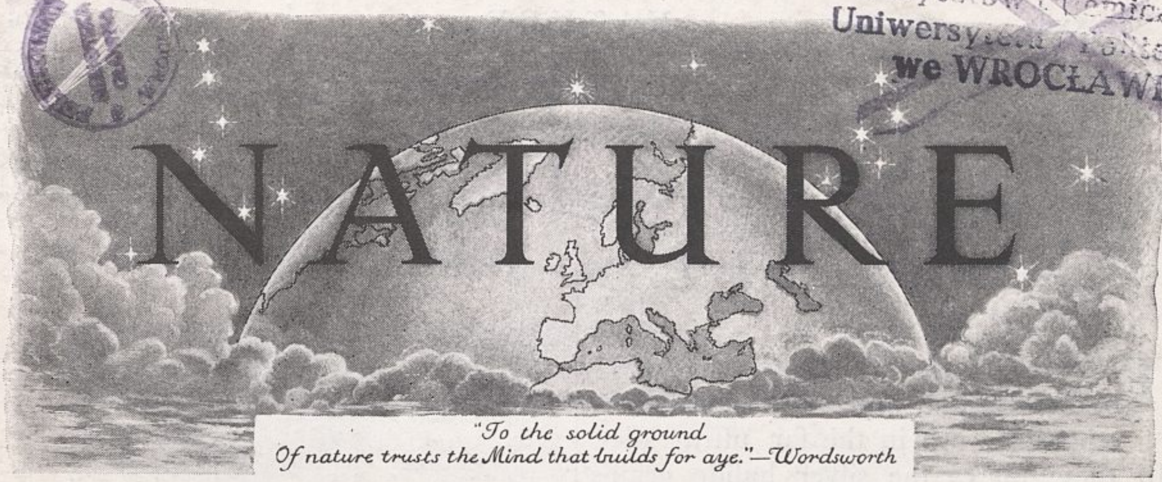

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THE WAR EXTENDED

SIGNOR MUSSOLINI'S decision of June 10 has inspired the contempt of all freedom-loving peoples. That two men are able to decide the fate of about a hundred and fifty million people, and challenge, directly or indirectly, the peace and prosperity of the rest of the world with little or no reference to other authority, is perhaps the greatest blow to human dignity in history. But this is not the time for recrimination and criticism. The challenge must be met now.

On the same day, Mr. Duff Cooper, Minister of Information, spoke of this new tragedy, pointing out that there is so much that we all like and admire in Italy and the Italian people. All scientific people will contribute to this view. It is scarcely necessary to mention the fruitful fields for archæological and historical studies offered by that country, the first marine biological station at Naples, the important contributions to the mathematical and physical sciences made by Italy over a period of centuries. Yet it is a sad reflection on modern civilization that we must now anticipate an "increase in the number of ruins for which Italy has long been famous". Much, far too much, of Europe is already in ruins ; there is not the slightest reason or excuse for opening out the vista of this hideous carnage. "No war has ever been declared with so little provocation as this. Italy had no quarrel with Great Britain or with France, and had made no claim which had been refused." Every problem could have been solved by scientific and honest debate.

M. Reynaud, on this same sad day, asks : "How shall we judge this act ? France has nothing to say. The world which is looking on will pass judgment." The lovers of freedom and of democratic government have passed their judgment in no uncertain terms. The highest moral authorities in the world, including the Pope and President Roosevelt, had repeatedly tried, but in vain, to prevent the extension of war, which is opposed to all ethical principles and to human solidarity.

Two great democracies, two great Empires, are fighting for their freedom and that of other countries—indeed of the world. After all else had failed, they were compelled to meet force with force. To those "evil things" which they have been fighting for ten months are now added more evil things. But great inspiration is forthcoming to those two democracies from a third. There has been no doubting the moral attitude of the United States since hostilities began ; but on the day of Italy's declaration, President Roosevelt, at the graduation exercises of the University of Virginia, spoke emphatically of Italy's scorning "the rights and securities of other nations".

"On this tenth day of June 1940," he said, "from this University, founded by the great American teacher of democracy [Thomas Jefferson, third president of the United States], we send forward our prayers and our hopes to those beyond the seas who are maintaining with magnificent valour their battle for freedom." The Americans have now seen beyond any shadow of doubt the ascendancy of the philosophy of force in country after country where free institutions and individual liberty to search for truth and to express opinion were once maintained ; where control of machines was retained in the hands of mankind as a whole. "Neither those springing from that stock nor those who have come hither in later years can be indifferent to the destruction of freedom in their ancestral land across the sea", the President said.

For years NATURE has striven hard for intellectual freedom in thought, word and action. We can never subscribe to any theory of nationalism in science; and therefore men of science can now look with deep satisfaction on the quick passing of the isolationist policy so recently advocated by certain groups of Americans, but now so clearly repudiated by their President.

The British and the French are not nations fighting nations, but freedom-loving peoples actively opposing the forces of evil and falsehood. In this hour of need it is a comfort to know that the United States is now to "extend to the opponents of force the material resources of this nation".

Unity in the common cause has been achieved within the British Empire and within the French Empire, and also between the two. Movement towards the achievement of such unity throughout the democratic States of the whole world is increasing in momentum, a movement in which science is playing an important part. In the leading article in NATURE of May 25, p. 796, attention was directed to the brilliant contributions to our war effort that many men of science of the Allies are making in the Fighting Services and research organizations immediately connected with them, to say nothing of the many scientific workers and teachers carrying on at the home front. (Alas, the work of many others in Poland, Norway, Holland and Belgium has been immobilized by the brute force which has temporarily overcome them.) But now to these efforts will be added much from our colleagues in the United States.

When "the control of machines was retained in the hands of mankind as a whole", untold benefits accrued, but under the system of force in the hands of irresponsible conquerors, the machine becomes master, with mankind a servant and victim. It cannot be denied that science has been a major element in forcing such a grievous issue resulting in this holocaust. But the conscience of science is clear. She offers man a rope to skip; she cannot be blamed if he chooses to hang himself with it. On the other hand, science is willing, nay eager, to assist him along the path of prosperity and happiness which she has helped to provide.

Thus, when Great Britain declared war on Germany, the voice of science was raised. In NATURE of September 9, 1939, p. 455, we emphasized that "It is the duty of the man of science to lay aside his just misgivings whether the greatest force of the human intellect should thus be harnessed to the forces of destruction. . . . The interests of pure science as an intellectual pursuit and discipline must remain in abeyance." The voice has proved strong and it did not cry in a wilderness. Science is being utilized in this war effort as never before. And now, we say, this voice must be even stronger. Our energies must be directed without remission to the cause of freedom. British and French men of science in collaboration, with the moral sympathy and active assistance of their American colleagues, must give their all, even at the expense of sacrificing or modifying their cultural pursuits. Thus alone can we hope for the overthrow of brute force and the speedy initiation of the period of reconstruction which shall enshrine the great prize of freedom.

CO-ORDINATION IN NATIONAL FOOD POLICY

THE new ministries established to deal with war-time problems must find it necessary to improvise policies and, since decisions are urgent, to adopt short-term arrangements for dealing with the manifold problems they are called upon to handle.

Food concerns every one of us. Food production and the trade in foods give employment to more people than any other form of industry or service. Hence it was only to be expected that the Ministry of Food should have become a target for a large volume of criticism.

As has already been pointed out in the leading article in NATURE of March 30, food policy has never been in peace-time the principal responsibility of any minister or of any Government department. Food production has been considered from the point of view of the farmer, imports of food as factors in commercial policy, food distribution as it related to the wholesale or retail trade. The Ministry of Health, largely preoccupied with the problems of local government, held a watching brief for the protection of the consumer from impure or adulterated food; but, although committees had been set up to consider nutritional requirements, there had been no attempt to co-ordinate agricultural, trade and health considerations into a national food policy.

Since food supplies are one of the most vital factors in national defence, the war-time Ministry of Food, developed from the nucleus of the pre-war Food (Defence Plans) Department, had rapidly to evolve such a co-ordination, and to do this simultaneously with the taking of decisions on every separate question concerning food.

The House of Commons, following a precedent of the War of 1914–18, called into being a Select Committee of the House to consider National Expenditure. This Committee consists of thirty-two members of the House drawn from all parties. Its main task is to consider whether full value is being obtained from Government expenditure, and whether proper regard is being paid to economy. Such tasks inevitably involve the consideration of policy. The fourth report of the Select Committee deals with the work of the Ministry of Food*. The functions of the Ministry are described, and the report then deals with considerable frankness with a number of matters of the greatest interest to national welfare and to the efficiency of our war effort. Ministers of the previous Government have stated that Government policy was to subsidize food in order to prevent an undue rise of prices. The Select Committee is clearly critical, not of this objective, but as to whether the subsidies which are actually being given should be mainly regarded as contributions from the State to keep down food prices, since their main effect appears to be to increase the assistance given to United Kingdom farmers. The report contains paragraphs dealing with milk, bacon, meat and wheat, from which it appears that the Committee tended to regard the sums, aggregating over £40,000,000, being found by the Government for these foods as being principally beneficial to agriculture.

The Committee asks whether reductions are not possible "in the costs and profit margins allowed in all stages of manufacture, trading and transport". The principal difficulty is the difference in efficiency between the large and the small concern. Striking contrasts in efficiency were brought to light by the National Expenditure Committee in the War of 1914–18, and the Costings Branch of the Ministry of Food has already accumulated considerable evidence of a similar character.

The tendency for decisions of great importance to be reached as a result of compromise between departments, or between the Ministry and a group of traders, is regarded as perhaps inevitable; but the Committee was clearly of opinion that the national interest might suffer. This consideration naturally led to the discussion of the utilization of trade directors of commodities often drawn from the trade with which the Ministry has to negotiate. While the Committee recognized the useful functions of trade directors, recommendations were made that all decisions on policy should be taken by the Minister on the advice of his Civil Servants.

Towards the end of the report, the Select Committee presented to the House a series of paragraphs referring to the need of forethought in dealing with the planning of food policy.

In these paragraphs the Committee suggested that "it must surely be right to be prepared for the possibility that shipping and other difficulties may necessitate wide modifications in existing diet and to devote the fullest scientific study to every possibility of providing the inhabitants in this country with a ration adequate in calories, etc., at a less cost in shipping and external currency than with the present normal form of diet".

The Committee went on to point out that this was not a matter for the Ministry of Food alone, that it involved the problem of nutrition and obviously also the question of what contribution home production can make. The Committee was obviously of opinion that, although this problem had no doubt been given some consideration, this had been of a "somewhat sporadic nature".

The Committee recognized that the scientific adviser to the Ministry of Food maintained contact with the scientific staff of other Ministries, but expressed doubts whether a single individual could possibly cope with the problems or determine how far scientific research was needed for their satisfactory solution. A Committee composed of scientific men and others was needed to enable full use to be made of scientific knowledge.

The new Government has lost little time in meeting this suggestion of the Select Committee. In the War of 1914–18 most useful services were rendered by a Scientific Committee established on the initiative of the Government under the auspices of the Royal Society. This precedent has now been followed and the Lord Privy Seal, as chairman of the Food Policy Committee of the Government, has announced the formation of an Advisory Committee to consider national food requirements and home food production (see NATURE of June 8, p. 887). The President of the Royal Society is to

* Fourth Report from the Select Committee on National Expenditure. Pp. 60. (London: H.M. Stationery Office, 1940.) 1s. net.

be chairman and the Society is further represented by four distinguished fellows, and by the Secretary to the Committee, three of whom are especially concerned with the physiological approach and two with crop production. There are two other well-known agricultural experts and an agricultural economist. Business has one representative in the vice-chairman, Sir Alan Anderson, while liaison with economics and finance is provided by the inclusion of Mr. Henry Clay, of the Bank of England, and now on Lord Stamp's Co-ordinating Committee.

The Advisory Committee, consisting of a chairman, vice-chairman, secretary and eight members, is not an unwieldy body, and, provided the Departments supply it with the fullest information and assistance, it should be able to perform most useful functions.

Its reports will presumably be made to the Food Policy Committee of the Government itself, and its task is nothing less than the evolution of a food policy for the nation. There can be no doubts as to the importance of food in war, nor of the urgency of bringing about the fullest co-ordination between the nutritional needs of the country, food production and the many factors affecting import policy, that is, shipping, financial considerations and the exigencies of economic warfare. Many of the policies evolved will need to be continued during the first years of peace, and it is to be hoped that the pressing necessities which are at last leading to the formulation of a war-time food policy will not be considered as unimportant when peace has been firmly re-established.

