under different experimental conditions, the profound effect of loss of the vagus on efficiency in exercise and the fact that the arterial blood pressure rises in spite of these mechanisms.

## The Patterns of Experience

THE controversies in which psychologists are now engaged are a sign of life and progress in the science, but an eclectic position is reasonable, provided that one maintains a point of view sufficiently unifying to avoid the danger of becoming a mere collector of odds and ends of fact and theory. Such a point of view appears to be afforded by the hypothesis of mental schemata, originally suggested by Sir Henry Head, and since advanced in other connexions by Prof. F. C. Bartlett and Mr. A. W. Wolters, who has chosen this topic for his presidential address to Section J (Psychology).

At the Norwich meeting of the British Association, Prof. E. Rubin demonstrated that there are predetermined 'ways of seeing', and that perception can be shaped by factors extrinsic to the material experienced. Under the influence of such factors, the mind actively patterns its experience, so informing the sensory material as to make the percept consistent with certain subjective principles. This implies that the patterns of experience are already latent in the subject's mind as he confronts the world. How they can so exist is partly explained by a consideration of the patterns of behaviour as exhibited in instincts and skills. The first necessity of every organism is to remain alive, and this task requires that it should master its environment and make it manageable. To this end it develops skills, which are qualities of the organism in virtue of which it is prepared to deal more adequately with situations of a particular kind, though prepared only in an outline, flexible manner. Such a preparation for reaction, dependent upon the integrated effects of previous experience, has been termed a *schema*, and it now appears that Rubin's 'ways of seeing' can be brought under the same conception. Thus perception, memory and conceptual thinking have been brought under common principles. They are reactions preliminary to further behaviour, and depend upon the existence of pre-formed schemata.

The same conception can be applied to problems of social psychology, for society is only actualized in its impact upon individual lives. Society becomes a psychological datum because it exists immanently in the minds of its members. A social group exists as such in virtue of conative tendencies developed by individuals in the course of accommodating their behaviour to each others', so that an observable group pattern is the product of the skill-characters, or behaviour schemata, of the constituent members. Often the schemata are not open to inspection or description, having been developed for other purposes. The difficulty of stating the principles underlying the English Common Law is psychologically explicable if it is considered that they are the ways of living together developed by a nation.

The subject-matter of psychology is taken to be the activities of the individual organism striving to maintain its full integrity. To obtain control of its universe it must organize the material of experience into patterns manageable by it. To this end it develops skills which we have termed schemata, and the system of a person's schemata embodies all his experience up to the present moment, and determines the direction and pattern of his future experiencing. Thus in outline the 'ways of seeing' and the 'ways of living' are reducible to a common psychological genus.

## Uses of Fungi

IN his address to Section K (Botany), Mr. J. Ramsbottom deals with many of the ways in which fungi have proved useful to man.

Edible fungi have been known from the earliest times, but only three species have been successfully grown on a large scale—the common mushroom (*Psalliota campestris*) in Europe and America, shiitake (*Cortinellus Shiitake*) in Japan, and *Volvaria volvacea* in many parts of the tropics.

Wood infected with fungi is used for various purposes, the green wood of Tunbridge Ware being the best known—the colour being due to the mycelium of the discomycete, *Chlorosplenium aeruginosum*; 'brown oak', much valued by wood-workers, has recently been shown to be due to infection by the beef-steak fungus (*Fistulina hepatica*), and wood rotted by *Mucor racemosus* is used as cattle food (*palo podrido*) in Patagonia.

The lack of chlorophyll imposes upon fungi their peculiar physiology, which has many consequences important to man. Every nation has its fermented drinks or foods, mostly dating back to antiquity. Sometimes the fermentation is brought about by one or more yeasts, sometimes by a 'symbiotic' combination of yeast and bacteria. Many of the processes which were formerly left to chance are now controlled to a greater or less extent, and pure cultures of yeasts are employed. Similarly in cheese-making the appropriate species of the mould *Penicillium* is used for ripening blue-streaked cheeses (Stilton, etc.) and cream cheeses of the Camembert type.

While yeasts are the chief agents of fermentation in the West, Mucoraceæ and species of the *Aspergillus flavus-Oryzæ* group are mainly concerned in the East. The importance of *Aspergillus* in the preparation of soy sauce (the basis of many table sauces), saké and other products is shown by the estimated annual value to Japan as £40,000,000.

Recently there has been considerable development of the use of fungi in industry. Takadiastase produced by *Aspergillus Oryzæ* and its allies has many commercial uses as well as in medicine. Citric acid is now manufactured in many countries on a large scale by the action of dark-spored Aspergilli on sucrose, nine acres of mycelium being said to be held in commission by one American firm for use in cheese-making alone. Gluconic acid, now being used in increasing amounts as the calcium salt, which is more satisfactory for many purposes than is calcium lactate, is obtained on a commercial scale by the action of *Penicillium* species, for example, *P. chrysogenum* on commercial glucose.

During the Great War, Germany obtained her supplies of the glycerol necessary for the production of high explosives by trapping the intermediate products of sugar fermentation by yeasts ; other countries developed similar methods. To supplement her inadequate bread ration, Germany employed *Torula utilis*, "mineral yeast", which is a poor fermenter but which grows readily on molasses, 100 gm. of this producing 130 gm. of yeast in eight hours. Russia also used a non-fermenting yeast, *Endomyces vernalis*, 'fat yeast', for food, the fat formed reaching 15–28 per cent of the dry weight in 10–15 days.

Many processes in which fungi play a part have been patented, and specifications cover the making of leather substitutes by tanning gelatinous growths, the artificial ageing of green coffee, the production of ergosterol, acetone, fumaric acid and so on.

Substances which have not previously been obtained have been produced by the action of moulds, and it is evident that compounds of almost every type known to organic chemistry can be synthesized.

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## The Future in Education

IF we consider that the goal of education is the making of men and citizens, that body, character and (in the widest sense) reason make the man, and need to be developed and trained, and that human beings cannot live intelligently in the world without some knowledge of literature, history and science, then we must admit that in spite of great achievements during the past sixty years in elementary, secondary, technical and university education, we have not produced an educated nation. We have provided opportunities for the minority who attend secondary school and university. Most of the rest have had no regular instruction after they leave school at fourteen years, an age when education in the real sense is about to begin, and this, according to Sir Richard Livingstone's presidential address to Section L (Education), is our great educational scandal and problem.

To solve it, two principles, commonly ignored, must be observed. First, it is useless to teach a subject before the mind can digest it. A liberal education cannot be given at the age of fourteen, fifteen or sixteen years. Secondly, the humanistic subjects—literature, history and philosophy—cannot be properly appreciated without some experience of life. In this they are unlike physical science and mathematics, which need no such experience. But if these principles are sound, our problem will not be solved by raising the school age to fifteen years ; indeed, even an education which stops at the age of seventeen or eighteen is quite incomplete. Unless we are content to have a largely uneducated nation, we must establish part-time compulsory education to the age of eighteen years, and follow this up by adult education. Thus and thus only can we secure that the whole nation has a chance of being educated.

The great successes of adult education in England are the Workers' Educational Association and the university extension movement. The former provided for the working-class intelligentsia, but left the masses untouched. If we are to reach them, we must develop a different, less academic, technique in adult education. In particular, we need to study the intellectual digestion of the average man (which is different from that of the intelligentsia), and also to develop the social, corporate element in education. On these points we can learn from the Danish folk high-schools and from the women's institutes, both of which reach a class which our adult education has largely failed to touch.

The future lies with adult education. Without it the masses will remain uneducated. But it is also needed for the 'educated classes', and an attempt should be made at the universities to provide opportunities for regular study by professional men, civil servants, politicians and others, whose systematic study and thinking is apt to end when they take their degree. Summer schools, doctors' 'refresher' courses, etc., are rudimentary forms of such study, which have evolutionary possibilities.

## Soil Science

THE advances which have been made in soil science in the twentieth century are discussed in his presidential address to Section M (Agriculture) by Prof. James Hendrick. At the beginning of this century, agricultural research was in a low state in Great Britain, where there was only one great research station, a private institution, Rothamsted. That has now been altered and, under the guidance of the Development Commission, a system of agricultural research stations has grown up covering all the leading branches of agricultural inquiry. The development of the system of agricultural education has led to increase and improvement of agricultural research.

In the great advance which has taken place in agricultural investigation, the fundamental subject of soil science has received much attention, especially since the Great War. A great part of the inspiration has come from foreign sources. In all parts of Britain the climate is temperate and humid with a rainfall distributed over all parts of the year, but in a great country like Russia the climate varies from arctic to sub-tropical and from humid to arid and desert. The Russians studied soil formation and classification from the point of view of climate, and showed how greatly the character of the soil depends upon climate. Cut off as the British were from Russia by linguistic, political and geographical barriers, nothing was learned of this until after the Great War. Though the British Empire extends through an even greater range of climatic conditions than Russia, little account was taken of the influence of climate on soil formation, and classification was based more on geology. A revolution has taken place in our views since the development of international soil congresses has established contact with the soil scientists of Russia and other countries, and attention is no longer confined to the comparatively narrow range of soils found in the British Isles.

Another field in which great advance has been made in recent times is in our knowledge of base exchange and soil acidity, and in the application of colloid chemistry to the study of the soil. Calcium carbonate has lost, to the exchangeable bases associated with the soil colloids, much of the high place it used to occupy in agricultural chemistry.

The two great classes of colloids found in the soil are the mineral colloids of the clay and the organic colloids of the humus. Much advance has been made in unravelling the structure of the clay colloids, but the exact nature and structure of the humus colloids is still obscure.

Another sphere in which great advances have been made during the present century is in the manufacture of, and trade in, fertilizers. In the case of nitrogenous fertilizers, this has amounted almost to a revolution.

## Preservation of Native Floras

THE preservation of native floras with special reference to the British flora is the topic of Dr. A. B. Rendle's presidential address to the Conference of Delegates of Corresponding Societies. The preservation of native floras is of high importance from a scientific point of view. The cases of St. Helena and the Bermudas are examples of interesting natural floras that had been largely destroyed by man's action, especially by the destruction of the trees and the introduction of alien plants which had proved superior in competition with the natural flora. But efforts should be made to preserve what remains. It will be a reproach to us if the only material for study by future students of a flora is that found in herbaria.

Our British flora is worth preserving. We cannot regard it as merely a part of the west European flora that invaded Britain after the disappearance of the glacial ice before we were cut off by sea. There is evidence for the survival of fragments of the original flora in sheltered unglaciated spots during successive periods of glaciation, and various elements of special interest may be associated with special areas that presumably remained open. Intensive work on British genera and species indicates that there is still scope for investigations of taxonomic, distributional and ecologic interest. Apart from an æsthetic point of view, there is good reason for efforts to preserve our flora, even though it has already been much changed by the action of man and his crops and herds.

Various means to ensure conservation can be used. The Plant Conservation Board of the Council for the Preservation of Rural England, in particular, does important work. Three methods of promoting conservation are available : legislation, education and Nature reserves. The last was fully discussed by Sir David Prain in his address to the Conference at the York meeting of the British Association. Its value in the preservation of areas of special types of vegetation such as an alpine flora, that of a Yorkshire dale, or a fenland such as Wicken or Chippenham, or smaller special areas, is inestimable. But the Nature reserve will not preserve the flora of the countryside as a whole, and here we are concerned with legislation and education. The former is only the next best thing, but until the community is educated to leave for the enjoyment of all that which appeals to the individual, some form of legislation seems necessary. The Conservation Board has enlisted the help of local Councils throughout the country and their response has been encouraging. Posters appealing for the preservation of wild plants have been very widely distributed, and the by-law approved by the Home Office forbidding uprooting on land to which the public have right of access has been adopted and copies have been posted in prominent places. Lists of species demanding special protection in individual counties, on account of beauty or rarity, have been prepared and circulated.

Up to the present it has not been found possible to frame a by-law for the protection of wild plants growing on private property.

Plants may be studied as growing ; uprooting is rarely necessary, and, if it is desirable, permission from the owner of the land may be obtained.

The introduction of our native species by planting or sowing in places in which they have never been known to grow wild is strongly to be deprecated. A natural harmony is disturbed and the introduced species may oust other species or even increase to become a nuisance. Introduction of alien plants in wild localities, and indiscriminate seed scattering are thoroughly reprehensible.

Education of the adult is difficult. He is not interested, but may be reached by appeals or occasional talks by the B.B.C. and by helpful articles and notes in the public Press. The botanical collector who wants rare species for his herbarium or for exchange purposes is even more difficult to convert. Education of the children, instilling a love and respect for our wild flowers, seems the most hopeful method. A pamphlet on "The Protection of Wild Flowers" has been widely distributed by the Conservation Board among school teachers. Every school should, where possible, have a garden in which the children are encouraged to grow wild plants from seed and note their development. Flora's League publishes an admirable booklet by Mr. T. A. Dymes with full instructions for growing wild plants from seed.

The active co-operation of everyone interested is necessary if the movement is to succeed.

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### Dartford-Purfleet Tunnel

BELOW Blackwall tunnel, which is thirty-five miles from the mouth of the Thames estuary, there are no facilities for crossing the Thames either by bridge or tunnel. The construction has now been approved of a tunnel, which will be called the Dartford-Purfleet tunnel and will connect the Purfleet-Grays Road on the north side of the river with the Dartford Southern by-pass, and a connexion will then be made with the London-Folkestone and the London-Hastings roads. As a first step (*Roads and Road Construction*, September 1), a pilot tunnel will be constructed 900 yards in length and with an internal diameter of 12 feet. Two ventilating shafts with diameters of 18 feet will be constructed on the Kent and Essex banks of the river. They will be approximately 100 feet in depth. The pilot tunnel will cost £300,000 and will provide information as to the strata under the river at this place. This will be very helpful in connexion with the construction of the main tunnel. The tunnel will be rather more than a mile in length. The cost of the whole scheme is estimated to be about three million pounds, the pilot tunnel costing about a tenth of this. The Ministry of Transport, which will be directly responsible for carrying out the work, has made, in conjunction with the county councils of Essex and Kent, all the necessary arrangements. This tunnel, which will be twelve miles down the river from the Blackwall tunnel, will form a much-needed link between the north and south sides of the Thames Estuary.

### Electrical Accidents in 1935

THE report on electrical accidents in 1935 by H.M. electrical inspector of factories (London: H.M. Stationery Office. 9*d*.) is of special value to all who design and operate electrical apparatus. The total number of accidents reported under the Acts was 447, of which 23 were fatal. Although the use of electricity has doubled during the last ten years, the annual total of the number of accidents has varied very little. The total number, twenty-three, of fatal accidents on factory premises is eight less than last year. This is probably due to the much larger use now made of artificial respiration when attempting to revive the victims of electric shock. In successful cases the time of application necessary varied from a few minutes to half an hour. Last year there were nine successful cases, but if it had been tried in every case there would doubtless have been more, as signs of life in some of the cases which ended fatally were evident after the shock. The inspectors specially mention the very rapid growth of electric arc welding to structures of all kinds. Although there were thirty-six electrical accidents to electrical welders, none of them was fatal. This is probably largely due to the attention now being paid to the personal equipment of the operator. Gauntlets, hand screens and helmets are made of suitable insulating materials, and are standardized. In addition, the harmful effects produced on the eyes of workmen not concerned in the welding processes, but liable to flashes from an arc in their vicinity, are considered. It has been found that plain glasses cut off a large proportion of the harmful ultra-violet rays. Until they had experienced the painful effects of eye flash, workmen were reluctant to wear them; in works where they are used, eye trouble has been eliminated.