The Advisory Committee might therefore regard its task as consisting of, first, urgent and immediate problems to ensure the maintenance of the physical vigour and morale of a nation fighting not only for its existence but also to save the world from the dominance of Nazism; and, secondly, to secure that, on a longer range basis, the newer knowledge of nutrition shall be allowed to bring its full influence to bear upon public health. This, as the Final Report of the League of Nations Committee on Nutrition shows, involves the closest relationship between health, agriculture and commercial policy.

From the point of view of the immediate task, it is greatly to be regretted that the Advisory Committee was not set up months ago. The agricultural season is now advanced, and, although in certain directions it is not too late for action affecting this season to be taken, yet far more could have been accomplished had the need for agricultural policy to be determined by the food requirements of the nation been recognized earlier.

A single example will suffice to illustrate this point. United Kingdom agriculture is mainly based upon animal husbandry, and this, in turn, has depended to a very great extent upon imported feeding stuffs. The British Isles has, however, a largely unexploited asset in its grass. The normal processes of haymaking and aftermath involve an enormous waste of valuable food for animals. There is extreme need for pasture improvement and for better conservation of the food values of young grass. The fact that so little has yet been done to secure the fuller utilization of this great asset is not due to any lack of knowledge of practical means for securing both objectives. Sir George Stapledon and others have for years been both preaching and demonstrating methods whereby the yields from pastures could be doubled. So far as conservation is concerned, cheap and practical methods of making first-class silage from young grass in pits or trenches are well known and have been fully demonstrated. Had vigorous action been taken before the summer flush of grass commenced, sufficient silage could have been conserved to have made a most important contribution to the maintenance of dairy herds during the coming winter, thus reducing the need for imported feeding stuffs or, alternatively, increasing the allowance for poultry or pigs. Given immediate and most vigorous action, a good deal of silage might yet be made, but the major opportunity has been lost for this season.

On this, as on other problems, the members of the Advisory Committee will themselves bring both expert and practical knowledge to the service of the country. More important still, they will, through their scientific associations, have access to the vast mass of information which is available on nutrition, public health, and the impact of biological science upon agriculture. The membership includes men of vision and decision, and it may confidently be anticipated that the Cabinet Food Policy Committee will receive sound advice without unnecessary delays. What may be more in question is whether early action will be taken to make effective use of the advice tendered. A great mass of tradition has to be overcome, vested interests may be in opposition; the Food Policy Committee of the Government will need to exercise considerable resolution if maximum benefits are to be derived from this belated but wholly desirable development.

THE GENUS LILIUM

A Supplement to Elwes' Monograph of the Genus Lilium
By A. Grove and A. D. Cotton. Seven parts. (London: Dulau and Co., Ltd., 1935–1940.) £19 13*s*. 9*d*.

DURING 1877–80 appeared a monumental work by H. J. Elwes entitled "A Monograph of the Genus Lilium". In this publication a series of magnificent plates represented all the lilies at that time in cultivation in Great Britain, the figures being drawn from actual living specimens. Elwes recognized that his work was incomplete, as many other species had still to be introduced into European cultivation. It was characteristic of his enthusiasm and energy that immediately on publication of his monograph he began the long and laborious task of collecting material for a supplement. This he pursued for many years, and although length of life was given to him in full measure, it was not sufficient for the completion of his aim. Associated with him in assembling this additional material was Mr. Arthur Grove, who among other pursuits has devoted a long life to the cultivation and study of lilies. The task has been almost too great for Mr. Grove, but he was fortunate in being able to call in as a colleague Mr. A. D. Cotton, keeper of the Herbarium at the Royal Botanic Gardens, Kew. These two authors have now carried to a conclusion the publication of a valuable supplement, which has been produced in the same form as the original monograph.

Botanical and horticultural publications reached a very high standard during the nineteenth century, and especially in the accuracy and artistic merit of the illustrations they contained. In the present century corresponding publications have not surpassed the products of nearly a hundred years ago, and many would say that they have lagged decidedly behind in their quality. Among these publications of the past the monograph of Elwes is one of the outstanding examples, and appreciation of this is shown by a market value which several times exceeds the original published price. The same is true of another publication of Elwes, entitled "The Trees of Great Britain and Ireland", which was issued in collaboration with the late Prof. Augustine Henry. One may say that the supplement now under review shows the same high quality both in text and in illustrations as was characteristic of the century that is past. As it forms a natural corollary to the monograph, I anticipate that it will receive the same appreciation and that its value will continue to be augmented.

There are some genera of plants which always keep the love and devotion of the horticulturist, and among these, of course, are the rose and the lily. Enthusiasm for these does not always remain at the same level, but during the last thirty years there has been a great revival of interest in the genus Lilium. This may have been only fortuitous, but I am inclined to think that the explorations of these years in China, especially those which brought E. H. Wilson his fame, are in some measure responsible for the increased attention now given to these beautiful plants. This view seems to me to be confirmed by the appearance among the species figured of a large number of Chinese species of Lilium, some of which have already made themselves familiar objects in our gardens while others may yet do so. Among these one cannot fail to mention *L. regale*, *L. Henryi*, *L. Sargentiæ*, *L. Davidi*, *L. Willmottiæ*, *L. Duchartrei*, *L. Wardii*, and that is not the complete tale. This interest in the garden cultivation of Lilium has extended quite naturally to publications on the genus, and amidst many recent and valuable books the older ones on the subject are sharing in this appreciation. This is the case not only in Great Britain; the same attention is also shown in the United States and in France. Among all the publications dealing with the genus, Elwes' monograph and the present supplement occupy pride of place. The two combined form a work of which any possessor may well be proud. If one may judge from similar examples in the past and with the knowledge of the real merit of the work, one may safely prophesy that their scientific value will not diminish and that they will continue to be indispensable for all those interested in the genus.

The supplement has been issued in seven parts, and the number of full-page plates is thirty, as compared with forty-eight in the monograph. The foreword by Dame Alice Godman gives an outline of the genesis of the publication and of the difficulties encountered in the search for completeness of the record. Much is due to her for her support and interest from the beginning and for assuming the entire financial responsibility for the publication itself. The plates have been prepared by Miss Lilian Snelling, whose artistic talent combined with accuracy is well known in other fields of botanical illustration. In beauty as well as in their botanical details they are in my opinion superior even to the fine figures in the original monograph. When we come to the text prepared by the long and painstaking efforts of Messrs. Grove and Cotton, there is no question but that the supplement compares much more than favourably with the text of the monograph. The authors have spared no pains to investigate all the literature dealing with their subject. This has involved not merely reference to botanical literature in order to elucidate the taxonomy, history, and often intricate nomenclature of the species concerned, but also to the horticultural periodicals, for many useful hints concerning cultivation are included in their comments. Much of this valuable information would naturally come from Mr. Grove, who has been for so long an enthusiastic and successful grower of many of the species. The illustrations have been prepared exclusively from living specimens, and there is no doubt that the study of the species in the living state has added greatly to the accuracy of the work. The authors have safeguarded their results by borrowing historical specimens and much herbarium material from many centres throughout the world; these they interpret in the light of living specimens. Their final judgment has been based in great measure on each species in life.

The perusal of the text will not fail to convince any reader of the scrupulous care and intensive research given to the issue of this supplement. It is admirably done. Of course, in these matters there is never full completion. A few species, which have never been in cultivation in Europe and of which little or nothing is known except the mummified remains in herbaria, have had to be omitted. The aim set by Elwes has been adhered to, and the illustrations feature the plants as they appear in our gardens. At the risk of praising it once again, I affirm that this supplement takes its place with the classics of last century and is no ephemeral but a perpetual treasure.

W. WRIGHT SMITH.

THE INSTITUTION OF ELECTRICAL ENGINEERS

The History of the Institution of Electrical Engineers (1871–1931)
By Rollo Appleyard. Pp. 342 + 38 plates. (London: Institution of Electrical Engineers, 1939.) 18*s*. 6*d*.

IN the sixty-odd years of its existence, progress in the electrical industry has been so extraordinarily rapid and the applications of electricity in the service of man so numerous and widespread that the passing of time may serve to dim or obscure the labours of those who have "directed and safeguarded electrical progress". That this may not be so, the Council of the Institution of Electrical Engineers very wisely decided on the preparation of a history of the Institution, and were fortunate in entrusting the work to Commander Appleyard.

Apart from due cognizance being taken of earlier electrical knowledge and the necessity to refer to post advances, it was decided to confine the history mainly to the sixty years from 1871, when the Society of Telegraph Engineers was founded, to 1931—a fitting limit to such a period of achievement, since it marked the centenary of one of the most fundamental and important of discoveries, namely, Michael Faraday's discovery of "the evolution of electricity from magnetism".

It is perhaps not unnatural that the energy and discoveries of many of the early pioneers of electrical science should be directed to the solution of what was then one of the most urgent problems of man—rapid and easy communication. In the period immediately prior to the formation of the Society of Telegraph Engineers, the importance of electrical telegraphy had irresistibly become recognized. By 1871 the nominal capital of telegraph companies registered in England had reached approximately £40 million, and the "need for a corporate organization to collect, to coordinate and to preserve the results of electrical investigations" had become apparent and found expression in the meeting held on May 17, 1871, at No. 2, Westminster Chambers, Victoria Street, S.W., the minute book of which contains the following eight names: W. Whitehouse; Captain P. H. Colomb, R.N.; Major R. H. Stotherd, R.E.; Louis Loeffler; Captain C. E. Webber, R.E.; Captain E. D. Malcolm, R.E.; Robert Sabine; and Major Frank Bolton.

Rapidity of progress and extension of the spheres of activity and thought, arising in no small measure from developments such as the Gramme generator and the Jablochkoff lamp, brought about, within the short space of nine years, a broadening of the title to "The Society of Telegraph Engineers and of Electricians", which was later modified to "The Society of Telegraph Engineers and Electricians", under which title it became incorporated in 1883. Improvements in machines associated with such names as Siemens, Edison, Brush, Mordey, Hopkinson and Crompton, and the epoch-making discoveries of Swan and Edison in regard to lamps, provided stimulus for the plea for a society of "sound electricians and engineers only", having for its task the shaping of the practice of electrical engineering into "something like an art, having some definite rules and principles". The title was thus altered in 1888 to "The Institution of Electrical Engineers", under which, in 1921, was granted a Royal Charter of Incorporation. Meanwhile, communication had witnessed the introduction of telephony with the development of the telephone by Bell in 1875 and the microphone in 1878 by Hughes, whilst electrical measurement had advanced by the work of Ayrton, Perry and Thompson, to name only a few.

The period from 1888 was one of progress marked by the development of electrical distribution, transmission and the use of electrical energy spurred by improvements in dynamos, A.C. machines and transformers, at the hands of Hopkinson, Crompton, Mordey, Ferranti and others, until by the close of the century electric power had truly become a handmaid of industry. The application of electrical knowledge was finding an ever-widening field. Electric traction had already been introduced, and a paper by Lodge in 1898 on "Improvements in Magnetic Space Telegraphy" and contributions by Evershed, Dolbear, Willoughby-Smith, Marconi and Tesla inaugurated wireless telegraphy. Contemporary development of the steam turbine by Parsons afforded impetus to bulk generation of electric power, and extensive development of the industrial use of power during the War of 1914–18, followed by more encouraging legislation, brought into being its widespread distribution as afforded by our national 'grid' system. Development of the thermionic valve by J. A. Fleming and the addition to it of a third electrode by de Forest played an all-important part in the transition from wireless telegraphy of 1898 to wireless telephony or broadcasting, which came into service in 1922, soon to be followed by the 'phonofilms' or 'talking pictures' and 'television' of modern times.

This pattern of the development of electrical science and engineering, which has been carefully woven by the author from the work of the Institution and "those who gave it lustre", is coloured throughout by his apt interpretation of vital influences and their magnitudes, by his appreciation of the trials and difficulties inseparable from such progress, and by his skilful presentation of excerpts from discussions and proceedings to illustrate the trend of thought and enlightenment as each new contribution was made. Throughout the pages of the history, names and personalities stand forth in their proper perspective, and the historian brings to light many human characteristics which serve to make very real the personalities he portrays. Just prominence is also given to such important factors in the history of the Institution as its close and beneficial association with the Services, its acknowledgment of duty to the public as exemplified by the issue of rules and regulations governing the installation of equipment and by the encouragement of public interest in matters electrical, its early and sustained assistance to the establishment of a working system of electrical units and to the work of standardization, and its unremitting efforts and encouragement on behalf of the education and training of personnel.

That the preparation of this narrative was no mean task is amply demonstrated throughout the book. The author and all those who assisted in the historical researches are to be congratulated on the result of their labour, which occupied a period of three years, for in the fulfilment of the task there is presented a record and appreciation of those who have had the furtherance of the industry and the well-being of their fellowmen at heart; it will serve as a worthy source of inspiration for those who follow.

The volume, which contains a wealth of fine illustrations, is beautifully produced.

A. P. M. FLEMING.

GRAHAM WALLAS: A SCIENTIFIC HUMANIST

Men and Ideas

Essays. By Graham Wallas. Pp. 221. (London: George Allen and Unwin, Ltd., 1940.) 8*s*. 6*d*. net.

THOUGH the interests of the late Graham Wallas were essentially humanistic, there are more reasons than one why the recently published volume of his essays should receive attention in a journal which, while mainly devoted to the physical and biological sciences, takes cognizance of other work which is informed by the scientific spirit. Such work was that of Graham Wallas, who did great service in helping to make social science worthy of its name. He relates how, at the beginning of his maturer studies, he undertook a voyage of exploration among the papers of Francis Place, and how he came out of his years of research a different man. Research was thereafter the keynote of his intellectual life.

Shrewsbury and Oxford had done much for his general equipment, but the real work of Graham Wallas's life was bound up with London, its school system, and its University. Jeremy Bentham, the spiritual father of that University, had adopted as the aim of all his efforts "the application to the social sciences of the methods already invented for the natural sciences", as these methods presented themselves at the end of the eighteenth century. Graham Wallas adopted the same principle, but with the vital difference in practice that he was born within a year of the appearance of Darwin's "Origin of Species", and that as a youthful 'intellectual' he witnessed the lively controversies that ensued. No one who knew Graham Wallas as a man will be surprised to learn that as an undergraduate at Oxford he wrote to the professor of moral philosophy, defending the theory of evolution against an attack made by that functionary in the course of a lecture.

Graham Wallas was nearing his fortieth year when his "Life of Francis Place" appeared. In his fifties he produced his "Human Nature in Politics" and "The Great Society", and in his sixties "The Social Heritage" and "The Art of Thought". These important works bear the impress of his keen interest in the development, during that period, of a more helpful psychology than had hitherto been at the disposal of the cultivators of social science. They bear also the marks of the man of affairs, who had taken leading parts in the work of the old London School Board, the Education Committee of the London County Council, and the Senate of the University of London, who had undertaken lecturing tours in America, and had served on a Royal Commission on the Civil Service.

Besides his major contributions to the thought of his time, Graham Wallas wrote a number of articles and addresses, a selection of which, edited by his daughter, is given in "Men and Ideas". Some of these papers, such as those on Bentham, remain of substantial value in themselves. Others are of permanent interest as contemporary criticism of the movements to which they refer. His criticism of Froebelian pedagogy, for example, written forty years ago, showed the Froebelians that their master lived under the influence of pre-Darwinian science, and taught them to sift the chaff from the wheat in his teaching. It is, therefore, a paper to be reckoned with by the historian of English education, though the criticism does not apply at the present time. The same may be said of the paper on "Oxford and the Nation", written in 1908, and on "English and American Universities", written in 1914.

Graham Wallas devoted himself to research, and gratefully acknowledged his debt to those men of science who pursue their researches in laboratories, and whose example he followed. But he ventured also to give them a timely hint as to the futility of some work which passes as research and is rewarded with academic distinctions. "It may be essential", he said, "that a young astronomer should pass the years between twenty-one and twenty-three in mastering the mathematics of relativity or the quantum theory. Such work would not produce 'a distinct contribution to the knowledge of the subject', because that contribution has already been made by Einstein and Planck. But when Einstein dies, the collection of personal incidents in his life, or misprints in his editions, will be research." Wallas was capable, not only of a hearty laugh, but also of a shrewd thrust. T. RAYMONT.

LOCATION OF INDUSTRY

The Location of Industry and the Depressed Areas

By Prof. S. R. Dennison. Pp. vii + 216. (London: Oxford University Press, 1939.) 10*s*. net.

MUCH is expected of the publications of the Economics Research Department of the University of Manchester, and if in some respects Prof. S. R. Dennison scarcely maintains that high standard, he has at least given us a work which no serious student of the Special Areas and the problems they present can afford to overlook. His admirable and careful analysis of the work of the Commissioners for the Special Areas, and appreciation of the results achieved and of the limitations inherent in either their work or policy, sets the problem in its true perspective in relation to unemployment and industrial development generally. While he appears to ignore the experimental character of the Special Areas Act on which stress was laid when the legislation was introduced, he recognizes that the Special Areas measures cannot continue indefinitely as they now operate, and that it will soon be necessary either to rescind them and leave the problem as it is or to extend them.

The second part of the book, in which in successive chapters Prof. Dennison discusses the problem of the Special Areas, the apparent drift of industry to the south and the nature and limitations of Government policy, is most valuable and constructive. He rightly points out that in any industrial system which is not entirely static, technical change coupled with occupational immobility must be a cause of some unemployment, more or less short-lived, but he is concerned at the effect of the immobility of unemployed workers coupled with the decreased mobility of labour generally, particularly as the greater freedom of the location of industry from supplies of raw materials involves the risk of periodic shifts at a greater frequency. He appears to consider that policy should therefore be directed towards increasing the mobility of labour, and he is of the opinion that the policy of transference has not been of a character appropriate to the needs of the Special Areas. Prof. Dennison insists that there are limits also to the possibilities of attracting industries to the Special Areas, particularly in the provision of trading estates, and considers that the Commissioners have never had a well-defined aim : attempts to attract industries and the reconditioning of areas to receive them are clearly inconsistent with a policy of transference.

In his analysis of the drift of the industrial population to the south, Prof. Dennison points out that the relative growth of the industrial population in London and the south-east was not due to the relative rate of expansion of the expanding industries, which expanded with almost equal or even greater rapidity elsewhere, but to the fact that in other areas a much greater proportion of the industrial population was employed in declining industries. The problem of the Special Areas emerges from a series of general changes in industrial structure, and the causes being deep-seated, any policy which deals merely with the symptoms of depression in the areas will be only palliative ; if the causes which have created the Depressed Areas are to be removed, the trends of locational change must be reversed. As the only alternative to a long process of attrition, Prof. Dennison somewhat reluctantly advocates a short-period policy of transference and of encouraging new industrial development in non-derelict Depressed Areas. Such a short-period policy may also throw further light on factors to be taken into account in deciding upon the merits of policy designed to deal with the long-period problems.

It is in the lack of constructive criticism and positive suggestion that Prof. Dennison's book falls short of the standard generally set in the publications of the Economics Research Department at Manchester where the work was carried out. This defect is the more conspicuous in the first part of the volume, in which the economic aspects of the location of industry are discussed in detail. Excellent as is much of the analysis, though sometimes one-sided, Prof. Dennison appears to stress the difficulties in the way of control to an extent which paralyses action. It is well, however, that the implications of control should be set forth with such lucidity, and that in appraising the recommendations of the Majority or Minority Reports of the Royal Commission we should keep in mind the difficulty of defining the areas within which control is to be exercised ; the necessity of basing a policy of control on fairly definite criteria ; the major problem of deciding between diversity and specialization of industries ; or the relation between control and long-term planning and their application not to industry in the abstract but to individual firms. We may equally be grateful for the warning against a too facile assumption that policy will necessarily be distinguished by thought for larger issues and long-period aims, undisturbed by irrational or vested interests.

Prof. Dennison's obvious dislike of control, though he clearly distrusts *laissez-faire*, may possibly be attributed in part to the fact that, by limiting himself to the economic side, he leaves out of account those other large aspects such as town and country planning and regional development with which location of industry is interlocked, and in which such factors as strategic considerations, the preservation of amenities and the like are making action imperative if irreparable damage is not to be done. With miscellaneous exceptions, expert opinion is moving solidly in favour of control of the location of industry, differing only in regard to the means by which control is to be exercised and its extent. So, too, while the report of the Royal Commission and the P.E.P. Report stress the need for the collection and co-ordination of information on the location of industry and on natural resources, Prof. Dennison makes the somewhat naïve suggestion that information already available affords adequate guidance for the location of industry in general.

Here and elsewhere, Prof. Dennison is open to criticism on the grounds of a disappointingly narrow approach. Nevertheless, his discussion of theories of industrial location, particularly of Weber and his school, and analysis of the various factors in location such as transport, labour, taxation, and relation to markets, form an admirable background to the more important part of the book. He makes free use of evidence presented before the Royal Commission, and however disappointing the absence of more positive conclusions may be, the book is one which makes a contribution to the accurate knowledge and diagnosis which Prof. Dennison rightly insists must form the basis of any successful policy. R. BRIGHTMAN.

THE EIGHTH AMERICAN SCIENTIFIC CONGRESS

By Dr. Austin H. Clark

THE Eighth American Scientific Congress was held in Washington, D.C., during May 10–18, 1940. This Congress was convened by the Government of the United States with two purposes in view. The first was to advance scientific thought and achievement by enabling the scientific men and women of the twenty-one American Republics to meet each other, to exchange ideas, and to form lasting friendships. The second was to assist in the celebration of the fiftieth anniversary of the Pan American Union.

Though primarily scientific, the Congress aimed at integrating science in the Americas with the social and political life of the people, for science can no longer be considered as separate and distinct from other forms of human activity. In our modern civilization science in one form or another enters into every element of our social structure. This is particularly true in the Americas, where the origin and development of science have been democratic to an extent known nowhere else. In the Americas science knows no social classes. All groups have contributed to its advancement. There it has arisen from the people as a whole ; it has been, and is being, supported by the people as a whole ; and its broad aim is the betterment of the condition of the people as a whole.

Man as he used to be, as he is to-day, and as he is to be in the future ; his social organization, welfare, and activities of every kind, and especially man in his relation to America and other Americans —this was the broad subject that occupied the attention of the Eighth American Scientific Congress.

This attitude must not be mistaken for one of isolationism. For the American Republics are all keenly alive to their close affinities, individually and collectively, with the nations of the Old World. This was emphasized at the formal opening of the Congress on the evening of May 10 in a stirring and memorable address by President Franklin D. Roosevelt in which he said :

"All of the men and women of this Pan American Scientific Congress have come here to-night with heavy hearts. During the past few years we have seen event follow event, each and every one of them a shock to our hopes for the peaceful development of modern civilization. This very day three more independent nations have been cruelly invaded by force of arms.

"In some human affairs the mind of man grows accustomed to unusual actions if they are oft repeated. That is not so in the world happenings of to-day—and I am proud that it is not so. I am glad that we are shocked and angered by the tragic news from Belgium and the Netherlands and Luxembourg.

"The overwhelmingly greater part of the population of the world abhors conquest and war and bloodshed—prays that the hand of neighbour shall not be lifted against neighbour. The whole world has seen attack follow threat on so many occasions and in so many places during these later years. We have come, therefore, to the reluctant conclusion that a continuance of these processes of arms presents a definite challenge to the continuation of the type of civilization to which all of us in the three Americas have been accustomed."

In his address, President Roosevelt acknowledged with appreciation the great achievements of science in the extension and development of modern civilization. He said that the objectives toward which science is striving are closer and more peaceful relations between all nations through the spirit of co-operation and the interchange of knowledge. He deprecated the idea that science is responsible for the present "attacks on civilization which are in progress elsewhere", remarking that, "The great achievements of science and even of art can be used to destroy as well as to create ; they are only instruments by which men try to do the things they most want to do."

The comprehensive scope of the Congress and the interdigitation of science, as commonly understood, with other forms of human activity are well brought out by the titles of the sections into which the proceedings were divided. These were : I. Anthropological Sciences (Herbert J. Spinden, chairman ; Alfred V. Kidder, vice-chairman ; Julian H. Steward, secretary). II. Biological Sciences (Edwin G. Conklin, chairman ; Henry A. Gleason, vice-chairman ; James A. G. Rehn, secretary). III. Geological Sciences (T. Wayland Vaughan, chairman ; Wendell P. Woodring, secretary). IV. Agriculture and Conservation (Hugh H. Bennett, chairman ; Ernest G. Holt, secretary ; J. L. Colom, assistant secretary). V. Public Health and Medicine (Thomas Parran, chairman ; Hugh S. Cumming, honorary chairman ; Lewis H. Weed, vice-chairman ; A. M. Stimson, secretary ; A. A. Moll, assistant secretary). VI. Physical and Chemical Sciences (Lyman J. Briggs, chairman ; Eugene C. Crittenden, secretary). VII. Statistics (Stuart A. Rice, chairman ; Raymond Pearl, vice-chairman ; Holbert L. Dunn, secretary ; Elizabeth Phelps, executive assistant). VIII. History and Geography (C. H. Haring, chairman ; Preston James, vice-chairman ; Robert C. Smith, secretary ; Frank Vane, assistant secretary). IX. International Law, Public Law and Jurisprudence (James Brown Scott, chairman ; Herbert F. Goodrich, vice-chairman ; George A. Finch, secretary ; William Sanders, assistant secretary). X. Economics and Sociology (Harold G. Moulton, chairman ; Benjamin Colby, secretary). XI. Education (Nicholas Murray Butler, chairman ; I. L. Kandel, vice-chairman ; Richard Pattee, secretary ; Harold Benjamin and George I. Sánchez, rapporteurs).