### New Conceptions of a Rock Garden

ENGLISH gardens have been enriched with many beautiful herbaceous plants from South Africa, but the succulent and xerophytic species of that region are not yet common in England. The rockery which is being made in Johannesburg for the Empire Exhibition of September, 1936–January, 1937 should provide an adequate portrayal of South Africa's wonderful endowments in these sections of its flora. Prof. John Phillips, professor of botany in the University of the Witwatersrand, describes the rockery in the *Journal of the Royal Horticultural Society* of August, 1936. It is planned upon a scale which is somewhat gigantic when judged from most English standards. Summits are broken with plantings of *Aloe Marlothii*, *A. dichotoma*, and other species, whilst the most striking effects are produced by the mesembryanthemums, the euphorbias, members of the genus *Encephalartos*, the pelargoniums, and by *Aster capensis*, *Dimorphotheca Ecklonis* and *Euryops athanasia*. A stream, rushing from the rock garden into the lake below, affords opportunity for the planting of indigenous hygrophilous plants, and lawns of *Cynodon* sp. and *Pennisetum clandestinum* have been laid. Large woody shrubs, and even small trees, such as *Chilianthus arboreus*, *Rhus lancea*, *Dombeya rotundifolia*, *Cussonia spicata*, *Tecomaria capensis*, *Plumbago capensis*, and other species, are employed for certain effects. Mr. Frank Frith, an expert on succulents, is supervising the making of the rockery.

### Early Man in Colorado—Further Investigations

EARLY in June, Dr. Frank H. H. Roberts, jun., of the Smithsonian Institution, Washington, D.C., resumed excavations on the Lindenmeier site in northern Colorado for the third consecutive summer (see NATURE, Oct. 5, 1935, p. 535). While this habitation or camp site of Folsom man, the only known site of its kind and the only source of more than isolated specimens of the characteristic grooved stone Folsom point, has produced an abundance of evidence of the mode of life of Folsom man, hitherto no human skeletal remains have been found in association with this culture. Dr. Roberts's investigations during the coming season, therefore, will be devoted especially to the search for human skeletal remains. That early man was a contemporary of the extinct forms of bison found on the Lindenmeier site and dating possibly from the last stages of the Ice Age, is incontestable, as the tip end of a point was discovered in the foramen of the spinal column of a bison, of which a considerable portion of the skeleton was uncovered with the bones still articulated. A further matter of interest is that the palæontological evidence obtained by Dr. Roberts points to a climate somewhat warmer than that of the present day, some of the invertebrates represented by fossils being considerably north of their present range.

**Bureau of Human Heredity**

THE object of the Bureau of Human Heredity, which has recently been founded (see NATURE, **137**, 795 ; 1937), is collection on as wide a scale as possible of material dealing with human genetics. Later, the tasks of analysis of material and distribution of the information available will be added. It is affiliated to the International Human Heredity Committee, which ensures co-operation in all areas where research is proceeding. The Council would be grateful to receive all available material from institutions and individuals, furnishing well-authenticated data on the transmission of human traits whatever these may be. Pedigrees are particularly desired ; twin studies and statistical researches are also relevant. Announcements in regard to the services undertaken by the Bureau will be published from time to time. The address of the Bureau is 115 Gower Street, London, W.C.1.

**Announcements**

DR. H. R. MILL has been elected a member of the German Academy of Naturalists at Halle "in recognition of his original contributions to geographical science and particularly to Oceanography and the furtherance of Polar research". This Academy, the full title of which is the Kaiserlich Leopoldinisch-Carolinisch Deutsche Akademie der Naturforscher, was founded at Schweinfurth in 1652 by a group of medical men who called themselves the Argonauts, as their object was to explore new realms of science in order to bring back the 'gold of knowledge' for the benefit of mankind, an aim which it now defines as the study of Nature for the good of humanity.

MR. R. A. WATSON WATT has been appointed superintendent of the Air Ministry Research Station, Bawdsey Manor, Suffolk. Mr. Watson Watt began his Civil Service career in the Meteorological Office, and later was appointed superintendent of the Radio Research Stations of the Department of Scientific and Industrial Research at Aldershot and Slough. He became superintendent of the Radio Department of the National Physical Laboratory when it was formed in 1933. In this post he has been responsible for an increasing amount of important work for the Air Ministry, especially in connexion with radio direction finders and beacons. His present appointment arises from a decision by that Department to establish a research station to continue this work.

PROF. FRANZ FISCHER, of the Kaiser-Wilhelm Institute, Mulheim-Ruhr, will deliver the Melchett Lecture of the Institute of Fuel at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1, on October 15, at 3.30 p.m. The subject of Prof. Fischer's lecture will be "Production of Synthetic Motor Spirit".

THE Prussian Academy of Sciences has awarded the gold Leibniz medal to Prof. Heinrich Lotz, of Berlin, and the silver Leibniz medal to Dr. Ludwig Kohl-Larsen, of Allensbach a. Bodensee.

PROF. REINHOLD RIECKE, director of the Chemico-Technical Experimental Institute of the German Porcelain Factory of Berlin and scientific director of the German Ceramic Society, has been nominated an honorary member of the American Ceramic Society.

IN connexion with the research item in NATURE of July 11, p. 83, on the Netherland's Meteorological Institute's publication, "Oceanographic and Meteorological Observations in the China Seas", Mr. H. Keyser, of De Bilt, writes that for the English text very valuable assistance was given by Mr. E. W. Barlow, of the Marine Division of the Meteorological Office in London, who took much trouble in correcting the manuscript, etc. Mr. Barlow has also given assistance, "on behalf of international co-operation", in the preparation of Part 2 of the work.

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APPLICATIONS are invited for the following appointments, on or before the dates mentioned :

An inspector of agriculture in the Department of Agriculture and Forests, Sudan Government—The Controller, Sudan Government London Office, Wellington House, Buckingham Gate, London, S.W.1 (September 15).

Two junior investigators for the Royal Commission on Historical Monuments—The Secretary, 29 Abingdon Street, London, S.W.1 (September 19).

An assistant horticultural instructor for the Hampshire County Council—The Clerk, The Castle, Winchester (September 21).

An assistant lecturer in electrical engineering in University College, London—The Secretary (September 23).

An instructor in engineering workshop practice and production engineering in the Borough Polytechnic, London, S.E.1—The Principal (September 23).

A head of the Production, Engineering and Trades Course Section of the Department of Mechanical Engineering, and a lecturer in metallurgy, in the Central Technical College, Birmingham—The Chief Education Officer (September 26).

An assistant conservator of forests in the Department of Agriculture and Forests, Sudan Government—The Controller, Sudan Government London Office, Wellington House, Buckingham Gate, London, S.W.1 (September 30).

A biologist for research in the eastern Canadian lobster fishery—The Director, Atlantic Biological Station, St. Andrews, N.B., Canada.

A temporary assistant engineer in the Experimental Section of the Ministry of Transport—The Establishment Officer, Ministry of Transport, Whitehall Gardens, London, S.W.1.

Architectural and structural engineering assistants in the Design Branch of the Directorate of Fortifications and Works at the War Office—The Under-Secretary of State (C. 5), The War Office, London, S.W.1 (quote 8314).

An assistant master to teach zoology in the Swansea Technical College—The Director of Education, Education Offices, Guildhall, Swansea.

# Letters to the Editor

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

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 469.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

## Conservation of Energy in Radiation Processes

AT the beginning of this year, R. Shankland[1] reported experiments on the Compton effect which indicated a breakdown of the conservation laws in radiation processes and a reversal to the type of theory put forward by Bohr, Kramers and Slater in 1924. According to the latter, light-quanta have no existence, and energy is only statistically conserved in the interaction of matter and radiation. In view of the difficulties of accepting Shankland's results—it was pointed out by one of the present writers in an earlier note[2] that they "run counter to the Uncertainty Principle"—we have carried out certain experiments with a view of testing further the points at issue.

In these experiments, which were referred to in the above-mentioned note, a narrow beam of X-rays ($h\nu \sim 20,000$ volts) is passed through a Wilson chamber containing argon, thus producing photo-electrons. Of the photo-electrons which come from the $K$-level, the great majority are accompanied by Auger electrons, the latter being produced by the process of internal conversion (the combination of the two tracks will be called a $P$ track and represented in Fig. 1 by /\). The remainder of the $k$-photo-electrons—about 1 in 13—are not accompanied by Auger electrons ($Q_1$ tracks, denoted /). On the light-quantum theory, and strict conservation, the ionized atoms which do not give Auger electrons emit a $k$ fluorescent quantum, which, if absorbed in the surrounding gas, produces a photo-electron ($F$ track, denoted \). This state of affairs is represented in Fig. 1, the dotted line being the path of the light-quantum.

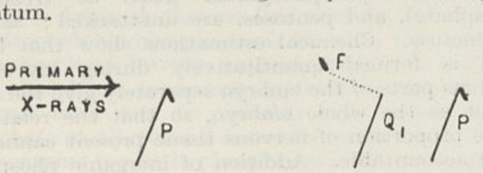


FIG. 1.

Now the ionized atoms have *exactly the same durations in the excited state* whether they give rise to an Auger electron or not, and on the theory of statistical conservation such as the Bohr-Kramers-Slater theory, they 'emit' fluorescent radiation to exactly the same extent, and *are equally responsible for the production of the fluorescent F tracks.* The latter would therefore not be associated with a $Q_1$ track any more than with a $P$ track, while if there is strict conservation an $F$ track has nothing to do with a $P$ track. A test of the points at issue may therefore be made by seeing whether a track of the $Q$ type is systematically associated with a fluorescent track or not. A statistical examination is necessary, especially in view of the fact that the photo-electrons coming from the $L$ level ($Q_2$ tracks) are not distinguishable in the photographs from the $Q_1$ tracks, and are about equal in number.

Out of about 350 photographs (about 10 tracks per photograph, effective length of chamber $\sim$ 14 cm.) 21 were found with $F$ tracks within 2 cm. of the

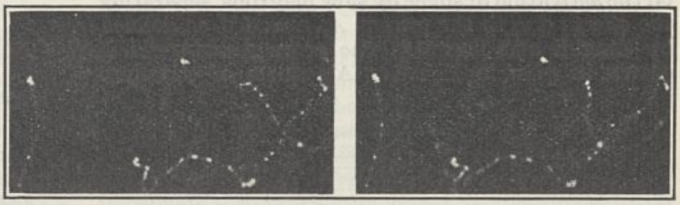

FIG. 2.

primary X-ray pencil, in approximate accordance with the value of the absorption coefficient of argon for argon $k$-radiation, the argon being at a pressure of about 14 cm. A general inspection of the photographs showed a distinct association of $Q$ and $F$ tracks, indicating strict conservation. One of the photographs is reproduced above (Fig. 2), the short track by itself being that of a fluorescent photo-electron ($F$ track) and the middle long track that of a primary photo-electron without an Auger electron ($Q$ track).

The distribution of the distances ($x$), measured parallel to the X-ray pencil, of the $Q$ tracks from the $F$ tracks for all the photographs is shown by the full line in Fig. 3, for $x$ up to 6 cm. The calculated distribution according to strict conservation is represented by the broken line (– – –). The peak for small $x$ represents the association of $Q_1$ and $F$ tracks. The background is to be attributed mainly to the photo-electrons from the $L$-level ($Q_2$ tracks). The statistical fluctuation comes almost entirely from this background and is about $\pm 1\frac{1}{2}$. The total number of tracks per photograph is such that on the statistical theory the $Q$ tracks have practically a random distribution with respect to the fluorescent photo-electrons. This is represented by the dotted line (......). The observed distribution is seen to have a peak in good agreement with the calculated distribution assuming strict conservation.

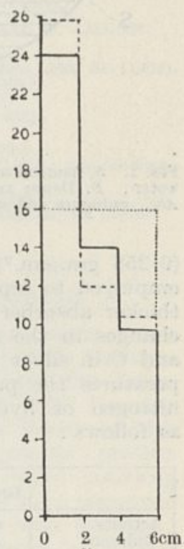


FIG. 3.

In view of Shankland's results, other workers have also recently carried out experiments on the conservation of energy and momentum in radiation processes[3]. In these investigations the counter coincidence method has been used. In all cases the results obtained, in conformity with the present results, confirm the light-quantum theory and the strict applicability of the conservation principles.

E. J. Williams.
E. Pickup.
Physical Laboratory,
Manchester.
Aug. 7.

[1] *Phys. Rev.*, **49**, 8 (1936).
[2] Nature, **137**, 614 (1936).
[3] Bothe and Maier-Leibnitz, *Göttingen Nacht.*, **10**, 127 (1936).
4. C. Jacobsen, Nature, **138**, 25 (1936). Present results were reported at Physics Conference, Zurich, July 1.

## Influence of Temperature on the 'Groups' of Slow Neutrons

We have investigated the influence of temperature on the activation of silver by slow neutrons, separating the effects due to the groups $A$, $B$ and $C$ as defined by Amaldi and Fermi[1]. The arrangement used is shown in plan in Fig. 1. Absorbers of cadmium

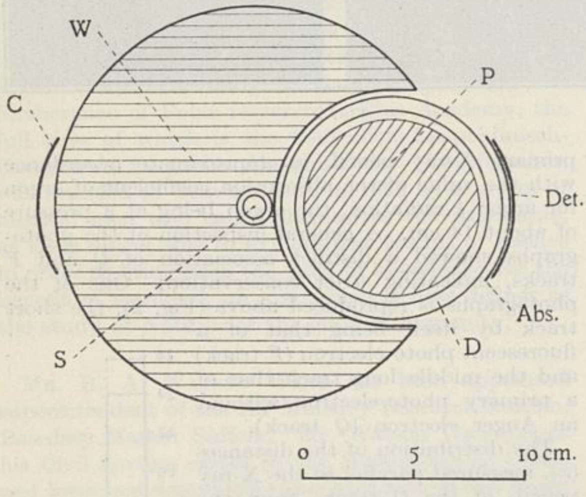


Fig. 1. $S$, neutron source (beryllium and radon); $W$, tin containing water; $D$, Dewar vessel; $P$, paraffin wax; *Det.*, silver detector; *Abs.*, cadmium and/or silver absorbers; $C$, position of detector for comparison runs.

(0·258 gm./cm.²) and silver (0·077 gm./cm.²) were employed to separate the groups, and the use of a thicker absorber of silver (1·023 gm./cm.²) enabled changes in the absorption coefficients of groups $B$ and $C$ in silver to be measured. For the low temperatures the paraffin wax was cooled with liquid nitrogen or hydrogen. The results obtained were as follows:

| | Group | 290° K. | 77° K. | 20° K. |
|---|---|---|---|---|
| Activity induced | $C$ | 100·0 ± 1·4 | 83·7 ± 1·3 | 96·4 ± 1·2 |
| | $B$ | 100·0 ± 2·0 | 101·4 ± 2·0 | 88·5 ± 1·6 |
| | $A$ | 100·0 ± 5·0 | 75·3 ± 5·6 | 72·0 ± 5·4 |
| Absorption coefficient | $C$ | 100·0 ± 4·5 | 117·8 ± 5·2 | 160·8 ± 5·0 |
| | $B$ | 100·0 ± 7·0 | 123·1 ± 7·0 | 110·6 ± 6·7 |
| 'Number of neutrons' $\left(=\frac{\text{activation}}{\text{abs. coeff.}}\right)$ | $C$ | 100·0 ± 4·7 | 71·1 ± 3·2 | 60·0 ± 2·2 |
| | $B$ | 100·0 ± 7·3 | 82·4 ± 5·0 | 80·1 ± 5·1 |

N.B. Each row has been scaled to make the first figure 100, and figures in different rows are not comparable. The errors shown are the mean square errors due to statistical fluctuations.