Of most immediate interest to everyone are the sciences grouped under public health and medicine. These in recent years have attracted much attention throughout the Americas. In this section 119 papers were presented. Most of them were of broad general interest from the point of view of public health, though some gave details of the latest work on important and widespread ailments, or on obscure or little-known tropical diseases.

The accumulation of adequate statistical information regarding the population is recognized throughout the Americas as a matter of vital importance. In the section on statistics there were 71 papers, covering nearly all phases of the subject. These were read by statistical experts from all the twenty-one American Republics. An examination of these contributions shows how closely the conditions among the people are now being checked throughout the western hemisphere.

There were many papers on sociology and economics, these subjects being treated both from the point of view of national units and from the point of view of a closer unification of the American Republics.

A closer unification of the American Republics envisions a greater uniformity in legal systems and in legal procedure than exists at present. There were 78 papers dealing with various aspects of international law, public law and jurisprudence. Many eminent jurists took part in the discussion, including the Ministers to the United States from El Salvador and Honduras, the Mexican Under-Secretary for Foreign Affairs, and three members of the faculty of law in the University of San Marcos at Lima, Peru, the oldest university in the Americas, founded in 1551.

There were 61 contributions in the section on education, and 64 in the section on history and geography.

Among the 42 papers in the section of agriculture and conservation, there were several of more than usual interest. Among these were the opening address by the Hon. Henry A. Wallace, Secretary of Agriculture, on "The Vital Role of Agriculture in Inter-American Relations", and another by the Hon. Gifford Pinchot, former Governor of Pennsylvania, on "Conservation as the Foundation of Permanent Peace". The papers as a whole covered a wide range of subjects. Soil erosion, the conservation of agricultural and forest resources, improved agricultural practices, and range problems in both South and North America received special attention.

In the section on geological sciences there were 57 papers dealing with all phases of the subject, though especially with the mineral resources.

The programme of the section of physical and chemical sciences included 62 papers, of which the most outstanding was a contribution by Prof. Albert Einstein, of the Institute for Advanced Study, Princeton University, entitled "Considerations concerning the Fundaments of Theoretical Physics" [see p. 920 of this issue].

There were 79 contributions in the section of biological sciences. Many of these were on various aspects of the extraordinarily rich fauna and flora of tropical America, though there were also many on genetics, evolution, distribution, and other topics.

The scientific programme was supplemented by an elaborate social programme which included, in addition to receptions, teas, garden-parties, and other entertainments, a visit to the famous Luray caverns of Virginia, and an inspection of the restoration of Colonial Williamsburg, Virginia, over which the "Grand Union", the predecessor of the present Union Jack, still flies.

On May 20 the delegates to the Congress were the guests of the American Philosophical Society at Philadelphia, the oldest scientific society in the United States, founded by Benjamin Franklin, and May 21 was set apart as Eighth American Scientific Congress Day at the New York World's Fair, the delegates from the Latin American Republics being the guests of the Fair throughout the day.

In the preparation and carrying out of this extensive social and scientific programme many individuals participated. Mr. Cordell Hull, Secretary of State, was honorary chairman of the Advisory Committee, of which the other cabinet officers were honorary vice-chairmen. On the organizing and advisory committees were practically all the outstanding men of science in the United States.

Those chiefly responsible for the success of the Congress were the Hon. Sumner Welles, Under-Secretary of State, president of the Congress and chairman of the Organizing Committee ; Dr. Warren Kelchner, chief of the Division of International Conferences, Department of State, executive vice-president of the Congress and vice-chairman of the Organizing Committee ; Dr. Alexander Wetmore, assistant secretary of the Smithsonian Institution, secretary general of the Congress and secretary of the Organizing Committee ; and Dr. Frank B. Jewett, president of the National Academy of Sciences, chairman of the Advisory Committee.

The Congress was adjourned with the same note of uneasiness and apprehension with which it had been opened by President Roosevelt. In his farewell address, Mr. Sumner Welles said :

"You scientists have been free to seek the truth for the sake of that truth. You have been free to use your great powers without hindrance. You have been free to publish the results of your quiet study in your laboratories, or your often hazardous observations, sometimes at the far ends of the earth, without fear that because these results might differ from accepted concepts, you, and even your families, would be subjected to the control and the oppression of the State.

"The suppression in some parts of the world to-day of the right of free inquiry, and the endeavour to control the thoughts of men, is therefore of intimate concern, not only to all scientists but likewise to all persons who believe that science has within its grasp the capacity to remedy in great part the ills of our present civilization. We cannot but speculate whether, in those parts of the world where free inquiry is no longer possible, there will not be, at least in so far as the things of the mind and the spirit are concerned, a return to the Dark Ages. What hope is there for future generations in countries where the State by fiat has declared that all persons must believe glaring distortions of the truth ; where evil is declared to be good ; where falsehood is paraded as the truth ; and where aggression, pure and simple, is represented as self-defence ? . . .

"I believe—as firmly as I believe that the sun will rise once more to-morrow—that the present menace to civilization will pass, and that the day will come when the now destructive forces of evil which men themselves have created will be vanquished. I believe that mankind will again be afforded opportunity to lay the foundations of a better world—a world in which freedom from fear will be established for all mankind and the right of every person to worship God, to think, to speak, to know the truth and to search for the truth will be made sure."

CONSIDERATIONS CONCERNING THE FUNDAMENTS OF THEORETICAL PHYSICS*

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WHAT we call physics comprises that group of natural sciences which base their concepts on measurements ; and the concepts and propositions of which lend themselves to mathematical formulation. Its realm is accordingly defined as that part of the sum total of our knowledge which is capable of being expressed in mathematical terms. With the progress of science, the realm of physics has so expanded that it seems to be limited only by the limitations of the method itself. The larger part of physical research is devoted to the development of the various branches of physics, in each of which the object is the theoretical understanding of more or less restricted fields of experience, and in each of which the laws and concepts remain as closely as possible related to experience. It is this department of science with its ever-growing specialization, which has revolutionized practical life in the last centuries.

On the other hand, from the very beginning there has always been present the attempt to find a unifying theoretical basis for all these single sciences, consisting of a minimum of concepts and fundamental relationships, from which all the concepts and relationships of the single disciplines might be derived by logical process. This is what we mean by the search for a foundation of the whole of physics.

It is clear that the word foundation in this connexion does not mean something analogous in all respects to the foundations of a building. Logically considered, of course, the various single laws of physics rest upon this foundation. But whereas a building may be seriously damaged by a heavy storm or spring flood, and yet its foundations remain intact, in science the logical foundation is always in greater peril from new experiences or new knowledge than are the branch disciplines with their closer experimental contacts.

The first attempt to lay a uniform theoretical foundation in physics was the work of Newton. In his system everything is reduced to the following concepts :

(1) Mass points with invariable mass ;
(2) action at a distance between any pair of mass points ;
(3) law of motion for the mass point.

There was not, strictly speaking, any all-embracing foundation, because an explicit law was formulated only for the actions-at-a-distance of gravitation ; while for other actions-at-a-distance nothing was established *a priori* except the law of equality of

* An address, slightly abridged, delivered at the Eighth American Scientific Congress at Washington on May 15.

actio and *reactio*. Moreover, Newton himself fully realized that time and space were essential elements as physically effective factors of his system, if only by implication.

This Newtonian basis proved eminently fruitful and was regarded as final up to the end of the nineteenth century. It not only gave results for the movements of the heavenly bodies down to the most minute details, but also furnished a theory of the mechanics of discrete and continuous masses, a simple explanation of the principle of the conservation of energy, and a complete and brilliant theory of heat. The explanation of the facts of electrodynamics within the Newtonian system was more forced; least convincing of all, from the very beginning, was the theory of light.

It is not surprising that Newton would not listen to a wave theory of light; for such a theory was most unsuited to his theoretical foundation. The assumption that space was filled with a medium consisting of material points that propagated light waves without exhibiting any other mechanical properties must have seemed to him quite artificial. The strongest empirical arguments for the wave nature of light, fixed speeds of propagation, interference, diffraction, polarization, were either unknown or else not known in any well-ordered synthesis. He was justified in sticking to his corpuscular theory of light. During the nineteenth century the dispute was settled in favour of the wave theory. Yet no serious doubt of the mechanical foundation of physics arose, in the first place because nobody knew where to find a foundation of another sort. Only slowly, under the irresistible pressure of facts, there developed a new foundation of field-physics.

From Newton's time on, the theory of action-at-a-distance was constantly found artificial. Efforts were not lacking to explain gravitation by a kinetic theory, that is, on the basis of collision forces of hypothetical mass particles. But the attempts were superficial and bore no fruit. The strange part played by space (or the inertial system) within the mechanical foundation was also clearly recognized, and criticized with especial clarity by Ernst Mach.

The great change was brought about by Faraday, Maxwell and Hertz—as a matter of fact half-unconsciously and against their will. All three of them, throughout their lives, considered themselves adherents of the mechanical theory. Hertz had found the simplest form for the equations of the electromagnetic field, and declared that any theory leading to these equations was Maxwellian theory. Yet towards the end of his short life he wrote a paper in which he presented as the foundation of physics a mechanical theory freed from the force-concept.

For us, who took in Faraday's ideas so to speak with our mother's milk, it is hard to appreciate their greatness and audacity. Faraday must have grasped with unerring instinct the artificial nature of all attempts to refer electromagnetic phenomena to actions-at-a-distance between electric particles reacting on each other. All these electric particles together seemed to create in the surrounding space spatial states, to-day called fields, which he conceived as states of mechanical stress in a space-filling medium, similar to the states of stress in an elastically distended body. For at that time this was the only way one could conceive of states that were apparently continuously distributed in space. The peculiar type of mechanical interpretation of these fields remained in the background —a sort of placation of the scientific conscience in view of the mechanical tradition of Faraday's time.

With the help of these new field concepts, Faraday succeeded in forming a qualitative concept of the whole complex of electromagnetic effects discovered by him and his predecessors. The precise formulation of the time-space laws of those fields was the work of Maxwell. Imagine his feelings when the differential equations he had formulated proved to him that electromagnetic fields spread in the form of polarized waves and with the speed of light! At that thrilling moment he surely never guessed that the nature of light, apparently so completely solved, would continue to baffle succeeding generations. Meantime, it took physicists some decades to grasp the full significance of Maxwell's discovery, so bold was the leap that his genius forced upon the conceptions of his fellow-workers. Only after Hertz had demonstrated experimentally the existence of Maxwell's electromagnetic waves did resistance to the new theory break down.

But if the electromagnetic field could exist as a wave independent of the material source, then the electrostatic interaction could no longer be explained as action-at-a-distance; and what was true for electrical action could not be denied for gravitation. Everywhere Newton's actions-at-a-distance gave way to fields spreading with finite velocity.

Of Newton's foundation there now remained only the material mass points subject to the law of motion. But J. J. Thomson pointed out that an electrically charged body in motion must, according to Maxwell's theory, possess a magnetic field the energy of which acted precisely as does an increase of kinetic energy to the body. If, then, a part of kinetic energy consists of field energy, might that not then be true of the whole of the kinetic energy? Perhaps the basic property of matter, its inertia, could be explained within the field theory? The question led to the problem of an interpretation of matter in terms of field theory, the solution of which would furnish an explanation of the atomic structure of matter. It was soon realized that Maxwell's theory could not accomplish such a programme. Since then many men of science have zealously sought to complete the field theory by some generalization that should comprise a theory of matter; but so far such efforts have not been crowned with success.

For several decades most physicists clung to the conviction that a mechanical substructure would be found for Maxwell's theory. But the unsatisfactory results of their efforts led to gradual acceptance of the new field concepts as irreducible fundamentals—in other words, physicists resigned themselves to giving up the idea of a mechanical foundation.

Thus physicists held to a field-theory programme. But it could not be called a foundation, since nobody could tell whether a consistent field theory could ever explain on one hand gravitation, on the other hand the elementary components of matter. In this state of affairs it was necessary to think of material particles as mass points subject to Newton's laws of motion. This was the procedure of Lorentz in creating his electron theory and the theory of the electromagnetic phenomena of moving bodies.

Such was the point at which fundamental conceptions had arrived at the turn of the century. Immense progress was made in the theoretical penetration and understanding of whole groups of new phenomena; but the establishment of a unified foundation for physics seemed remote indeed; and this state of things has even been aggravated by subsequent developments.

The development during the present century is characterized by two theoretical systems essentially independent of each other: the theory of relativity and the quantum theory. The two systems do not directly contradict each other; but they seem little adapted to fusion into one unified theory.

The theory of relativity arose out of efforts to improve, with reference to logical economy, the foundation of physics as it existed at the turn of the century. The so-called special or restricted relativity theory is based on the fact that Maxwell's equations (and thus the law of propagation of light in empty space) are converted into equations of the same form, when they undergo Lorentz transformation. This formal property of the Maxwell equations is supplemented by our fairly secure empirical knowledge that the laws of physics are the same with respect to all inertial systems. This leads to the result that the Lorentz transformation—applied to space and time co-ordinates—must govern the transition from one inertial system to any other. The content of the restricted relativity theory can accordingly be summarized in one sentence: all natural laws must be so conditioned that they are co-variant with respect to Lorentz transformations. From this it follows that the simultaneity of two distant events is not an invariant concept and that the dimensions of rigid bodies and the speed of clocks depend upon their state of motion.

A further consequence was a modification of Newton's law of motion in cases where the speed of a given body was not small compared with the speed of light. There followed also the principle of the equivalence of mass and energy, with the laws of conservation of mass and energy becoming one and the same. Once it was shown that simultaneity was relative and depended on the frame of reference, every possibility of retaining actions-at-a-distance within the foundation of physics disappeared, since that concept presupposed the absolute character of simultaneity (it must be possible to state the location of the two interacting mass points "at the same time").

The general theory of relativity owes its origin to the attempt to explain a fact known since Galileo's and Newton's time but hitherto eluding all theoretical interpretation: the inertia and the weight of a body, in themselves two entirely distinct things, are measured by one and the same constant, the mass. From this correspondence follows that it is impossible to discover by experiment whether a given system of co-ordinates is accelerated, or whether its motion is straight and uniform, and the observed effects are due to a gravitational field (this is the equivalence principle of the general relativity theory). It shatters the concepts of the inertial system, as soon as gravitation enters in. It may be remarked here that the inertial system is a weak point of the Galilean-Newtonian mechanics. For there is presupposed a mysterious property of physical space, conditioning the kind of co-ordination systems for which the law of inertia and the Newtonian law of motion hold good.

These difficulties can be avoided by the following postulate: natural laws are to be formulated in such a way that their form is identical for co-ordinate systems of any kind of states of motion. To accomplish this is the task of the general theory of relativity. On the other hand, we deduce from the restricted theory the existence of a Riemannian metric within the time-space continuum, which, according to the equivalence principle, describes both the gravitational field and the metric properties of space. Assuming that the field equations of gravitation are of the second differential order, the field law is clearly determined.

Aside from this result, the theory frees field physics from the disability it suffered from, in common with the Newtonian mechanics, of ascribing to space those independent physical properties which heretofore had been concealed by the use of an inertial system. But it cannot be claimed that those parts of the general relativity theory which can to-day be regarded as final have furnished physics with a complete and satisfactory foundation. In the first place, the total field appears in it to be composed of two logically unconnected parts, the gravitational and the electromagnetic. In the second place, this theory, like the earlier field theories, has not yet supplied an explanation of the atomistic structure of matter. This failure has probably some connexion with the fact that so far it has contributed nothing to the understanding of quantum phenomena.

In 1900, in the course of a purely theoretical investigation, Max Planck made a remarkable discovery : the law of radiation of bodies as a function of temperature could not be derived solely from the laws of Maxwellian electrodynamics. To arrive at results consistent with the relevant experiments, radiation of a given frequency had to be treated as though it consisted of energy atoms of the individual energy $h\nu$, where h is Planck's universal constant. During the years following it was shown that light was everywhere produced and absorbed in such energy quanta. In particular, Niels Bohr was able largely to understand the structure of the atom, on the assumption that atoms can have only discrete energy values, and that the discontinuous transitions between them are connected with the emission or absorption of such an energy quantum. This threw some light on the fact that in their gaseous state elements and their compounds radiate and absorb only light of certain sharply defined frequencies. All this was quite inexplicable within the frame of the theories hitherto existing. It was clear that, at least in the field of atomistic phenomena, the character of everything that happens is determined by discrete states and by apparently discontinuous transitions between them, Planck's constant h having a decisive role.

The next step was taken by de Broglie. He asked himself how the discrete states could be understood by the aid of the current concepts, and hit on a parallel with stationary waves, as for example in the case of the fundamental frequencies of organ pipes and strings in acoustics. True, wave actions of the kind here required were unknown ; but they could be constructed, and their mathematical laws formulated, employing Planck's constant h. De Broglie conceived an electron revolving about the atomic nucleus as being connected with such a hypothetical wave train, and made intelligible to some extent the discrete character of Bohr's 'permitted' paths by the stationary character of the corresponding waves.

Now in mechanics the motion of material points is determined by the forces or fields of force acting upon them. Hence it was to be expected that those fields of force would also influence de Broglie's wave fields in an analogous way. Erwin Schrödinger showed how this influence was to be taken into account, re-interpreting by an ingenious method certain formulations of classical mechanics. He even succeeded in expanding the wave mechanical theory to a point where, without the introduction of any additional hypotheses, it became applicable to any mechanical system consisting of an arbitrary number of mass points, that is to say, possessing an arbitrary number of degrees of freedom. This was possible because a mechanical system consisting of n mass points is mathematically equivalent, to a considerable degree, to one single mass point moving in a space of $3n$ dimensions.

On the basis of this theory there was obtained a surprisingly good representation of an immense variety of facts which otherwise appeared entirely incomprehensible. But on one point, curiously enough, there was failure : it proved impossible to associate with these Schrödinger waves definite motions of the mass points—and that, after all, had been the original purpose of the whole construction.

The difficulty appeared insurmountable, until it was overcome by Born in a way as simple as it was unexpected. The de Broglie – Schrödinger wave fields were not to be interpreted as a mathematical description of how an event actually takes place in time and space, though, of course, they have reference to such an event. Rather they are a mathematical description of what we can actually know about the system. They serve only to make statistical statements and predictions of the results of all measurements which we can carry out upon the system.

Let me illustrate these general features of quantum mechanics by means of a simple example : we shall consider a mass point kept inside a restricted region G by forces of finite strength. If the kinetic energy of the mass point is below a certain limit, then the mass point, according to classical mechanics, can never leave the region G. But according to quantum mechanics, the mass point, after a period not immediately predictable, is able to leave the region G, in an unpredictable direction, and escape into surrounding space. This case, according to Gamow, is a simplified model of radioactive disintegration.

The quantum theoretical treatment of this case is as follows : at the time t_0 we have a Schrödinger wave system entirely inside G. But from the time

t_0 onwards, the waves leave the interior of G in all directions, in such a way that the amplitude of the outgoing wave is small compared to the initial amplitude of the wave system inside G. The farther these outside waves spread, the more the amplitude of the waves inside G diminishes, and correspondingly the intensity of the later waves issuing from G. Only after infinite time has passed is the wave supply inside G exhausted, while the outside wave has spread over an ever-increasing space.

But what has this wave process to do with the first object of our interest, the particle originally enclosed in G? To answer this question, we must imagine some arrangement which will permit us to carry out measurements on the particle. For example, let us imagine somewhere in the surrounding space a screen so made that the particle sticks to it on coming into contact with it. Then from the intensity of the waves hitting the screen at some point, we draw conclusions as to the probability of the particle hitting the screen there at that time. As soon as the particle has hit any particular point of the screen, the whole wave field loses all its physical meaning; its only purpose was to make probability predictions as to the place and time of the particle hitting the screen (or, for example, its momentum at the time when it hits the screen).

All other cases are analogous. The aim of the theory is to determine the probability of the results of measurement upon a system at a given time. On the other hand, it makes no attempt to give a mathematical representation of what is actually present or goes on in space and time. On this point the quantum theory of to-day differs fundamentally from all previous theories of physics, mechanistic as well as field theories. Instead of a model description of actual space-time events, it gives the probability distributions for possible measurements as functions of time.

The new theoretical conception owes its origin not to any flight of fancy but to the compelling force of the facts of experience. All attempts to represent the particle and wave features displayed in the phenomena of light and matter, by direct recourse to a space-time model, have so far ended in failure; and Heisenberg has convincingly shown, from an empirical point of view, that any decision as to a rigorously deterministic structure of Nature is definitely ruled out, because of the atomistic structure of our experimental apparatus. Thus it is probably out of the question that any future knowledge can compel physics again to relinquish our present statistical theoretical foundation in favour of a deterministic one which would deal directly with physical reality. Logically, the problem seems to offer two possibilities, between which we are in principle given a choice. In the end, the choice will be made according to which kind of description yields the formulation of the simplest foundation, logically speaking. At the present, we are quite without any deterministic theory directly describing the events themselves and in consonance with the facts.

For the time being, we have to admit that we do not possess any general theoretical basis for physics which can be regarded as its logical foundation. The field theory, so far, has failed in the molecular sphere. It is agreed on all sides that the only principle which could serve as the basis of quantum theory would be one that constituted a translation of the field theory into the scheme of quantum statistics. Whether this will actually come about in a satisfactory manner, nobody can venture to say.

Some physicists, among them myself, cannot believe that we must abandon, actually and for ever, the idea of direct representation of physical reality in space and time; or that we must accept the view that events in Nature are analogous to a game of chance. It is open to every man to choose the direction of his striving; and also every man may draw comfort from Lessing's fine saying, that the search for truth is more precious than its possession.

OBITUARIES

Prof. Hugo Merton

THE Nazi régime has claimed as victim another scientific worker in the person of Prof. Hugo Merton, zoologist and traveller. In 1935 he was compelled to withdraw from his posts of deputy director of the Senckenberg Naturalist Society's Museum, assistant in the Zoological Institute of the University of Heidelberg and professor without chair of zoology, and in 1937, at the invitation of Prof. F. A. E. Crew, he went to the University of Edinburgh to work at the Institute of Animal Genetics. In the autumn of 1938 he set out for Heidelberg, but on reaching Germany was arrested and sent to the concentration camp at Dachau, and when he was released and returned to Edinburgh in the following year his health was broken. He died on March 23, 1940, sixty years of age.

Merton was educated at the Universities of Bonn, Berlin and Heidelberg, and specialized in the biological sciences. His many researches fall into groups, to each of which he made contributions of value: the histology of the sense-organs, nervous system and musculature of various molluscs; the anatomy and histology of the aberrant Temnocephala linking Turbellaria and Trematoda; studies on spermatozoa and experiments on ciliary movement and Protozoa, including his work on the geotaxis of Paramecium. In Edinburgh he concentrated upon physiological problems relating to sex.

But the most striking of all Merton's achievements was his expedition to the south-east Moluccas, undertaken on behalf of the Senckenbergischen Naturforschenden Gesellschaft. From October 1907 until August 1908 he explored the Aru and Kei Islands, bringing home vast zoological collections, the description of which by experts occupies two large volumes published at Frankfurt-am-Main in 1911 and 1913. The catholicity of his own interests is shown by his 200-page introductory account of the geography and ethnology of the islands.

Dr. Merton is survived by his widow, to whom the late Prof. Max Weber paid the compliment of dedicating one of his new species of fish from the Moluccas, on the ground that throughout she took an active part in the labours of her husband.

JAMES RITCHIE.

Prof. Pierre Marie

PROF. PIERRE MARIE, the celebrated French neurologist, whose death took place recently, was born on September 9, 1853, in Paris, where he received his medical education and qualified in 1883 with a thesis on the incomplete forms of Graves' disease, which afterwards became a classic. After serving as Charcot's chief assistant at La Salpêtrière he was elected physician in 1885 to the Bicêtre Infirmary, where he set up a rich collection of interesting records of cases, specimens and photographs of various diseases of the nervous system and attracted a large number of practitioners and students, many of whom have become distinguished neurologists. In 1907 he was elected professor of morbid anatomy in the Paris faculty of medicine in succession to Victor Cornil.