Some measurements using ice instead of paraffin wax in the Dewar vessel have given similar results.

It will be seen that groups $A$ and $B$, as well as $C$, are affected by changes of temperature. This is in contradiction with the estimates of the energies of the former groups hitherto accepted[2], which gave values of several electron-volts, compared with the 0·037 e.v. or less corresponding to the temperatures used. For other reasons it appears unlikely that the energies of groups $A$ and $B$ have values lying in the region of thermal equilibrium, but according to our experiments they cannot be greatly in excess of such values. It follows from this that the assumption that the absorption coefficient of boron varies inversely as the velocity of the neutrons must be in error.

We desire to thank Lord Rutherford for putting the facilities of the laboratory at our disposal, and Dr. M. L. Oliphant for helpful discussions. It is hoped to continue experiments on these lines, and a fuller account will be published in due course.

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O. Heil.
C. H. Westcott.
Cavendish Laboratory,
Cambridge.
Aug. 10.

[1] *Ric. Scient.*, (ii), **6**, 344 and 443 (1935); (i), **7**, 454 (1936).
[2] Amaldi and Fermi, loc. cit.; Frisch and Placzek, Nature, **137**, 357 (1936); Weeks, Livingstone and Bethe, *Phys. Rev.*, **49**, 471 (1936).

## Mechanism of Carbohydrate Breakdown in Early Embryonic Development

During the past twelve months, we have been engaged in a systematic study of the intermediary mechanisms of carbohydrate breakdown in the chick embryo in the first week of its developmental period. Although we have not yet brought our work to a conclusion, we wish to give an interim summary of it.

Attention has been concentrated throughout on the embryo of 4–6 days' incubation, and the first experiments done were measurements of anærobic glycolysis with different substrates. It is found that glucose and mannose are the only sugars which give a steady long-continuing glycolysis; disaccharides, even when phosphorylated (such as trehalose-phosphate), and pentoses, are unattacked; as also is fructose. Chemical estimations show that lactic acid is formed quantitatively during glycolysis. Various parts of the embryo separately give the same result as the whole embryo, so that the relatively large proportion of nervous tissue present cannot be held accountable. Addition of inorganic phosphate does not increase the glycolytic rate of glucose or mannose, or cause the breakdown of other sugars. Glycogen is not glycolysed by pulped or minced embryo any more than it is by intact embryos, and even fairly active acetone powders prepared according to the method applied to brain by v. Euler, Gunther and Vestlin[1], will not glycolyse glycogen. With intact embryos, embryo-*Brei* and acetone powders, there is often an induction period of a few minutes in the glycolysis of mannose and glucose; this initial lag may be abolished by the addition of co-zymase or adenyl-pyrophosphate.

The trisaccharide of Levene and Mori[2] (2 mannose plus 1 glucosamine), contained in egg proteins, is not attacked by intact embryos; but when the mannose has been made available by hydrolysis, embryos can glycolyse the product. Probably the yolk-sac hydrolyses it *in vivo*. Glucosamine itself is not glycolysable, and another trisaccharide, raffinose, is also unattacked.

Chick embryo resembles mammalian brain in that its glycolysis, whether of glucose or mannose, can be almost completely abolished by the addition of glyceraldehyde. The autoglycolysis, however, cannot be inhibited in this way.

Study was also made of the appearance of bisulphite-binding compounds during embryonic glycolysis. By the methods of Clift and Cook[3], it was found that a considerable accumulation of pyruvic acid occurs both ærobically and anærobically. Of the carbohydrate glycolysed, some 60 per cent appears temporarily in the form of pyruvic acid, if no substrate is given, but if glucose is present the relative amount is much reduced (to less than 10 per cent) although more pyruvic acid appears. The accumulation of pyruvic acid occurs in embryo tissues of 10 days incubation also. In view of the work of Peters and his collaborators[4], on avitaminous bird brain, it was conjectured that the embryo might be physiologically $B_1$-deficient, but on the contrary the addition of crystalline vitamin $B_1$ had no effect on the pyruvic acid accumulations.

Next, the rates of anærobic and ærobic glycolysis of the embryo were compared with the rate of oxidative disappearance of lactic acid. In embryo, the Pasteur effect is extremely marked. If Meyerhof's resynthesis theory were the correct explanation of this, the rate of disappearance of added lactate (in the absence of glycolysable substrate) should be equal to the observed difference between ærobic and anærobic glycolysis in the presence of glucose. But in fact it is far less than that. Some explanation of the Pasteur effect in embryo, other than the Meyerhof cycle, must therefore be found.

In this respect, chick embryo resembles mammalian brain (Dixon[5]). The effect of potassium in increasing respiration and anærobic glycolysis observed by Ashford and Dixon[6] was, however, looked for, and found not to exist in the case of embryo. In this respect, it differs from brain.

Another line of attack which we have used is that of analysing the distribution of phosphorus among the various fractions of the aqueous trichloracetic acid extract. Chick embryo differs widely from muscle or brain in that no less than 60 per cent of its water-soluble phosphorus is found in the 'hexose-monophosphate' fraction unprecipitable with barium. This phosphorus-containing material cannot be the Robison ester and is probably not hexose-monophosphate at all, since it is not fermentable by yeast and contains too little phosphorus in the elementary analysis. It is very resistant to acid hydrolysis. Embryo is therefore similar to tumour, where, as Outhouse[7] has shown, a large amount of the same fraction is present, perhaps as hexosamine-phosphate or amino-ethyl-alcohol-phosphate; and with blood where, according to Kerr and Daoud[8], half the whole amount of phosphorus may be in the form of diphosphoglyceric acid.

The distribution of the phosphorus was further investigated after treatment of the embryos at 37° for some time with fluoride in a dosage just sufficient to inhibit glycolysis 90 per cent. The medium contained inorganic phosphate. Contrary to what would be expected if the embryo followed the example of muscle, there was no accumulation of difficultly hydrolysable esters; on the contrary, there was a piling up of inorganic phosphate at the expense of the phosphagen and the adenyl-pyrophosphate. This is not a specific effect of the fluoride, but happens also when the embryos are suspended in Ringer-bicarbonate anærobically without the addition of any substance. Upon the fraction not precipitable by barium, fluoride has no effect; this remains constant. It persists, moreover, in about the same relative proportion until at least the fifteenth day of development.

One of the main points of interest in this work is, of course, the question whether the embryo's carbohydrate breakdown is entirely, partially, or not at all effected by means of a phosphorylation system. At present we only wish to record that apparently neither intact embryo nor embryo-*Brei* will glycolyse any combination of the phosphorus-containing intermediates, for example, sodium glycerophosphate with sodium pyruvate, sodium phospho-pyruvate, or sodium phospho-glycerate. Dihydroxyacetone is not broken down, whether inorganic phosphate is present or not. As we expected from the work of Neuberg, Kobel and Laser[9], methyl-glyoxal is converted to lactic acid at a rate about half that of glucose, which under certain conditions may be increased by added sulphydryl. The embryo will not form lactic acid from hexose-diphosphate, glucose-monophosphate, or mannose-monophosphate. But on the other hand, inactivated embryo-*Brei* forms a dihydroxyacetone-phosphate fraction from added hexose-diphosphate to the same extent as mammalian muscle extract, and forms phospho-glyceric acid from phospho-pyruvic acid. It also transfers phosphorus from phospho-pyruvic acid to adenylic acid (the first part of the Parnas reaction). We hope that our experiments will shortly permit of final decision regarding the question of phosphorylation in the embryo.

JOSEPH NEEDHAM.
W. W. NOWIŃSKI.
R. P. COOK.
KENDAL C. DIXON.
Biochemical Laboratory,
Cambridge.
July 20.

[1] v. Euler, Gunther and Vestlin, *Z. physiol. Chem.*, **240**, 265 (1936).
[2] Levene and Mori, *J. Biol. Chem.*, **84**, 49 (1929).
[3] Clift and Cook, *Biochem. J.*, **26**, 1788 (1932).
[4] Peters *et al.*, *Proc. Roy. Soc.* B, **110**, 431 (1932).
[5] Dixon, *Biochem. J.*, **29**, 973 (1935).
[6] Ashford and Dixon, *Biochem. J.*, **29**, 157 (1935).
[7] Outhouse, *Trans. Roy. Soc. Canada*, v, **29**, 77 (1935); and *Biochem. J.*, **30**, 197 (1936).
[8] Kerr and Daoud, *J. Biol. Chem.*, **109**, 301 (1935).
[9] Neuberg, Kobel and Laser, *Z. Krebsforschung*, **32**, 92 (1930).

## Reliability of Seismograph Stations

In a recent paper, Dr. H. Jeffreys[1] works out a 'reliability' factor for seismograph stations throughout the world, using information from the International Seismological Summary for 1930 January to 1931 March. Reliability results based on this information do not, however, represent present conditions. Seismology has made rapid headway since 1931, and a number of stations have improved both their recording equipment and their timing.

The characteristic which Jeffreys terms 'reliability' is obtained by expressing the number of $P$ residuals not exceeding $\pm 4$ seconds, as a decimal of the total number of $P$ residuals; so that the 'reliability' values vary between 0·0 and 1·0. A table of such values for each station is given, the stations being grouped into five regions. Of the seventeen stations in the 'Pacific' group, we find Wellington, with readings from two Milne-Shaw seismographs, taking thirteenth place; and Christchurch, with readings from a single Milne seismograph, taking fifth place. The 'reliability' values given are as follows :

Wellington $\frac{8}{24}=0\cdot3$;

Christchurch $\frac{4}{8}=0\cdot5$.

This surprising result led me to make a detailed examination of the data for Wellington and Christchurch. Working on the same lines as Jeffreys, and using the same data, I obtained the following values for the 'reliability' :

Wellington $\frac{11}{27}=0\cdot4$;

Christchurch $\frac{3}{9}=0\cdot3$.

The above results differ from those obtained by Jeffreys, but they are more in accordance with the instrumental equipment at the two stations. However, if more recent observations were used, both stations would undoubtedly have higher values.

The $P$ residuals at Wellington are nearly all negative. Of the eleven not exceeding $\pm4$ seconds, eight are negative, two are zero, and one is positive ; giving a mean residual of nearly $-2$ seconds. This suggests that the deviations found for this station are not random errors, and that the station should be classed with those showing systematic errors. These observations giving negative residuals refer to Pacific earthquakes with epicentres to north or north-west of Wellington, and it is possible that these need some readjustment, as there is generally a lack of near stations in eastern azimuths as compared with western azimuths. It seems certain, as suggested by Jeffreys, that sufficient weight has not been given to Wellington and Christchurch in the determination of Pacific epicentres.

In dealing with the utility of his results, Jeffreys selects a number of stations of good 'reliability' for each of the five regions. As 'Pacific' stations, those selected are : Riverview, Palau, Manila, with Melbourne and Adelaide to check Riverview.

This cannot be considered a complete list for years following 1931, since both Wellington and Christchurch would almost certainly be included as stations of good 'reliability'. Also, the standard errors of $P$ should now be less than the value of 4 seconds, which Jeffreys applies to these stations.

R. C. HAYES.
(Acting Director.)

Dominion Observatory,
Wellington,
New Zealand.
July 17.

[1] "A Comparison of Seismological Stations", *Mon. Not. Roy. Ast. Soc., Geophys. Suppl.*, 3, No. 9, 423 (April, 1936).

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I SHOULD agree with Mr. Hayes that not much importance should be attached to the difference between Wellington and Christchurch. The standard error of a reliability $r$ based on $n$ observations is $\sqrt{\{r(1-r)/n\}}$ ; then with my data the results are Wellington $0\cdot33\pm0\cdot10$, Christchurch $0\cdot50\pm0\cdot18$. This is for all earthquakes recorded at the stations. For Pacific earthquakes alone, I get Wellington $0\cdot36\pm0\cdot13$, Christchurch $0\cdot56\pm0\cdot19$. The difference is therefore not more than might be attributed to random sampling. On the other hand, we may notice that there were three times as many readings of $P$ at Wellington as at Christchurch, though in most cases the amplitude of the motion of the ground must have been about the same, and many of the inferior observations at Wellington refer to earthquakes when Christchurch failed to record $P$ at all.

The data as presented in the International Seismological Summary do not indicate the clearness of the movement, and it is probable that the clearer movements at Wellington correspond to a much higher reliability. I also directed attention in my paper to the fact that in some cases too little weight seems to have been given to the near stations in determining the epicentres, and that for this reason the reliabilities found for both stations may be too low for earthquakes in the South Pacific ; but to remove this error would mean recalculating the whole of the epicentres.

Support can be found for the higher reliability of Wellington in strong or fairly near earthquakes from the residuals at the British stations with Milne-Shaw instruments in the series of deep-focus earthquakes that I have discussed recently[1]. Oxford is excluded because it has already been found to have a high reliability. The residuals for the others together have the following distribution :

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Residual (seconds) | −2 | −1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Number | 2 | 2 | 6 | 2 | 2 | 1 | 0 | 1 | 1 | 0 | 1. |

These correspond to a mean reliability of $15/18=0\cdot83\pm0\cdot09$ ; but the mean for these stations for general work was only $0\cdot50\pm0\cdot08$.

The results in my paper do not place the stations in a definite order of merit, since the sampling error is appreciable ; but they serve to indicate approximate weights to use in the determination of epicentres. I should recommend using for Wellington, when within 30°, the weights for reliability $0\cdot6$ until further information is available.

HAROLD JEFFREYS.

St. John's College,
Cambridge.

[1] *Mon. Not. Roy. Ast. Soc., Geophys. Suppl.*, 3, 310 (1935).

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## "A Treatment of Modern Physics"

UNDER the above title, E. N. da C. A., in NATURE of June 13, has subjected my co-worker, Mr. N. K. Saha and myself, to a vigorous 'strafing' for writing "A Treatise on Modern Physics", Vol. 1, published by the Indian Press of Calcutta and Allahabad. In fairness to the large number of readers (not merely Indian) who, between the publication of the book in November, 1934, and its review in NATURE, have wasted, according to the reviewer, thirty shillings on a book advocating a "method of teaching" which he holds "to be pernicious", I, as the senior author, seek permission to publish the following apologia in NATURE.

Reviewers have their own right, which I do not propose to question, but they are expected to give a short *résumé* of the subject matter of the book, point out mistakes or misstatements of facts, find out possible errors in the presentation of current ideas and to deal with important omissions, as has been done in NATURE by Prof. R. H. Fowler in a review of another work by me. In no case have we come across a review in which the reviewer finds faults with the author for not including matter which is expressly stated to be reserved for subsequent treatment.