Prof. Marie made numerous valuable contributions to neurology. In addition to adding to our knowledge of well-recognized diseases such as rabies, disseminated sclerosis and epilepsy, he was the first to describe acromegaly (1886). In 1892 he brought out a book on diseases of the spinal cord which, like his articles on acromegaly, was published in English by the New Sydenham Society. In 1906 he caused a considerable sensation in the medical world by the publication of three articles on aphasia in the *Semaine Médicale*, in which he declared that the third left frontal convolution of the brain played no special part in the function of language, as had been maintained by Broca. During the War of 1914–18 he did valuable work in conjunction with his *interne*, Mme. Athanasio Benisty, on the symptoms and treatment of injuries of the nerves, which were published by her in the French "Horizon" series and in English form in the "Medical Military Manuals". In 1926 and 1928 he did good service to neurologists and others by publishing in two volumes, entitled "Travaux et Mémoires", the most important of his articles which had appeared in various periodicals and society reports.

J. D. ROLLESTON.

Prof. W. Blackadder

PROF. W. BLACKADDER, who died on May 14, graduated B.Sc. in engineering in the University of Edinburgh in 1897 and was awarded the Vans Dunlop Scholarship. After graduating he gained a wide experience in general engineering practice with the Caledonian Railway, Aberdeen Harbour Commissioners and the Clyde Navigation Trust. In 1907 he was appointed lecturer in civil engineering and applied mechanics in the Royal Technical College, Glasgow, under the late Prof. Longbottom, who at one time acted as assistant to the late Karl Pearson.

Prof. Blackadder was specially interested in structural theory and hydraulics and succeeded in developing this interest in students and staff alike. His teaching bore the hallmark of the master and was always abreast of modern developments. In 1924 he was appointed as first occupant of the Jackson chair of engineering in the University of Aberdeen and succeeded in building up a most efficient department. He was deeply interested in the welfare of his students and aimed at giving a sound theoretical training in engineering science in which the teaching of practical engineering formed little part except to illustrate to some small extent the application of that science in practice.

As a result of researches into the losses in turbine pumps and flow of water in looped pipes he was awarded the D.Sc. by his Alma Mater in 1923, while in 1932 he was awarded the Telford Premium by the Institution of Civil Engineers for his paper on "Direct Methods for Construction of Influence Lines for Continuous Girders".

WE regret to announce the following deaths:

Sir James Baillie, O.B.E., formerly vice-chancellor of the University of Leeds, on June 9, aged sixty-seven.

Sir Thomas Hudson Beare, regius professor of engineering in the University of Edinburgh, on June 10, aged eighty.

Mr. Oliver Gatty, research chemist, aged thirty-two, and Mr. A. S. Chessum, research engineer, aged twenty-seven, during an experiment in connexion with air raid precautions, on June 5.

Prof. A. E. H. Love, F.R.S., Sedleian professor of natural philosophy in the University of Oxford, on June 5.

Sir Jocelyn Thorpe, C.B.E., F.R.S., emeritus professor of organic chemistry in the University of London and in the Imperial College of Science and Technology, on June 10, aged sixty-seven.

NEWS AND VIEWS

Prof. T. Slater Price, O.B.E., F.R.S.

THE retirement has been announced at the end of the present academic year of Prof. T. Slater Price from the chair of chemistry at the Heriot-Watt Technical College, Edinburgh. Dr. Slater Price's early work was concerned with the oxidation of iodide by persulphates, with electro-analysis, and with the electrolytic method for the preparation of organic disulphides and diselinides. His interest in the oxyacids of sulphur continued, and he later provided some of the first evidence for the structure of Caro's acid. In 1903 he was appointed head of the Chemistry Department of the Birmingham Municipal Technical College, a position which he held with great success until 1920. There was, however, one interruption to this work at Birmingham ; this was caused by his appointment, as Lieut.-Commander, R.N.V.R., to the Naval Experimental Station during 1916–19, where he carried out many valuable investigations on smoke screens, etc., for which he was afterwards given the O.B.E.(Mil.). Returning from this excursion, Dr. Slater Price met the chaos produced by a great influx of demobilized service men to technical classes. His Chemistry Department included pharmacy, so that the number of students to be accommodated was very large. However, order was soon established and the teaching work went on smoothly, though its demands prevented any rapid extension of the researches on complex cobaltammines upon which Slater Price had been engaged for several years.

Nor did Dr. Slater Price take up this work again, for in 1920 he was appointed director of the British Photographic Research Association, where he remained until 1930. The mechanism of light action on photographic materials was very little understood and formed a constant subject of research in his laboratory throughout this period, and by the end of 1930 work on the photoconductivity of silver halides had laid the foundations for much of the modern advance in the theory of the photographic image. The chemistry of the photographic emulsion also was studied, and much work was done on the influence of the chemical environment of the growing crystals of silver halide in a medium of gelatin and water. In spite, however, of the interest of industrial chemistry, the appeal of academic work was very strong, and in 1931 Dr. Slater Price returned to it once more in the post which he has held from that time, giving his energy in great part to the reorganization of his department, one section of which now includes equipment for micro-analysis. He has encouraged research by the members of his staff, one of whom is now studying the properties of chromium-ammines. Dr. Slater Price has also given much service on the councils of various scientific bodies, notably the Institute of Chemistry, the Chemical Society, and the Royal Photographic Society.

James Nevins Hyde (1840–1910)

DR. JAMES NEVINS HYDE, one of the most distinguished American dermatologists, was born at Norwich, Connecticut, on June 21, 1840, the son of a merchant. He received his medical education at the College of Physicians and Surgeons, New York, and qualified in 1869 at the University of Pennsylvania in Philadelphia. From that date until his death he practised in Chicago, where he was the principal pioneer in dermatology. His first appointment was that of lecturer in dermatology at the Rush Medical College from 1873 until 1876, when he was made professor of dermatology in the Northwestern University. Three years later he became professor of dermatology, genito-urinary and venereal diseases at Rush Medical College, and from 1902 until 1910 he held the chair of dermatology at the University of Chicago. He was also attending dermatologist to several hospitals in Chicago. His literary output was considerable. In addition to his principal work, "A Practical Treatise on Diseases of the Skin", which first appeared in 1883 and ran through eight editions, he contributed more than a hundred articles to dermatological literature. Hyde enjoyed an international reputation as shown by his membership of the dermatological societies of France, Italy, Berlin and Vienna. He was twice president of the American Dermatological Association and was secretary for America at the Fifth International Dermatological Association held in Berlin in 1904. He died suddenly at the age of seventy on September 6, 1910.

Dr. Waldemar Kernig

DR. WALDEMAR KERNIG, an eminent Russian physician, who died in 1917, was born on June 16, 1840, at Dorpat, where he received his medical education. He qualified in 1864 with a thesis on the regulation of the temperature in man and immediately afterwards became physician to the Obuchow Hospital at St. Petersburg. Subsequent posts held by him were those of physician to a deaf and dumb school from 1873 until 1890 and lecturer in internal medicine in the medical courses for women in the Empress Marie's institutions. He contributed several articles to periodical medical literature on splenic abscesses, subfebrile conditions of considerable duration, subcutaneous injection of Fowler's solution, etc., but he is best known by his name having been attached to a sign indicating meningitis which he described in two articles (*Berlin klin. Woch.*, **21**, 829 ; 1884 ; and *Z. klin. Med.*, **64**, 19 ; 19C7).

M. V. Lomonosov

A LECTURE on Lomonosov (1711–1765), the first Russian man of science, will be given by Prof. J. D. Bernal at the Ambassadors' Hotel, W.C.1, at 7.30 p.m. on June 28. This fisherman's son from Archangel, his

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curiosity aroused by the icebergs and aurora borealis of his native province, ran away to school in Moscow at the age of nineteen. He entered the German-staffed Academy of Sciences set up by Peter the Great, being the first Russian to do so, and the first to lecture in his native tongue instead of in Latin.

He propounded theories on the structure of matter, the kinetic theory of gases, and the mechanical theory of heat, a hundred years in advance of their general introduction ; he built a 'thunder-machine' to study electricity ; he wrote about the physical condition of the sun, the atmosphere of Venus, metallurgy, and gravity ; he was the first to point out the possibility of the passage now established as the Great Northern Sea Route ; he published the first Russian grammar and founded the University of Moscow. Because he was only one outstanding figure in an age of absolutism, much of his work perished with him, and his importance as a pioneer has only recently been recognized. Further information concerning the lecture can be obtained from the Secretary, S.C.R., 98 Gower Street, London, W.C.1.

The British Pharmaceutical Conference

THE seventy-sixth annual meeting of the British Pharmaceutical Conference was the briefest in its annals. It was held at the headquarters of the Pharmaceutical Society on the afternoon of June 11, and the proceedings were limited to the address of the chairman, Mr. H. Humphreys Jones. The theme of the address was the role of pharmacists in relation to the food problem. He said that physiology is an integral part of the curriculum of study of the pharmaceutical student. Items in the syllabus are the physiology of the alimentary tract, comprising a knowledge of the control of salivary, gastric, pancreatic and biliary secretion. The chemistry of certain specified food sustances and the properties of the digestive juices and bile are also subjects of the curriculum. The main reason for their inclusion is, he said, the acceptance of the fact that pharmacists must keep pace with medical progress, and a further reason is the necessity for the pharmacist to be alive to the general awakening regarding food values. He must know not only the pharmacopœia —in which standards are laid down for certain organo-therapeutical substances, such as insulin, pituitary and thyroid as well as sera and vaccines— but also the chemistry of meat, eggs and bread and the properties of the digestive juices.

Mr. Humphreys Jones argued that, while in the past the aim of pharmacy has been to provide drugs to cure diseases rather than to prevent them, a wider vista has been opened up which invites the application of the knowledge of food values with a view to the prevention of disease and the maintenance of a general high standard of health at all periods of life. It has long been recognized that rickets, scurvy and many other diseases are due to the absence of certain food constituents ; this emphasizes the desirability of the close study by students of this part of the curriculum. In this connexion he said, "The [Pharmaceutical] Society has already done good work in connexion with vitamins. But why regard vitamins as the only important ingredients in real food ?" Hitherto, he said, the pharmacist has depended almost exclusively upon his own initiative and ingenuity ; as a servant of the State, his main privilege is that he can sell and dispense scheduled poisons and dispense medicines under the National Health Insurance Act. In Mr. Jones's view, there ought to be an avenue through which the pharmacist's knowledge of nutrition would be similarly recognized ; if a person is compelled by the State to pass an examination in a subject of first-class importance, he should be provided with the opportunity of utilizing that knowledge in the public service. In short, the public should be taught to regard the pharmacist as a dietitian.

The Institution of Professional Civil Servants

THE twenty-first annual report of the Council of the Institution of Professional Civil Servants, presented to the annual general meeting on April 25, indicates that in spite of the pre-occupation of Government departments, and especially the defence departments, with more pressing issues than service conditions, the Council has been available to secure a considerable number of increases in salary and other improvements in the conditions of employment. The report gives a review of activities which shows that the Council has fully maintained its vigilance over the interests of members in the difficult conditions of war-time, despite the removal to temporary offices and the heavier responsibilities falling on the honorary officers since the usual method of control by Council and its committees came in abeyance, and that claims or representations have been preferred with a sense of proportion and balance highly creditable to the Institution.

Special attention is given in the report of the Institution to numerous problems arising out of the evacuation of civil servants, of whom to date about 20,000 have been transferred to provincial towns. Concessions have been secured in regard to visits to families, billeting payments, daily travelling expenses and the like, and the formation of committees of the staffs of evacuated departments in the reception towns is being attempted. Numerous details are included in the report of representations on matters affecting the staffs of Government scientific establishments.

Scientific Films in War-Time

THE London Scientific Film Society gave four shows last winter of scientific and documentary films and received encouraging support. A new form of programme was generally appreciated. Several films with a common subject or theme were shown together ; programmes on contrasting or complementary treatments of psychology, civics in Great Britain, and agriculture being presented. All films shown by the Society are approved by the Scientific Films Committee of the Association of Scientific Workers, 30 Bedford Row, London, W.C.1. This body was set up in 1937 to further the interests of the scientific documentary film, to encourage the making and to sponsor the exhibition of such films. The films are broadly of three kinds: interpretative films, which bring out the relations of science to society and which try to smooth out the difficulties arising from developments and changes in science and social life; educational films, aiming simply to instruct; and research films, serving as a scientific instrument in the hands of the research worker. The Scientific Films Committee grades films into classes in this way, and also appraises their scientific value. The Committee's lists can be obtained on application; universities, schools and scientific societies can use them to help in making up programmes of scientific films. The work of appraising films will go on through the summer. In addition, the Committee's advice is available to producers, and recommendations for new films are to be made; certain subjects, such as chemistry, are very inadequately covered. The Committee wants the opinions of teachers and heads of scientific departments on what is needed, and the special requirements of war-time will be borne in mind.

Radiotherapeutic Panel of Physicists

SINCE the gift of a large sum of money to the King Edward's Hospital Fund by Sir Otto Beit in 1928 for the purchase of radium for use in the treatment of cancer, the Fund has taken an ever-increasing practical interest in the work associated with this and other gifts especially reserved for radium. When the National Radium Commission came into being in 1929, working arrangements were soon made between it and the Fund whereby the latter body became responsible for seeing that the radium needs of the London area were satisfied. In the developments of the last few years, the Fund has been assisted by an expert Radium Committee, which is now presided over by Sir Cuthbert Wallace. Recently this Committee has been considering in what way radiological treatment could be improved, and the Fund has approved the formation of a panel of consultant physicists. The chief reason that has led to this step is the realization that radiotherapy should be, can be, and is at some centres carried out on a quantitative basis, and that for this purpose the services of a physicist are necessary. The panel is designed to serve the needs of the many hospitals in which radium and X-ray treatment is carried out, but at which the employment of a physicist is precluded by expense. The groups of physicists constituting this panel are as follow: Dr. H. T. Flint and colleagues, Physics Department, Westminster Hospital, S.W.1; Mr. L. G. Grimmett and colleagues, Physics Department, Radium Beam Therapy Research, Radium Institute, Ridinghouse Street, W.1; Prof. F. L. Hopwood and colleagues, Physics Department, St. Bartholomew's Hospital, E.C.1; Dr. W. V. Mayneord and colleagues, Physics Department, Royal Cancer Hospital, Fulham Road, S.W.3; Prof. S. Russ and colleagues, Physics Department, Middlesex Hospital, W.1.

African Studies in War-time Paris

WHILE the intellectual and scientific activities of Paris, like those of London, suffered dislocation at the outbreak of war, efforts have been and continue to be made to resume them in as full a measure as is compatible with the demands of war on the resources of the city. In a review of what has been accomplished so far, with special reference to the facilities for African studies, Prof. Henri Labouret (*Africa*, **13**, 2; 1940) refers to the action of the Government in sanctioning the reopening of the École Nationale de la France d'Outremer (École Coloniale). As an adjunct, the public as well as the students have been readmitted to the facilities for reading and study in the libraries and exhibition galleries of the Musée de l'Homme (Trocadéro) and the Institut d'Ethnologie. The Institut Français d'Anthropologie, the Société des Africanistes and the Société d'Anthropologie have resumed work and are to continue their meetings.

In view of the need for the extension of the co-operation of French and British authorities in Africa to the field of scientific research—a need which should be self-evident—it is interesting to note that M. Labouret is able to record that the Institut Français d'Afrique Noir, although it has lost a number of its most prominent supporters, has survived the crisis. This body was founded in 1938 only, but is already recognized as an important centre of African research. It will continue to publish its substantial *Notes Africaines*, and has taken over the responsibility of issuing the *Bulletin du Comité d'Études Historiques et Scientifiques de l'Afrique Occidentale Française*, founded by Prof. M. Delafosse in 1915. It will appear, however, in a new and enlarged form.

Daytime Lighting of Blacked-out Factories

THE Industrial Health Research Board is at present investigating the effects of complete obscuration of daylight on health and output, and also the problem of securing the best artificial lighting during the hours of daylight. R. Maxted and J. Bertram, who have been associated with this work, have written an interesting account in the *Electrical Times* of June 6 of experiments in factory lighting, reproducing by artificial means the most desirable features of natural lighting. Normal modern practice, based on pre-War experience, dwells on the importance of adequate illumination levels and of limitation of glare. But war-time conditions have greatly accentuated defects which were tolerable under peace conditions of working. In addition, the blacking-out of windows and skylights has usually resulted in conditions such that the psychological effect is of a magnitude creating an entirely new factor. It is unavoidable that operatives are required to work longer hours. It is obviously vital to ensure that any sense of strain is not associated in their minds with factory conditions, which should clearly be designed to conserve both mental and physical reserves. No other factor is more potent psychologically than the lighting installation. Diagrams are given showing the objectionable tunnel effect produced when the natural skylights are blacked out. The absence of distracting dazzle and the avoidance of glare raise and maintain the output of the factories.

War-Time Museum Exhibitions

The *Museums Journal* of May shows in what way many museums in Great Britain are endeavouring to stimulate interest by supplying information bearing upon warfare or upon the needs which it has created. In the former group is the special war-time exhibition at the National Maritime Museum, described by Sir Geoffrey Callender. Two contrasting sets of medals are shown, one German and one wrongly described as "English", for the only representative mentioned is "the General Service Medal conferred on *British* officers and men" during the Napoleonic wars. Lightship and lifeboat models, models showing the story of the development of the torpedo-boat, and of the evolution of anchors from their simple beginnings as heavy stones, are arranged with larger exhibits such as that illustrating the evolution of naval ordnance, to make a varied show which as a whole illustrates "the age-long character of our sea-experience and the continuity of our maritime prestige". The second type of exhibit has been created in several museums "to show how the various kinds of foods, essential to man's existence, may be provided by vegetables and grown on a small allotment or in a garden". Several illustrations indicate how, by models of garden plots and cropping plans, this good work may be pursued.

Investigation of Atmospheric Pollution

Representatives of local authorities and other bodies co-operating in the investigation of atmospheric pollution met in London on May 28. The Conference, in considering its annual report to the co-operating bodies, unanimously agreed that while contribution to the war effort is the first duty and desire of every organization, the need for vigilant attention to the purity of the atmosphere has by no means decreased since the outbreak of the War. The wasteful burning of fuel, and the detriment which pollution causes to the nation's health were stressed. The Conference therefore urged all local authorities to do whatever lies in their power to maintain the investigation. At the close of the meeting, Prof. W. H. Roberts, associate professor of public health chemistry in the University of Liverpool, was unanimously elected chairman of the Conference.

Electricity Applied to Metallurgy

In the Menelaus Memorial Lecture delivered to the South Wales Institute of Engineers on March 19, Dr. A. P. M. Fleming chose as his subject "Electricity as applied to Metallurgy". A most important application arises in connexion with methods of testing. Dr. Fleming points out that electricity has proved an invaluable aid to the metallurgist when making fine measurements and researches, as well as for checking the quality of his materials. Using standardized specimens the composition and heat treatment of which are known, comparisons may be made of unknown specimens by magnetic testing. By suitable exploration of the magnetic behaviour of the specimen in an alternating magnetic field, it is possible to relate the phase and quadrature components of the voltage induced in a search coil, and by comparing these with the standardized specimen, definite inferences can be drawn as to the composition of the material without the necessity of destroying the specimen under test.

Magnetic methods have also been developed for fault detection, and have been of increasing importance due to the tendency to cut down material costs and weight, while still maintaining the safety factor, by more rigid inspection and care in production. The presence of a fault or change in magnetic composition can be detected by the distortion these cause in the magnetic field, the distortion being located either by a direction indicator like a magnetic needle or a moving search coil. Another and most valuable method is that developed largely by the Metropolitan-Vickers Electrical Co., Ltd., in which the specimen is magnetized and then subjected to examination under a coating of liquid containing very finely divided magnetic particles. When examining material in the shape of a bar for longitudinal cracks, a heavy current is passed down the bar while it is immersed in a bath of finely divided magnetic particles, suspended in a light oil. These particles form sharply defined lines which indicate the flaws. This method is of growing importance, and is probably the most effective means at present available of checking this form of weakness in metals.

Incorporated Municipal Electrical Association

The activities of the Incorporated Municipal Electrical Association (I.M.E.A.) are described in the *Electrical Review* of May 10. The Association is taking steps to ensure that stocks of coal held by public utility undertakings in Great Britain shall be built up during the coming months to ensure that by September 30 the undertakings will have not less than ten winter weeks supply on hand. The Council has agreed that a scheme of insurance in respect to war damage to electricity undertakings should be prepared and has referred the matter to the Joint Committee of Electricity Supply Associations. The members of the Association have been recommended by the National Whitley Council to grant a temporary increase of salary to administrative, technical and clerical staffs. The Joint Committee of Electricity Supply Associations has approached the Minister of Home Security with a view to the relaxation of the restrictions upon the use of neon and other outdoor signs during hours of daylight.

The Finance Officer of the London and Home Counties J.E.A. (Mr. A. L. Burnell) recently prepared a memorandum on the transfer of hire-purchase agreements from one authority to another upon the removal of a consumer when he is unable immediately to complete payment. Difficulties are raised by the varying practice among undertakings in such matters as maximum periods, interest-rates, local limitations as to the type of apparatus and absence of hire purchase facilities in some areas, but all of these can be surmounted. Mr. Burnell suggests that all undertakings should be prepared to take over agreements on the original terms.

Cancer Research and Treatment in Australasia

THE Tenth Australian – New Zealand Cancer Conference, held at Wellington in February of last year, was concerned with cancer control, reports on particular forms of treatment (Koch and Baker) and radiological physics. The part being played by the physicist in the use of X-rays and radium is a rapidly growing one ; this arises from the growth of quantitative methods in giving doses of radiation to patients. These methods not only allow the specification of the dose actually given, but also they aim at arranging for the optimum distribution of the radiation throughout the tissues. The report from the Commonwealth X-ray and Radium Laboratory shows a wide range of activity at this centre, with a most progressive outlook as to the function of the physicist in collaboration. It is good to learn that the Commonwealth Department of Health has made the services of the physicists-in-charge available to radiotherapeutic institutions for consultation on the various physical problems of X-ray and radium therapy, and advantage is being taken of such facilities, doubtless to the benefit of patients.

American Zeal for Education

SCHOOL and college summaries seem perpetual in the United States. "A Review of Educational Legislation : 1937 and 1938", by Mr. Ward Keesecker (Washington, D.C., 10 cents), has involved, we are told, a study of 1,500 enactments. The main tendencies exhibited are increased support from the State with more control and the establishment of minimum State-aid foundations. Pennsylvania in 1937 paid special attention to local schools, county boards of directors, the merging of schools poorly attended, and transportation routes. In Georgia all teachers now have to be classified according to their training and experience. In Nevada, amendment of the liquor-licence law increased the amount set aside for education. Tennessee added 4½ million dollars to school funds. Two States, Arkansas and Vermont, made teaching on the effects of alcohol compulsory from grades 3 to 8. Montana required all public schools to give instruction in music, art, and elementary agriculture. Several States increased the minimum salaries of teachers and their benefits on retirement, and Kentucky forbade city schools to discriminate against married women as teachers. It is clear that throughout the country great pains have been taken to see that education is better managed and financed.

Smithsonian Institution : Annual Report

THE report of the secretary of the Smithsonian Institution for the year ended June 30, 1939, which has been published, refers to the completion by the Astrophysical Observatory of the enormous task of recomputing the daily solar constant values from all its observing stations since 1923, apart from the final corrections and general discussion, which were expected to be concluded by October 1939. The Division of Radiation and Organisms gave much attention during the year to photosynthesis, factors influencing plant growth and the stimulative action of ultra-violet radiation. Experimental evidence was obtained indicating the formation during photosynthesis of a material which combines with or absorbs carbon dioxide and resembles chlorophyll in character. A quantitative method for the isolation of hormones from plants is being developed, and the effect of radiation on the growth of excised roots and leaves has been investigated.

Numerous scientific field investigations in anthropology have been conducted by the National Museum as well as archæological and ethnological expeditions by the Bureau of American Ethnology, including investigations of Folsom man at the Lindenmeier site in northern Colorado, studies in the northern province of the Navaho Indians, as well as in western South America. In addition to the report of the Executive Committee of the Board of Regents, appendixes include detailed reports of the work of the various divisions, including the National Gallery of Art, the Freer Gallery of Art, the National Collection of Fine Arts and the National Zoological Park, the last-named giving a detailed list of animals in the collection that had not previously been exhibited.