In the present case, the reviewer has followed an original line in his review. He does not give a *résumé*, does not point out a single mistake, and does not say that the presentation of ideas has been marked by any serious error or bad style. He deals only with *omissions*, in spite of the fact that the authors themselves noted these omissions in the following passage which occurs in the preface :

"It was first intended to include chapters on Molecular Physics, interaction between matter and light, wave-mechanics and Nuclear Physics, but as the book has already become bulky, it was decided to incorporate these chapters in a second volume."

Most of the omissions to which the reviewer devotes three-quarters of his criticism, namely, failure to give an account of the correspondence principles, selection rules, principles of wave-mechanics and also some advances on positive rays fall under the chapters mentioned above. The reviewer's remarks regarding the omissions are, therefore, not only irrelevant but also extremely ungracious to the authors.

As to the other minor charges—omission in Chapter iii (Positive Rays) of mention of Aston's and Bainbridge's precision mass-spectrograph and of the results obtained therefrom—the explanation is very simple. The present volume, being confined solely to discussion of atomic structure, the authors were justified in omitting all references to such works, which have a bearing on nuclear physics. This has been expressly mentioned on page 99. Further, at the time of writing, Aston and others (Rutherford, Oliphant, Kempton, Bethe) were engaged in revising the mass-scale. The authors did not, therefore, feel justified in including such matter as would become obsolete before the ink had dried. Probably if the results had been included, the reviewer would have found fault for their inclusion.

Regarding the chapter on magnetism, the authors were aware of the current theories of ferromagnetism, but on perusal of these had come to the conclusion that these theories were only 'phenomenological' and had better be omitted from a text-book. The wisdom of such a step was justified in Simon's recent discovery that, near the absolute zero, all paramagnetic substances tend to become ferromagnetic. This probably necessitates a revision of the current theories of ferromagnetism, which trace it to exchange resonance amongst the *d*-electrons of the transitional elements of the first group. I do not think that such matter as magneto-caloric effect or of magnetostriction need be incorporated in a book dealing mainly with atoms. It is possible to have legitimate differences of opinion on this question.

The reviewer complains that there has been too much of complex spectra in this treatise. In this connexion the following passage in his well-known text-book published in 1927 ("The Structure of the Atom") may be quoted :

"A discussion at Danzig in September, 1925, between some of the most celebrated workers in the field of quantum analysis of spectra, at which the writer had the pleasure of being present, foundered, if the expression may be used, on the question of notation, none of the speakers being able to understand the notation of the others and each having also apparently difficulties with his own."—(Footnote, p. 569.)

In spite of this situation nine years ago, the writer of this text-book, who according to his own admission did not at the time understand the subject, devoted 79 pages of his text-book to multiplet structure. The reviewer admits that the difficulties of a lucid exposition of the subject of complex spectra have largely disappeared as a result of advance of knowledge within the last ten years, but he puts forward the very curious view that the necessity of giving a full exposition of the subject, in the circumstances, no longer remains.

It is rather difficult to understand the reviewer's remarks about the inner quantum number and the spinning electrons. The writer's point of view has been the approach of the subject from the side of spectroscopy, while the reviewer would like to develop it from the mechanical side. The two views being divergent, the criticisms are rather ungracious. In one case he has misrepresented the actual language used about the rotating electron. I may add that Goudsmit and Uhlenbeck used the term "Rotierende Elektron". He writes "the perephral velocity is even worked out on these lines and the absurd value which results is said to be unexplained". The mathematical results, for quoting which fault is found, have been taken from Goudsmit and Uhlenbeck's original note to *Die Naturwissenschaften*, and the words used by these authors are as follows : "The linear velocity at the periphery of the electron thus comes out to about 308 times the velocity of light, a deduction which has still to remain *incomprehensible*."

The authors at any rate may be expected to know the methods of teaching, pernicious or otherwise, which prevail in India, and they do not propose to bother about the *ex cathedra* remarks of the reviewer on this question.

M. N. Saha.

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It is now more years than I care to think of since books were entrusted to me for review in Nature, but it is the first time that I have seen a letter anything like that which Prof. Saha has sent for publication, and in the original and longer form in which the Editor showed it to me it was even more individual. I can scarcely be expected, at this time of day, to take lessons from Prof. Saha as to how to review a book, or to deal with his letter point by point, especially as a great deal of it is, to speak mildly, disingenuous. I may remark, however, that it is not correct to say that I did not point out a single mistake, and, further, that I was less concerned with details than with general principles. It was owing to a delicacy which I now realize to have been misplaced that I did not remark on the style in which the book is set down. Perhaps Prof. Saha's letter furnishes comment on that point.

My criticism was mainly directed to the fact that the book contains masses of detail, much of it unnecessary and some of it out of date, omits matters of prime importance for the subject under discussion, and provides little or no explanation of the principles on which the complicated calculations printed in the book are based. I have made my point of view perfectly clear, as I am entitled to do, and have not misrepresented that of the authors, and, in my experience, misrepresentation and ambiguity are the sole grounds which are held to justify a reply to a review. Those who hold that the points raised are trivial will set me down as mistaken, as in the case of the spinning electron, where all the relevant matter is before the reader.

What I gather to be the point of Prof. Saha's present communication is, first, that all the missing matter which one might have expected to find in this book—

some description of the method of anode rays and of the work of Bainbridge in the chapter headed "Positive Rays"; some explanation of the general methods of quantization before, for example, fourteen pages are devoted to the calculations on the Stark effect; some mention of the work of Hartree and others where the old work on electron distribution is discussed; and, in short, all the other fundamental points which, as I point out in my review, are completely neglected—is going to be described in a second volume; and secondly, that I ought to have known this from the passage which he quotes from the preface. The answer is, first, that the passage which he quotes does not say this, and, secondly, that even if it did, this is, *in my opinion*, a bad way of writing a book, especially as Prof. Saha's disciples are still awaiting the second volume which shall explain the first. In my opinion—but Prof. Saha says that my opinion is not worth much. For all I know he may be right, but there his quarrel is with the Editor, who invited me to give it, and not with me. In any event, Prof. Saha's remark that the authors "do not propose to bother about the *ex cathedra* remarks of the reviewer" on methods of teaching absolves me from the distasteful task of spending further time on Prof. Saha's favourable review of this volume of his book. I look forward, however, to reading his review of the second volume.

E. N. DA C. ANDRADE.

## 'Lines' on the Surface of Moving Water

SINCE reading the interesting accounts of this phenomenon by Prof. W. Schmidt[1] and Prof. H. Stansfield[2], I have noticed several striking instances which yield a clue to their cause. They occurred on the surfaces of clear country streams bridged by planks that touched the water, obstructions which, mechanically, resemble the mill-stream example described by Prof. Stansfield. Evidently the macroscopic agent causing the sudden change in velocity need penetrate only to a very small depth.

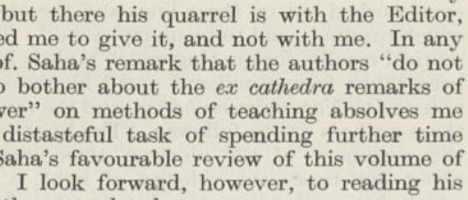


FIG. 1. Schematic diagram of stream (vertical longitudinal section); *a*, beam penetrating surface; *b*, surface line and secondary waves.

In the case illustrated, the 'line' was remarkably stable at an average distance of about 40 cm. from the bridge, and the conditions such as to be easily reproducible in a laboratory. The stream was about 1·3 m. wide and 40 cm. deep. The water flowed without visible turbulence and with a mid-stream surface velocity of about 25 cm. per sec. Fig. 1 represents a vertical, longitudinal section of the stream and foot-bridge, which touched its surface across the full width. Close to the line on the up-stream side was a series of parallel waves of diminishing amplitude and stationary with respect to the line. These secondary waves are clearly visible in the photograph (Fig. 2), and the reflections of overhanging foliage demonstrate the relative tranquillity of the surface between the line and the obstruction causing it.

In a wider and more slowly moving portion of the stream, a similar bridge had collected a band of scum. Here the line occurred nearly a metre above the scum, and secondary waves were visible only when the line was disturbed by winds, to which it was more sensitive than the line photographed.

FIG. 2. Photograph of a particularly stable 'line'.

The experiments recorded in previous letters concerning the behaviour of floating particles and the effect of soap were repeated. The initial position of the line depends on the velocity of the stream, whilst the extent of its temporary displacement up-stream caused by substances affecting the surface tension depends on the velocity of the stream, and on whether the addition is made up-stream or down-stream relative to the line. Qualitatively, the observations, including the 'oil-patch' effect, are consistent with the idea that the line marks the boundary of a surface film of colloidally dispersed material under lateral compression caused by movement of the water.

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[1] NATURE, 137, 777 (1936).
[2] NATURE, 137, 1073 (1936).

## Habit and Shell-shape in the Portuguese Oyster, *Ostrea angulata*

IT is known that the form of the shell of Portuguese oysters (*O. angulata*) living on the shore is different from that of individuals living permanently below tide-marks[1]. In the latter the shell is relatively very broad, in the former long and narrow, almost in the shape of a shoe-horn with the hinge at the narrow end. No explanation of this difference in shape could formerly be offered, but in a recent inspection of extensive inter-tidal beds of Portuguese oysters in the River Blackwater, to which I was courteously invited by Mr. Louis French, a probable explanation of the prevailing elongate-shaped shell suggested itself.

The oysters were lying on the normal muddy bed and had recently put on extensive new shell growth which was concentrated mainly at the end of the shell remote from the hinge; in almost all cases, the new growth was turned up from the substratum, whichever way the oyster was lying, so that in crossing the beds one walked on the sharp protruding shell-edges. As increments in shell-area are laid down by the mantle, this organ must be protruded mainly at the end of the shell, at least during growth, in a foreshore habitat. It seems probable that on the usual muddy foreshore bed the mantle is normally extended upwards in this part for feeding and respiration. Such a habit would give the advantage of an intake of clearer or less muddy water than is available around the more anterior edges of the shell which lie more or less in the mud, while if muddy water is inhaled the particles of foreign matter can readily be got rid of from a restricted region. If the normal habit is to extrude the mantle from the broad end of the shell as stated above, then it would follow that shell would be laid down with the mantle extended in this way and an elongate form of shell results. The sensory equipment of the bivalve is doubtless adequate to determine the most suitable region for intake of water.

On the other hand, in deep water where broad shells were found, the beds tend to be less muddy and the direction of the currents of water more regular ; it is therefore reasonable to suppose that there is less need for restriction of the mantle opening in this habitat, and that the mantle will normally be more uniformly extended. In that event, new growth will not be concentrated at the broad end of the shell and a broader shell will result.

It seems, therefore, that a difference in habit of controlling the extension of the mantle in the two habitats may account for the difference in the shape of the shell. At least two factors appear to be concerned, namely, the nature of the substratum, and the simplicity or complexity of the water-currents in the respective habitats. Further researches on shell-shape of this and *O. virginica*, the allied American species, living on different types of substratum below low water, would be interesting; for the American species resembles the Portuguese form to a considerable extent in habitat and shell-modifications[2].

The variable sinuous or irregularly twisted elongate form of the shell seen more commonly in the cultivated Portuguese oyster is clearly due to the habit of adding large new shell-shoots mainly from the upturned broader end.

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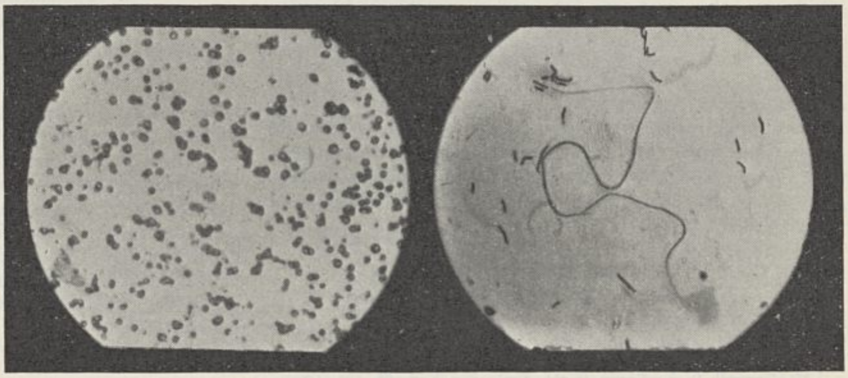
Aug. 14.

[1] J. H. Orton and P. R. Awati, *J. Mar. Biol. Assoc.*, 14, 227 (1926).
[2] Dean Bashford, *Bull. U.S.F.C.*, 10, 367, 1890 (1892).

## Life in the Dead Sea

THE remarkably high salt tolerance of unicellular organisms, which have been found in a saline lake of salt concentration so high as 19–26 per cent sodium chloride by Ruben Tschik, T. Hof, Baas-Becking and others, caused us to doubt the accuracy of the reputation of lifelessness, which tradition imputes to the Dead Sea. Accordingly, samples of Dead Sea water were taken under sterile conditions at a distance of 3–4 km. from the mouth of the Jordan at various sea depths up to 7 metres. The total salt concentration of the water samples was 28–29 per cent. Bacterial organisms could be grown in 1 per cent peptone sample water media at temperatures of 21°–23° C. and 30° C. from all the samples taken.



*a* *b*

FIG. 1. Dead Sea micro-organisms. × 550.

In addition, microscopic examination of a hanging drop of the water revealed the presence of a living phytoflagellate 13μ long, which we believe is either a *Chlamydomonas* or a *Dunaliella*. Three micro-organisms have so far been distinguished : a yeast-like, Gram negative orange pigment producer $1 \cdot 6 \times 1 \cdot 6\mu$ (Fig. 1*a*), a Gram negative small rod-like organism $1–4 \cdot 8\mu \times 0 \cdot 8\mu$, and a Gram positive long filamentous organism (Fig. 1*b*) $3 \cdot 3–9 \cdot 9\mu$ to $170\mu \times 0 \cdot 8\mu$. The investigations are being continued.

We take this opportunity of expressing our thanks to Mr. M. A. Novomeysky, managing director of the Palestine Potash Co. Ltd., for his most kind assistance.

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## A New Blowfly attacking Sheep in Western Scotland

IT is now generally accepted that *Lucilia sericata* is the only species of blowfly which causes primary 'strike' of sheep in Britain. Although MacDougall (1909)[1] recorded instances of sheep being struck by *Calliphora erythrocephala* alone, the more recent investigations of Davies (1934)[2] in Wales, and of Ratcliffe (1935)[3] in Aberdeenshire, failed to reveal any primary species other than *Lucilia sericata*. The following record is, therefore, of interest.

In the course of an investigation of the blowfly problem, I have obtained, from Mull and western Argyllshire, several collections of larvæ taken from field cases of strike. The larvæ were in each case transferred directly from the sheep into metal containers filled with a sand-sawdust mixture. On arrival they were placed in breeding jars, of a type which prevented the possibility of contamination of the cultures by ovipositing flies. Out of thirteen batches bred out to the adult stage, seven were found to be pure collections of *Phormia terræ-novæ R.-D.*

I am indebted to the Natural History Museum for the identification of the species from specimens submitted. The batches were all obtained from blackfaced sheep in long wool; the strikes occurred on various parts of the body, for example, the throat, loins, tailhead, breech, etc. Each batch yielded anything from a dozen or so to more than three hundred individuals.

It would appear, therefore, that in western Scotland at least, this species acts as a primary blowfly, initiating strike on relatively clean-woolled areas.

The closely related species, *Phormia regina*, is the principal sheep blowfly of North America, but *Phormia terræ-novæ* has not been recorded previously, from any country, as attacking sheep. In view of its wide European and North American distribution, and of the newly emerged fact that it is able to strike sheep, the absence of any such records is a matter of considerable interest.

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Aug. 21.

[1] MacDougall, R. S., *Trans. Highl. Agric. Soc. Scot.*, 21, 135 (1909).
[2] Davies, W. Maldwyn, *Ann. App. Biol.*, 21, 267 (1934).
[3] Ratcliffe, F. N., *Ann. App. Biol.*, 22, 742 (1935).

## Temperature Coefficient of the Electrolytic Separation of the Hydrogen Isotopes

IN the course of an experimental study of the electrolytic separation of the isotopes of hydrogen at current densities of one milliamp./cm.[2] and less with rigorous exclusion of oxygen, grease and other contamination, we have measured the temperature variation of the separation at mercury and silver cathodes with somewhat unexpected results.

The electrolyte was $0{\cdot}5N$ hydrogen chloride (with $0{\cdot}5N$ potassium chloride added in the experiments with mercury), and the anode consisted of the same metal as the cathode. The deuterium content of the cathode gas was determined by the micro-thermal conductivity method of Farkas[1]. The following values for the electrolytic separation coefficient ($\alpha$) were obtained at 15° C. and 98° C.:

| Cathode | 15° C. (i) | 15° C. (ii) | 98° | 98° (calc.) |
|---|---|---|---|---|
| Mercury | 2·8 | 3·35 | 3·25 | 2·3 |
| | 3·1 | 3·25 | 2·95 | 2·5 |
| Silver | 7·0 | 6·5 | 4·6 | 4·6 |
| | 7·0 | 6·6 | 4·4 | 4·6 |

The two columns for the lower temperature relate to measurements made respectively before and after the high temperature measurements. The last column gives the separation factor that would be expected at 98° C. from the relation

$$\ln \alpha = \frac{\Delta E}{RT},$$

where $\Delta E$ is the difference in activation energy necessary to account for the separation factor (i) at 15° C. The probable error in the values of $\alpha$ is 2–3 per cent. The anomalous behaviour of mercury is remarkable, but might perhaps be accounted for by assuming that both of the alternative mechanisms ('catalytic' and 'electrochemical') of Horiuti and Okamoto[2] contributed to the cationic discharge, and that at the higher temperature the relative participation of the two mechanisms became more nearly equal.

With the view of testing this possibility, small quantities of $\alpha$-naphthoquinoline, which might be expected to inhibit the 'catalytic' mechanism, were added to the electrolyte with the following results:

| Cathode | Concentration of inhibitor | 15° (i) | 15° (ii) | 98° |
|---|---|---|---|---|
| Mercury | 2 millimols/litre | 1·25 | 1·4 | 1·7 |
| | 0·3 ,, ,, | 1·55 | 1·55 | 2·2 |
| Silver | 0·3 ,, ,, | 1·7 | 3·0 falling to 2·3 | 3·7 |

The results for mercury, which incidentally show the lowest separation yet recorded, do not seem to fit in with the provisional hypothesis outlined above. The possibility that isotopic discrimination in cathodic reduction of the catalytic poison would account for the anomalous temperature variation seems to be excluded by the duration of the electrolysis.

The experiments are being continued and their possible interpretation will be discussed in detail elsewhere.

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J. H. WOLFENDEN.

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College Laboratory,
Oxford.
August 8.

[1] A. and L. Farkas, *Proc. Roy. Soc.*, A, 144, 467 (1934).
[2] Horiuti and Okamoto, *Sci. Papers Inst. Phys. Chem. Research, Tokyo*, 28, 231 (1936); *Brit. Chem. Abstracts*, 430 (1936).

## Raman Spectrum of Thiophosphoryl Chloride

THE Raman spectrum of phosphorus oxychloride has been explained by assuming an asymmetric tetrahedral structure for its molecules. The molecules of thiophosphoryl chloride may, by analogy with those of the oxychloride, be supposed to have a similar tetrahedral structure; and the Raman spectra of these two compounds should then be similar.

The following table gives the prominent shifts that I have observed in the Raman spectrum of thiophosphoryl chloride:

| | $PSCl_3$ | $POCl_3$[1] |
|---|---|---|
| $A$ | 171 cm.$^{-1}$ | 192·85 cm.$^{-1}$ |
| $B_1$ | 246 ,, | 267·39 ,, |
| $B_2$ | 382 ,, | 337·44 ,, |
| $C$ | 432 ,, | 486·24 ,, |
| $D_1$ | 543 ,, | 581·2 ,, |
| $D_2$ | 750 ,, | 1289·9 ,, |

The data for the oxychloride are taken from Langseth's work[1]. The slight reduction in the values of the Raman shifts in thiophosphoryl chloride is presumably due to the substitution of the oxygen atom in the oxychloride by an atom of sulphur.

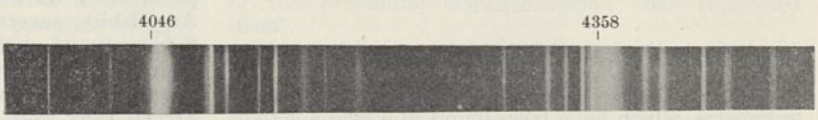


FIG. 1. Raman spectra of thiophosphoryl chloride ($PSCl_3$).

The shift $\Delta\nu = 1{,}290$ has been assigned to the P—O bond in the oxychloride[2]; the shift $\Delta\nu = 750$

in thiophosphoryl chloride can then be assigned to the P—S bond. The shifts $\Delta\nu = 171$; 246; 432 are very strong and the corresponding anti-Stokes lines excited by $\lambda = 4046$ can be seen in the spectrum.

A further study of the Raman spectrum of these two compounds as regards polarization and structure of the Raman lines is in progress, and the results of these studies will be published elsewhere.

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July 28.

[1] Langseth, *Z. Phys.*, **70**, 350 (1936).
[2] Venkateswaran, *Ind. J. Phys.*, **6**, 275 (1931).

## Scientists and War

AT a meeting of prominent scientists held at Bangalore on August 22, under the joint auspices of the Institute of Chemistry of Great Britain and Ireland (Bangalore Branch) and the Society of Biological Chemists (India), to discuss the question of the moral responsibility of scientists in modern warfare, which has recently attracted much attention in these columns[1] and elsewhere, the following resolution was carried:

"This meeting while pledging its support to every united effort which can be made to abolish methods of warfare which are repugnant to the common instinct of humanity, recognizes that the more important objective is the abolition of war itself. To attain this end it would urge constant and strenuous activity on the part of thinkers and men of science. In particular, it records its opinion that more attention should be given by them to the study of the new economic conditions which of necessity accompany the advance of scientific research. Of equal or greater importance is the study of means for controlling the evil effects of mass suggestion by the more powerful agency of widely disseminated right ideas through the adoption of an international system of education."

C. N. ACHARYA.

Bangalore.
August 23.

[1] NATURE, **137**, 757 (1936); **137**, 829 (1936); **138**, 80 (1936); *J. Inst. Chem.*, Pts. 1 and 2 (1935).

## Points from Foregoing Letters

FURTHER experiments on the production of photo-electrons in argon gas by X-rays, carried out by Dr. E. J. Williams and E. Pickup, support the quantum theory and the principle of conservation of energy, the applicability of which to X-radiation processes had been disputed, following upon the results of Shankland's experiments.

The radioactivity induced in silver at 20°, 77° and 290° K. by slow neutrons of different energies (groups *A*, *B*, and *C* of Amaldi and Fermi) has been determined by Drs. A. Arsenjewa-Heil, O. Heil and C. H. Westcott. They are led to conclude that the energies of groups *A* and *B* must be much lower than had been supposed, and that the absorption of boron is not inversely as the velocity of the neutrons.

The changes which sugar-like substances undergo in, or under the influence of, chick embryos of 4–6 days' incubation have been studied by Dr. J. Needham, W. W. Nowiński, R. P. Cook and K. C. Dixon, and compared with those effected by brain and muscle tissues. They find that the embryo does not glycolyse phosphorus-containing intermediate compounds; that glucose and mannose are the only sugars which give steady, long-continuing glycolysis; that the Pasteur effect is extremely marked; that the phosphorus distribution in various fractions is different from that obtained with muscle and brain preparations.

Referring to the reliability of different earthquake-registering stations deduced by Dr. H. Jeffreys, R. C. Hayes recalculates the values for the Pacific stations at Wellington and Christchurch; he finds that Wellington has a slightly greater reliability factor and considers that, in view of recent improvements, both stations should be included among those of good reliability. Dr. Jeffreys agrees that the order of reliability of Christchurch and Wellington stations cannot be definitely determined owing to the probable error involved in the calculations; he recommends that, for the time being, a 'weight' of 0·6 be accepted for Wellington observations.

Profs. W. Schmidt and H. Stansfield have described instances of the capillary wave that often appears when flowing water encounters an obstacle. Further observations are recorded by Dr. R. O. Hall, who suggests that the line marks the boundary of a compressed surface film of colloidal matter.

The difference in the shape of the shell of the Portuguese oyster, *O. angulata*, living on the shore, as compared with that of oysters permanently below tide-marks, is accounted for by Prof. J. H. Orton in terms of the surroundings. In deeper and less muddy water, the 'mantle' of the oyster, which secretes the shell, is uniformly extended and produces a broad shell; in the muddier tidal water of the foreshore, the mantle is probably protruded mainly at the end of the shell and an elongated form results.

Photographs of micro-organisms (three bacteria and a phytoflagellate) from the Dead Sea, where the total salt concentration is 28–29 per cent, are submitted by Dr. B. Wilkansky.

Dr. John MacLeod records *Phormia terræ-novæ R.-D.* as a hitherto unsuspected agent in the causation of cutaneous myiasis (attack on the skin by larvæ of flies) in sheep in Scotland (western Argyll and Mull).

H. F. Walton and J. H. Wolfenden have measured the temperature variation of the electrolytic separation of the hydrogen isotopes at mercury and silver cathodes, and find that the separation coefficient at silver falls with rising temperature while that at mercury is almost unaltered. Addition of a catalyst poison lowers the separation coefficient considerably and alters the sign of its temperature coefficient.

A reduction in the values of the shifts in the Raman spectrum of thiophosphoryl chloride, $PSCl_3$, as compared with phosphorus oxychloride, $POCl_3$, is found by Prof. V. N. Thatte.

# Research Items

## Blood Group Investigation

RECENT advances in blood group investigation have been reviewed by Prof. R. Ruggles Gates as a contribution to a volume commemorating the work of Miss van Herwerd on blood groups and eugenics in Holland (*Genetica*, 18, 1936. Manuscript received for publication, May 29, 1935). All the evidence indicates that in man the blood groups are mutations forming the mechanism of species modification of the non-adaptive category. The distribution of the blood groups in the anthropoids, when compared with that in man, on the hypothesis that *O* is the primitive condition in man, suggests that the development of the blood groups in both must be regarded as a case of 'convergent evolution'. It seems probable that a particular race in man in a particular locality developed the ability to produce the *A* mutation with sufficient frequency for it to spread without the aid of selection, but through a change in the mutation rate, which would be either gradual or marked and decisive, probably the latter. Recent developments have strengthened the view that the *A* mutation is much older than *B*, of which the occurrence is so low in peripheral peoples as to suggest that it is due to interbreeding with adjacent peoples. This view increases the difficulty relating to the *O* character of the American Indians, unless it be held that they are derived from primitive peoples who were isolated on the chain of islands from Sakhalin to Formosa and the Philippines, while *A* and *B* were spreading on the mainland of Asia. The aboriginal tribes of Formosa are still strikingly high in *O*. The occurrence of a high percentage of *A* in a group of "Blackfeet" can only be accounted for as an independent island of *A* mutations; and the *B* of the Caraja Indians and the Yahgans of Tierra del Fuego must be accounted for in the same way. Recent investigations in Africa suggest the probability that there have been three independent centres of *B* mutation, namely, the African negro, the Hindu and the Mongolian.

## Arminghall Timber Monument

THE prehistoric monument at Arminghall, near Norwich, discovered by aerial photography in 1929, and excavated by Dr. J. G. D. Clark immediately before the Norwich meeting of the British Association last year, proves, like "Woodhenge" in Wiltshire, excavated by Mrs. M. E. Cunnington, to have been a circle in which the place of stone uprights was taken by wooden posts. The character of the monument in detail, its purpose, dating, and affinities, have now been made the subject of close study by the excavator (*Proc. Prehist. Soc.*, N.S. 2, 1; 1936). The monument consists of two concentric ditches separated by a bank, and surrounding a central portion, in which had been erected eight wooden uprights in U-shaped formation, and approached by a causeway interrupting the inner ditch. In this central area there was no sign of disturbance, excepting the post-holes and the ramps, by means of which the posts had been erected. The size and depth of the post-holes and the size of the ramps indicate that the posts were of considerable height—oaks, as shown by the charcoal found in the holes, probably of about a hundred years old. The absence of any burial precluded the idea that the purpose of the monument was sepulchral. The primary material obtained from the inner ditch consisted of 107 flints of indeterminate age, and fragments of hand-made 'rusticated' pottery, that is, pottery decorated with pinches or jabs, of a type to which the specific name 'Arminghall' is here given. On archæological evidence, this pottery is shown to date the monument as belonging to the Beaker period, as do other 'henges' in Britain which so far have been satisfactorily dated. Two hypotheses as to the origin of this class of monument are current—one that they are derived from the palisade barrows of the Low Countries, the other that they are degenerate megalithic cairns; but at present there is no decisive argument in favour of either.

## Coloration of Nest Linings and Nestlings

DR. JEAN M. LINSDALE has noted a correspondence between the colour and tint of the linings of birds' nests and of the down of the nestlings themselves, especially in the Great Basin of the western United States. Further, these are both correlated with the kind of cover at the nest side and with the general climatic ranges of the birds (*Condor*, 38, 111; 1936). Apparently these species of birds which nest in exposed situations and live in hot regions have pallid nestling plumages and nest linings which reflect and counteract the harmful effect of the sun's rays. Species which live in the opposite conditions have dark colours in down and nest, so that they are able to absorb and take advantage of the warmth of the sun's rays.

## Habits of American Sunfishes

THE American sunfishes excavate nests in shallow places, usually on sandy shores, which are familiar objects in late spring and early summer. Mr. C. M. Breder in his paper "The Reproductive Habits of the North American Sunfishes (Family Centrarchidæ)" (*Zoologica*. Scientific Contributions of the New York Zoological Society. Part I, Nos. 1 and 2, 21, 1936) brings a large amount of material together with special reference to reproductive behaviour of these fishes, which is closely similar in all genera. The male constructs the nest and guards the eggs. The female is only concerned with their deposition, her behaviour being very characteristic as she approaches the nest when sex recognition takes place. The primitive forms make the most elaborate nests, and there is more parental care in these than in the higher forms, the nests of which are much simpler. Broadly speaking, the annual cycle of habit in the family shows an interesting series of items of behaviour largely controlled by temperature, and the position and form of the nest depend on a variety of purely physical factors in the environment which include temperature, sunshine, depth of water, rate of flow, nature of bottom and proximity of protecting objects. This is a very interesting study embracing much previous work as well as a great deal of first-hand information.

### The Chordate Head

THE problem of the constitution of the head region in the Chordates is discussed in a fully illustrated article by de Lange (*J. Anat.*, July 1936) based upon three lectures delivered at King's College, London. The vertebrate embryo is regarded as consisting of two portions: a non-metameric part, the gut, splanchnopleura, ventral body wall, brain region and the anterior cephalic mesoderm, arising in a similar manner to the three-layered, unsegmented larva of the invertebrates; and a dorsal, more or less segmented portion, the episome, having no homologue in invertebrates. The episome is pushed in a caudal direction in the Urochordata, in an anterior direction in the Cephalochordata, and in the true vertebrates it penetrates into the posterior part of the head region. This superimposed, axial episome has arisen and become segmented in conjunction with the need for locomotor efficiency. The axial musculature spreads over the trunk and into the head region. The branchial mechanism is afterwards formed, but it is in no way dependent upon the original metamerism of the episoma. As the head constitutes a structure for the gathering of sense organs, for presenting a firm front to the resistance of the water during locomotion and as a base from which the undulatory locomotor movements can take origin, its episomatic constituents lose their segmental structure. Some evidences of it remain, however, in the histological and functional character of the musculature. The hypobranchial muscles retain the metameric character of the invading episomatic mesomeres and of their cranial nerves.

### A New Type of Apospory in Ferns

MISSES I. ANDERSSON-KOTTÖ and A. E. Gairdner (*J. Genetics*, 32, No. 2), investigating the inheritance of apospory in the hart's tongue fern, describe a form known as *peculiar* which arose from spores of the variety *crispum muricatum*. This peculiar type of sporophyte only attains a height of 8 cm. and may bear twenty-five fronds at one time. There is a complete absence of sori, sporangia and spores, the fronds producing aposporous prothalli which bear sex organs and undergo fertilization. As there is no meiosis, the chromosome number increases from $n = 30$ (normal) to a maximum of about 110. Various lines of evidence indicate that the chromosome number is frequently diminished in some way at the formation of the sex organs, but no cytological indication has yet been found as to how this takes place. In crosses between peculiar and normal, the former type of life-cycle is shown to be controlled by a single recessive gene. Heterozygous sporophytes are thus normal in appearance, but they sometimes show a feature which is new in ferns, namely, sori containing some normal sporangia and others which produce spermatozoids. The heterozygotes thus show incomplete dominance as regards the time of sex differentiation, which takes place both in sporangia and in the gametophytes. The conclusion is reached that the sporangial stage in normals is represented by the sexual stage in peculiars, and that a reduction division is therefore attempted at the sexual stage in the peculiar. These results have a bearing on various questions of apogamy, apospory and life-cycles in plants.

### Properties of Oak

No. 11 of *Research Records* (Timber Series No. 3) contains a pamphlet on "The Properties of Home-grown Oak" (London: H.M. Stationery Office, 1936). It is stated in the pamphlet that in the past there has been much difference of opinion as to the merits of the timber, and this is largely attributable to its properties varying considerably with the conditions under which the trees are grown. The writer of the pamphlet appears to consider that there is little difference between the timber of the pedunculate and sessile oaks. By the purely practical test of felling and conversion in the forest, many hold the opinion that the timber of the sessile oak is more easily workable than that of the pedunculate. During the Napoleonic Wars, the finer lines of the French ships captured and the more artistic nature of their fittings were attributed to their having been constructed of the sessile oak, whereas the English ships were most usually constructed of the pedunculate or robur oak, a more stubborn and rugged grower. The pamphlet deals with the general properties and structure of the wood, seasoning, mechanical properties, durability and working qualities. A comparison of home-grown oak and American oak is made, and insect and fungus pests are discussed.

### Inheritance in Cotton

INHERITANCE of form and size play a large part in the improvement of commercial cottons. Dr. J. B. Hutchinson (*J. Genetics*, 32, No. 3) has summarized some of these results. He finds in Asiatic cottons a series of five multiple allelomorphs affecting leaf shape. Broad, laciniated and narrow leaf types occur in *Gossypium arboreum* in different crops, narrow leaf being absent from South India and rare in Burma; it occurs in Assam. Leaf shape is associated with corolla colour. Broad leaf is primitive, and two allelomorphic genes have arisen causing progressive narrowing of the leaf lobes. Both are widely distributed in the species, and in some circumstances one of them has a selective advantage over the broad. Another set of genes affects all foliar organs and not merely the leaves. The habit of the plants is determined by the length of the vegetative period, that is, the number of nodes on the main stem. This is followed by the formation of sympodia with a flower at every node. Wild cottons have a high primary node number, with late flowering. Interaction is indicated for various node number factors, some of which are linked with corolla colour and some with anthocyanin production.

### Carolina 'Bays'

THE 'bays' of the Carolina coastal plain are great oval depressions, usually well-timbered, each of which is rimmedwith a sand-ridge that is highest on the south-east side. Their peculiar and uniform shape, the prevalent orientation of their longest axes in a north-west to south-east direction, and the immense number of examples, suggested to Melton and Schriever that the bays had been caused by the fall of an immense shower of meteorites, during or possibly before the Pleistocene. In a recent issue of *Science*, Prof. D. Johnson has pointed out several objections to this hypothesis. The rims of the 'bays' are not composed of material thrown out of the bottoms by explosive impact, but consist of clean sand, such as might border a lake-beach. The major axes of some of the depressions follow a north to south direction, and at least a few trend from north-east to south-west. Such departures from the prevailing orientation are inconsistent with the meteoritic hypothesis. The area is underlain by thick beds of limestone in which caverns and sink-holes are common. Johnson considers that the 'bays' started as lakes in sink-hole basins; these afterwards drained, leaving their old beach-ridges where the prevailing winds had piled them. A book on the 'bays' from the pen of Prof. Johnson is in course of publication.

### The British Earthquake of April 6, 1580

LITTLE has so far been known about this earthquake, one of the strongest ever felt in Great Britain, and in some ways not unlike the North Sea earthquake of June 7, 1931. Mr. R. E. Ockenden, however, has lately reprinted "Thomas Twyne's Discourse on the Earthquake of 1580" (Pp. 40+1 plate. Oxford: Pen-in-Hand Publishing Co., 1936. 5*s*.), the original of which is now very rare, though copies are to be found in the British Museum, Bodleian and Emmanuel College libraries. He has also given a most useful introduction and a bibliography of contemporary pamphlets and other works. From these, it appears that the earthquake was felt throughout the south-east of England, and so far at least as Oxford and Norwich, also in Flanders and the north-east of France. In Great Britain, several churches near the coast of Kent were damaged. Even in London, stones were shaken from St. Paul's Cathedral and the Temple Church, and an apprentice was killed by the fall of a stone from the roof of Christ's Hospital Church. Except perhaps at Calais, little damage to buildings occurred in France and Belgium. The sea was greatly disturbed, and it is probable, as Mr. Ockenden remarks, that the earthquake was of submarine origin, and that its epicentre was not far from the east coast of Kent.

### Radio and the Sunspot Cycle

L. C. YOUNG and E. O. Hulburt (*Phys. Rev.*, 50, 45) have examined the correlation of radio transmission with sunspot activity over the years 1923–36. They find that the optimum radio-frequency for short-wave daylight transmission over a given long distance increases with the sunspot activity, and they derive a semi-empirical formula connecting these quantities. The correlation of the radio data with sunspot number is much better than with terrestrial magnetic activity or with the solar constant. The last fact suggests that the visible and infra-red radiation from the sun, on which the solar constant is based, does not vary in close accord with the ultra-violet radiation which ionizes the upper atmosphere.

### Structure of Benzene

ALTHOUGH the essential correctness of Kekulé's hexagon formula for benzene, with alternate single and double linkages, has been established by intensive chemical and physical investigation since its enunciation in 1867, and crystal analysis has shown that the ring is very approximately a plane, yet there are several other alternative formulæ (Dewar, Claus, Ladenburg, Thiele, Baeyer). The quantum-mechanical treatment of the problem has been dealt with by Hückel (1931–32) and by Pauling and Wheland (1933). Certain difficulties, however, were encountered in the comparison of the results with those of lines of experimental investigation. One of the most important was the apparent discrepancy between theory and experiment in the comparison between infra-red and Raman spectra. In a series of eight papers (*J. Chem. Soc.*, 912–987; 1936), C. K. Ingold and several collaborators have re-examined the matter in the light of the results of long-wave spectroscopy, which includes a study particularly of the infra-red and Raman spectra and the vibrational structure of bands arising from electron transitions. An important extension of the experimental method consisted in the substitution of hydrogen by deuterium, which does not alter the electron wave functions, so that the effect on vibration frequencies arises solely from changes of mass. Most of the coincidences in frequency in the infra-red and Raman spectra are shown to be the result of using liquids, in which cohesive forces disturb the conditions of symmetry, and the conclusion is reached that there is no need to assume the absence of a centre of symmetry in the benzene and hexadeuterobenzene molecules. The $D_{6h}$ model (plane regular hexagon) is supported, whilst the $D_{3h}$ (Kekulé) model fails to show itself in any spectroscopic features, and there is no indication of the $D_{3d}$ (puckered) model.

### Automatic Control of Road Traffic

IN the *G.E.C. Journal* of August, F. A. Downes gives a brief exposition of the elements of traffic flow and the requirements of automatic mechanism for controlling traffic. In the United States, traffic engineers have recently formed an Engineering Institution to study traffic problems. In Great Britain, the problems are studied by the engineers of the Ministry of Transport and by the staff of engineering works manufacturing traffic control apparatus. Of these engineers, there is probably no one who devotes his whole time to a theoretical and mathematical study of the subject. The design of modern traffic integrators requires a special knowledge of the mathematics of probability, and much useful work is being done in this direction. Theoretically, the only limit to the amount of traffic that can be dealt with by a single lane of traffic is that set by the limiting speed of the vehicles. For given road friction, and for a given average brake-power, it can be shown that there is a clearly defined optimum speed at which the greatest amount of traffic will be passed in a single lane per hour. The generally accepted figures lie between 12 and 18 miles per hour. At the lower speed, vehicles have 15 feet headway, but at the higher speed of 18 m.p.h. a headway of so much as 30 feet may be required. An optimum speed of 15 m.p.h. is often given, but this refers to dry roads of average surface. Unless a non-skid road surface is provided, this figure may be considerably increased. At intersections the first essential is a means of indicating 'stop' and 'go'. Interesting suggestions are made for indicating how soon change-over of colour may be expected. The full green indication, for example, consists of three concentric luminous rings; when one third of the time of the green signal has elapsed there are only two rings visible, then after two thirds only one. Another device embodies a dial divided into two portions, one of which is painted red and the other green, the indication being given by a large hand travelling in the clockwise direction.

# Hydrogenation of Coal: a French Process

THE hydrogenation of coal to produce liquid fuel is, as is known, a process now in technical operation. The French process as carried out at Béthune has been described by F. Vollette (*Bull. Soc. d'Encouragement pour l'Industrie Nationale*, 135, 353; 1936).

The coal and hydrogen must be brought into intimate contact by intense agitation, and the temperature must be increased progressively by passing the mixture through zones, sufficient time being allowed at 350° for pasty fusion and solution in the oil, and at higher temperatures up to 470° for the absorption of hydrogen. The apparatus consists of a bundle of long narrow tubes (*faisceau tubulaire*) united to one another by interior pipes like gas washing bottles, through which the hydrogen bubbles. The whole is heated in a cell of a coke furnace. The finely powdered coal is suspended in heavy oil and pumped at 200 kgm. pressure into the apparatus, where it meets a current of hydrogen from a compressor.

The volatile product, by cooling under pressure and removal of gas, is automatically divided into gas, heavy oil (at 300°) and light oil (atmospheric temperature). Very light petrol (5 per cent of the total light oil) is removed from the gas by adsorption on active carbon. Part of the gas is used for heating and part is mixed with the hydrogen. The heavy oil is used for the suspension of coal. The non-volatile product is partly hydrogenated with the heavy oil and partly carbonized to coke for making water-gas. The hydrogen is obtained from water-gas and steam and need not be pure: even coke-oven gas (50 per cent $H_2$) may be used.

The overall yield of light oil is given as 660 kgm. per metric ton of coal, and it contains 25–30 kgm. of phenol and cresols. Of this oil, 87·5 per cent distils below 300° and 27·5 per cent below 200°. The heavier fraction is further hydrogenated in the vapour phase under pressure in presence of a catalyst to give petrol, which is principally aromatic and hydro-aromatic. Lignite hydrogenates more easily than coal. From 660 kgm. of light oil, 460 kgm. of petrol are obtained, or 1 ton per 2·175 tons of coal. This requires 3,500 cu. m. of hydrogen, in making which 2·2 tons of coke are used. The steam used requires 1 ton of coal per ton of petrol and the electrical energy for compression of gas and works service consumes a further 2 tons of coal. Thus 7·375 tons of coal are used in making 1 ton of petrol, the calorific value of which is 20·75 per cent of the total fuel used.

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# Biology of *Tridacna* and its Relatives

THE largest bivalves in the world belong to the Tridacnidæ. They have always aroused much interest in conchologists although little was known of the living animals. Size is not the only distinction in the family, for Prof. C. M. Yonge* shows that they are unique among the Lamellibranchiata in the relation of the mantle and shell to the other organs, and in the universal presence of zooxanthellæ in the tissues. In his peculiarly interesting monograph, there is a large amount of new matter clearing up much that was puzzling in these gigantic molluscs, which are among the most conspicuous members of the fauna of coral reefs in the Indo-Pacific region. *Tridacna derasa*, the giant clam, may be 4½ ft. long: the largest lamellibranch ever evolved, and may weigh about 4 cwt. The largest specimens personally examined were a little more than 3 ft. in length, and were so heavy that the combined efforts of two men failed to raise them.

There are two groups in the Tridacnidæ, the smaller boring forms, living in coral rock, and the larger species lying free on the surface of the reefs. All these clams normally rest on the hinge side of the shell with the edges of the valves pointing upwards. The pedal aperture, when present, lies close to the umbo. Thus, "as a result of a turning movement in the longitudinal plane, the dorso-ventral relations of the visceral mass and associated organs, on the one hand, and of the mantle and shell on the other, have become . . . the exact opposite of those in other lamellibranchs". This has given rise to much controversy as to whether the visceral mass has moved relative to the shell or whether the mantle has moved relative to the visceral mass. Prof. Yonge is now in the position to prove that the latter supposition is correct, and in this he is in agreement with Lacaze-Duthiers.

It is, however, in the amazingly efficient partnership with the zooxanthellæ that these molluscs are of outstanding interest. On this depends the whole problem of feeding, structure and evolution. Immense numbers of these zooxanthellæ always occur in the Tridacnidæ, housed primarily in the blood cells of the inner lobes of the mantle edges on the dorsal side where they are fully exposed to the light. In *Tridacna* these lobes extend far over the free edges of the shell valves in life, exposing a broad sheet of highly pigmented tissue. In the allied *Hippopus*, where there are fewer zooxanthellæ, the mantle edges do not extend in this way, but the shell valves open to a greater extent. The zooxanthellæ are confined to the blood sinuses, and are invariably contained within amœboid blood cells. Conical protuberances on the mantle edge, carrying lens-like structures, hitherto regarded as eyes, are here shown to be means whereby the internal illumination of the mantle

* British Museum (Natural History). Great Barrier Reef Expedition, 1928–29. Scientific Reports, Vol. 1, No. 11: Mode of Life, Feeding, Digestion and Symbiosis with Zooxanthellæ in the Tridacnidæ. By Prof. C. M. Yonge. Pp. 283–321+5 plates. (London: British Museum (Natural History), 1936.) 5s.

tissues is increased for the benefit of the zooxanthellæ. The phagocytes, carrying the zooxanthellæ from the mantle, surround the reduced diverticula and other regions of the gut and contain these algæ in all stages of digestion. *Tridacna*, and to a less extent *Hippopus*, consumes a number of these, so obtaining a significant amount of food.

The mouth is small, there is no sorting mechanism in the stomach, and the selective action of the gills and palps is highly developed, particles 14 μ in diameter being rejected. Assimilation and intercellular digestion take place in the much-reduced digestive diverticula and also in the phagocytic blood cells which may pass through the lumen of the gut. Indigestible material remaining in the phagocytes is presumably carried to the kidneys, which explains the abnormal size of these and the presence within them of a great number of large concretions.

The Tridacnidæ are profoundly modified for the housing and final digestion of the zooxanthellæ, and *Tridacna* may be considered the supreme example of the exploitation of associated algæ by an animal, although unlike *Convoluta roscoffensis* it never loses the power of holozoic nutrition, and so only the surplus zooxanthellæ are consumed. Experiments failed to reveal any significant production of oxygen or removal of carbon dioxide by the zooxanthellæ in the light, but they automatically remove all phosphorus excreted by the animal and even the phosphorus present in the water around. This may be the limiting factor controlling their abundance.

In no case known where there is a partnership of algæ with an animal has it been so highly evolved as in *Tridacna*, resulting in the actual farming of the zooxanthellæ by the mollusc. Every stage in the evolution shows a step towards this end. In a *Cardium*-like ancestor, it is suggested that the zooxanthellæ first settled in the region of the siphons, having been taken in with the food and so ingested by wandering phagocytes. This partnership being of advantage to both alga and mollusc, but especially to the latter, the mollusc became so modified in structure that the largest possible surface might be exposed in which the algæ could dwell near the light, whilst with a larger consumption of these the ordinary digestive organs were more and more reduced, a very good combined method of feeding being the result, the boring forms having evolved after this adaptation of structure and functions. It is found that boring is entirely mechanical and that the byssus takes an essential part in this process.

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# Bacterial Epidemiology and Nutrition

A TEAM of statisticians and bacteriologists who for many years have been investigating experimentally the spread of epidemics of bacterial diseases caused by *Bacterium aertrycke* and *Pasteurella muriseptica* in herds of mice under controlled conditions, have now summarized the results of their published work with the addition of some new observations, including an account of epidemics of ectromelia, a virus disease of mice[1].

To the epidemiologist the work is of great interest and value, and many important conclusions emerge from it. It is found that the average resistance of surviving mice increases with survival in a herd, but never becomes absolute, and in the long run the great majority eventually succumb to the reigning disease, nor will the disease ever normally die out provided the herd does not become too small. The increased average resistance displayed by surviving mice is attributed to natural immunization.

It is considered proved that artificial immunization does confer a high degree of resistance, being more effective in a virus condition like ectromelia than in a bacterial disease like mouse typhoid. Experiments on the influence of 'bacteriophage' on mouse typhoid yielded entirely negative results. It is considered that a major importance may be attached in the genesis of epidemics to the evolution or importation of 'epidemic strains' of particular bacteria or viruses, and that association of two infecting agents may play a part in determining the character of an epidemic.

It seems to be clear that the amelioration or disappearance of an endemic or epidemic infection is more often the result of a summation of effects, many of them unidentifiable, than of any single known factor.

Mr. Knight has recently brought together in convenient form the available information respecting bacterial nutrition[2]. Knowledge of the conditions favouring or inhibiting bacterial development is of importance in bacteriological technique and in the study and control of infective diseases and morbid states, as well as indicating relationships which suggest the possible evolutionary scheme of the bacteria, particularly as it relates to parasitism.

The report is divided into three parts, of which the first and longest gives a systematic survey of the known facts, and summarizes the chemistry of bacterial metabolism and the nutritional requirements of bacteria. In the second part, these nutritional observations are co-ordinated, a brief attempt is made to develop an evolutionary scheme, and the parallelism between nutrient requirements and the development of pathogenic properties and parasitism is illustrated. In the final part, methods are described by which bacteria may be 'trained' and 'adapted' to a simpler mode of life, and the mechanism of nutritional variation is discussed.

There is much in Mr. Knight's report of interest to the general bacteriologist, such as his critical review of the gaseous requirements of bacteria, the various methods that may be employed for the study of bacterial metabolism, and the differentiation of essential from accessory food substances in relation to bacterial growth.

[1] Medical Research Council. Special Report Series, No. 209: Experimental Epidemiology. By Dr. M. Greenwood, Dr. A. Bradford Hill, Dr. W. W. C. Topley and J. Wilson. Pp. 204. (London: H.M. Stationery Office, 1936.) 3*s*. 6*d*. net.

[2] Medical Research Council. Special Report Series, No. 210: Bacterial Nutrition; Material for a Comparative Physiology of Bacteria. By B. C. J. G. Knight. Pp. 182. (London: H.M. Stationery Office, 1936.) 3*s*. net.

## German Chemists at Munich

NEARLY three thousand delegates representing thirteen different German societies took part in a national congress of German chemists held at Munich on July 7–11. Prof. P. Duden of Frankfort presided at the general meeting, which was welcomed by Staatsminister Herr Adolph Wagner. Dr. O. Nicodemus of Frankfort delivered an address on the development of the chemistry of acetylene and its national importance as a source of raw materials. From acetylene many derivatives of the vinyl group can be made, which can be developed by polymerization to a great variety of valuable synthetic products. Amongst these may be mentioned the unsaturated hydrocarbons isoprene and butadiene, from which synthetic rubber is made, and a chlorinated derivative, chloroprene, which polymerizes seven hundred times as fast as isoprene and gives rise to an oil-proof synthetic rubber. By varying the conditions of polymerization, it is possible to plan the synthesis of products possessing specified physical properties, so that the range of application of these products is increasing rapidly.

Prof. Noack of Berlin then addressed the meeting upon the chemistry and physiology of plant structures. Afterwards the Congress broke up into twenty sections, which met for the discussion of special subjects, full reports of which will be found in the August number of *Angewandte Chemie*.

Although the main interest of the Congress was in applied chemistry, we find that one section was devoted to the history of chemistry, and a proposal was made to undertake the complete documentation and collection of publications (or copies) relating thereto. In a paper by Dr. Theis of Mannheim, the discovery of catalytic activity was credited to Döbereiner, who described in 1823 the ignition of hydrogen at atmospheric temperatures in the presence of spongy platinum.

Reference can only be made here to a few of the subjects discussed during the sectional meetings. Prof. Hedvall of Göteborg and Prof. Jander of Frankfort discussed reactions between substances in the solid state, Prof. W. Kuhn of Karlsruhe the properties of thread-molecules in solution and Prof. Staudinger of Freiburg the chemistry of macromolecules. Dr. Bredereck of Leipzig described his work on the constitution of the nucleic acids and Dr. Seidel of Munich his synthesis of urobilin. In the sections on applied chemistry will be found numerous papers dealing with fuel-oils, colours, paints, dyes, foodstuffs, building materials, leather, photographic materials, agricultural chemistry and many other subjects.

A whole section has been devoted to the consideration of the rapidly increasing number of *Kunststoffe* or artificial products. Among those of practical importance we may mention the 'organic' glass of Dr. O. Röhm. This substance, which is free from silicates, is derived from α-methylacrylic acid. Esters of the acid are colourless liquids, which polymerize, under somewhat difficult conditions, to vitreous solids, possessing a very high degree of transparency and a low coefficient of expansion. These glasses can be bent and moulded into shape at high temperatures and can be used for making windows for motor-cars and aeroplanes. They can also be used for optical purposes and for the manufacture of apparatus, such as filter-presses.

Another artificial product of first-rate importance is the substance trolitul, formed by polymerization of the hydrocarbon styrene, which is distinguished from most other artificial resins by reason of its excellent insulating properties, resistance to wear and impermeability to water. Thus it can be moulded into insulators and is suitable for employment even where high frequencies are used. The growing use of artificial products in industry has given new interest to the scientific study of complex polymers.

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## Science News a Century Ago

### Schönbein and Faraday

IN 1836, the long and interesting series of letters began between Schönbein and Faraday which extended over twenty-six years and was afterwards published with notes and comments by G. W. A. Kahlbaum and F. V. Darbishire. The first two letters were from Schönbein, who was then professor of physics and chemistry at Basle. The first was dated May 17 and the second September 12, 1836. Both dealt with experiments on the action of nitric acid on iron and the protective influence of a film of oxide of iron. The most curious thing Schönbein said he had observed was that iron wire could be made indifferent to nitric acid. Previous to this second letter, Faraday had communicated an account of Schönbein's investigations to the *Philosophical Magazine*, and in his letter of September 12 Schönbein wrote: "I feel much obliged to you for the kind manner in which you mentioned my late researches on iron in the philosophical Magazine. It is this kindness which encourages me to address to you a second letter on the same subject".

### Worcestershire Natural History Society

UNDER the above heading, the *Analyst*, 5, 160 (1836), records: "The ceremony of opening the museum of this Society took place on the 13th of September; on which occasion upwards of eight hundred persons attended, including a large proportion of the inhabitants of the county and city distinguished for their literary and scientific attainments. The Bishop of Worcester entered the room about twelve o'clock accompanied by the members of the council and at the request of the Hon. and Rev. J. S. Cocks took the chair". His lordship in a short speech congratulated the members of the Society upon the completion of the building and then called upon Dr. Hastings to deliver the inaugural address, "which was listened to with marked attention, and frequently elicited very considerable applause". About a hundred members and friends afterwards dined together, some admirable speeches were made and it was gratifying, said the *Analyst*, "to observe the interest which the prosperity of the Society appeared to excite".

### De la Rue on Voltaic Electricity

THE first scientific paper of Warren De la Rue (1815–89) was a communication to the editor of the *Philosophical Magazine* dated September 15, 1836, and entitled "On Voltaic Electricity, and on the Effects of a Battery charged with Sulphate of Copper". "The greatest effect," the author said, "being always produced in those voltaic arrangements where the chemical agent exerted an action on only one of the metals constituting the battery, it occurred to me to use a saturated and perfectly neutral solution of the electro-negative metal, provided the other was capable of effecting its decomposition. I therefore tried the effect of a saturated solution of sulphate of copper in an elementary voltaic battery of the ordinary construction". After describing various experiments with his battery, he said, "It is worthy of notice, that after the batteries have been in action some time, a large proportion of the sulphate of copper is expended, and replaced by sulphate of zinc, *yet the action continues the same*. This naturally suggests using a saturated solution of any neutral salt, common salt, for example, and adding merely as much as the solution of copper as will serve for the time required. . . . I intend trying this, as I am still pursuing my inquiries on this subject, the object of which is to simplify as much as possible the voltaic battery. . . ."

### Death of Antoine-Laurent de Jussieu

On September 17, 1836, the celebrated French botanist, Antoine-Laurent de Jussieu, died in Paris at the age of eighty-eight years. The nephew of the three brothers Antoine, Bernard and Joseph de Jussieu, who all contributed to botanical science, Antoine-Laurent was born at Lyons on April 17, 1748. On leaving school at the age of seventeen years, he joined his uncle Bernard de Jussieu (1699–1777) who was then a demonstrator at the Jardin du Roi in Paris, and after taking a degree in medicine became an assistant in the same institution. The collection of plants at that time was arranged according to the system of Tournefort. It becoming necessary to rearrange them, Jussieu adopted a new system suggested by what his uncle had done at Trianon, and from this grew the natural system described by Jussieu in his book "Genera Plantarum" published in 1789, the year in which the Revolution broke out.

As with so many other men of science, Jussieu for a time found his labours interrupted by the political upheaval, and in 1790 he became a member of the municipality of Paris, of which Bailly was Mayor, and was charged with the direction of the hospitals and charities of the city. In 1793, when the Jacobins came into power, the Jardin du Roi was reorganized as the Jardin des Plantes and Muséum d'Histoire naturelle, and Jussieu was made professor of rural botany. His colleagues included Lamarck, Daubenton, Saint-Hilaire, Fourcroy and Brongniart. He afterwards became director and treasurer of the museum and a professor in the faculty of medicine. In 1822 he severed his connexion with the school of medicine and four years later resigned his chair at the Jardin des Plantes, and was succeeded by his son, Adrien de Jussieu (1797–1853).

The natural system of classification of plants introduced by Jussieu was not appreciated at first as it ought to have been, and it was not until the writings of Robert Brown (1773–1858) that it made any headway in Great Britain. Besides his "Genera Plantarum" Jussieu wrote many memoirs, in 1796 published his "Tableau synoptique de la méthode botanique" and in 1800 his "Tableau de l'école de botanique du Jardin des Plantes". A statue of him now stands in the vestibule of the botanical gallery of the gardens. His son, who also was director of the museum, died leaving no male heirs, and the family, which for a century had been an ornament of science in Paris, became extinct.

## Societies and Academies

### Paris

Academy of Sciences, July 20 (*C.R.*, **203**, 217–288).

LUCIEN CAYEUX : The coproliths of the North African phosphates. These coproliths consist of calcium phosphate, almost entirely free from organic or mineral inclusions.

LOUIS BLARINGHEM : The temperature of the spadices of *Arum italicum*. The temperatures are higher than the surrounding air : possible reasons for this are discussed.

LOUIS BOUVIER : Observations from the crayfish on the constitution of the side of the body-wall in the Crustacea.

ALEXANDRE GUILLIERMOND and MLLE. N. CHOUCROUN : An attempt at electrophoresis in the interior of plant cells.

MENDEL HAIMOVICI : Integral geometry on curved surfaces.

NORBERT WIENER and SZOLEM MANDELBROJT : Lacunar Fourier series. Inverse theorems.

JEAN MANDEL : The crumpling of a tube in a resistant elastic medium.

ALBERT PORTEVIN and LÉON GUILLET, JUN. : The elastic modulus of certain definite intermetallic compounds. Of the six compounds studied, CuZn, $Ag_3Sb$ and $MgZn_2$ obey the rule of mixtures, the others, $Cu_{31}Sn_8$, $Cu_9Al_4$ and $CuZn_6$ give elastic moduli 20–40 per cent higher than those calculated from the mixture rule.

CHOONG SHIN-PIAW : New systems of bands of selenious anhydride, $SeO_2$, of selenium, $Se_2$, and of tellurium, $Te_2$, in the ultra-violet.

NY TSI-ZE and CH'EN SHANG-YI : The displacements of the higher members of the principal series of rubidium by the rare gases. Study of the displacement of the lines of the spectrum of rubidium by helium (up to 12·75 atmospheres), neon (up to 13·59 atmospheres) and argon (up to 7·12 atmospheres).

ANDRÉ LALLEMAND : The application of electronic optics to photography.

JEAN REBOUL : A possible correlation between the intensity of the cosmic radiation and the velocity of certain chemical reactions.

PIERRE AUGER and MME. GRIVET-MEYER : Analysis of cosmic ray bundles by utilization of their divergence.

RENÉ DUBRISAY and JACQUES LEFOL : Study of the saline hydrates. The salt and a direct reading balance are placed under a bell-jar over a hygroscopic substance under reduced pressure, and the loss of weight studied as a function of the time. With crystallized copper sulphate over phosphoric anhydride, the curve of loss shows a sharp angle at $5H_2O$, and after ten days the weight is constant at $1H_2O$. Over dilute sulphuric acid (pressure of water vapour 0·85 mm.), $CuSO_4,3H_2O$ is the final product.

RENÉ DALMON : Heats of mixture of sulphuric and nitric acids free from water.

MLLE. VALÉRIE DEUTSCH : The adsorption of proteins. The serum albumen of the horse.

E. RINCK : Diagram of solidification and electrical conductivity of the potassium-cæsium alloys.

HENRI MOUREU, MICHEL MAGAT and GEORGES WETROFF : The two forms of phosphorus pentachloride. From a study of the melting and solidification curves of phosphorus pentachloride there would appear to be a modification in the molecular structure. This is in agreement with the results of the study of the Raman spectrum : the latter shows that dissociation into phosphorus trichloride and chlorine does not take place under the conditions of the experiment.

J. JARROUSSE : Oxidation of diphenylpyruvic acid.

RAYMOND QUELET and MAURICE ANGLADE : The synthesis of 1-methoxy-2,4-dimethylolbenzene and of some of its derivatives.

ANDRÉ MEYER and PAUL HEIMANN : The products of halogenation and of oxidation of 2,4-dihydroxyquinoline.

PIERRE CHATELAIN : The geometrical and optical study of the crystals of *p*-azoxyphenetol.

EDMOND ROTHÉ and MME. ARLETTE HÉE : Study of a zone of contact of granite-gneiss by the observation of penetrating rays.

HENRI JEAN MARESQUELLE and RAYMOND SCHNELL : Experimental study of the phases of cecidogenic action in a gall.

MME. SIMONE BELLUC, JULES CHAUSSIN, JEAN COTTET, HENRI LAUGIER and MME. THÉRÈSE RANSON : Urinary yield, total molecular diuresis and diuresis of the elaborated molecules.

NICOLAS BEZSSONOFF and MME. MÉLANIE WOLOSZYN : The reversible oxidation of vitamin C present in a biological medium or in pure solution.

ACHILLE URBAIN and R. CAHEN : The amount of protein compounds in the serum of some ungulates.

A. and R. SARTORY, J. MEYER and MLLE. M. J. MERGLEN : Thermostable activating factors of cryptogamic origin favouring the growth of bacteria.

JEAN LAIGRET and ROGER DURAND : Virus isolated from mice and refound in man in the course of vaccination against yellow fever.

ANDRÉ BOIVIN : The comparative behaviour of the endotoxins and exotoxins towards trichloracetic acid.

BARUCH SAMUEL LEVIN and IWO LOMINSKI : Attenuation of the virus of bird plague by X-rays.

## Moscow

Academy of Sciences (*C.R.*, 2, No. 3, 1936).

N. KOSHLIAKOV : Integral for the square of Riemann's function.

S. U. UMAROV : The Brownian movement of a supported girder and the transverse vibrations of bridges.

S. A. ARCYBYSHEV, M. N. BOGOMOLOVA, N. V. BORISOV and I. CH. REPSHE : Penetration of copper and gold ions into transparent crystals of sodium and potassium chloride.

V. ANTONOV-ROMANOVSKIJ : Direct proof of the bimolecular scheme of the luminosity of zinc phosphate.

V. RASUMOVSKIJ : Intensity of the valence and the structure of molecules.

J. G. RYSS and N. P. BAKINA : Complex fluorides (2). Hydrolysis of boro-fluoride ions.

I. I. CHERNIAJEFF and A. M. RUBINSTEIN : Interaction of pyridine with the chloride and the bromide of blomstrand salt.

K. V. KOSIKOV : The influence of the age and sex of the germ cells on the frequency of mutations in *Drosophila simulans*.

N. I. SHAPIRO : Is there germ cell selection in *Drosophila melanogaster* ?

P. O. VELTISHCHEV : The plant mites (*Tyroglyphidæ*, Acari) as the main cause of failure of root-caoutchuc plants in Transcaucasia.

P. S. CHANTURISHVILI : Experiments in changes of sexual cycle in certain tail-less Amphibia.

## Sydney

Royal Society of New South Wales, July 1.

D. P. MELLOR and F. M. QUODLING : Optical properties and crystal structure of some compounds of the type $R_xMX_4$. The marked double refraction of many compounds of the type $R_xMX_4$ where $M$ = Pt, Pd, Ni or Au, is attributed to the existence of strongly anisotropic square co-ordinated ions. As yet, the structure of relatively few of these compounds have been analysed, but where this has been carried out the crystal optics agree qualitatively with those to be expected from the structures proposed.

## Tokyo

Imperial Academy, June 12 (*Proc.*, 12, 147–177).

T. KAWATA : Regular analytic functions in the half plane.

A. KAWAGUCHI : (1) Some intrinsic derivations in a generalized space. (2) Certain identities in a generalized space.

H. HOMBU : (1) Invariant theory of the integral $\int F(x, y, y', y'', y''')dx$. (2) Geometry of the integral $\int (Ly''' + M)dx$.

N. WATANABE and M. IMAIZUMI : Possibility of measuring a distance of 500 m. in terms of the wavelength of light.

T. KUME : Saturation of non-volatile substances in aqueous solution.

H. YABE and M. EGUCHI : Deep-water corals from off Owasi, Mie Prefecture.

Y. INAI : *Discosiphonella*, a new ally of *Amblysiphonella*.

S. ENDÔ : New fossil species of *Sequoia* from the Far East.

T. KOBAYASHI : Proparian genus of the Olenidæ, and its bearing on Trilobite classification.

## Vienna

Academy of Sciences, June 18.

JOSEF SCHINTLMEISTER : Origin of α-rays of 2 cm. range. The α-rays of this range, which have been found by several authors, do not come from any known element with atomic number greater than 44 ; they are probably due to element 61.

H. MARK and G. SAITO : Fractionation of highly polymerized substances by colorimetric adsorption analysis (1).

H. DOSTAL and R. RAFF : Mechanism of polycondensation reactions.

E. BARONI and W. KLEINAU : Nitration of phenols in chloroform.

O. BRUNNER and W. KLEINAU : The material forming the retina (3).

O. BRUNNER and E. BARONI : The material forming the retina (4).

## Forthcoming Events

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (BLACKPOOL MEETING)

### Monday, September 14

At 10 a.m.—Prof. H. L. Hawkins: "Palæontology and Humanity" (Presidential Address to Section C).

Prof. J. Hendrick: "Soil Science in the Twentieth Century" (Presidential Address to Section M, followed by discussion).

Dr. T. E. Allibone, Dr. G. W. C. Kaye, Prof. W. M. Thornton, R. Davis, Dr. S. Whitehead, C. W. Marshall: "Production and Technical Application of High Voltages" (Discussion: Section A).

Dr. D. A. Allen, Prof. W. J. Dakin, Dr. A. C. Stephen, J. A. S. Stendall: "Function of the Museum in Zoology" (Discussion: Section D).

At 10.45 a.m.—Dr. Ll. Wynn Jones, Prof. H. R. Hamley, W. A. F. Hepburn, Prof. J. Drever: "The Reform of the Examination System" (Discussion: Section J).

At 2.15 p.m.—W. Hammett, Dr. A. W. Greenwood, E. T. Halman, Dr. E. L. Taylor, A. J. Macdonald, J. Wilson, Dr. A. L. Romanoff: "Poultry Industry" (Joint Discussion: Sections D and M).

At 2.30 p.m.—E. H. Fryer: "Traffic Safety" (Discussion: Section G).

At 7.30 p.m.—P. A. Francis: "Applications of Science to Poultry Farming" (Public Lecture at Poulton-le-Fylde).

### Tuesday, September 15

At 10 a.m.—Sir Frank Smith, Dr. L. J. Harris, Dr. L. H. Lampitt, Dr. F. Kidd, T. Herbert, Prof. H. A. Denham, Dr. A. J. Smith: "Chemistry and Food Science" (Discussion: Section B).

The Right Hon. Lord Horder, Dr. R. D. Gillespie, Dr. E. P. Poulton, E. M. Killick: "The Strain of Modern Civilisation" (Discussion: Section I).

At 7.30.—Prof. C. M. Yonge: "Common Shore Animals" (Popular Lecture at Fleetwood).

Prof. D. Fraser-Harris: "Joy in Scientific Discovery" (Public Lecture at Thornton Cleveleys).

At 8.15.—Capt. F. Kingdon Ward: "Plant-Hunting in Tibet" (Evening Discourse).

### Wednesday, September 16

At 8 p.m.—Prof. Allan Ferguson: "Splashes and what they teach" (Public Lecture at Preston).

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ROYAL METEOROLOGICAL SOCIETY, Wednesday, September 16, at 8.15—(in the Lecture Hall of the Royal Society of Edinburgh, 22 George Street, Edinburgh).

Prof. F. Linke: "Moving Cloud Pictures".

R. H. Weightman: "Stratosphere Flight in America".

INSTITUTE OF METALS, September 14–18.—Annual Autumn Meeting to be held in Paris.

September 14, at 8.—Prof. P. A. J. Chevenard: "The Scientific Organization of Factories" (Autumn Lecture).

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX, September 18–21.—Annual Conference to be held in Balliol College, Oxford.

September 18, at 8.30 p.m.—Dr. Cyril Norwood: "The Library in the School" (Presidential Address).

September 19, at 9.30 a.m.—Symposium on "Library Instruction for University and Research Students in America".

September 19, at 11.30 a.m.—W. H. Johnston: "The Collection of Information for the Commercial Pages of a Great Daily Newspaper".

September 19, at 2.30.—Colonel L. Newcombe: "Union Catalogues, National and Regional. Their Preparation and Utilization".

September 19, at 8.30 p.m.—Prof. A. M. Carr-Saunders: "The Need for the Centralization of Information on Social and Economic Surveys".

September 20, at 9.30 a.m.—B. M. Headicar: "Government Publications, British and Foreign. Their Collection, Classification and Utilization".

September 20, at 11.30 a.m.—Dr. J. Edwin Holmstrom: "A System for Card-indexing Abstracts and Research Data, with Instantaneous Cross Reference".

September 20, at 8.30 p.m.—J. Grierson: "The Film in Industry: the Development of the Documentary Film and its Growing Use in Research and Advertising".

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## Official Publications Received

### Great Britain and Ireland

Norman Lockyer Observatory. Director's Annual Report, April 1, 1935–March 31, 1936. Pp. 6. Council's Report and Accounts, and List of Council, Staff, Members, etc. Pp. 10. (Sidmouth: Norman Lockyer Observatory.) [178

The Manchester Museum. Museum Publication 109 (Notes from the Manchester Museum, No. 36): New Greek Antiquities in the Manchester Museum. By Prof. T. B. L. Webster. Pp. 8+3 plates. 6*d*. Museum Publication 110 (Notes from the Manchester Museum, No. 37): Decorated Textiles from Yunnan (in the Museum) collected by Augustine Henry, 1896–98. By Laura E. Start and Mabel C. Wright. Pp. 26. 6*d*. Museum Publication 111 (Notes from the Manchester Museum, No. 38): Contributions to the Archæology of the Manchester Region. By Dr. J. W. Jackson. Pp. 10+2 plates. 6*d*. (Manchester: Manchester Museum.) [178

Rubber Growers' Association. Rubber and Agriculture Series, Bulletin No. 3: Rubber for Roadless Tractors and Trailers. By Alexander Hay. Pp. 14. (London: Rubber Growers' Association.) [218

Leeds University: Department of Pathology and Bacteriology. Annual Report, by Prof. Matthew J. Stewart and Prof. J. W. McLeod, with Abstract Report on Experimental Pathology and Cancer Research, by Prof. R. D. Passey. Pp. 16. (Leeds: The University.) [228

### Other Countries

Conference of Governors of British East African Territories: Research Conferences. Conference on Co-ordination of Tsetse and Trypanosomiasis (Animal and Human) Research in East Africa, held at Entebbe, 29th to 31st January 1936. Pp. 87. (Nairobi: Government Printer.) [188

Polska Akademja Umiejetności. Starunia, Nr. 8: Pleistoceńskie jezioro pod Jasłem (Pleistocene Lake near Jasło in Poland). By Władysław Szafer and Bronisław Jaroń. Pp. 20. 1 zł. Starunia, Nr. 9: Interglacjał w Samostrzelnikach pod Grodnem (Interglacial in Samostrzelniki bei Grodno in Polen). By Jan Trela. Pp. 8. 1 zł. (Kraków: Nakładem Polskiej Akademji Umiejetności.) [188

Republique Polonaise: Institut National Météorologique. Tables crépusculaires: donnant l'altitude au zénith des rayons rasants du soleil pour toutes les latitudes de degré en degré. Par Jean Lugeon. Pp. xxxix+438. (Varsovie: Państwowy Instytut Meteorologiczny.) 25 zł. [188

Nigeria. Annual Report on the Geological Survey Department, 1935. Pp. ii+27. (Lagos: Government Printer; London: Crown Agents for the Colonies.) 2*s*. 6*d*. [208

Survey of India. Geodetic Report, 1935. Pp. v+101+20 plates (Dehra Dun: Survey of India.) 3 rupees; 5*s*. 3*d*. [248

Review of Agricultural Operations in India, 1931–32 and 1932–33. Pp. vi+408. (Delhi: Manager of Publications.) 5.12 rupees; 9*s*. 6*d*. [248

Trinidad and Tobago: Forest Department. Administration Report of the Conservator of Forests for the Year 1935. Pp. 18. (Trinidad: Government Printer.) 16 cents. [248

Fiskeridirektoratets Skrifter. Serie Havundersøkelser, Vol. 5, No. 1: Sydøstgrønland Jan Mayen; Fiskeriundersøkelser. Av Thor Iversen. Pp. 171+8 plates. (Bergen: A.s. John Griegs Boktrykkeri.) [248

Union of South Africa. Report of the Research Grant Board, 1918–1935. Pp. 35. (Pretoria: Government Printer.) 1*s*. 6*d*. [258

Colony and Protectorate of Kenya: Forest Department. Annual Report for the Year ended December 31, 1935. Pp. 40. (Nairobi: Government Printer; London: Crown Agents for the Colonies.) 1*s*. [278

Canada: Department of Mines: Mines Branch. The Canadian Mineral Industry in 1935. (No. 773.) Pp. iv+100. (Ottawa: King's Printer.) 25 cents. [278

South Australia: Department of Mines. Mining Review for the Half-Year ended December 31, 1935. (No. 63.) Pp. 87+5 plates. (Adelaide: Government Printer.) [278

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### Catalogues

Kodak X-ray Manual. Pp. 56. (London: Kodak, Ltd.)

Cressall Field Discharge "Shunt-Break" Switch-Fuses (for D.C. Inductive Circuits). (List No. 61.) Pp. 4. (Birmingham: The Cressall Manufacturing Co., Ltd.)