Awards of the Finney-Howell Research Foundation

THE Finney-Howell Research Foundation, Inc., of Baltimore, Maryland, announces that fellowships for research into the cause or causes and the treatment of cancer were renewed for the following : P. C. Aebersold, working at the Radiation Laboratory of the University of California at Berkeley ; G. M. Badger, working at the Royal Cancer Hospital (Free) at London, England ; Ll. W. Law, working at the Roscoe B. Jackson Memorial Laboratory at Bar Harbor, Maine ; J. L. Melnick, working at Yale University School of Medicine at New Haven, Conn. ; J. F. Menke, working at Stanford University Hospital, at San Francisco, California ; J. L. Wood, working in the Division of Chemistry, Harvard University, at Cambridge, Mass. ; P. C. Zamecnik, working at Copenhagen. New fellowships have been awarded as follows : J. C. Abels, to work at the Memorial Hospital for Cancer at New York City ; M. A. Graubard, to work at Clark University, Worcester, Mass. ; J. W. Howard, to work at Thorndike Memorial Laboratory, Boston City Hospital, Boston, Mass. ; B. E. Kline, to work at the Department of Physiology, University of Wisconsin, Madison ; Margaret N. Lewis, to work at Crocker Radiation Laboratory, University of California, Berkeley ; A. Marshak, to work at the Radiation Laboratory, University of California, Berkeley ; Dr. G. C. Gey was also awarded a grant of 2,000 dollars to carry on his work on cancer at the Johns Hopkins Medical School. The closing date for applications for awards during 1941 is January 1, 1941.

Bicentenary of the University of Pennsylvania

THE University of Pennsylvania, Philadelphia, celebrates this year the bicentenary of its foundation. During July and August, the laboratories, museums and libraries of the University, the Morris Arboretum and other places of interest will be open to visitors, and the principal celebrations will take place during the week September 15–21. The week will open with addresses by well-known authorities, which are intended not only to serve as tributes to the University of Pennsylvania but also to focus attention upon the contributions which higher education has made and can still make to the betterment of mankind. Among delegates announced from Great Britain are Sir Henry Dale, Sir Thomas Lewis, Sir William Beveridge, Prof. A. J. B. Wace, Sir Robert Robinson and Dr. C. S. Myers. Some forty symposia and conferences have been arranged to follow the general sessions. In connexion with the celebrations, a Bicentennial Fund has been inaugurated, and by the early part of April, more than four million dollars had already been subscribed, of which a half had been contributed by alumni of the University.

Announcements

SIR ARNOLD WILSON, K.C.I.E., C.S.I., C.M.G., M.P., distinguished for his administrative work in India and Persia, chairman of the Industrial Health Research Board during 1926–33, has been reported by the War Office as missing.

SIR FRANK E. SMITH, F.R.S., director of instrument production in the Ministry of Supply has, in addition, been appointed controller of telecommunications equipment with full authority, by the Minister of Aircraft Production.

MR. J. DAVIDSON PRATT has been appointed an additional deputy director-general for chemical research, experiment and development in the Ministry of Supply. Mr. Davidson Pratt has been since 1928 general manager of the Association of British Chemical Manufacturers, who have now agreed to second him for his present appointment.

THE joint committee of the Royal Society of Edinburgh, the Royal Physical Society and the Royal Scottish Geographical Society has awarded the Dr. W. S. Bruce Memorial Prize (1940) to Mr. Brian Roberts, Emmanuel College, Cambridge, for his valuable work in survey, ornithology and general biology in the north and south polar regions.

THE following appointments and promotions in the Colonial Service have recently been made: R. W. Rayner, plant pathologist, Kenya; C. B. Garnett, agricultural officer, Tanganyika Territory, to be marketing officer, Nyasaland; N. Humphrey, agricultural officer, to be senior agricultural officer, Kenya; E. B. Martyn, botanist and plant pathologist, British Guiana, to be plant pathologist, Jamaica; A. J. Wakefield, director of agriculture, Tanganyika Territory, to be inspector general of agriculture in the West Indies; R. H. Tyrwhitt-Drake, director of surveys, Zanzibar, to be director of surveys, Kenya; G. B. Simmins, senior veterinary research officer, to be chief veterinary officer, Palestine.

MR. NORMAN NEVILLS will head an expedition of nine on a trip down the Green and Colorado Rivers, leaving Green River, Wyoming, on June 20, and arriving at Boulder Dam about August 25. The group will travel in three specially designed boats and make botanical and geological observations and collections in the little-known Canyon country. Dr. Hugh C. Cutler, of Washington University, is in charge of botanical research, and Mr. Nevills of the geological work.

THE Goethe Medal for Art and Science has been awarded to Heinrich Ewald Hering, formerly professor of physiology in the University of Cologne.

BY a recent decree the State has authorized the creation in French universities of faculties of pharmacy and the consequent granting of doctorates in pharmacy. By this action universities will rank pharmacy with the other four faculties—arts, law, sciences and medicine. Prior to this decree aspirants to high qualifications in pharmacy were awarded either a "doctorat d'Université, Mention pharmacie" or a "diplôme supérieur de pharmacie".

THE Council of the Royal Aeronautical Society has accepted an offer from Mrs. G. Alston to found a prize in memory of her husband Peter Alston who was killed in a flying accident on February 16, 1939. The prize, an annual one of approximately £5 in value, will be awarded for work aiming at the improvement of the safety of aircraft and particularly at improvement in stability and control, and such award is open to a student and/or graduate of the Society.

THE New York Academy of Sciences announces three prizes offered by Mr. A. Cressy Morrison, to be known as the A. Cressy Morrison Prizes I, II and III, all of which will be awarded in December 1940. Prize I, of five hundred dollars, will be awarded for the best paper on solar and stellar energy. Prizes II and III will be awarded for the best papers on a scientific subject included within the field of the New York Academy of Sciences and its affiliated societies. The competition for Prize I is open to all. Prizes II and III are limited to members of the New York Academy of Sciences and affiliated societies, but non-members may become eligible by joining one of these organizations before the closing date. Further information can be obtained from the Secretary, New York Academy of Sciences, Central Park West at 79th Street, New York City.

WHEN dealing with Dr. Haddon's second expedition to the Torres Straits (NATURE, June 1, p. 849) reference was made to Haddon's visit to New Guinea "with Ray and Seligman"; Prof. Seligman informs us that this should read "with Ray, Wilkin and Seligman".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They 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.*

IN THE PRESENT CIRCUMSTANCES, PROOFS OF "LETTERS" WILL NOT BE SUBMITTED TO CORRESPONDENTS OUTSIDE GREAT BRITAIN.

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 940.

The Electronic Charge

THE determination of e by a new oil drop method in which the electric field is horizontal[1] has been completed. The expression for e in terms of the quantities measured is similar to that which applies to H. A. Wilson's method and is

$$ne_1 = 9\sqrt{2}\ \eta^{3/2}\ (\rho-\sigma)^{-1/2}\ g^{-1/2}\ v_g{}^{1/2}\ v_x\ X^{-1}. \quad (1)$$

The correction for the departure from Stokes's law is obtained from Millikan's relation

$$e_1{}^{2/3} = e^{2/3} + m/pa, \quad (2)$$

where $e_1{}^{2/3}$ is calculated from (1) and p cm. of mercury is the pressure and a is radius of the drop (cm.). The oil drops used are larger than those used by previous experimenters, and their velocity of fall being large, their motion was recorded photographically using exposures of 0·0005 sec. at intervals of 1/25 sec. The velocity of free fall, v_g cm./sec. and the velocity in the direction of the electric field v_x cm./sec., could be estimated with satisfactory accuracy. The electric field was obtained by means of a stabilized rectifier designed by Mr. T. P. Gill[2] and was measured by potentiometer methods in terms of Weston cells calibrated by the National Physical Laboratory.

Assuming $\eta_{23} = 1{,}830 \times 10^{-7}$ C.G.S. units, the value of e obtained is $(4{\cdot}8020 \pm 0\ 0013) \times 10^{-10}$ E.S.U. The probable error calculated by the theory of least squares is about one third of that obtained by Millikan, whose result becomes $e = (4{\cdot}7992 \pm 0{\cdot}0037) \times 10^{-10}$ E.S.U. when the above value of η_{23} is assumed. Millikan's 0·03784 and our value 0 03777 of m are in agreement within the smaller probable error. There are two other determinations of e by the drop method, namely, by Bäcklin and Flemberg[3], and by Ishida, Fukushina and Suetsuga[4]. Their results yield $4{\cdot}781 \times 10^{-10}$ and $4{\cdot}835 \times 10^{-10}$ E.S.U. for e respectively, when η_{23} is taken as $1{,}830 \times 10^{-7}$ C.G.S. units.

Careful determinations of e using the X-ray method have recently been made by several workers, and our reduction of their observations is given in Table 1

TABLE 1. X-RAY VALUE OF e.

Observer	$e \times 10^{10}$ E.S.U.
Soderman	4·8054
Bäcklin	4·8044
Bearden 1935	4·8029
1931	4·8049
Mean	4·8044 ± 0·0007

These results differ slightly from those given by the observers themselves, as we have used what we believe to be the most accurate values of antecedent data in the reduction of the results of the above observers.

It will be seen that the mean of the X-ray, $(4{\cdot}8044 \pm 0{\cdot}0007) \times 10^{-10}$ E.S.U., and of the oil drop determinations of Millikan and the authors, $(4{\cdot}8007 \pm 0{\cdot}002) \times 10^{-10}$ E.S.U., differ by $0{\cdot}0037 \times 10^{-10}$. The main uncertainty in the value of e as found by the oil drop method is in the value which is used for the viscosity of air. In the paper to be published describing the present determination, the errors in the measurement of η_{23} by the rotating cylinder and the capillary tube method are discussed. The most precise results obtained by these methods are given in Table 2, and using the weights given, the mean is $\eta_{23} = (1{,}830{\cdot}06 \pm 2{\cdot}5) \times 10^{-7}$ C.G.S. units. In this table the values of the viscosity have been recalculated using Sutherland's expression,

$$\eta_\theta = \eta_{273}\{(273+c)/(\theta+c)\}\ .\ (\theta/273)^{3/2},$$

where $c = 117$, for the change in viscosity with temperature. This gives the change in viscosity per degree at 23° C. as $4{\cdot}83 \times 10^{-7}$ C.G.S. units and not $4{\cdot}93 \times 10^{-7}$ units as is generally assumed.

TABLE 2. VISCOSITY OF AIR.

Method	$\eta_{23} \times 10^7$	Weight
Rotating cylinder:		
Bearden	1833·8	4
Houston	1829·2	3
Kellström	1832·6	2
Harrington	1822·6	1
Gilchrist	1825·7	1
Capillary Tube:		
Rigden	1830·0	2
Bond	1834·6	1
Rapp	1822·7	1
Maxwell	1827·3	1

Weighted mean = $(1830{\cdot}06 \pm 2{\cdot}5) \times 10^{-7}$ C.G.S. units.

It will be noticed that the probable error of η_{23} calculated by external consistence contributes an error in e of 1 in 500 compared with an error of 1 in 3,000 in the remaining factors which enter into expression (1), an error larger than the difference between the oil drop and X-ray values of e. Thus the uncertainty in η_{23}, although a number of precision determinations of it has been made, contributes the major uncertainty to the oil drop determination.

We are attempting to determine the viscosity of air with, it is hoped, improved precision, using a method suggested by Fabry and Perot[5] in which there is a laminar flow of the air between optically flat disks.

It may be noted that using $e = 4{\cdot}802 \times 10^{-10}$, $h/e = 1{\cdot}3765 \times 10^{-17}$ (a mean of h/e determined by the X-ray method and by Wien's law) and

$c = 2 \cdot 99774 \times 10^{10}$, then $1/\alpha = hc/2\pi e^2 = 136 \cdot 76$. If Rydberg's constant (109,737·43) and e/m ($1 \cdot 7589 \times 10^7$) are substituted in the formula $1/\alpha = (c/4\pi R(e/m)e)^{1/3}$, it then becomes 137·03, which is nearly integral.

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V. D. HOPPER.
Natural Philosophy Laboratory,
University of Melbourne.
April 29.

[1] Laby, T. H., and Hopper, V. D., NATURE, **143**, 157 (1939).
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Mass Centre in Relativity

UNDER this title, in NATURE of April 13, p. 587, Prof. M. Born and K. Fuchs gave some relations between the total and a relative momentum vector of a system of two free particles. They only define the magnitude, not the direction of their relative momentum vector. I believe things become clearer by the following statement. Let V^a, W^a ($a = 0, 1, 2, 3$) be (1 + 3)-dimensional velocity time-space vectors of the particles ($V^2 = W^2 = c^2$), and m_1, m_2 their scalar masses. Their individual energy-momentum vectors being $i_a = m_1 V_a$ and $j_a = m_2 W_a$, we may define the total energy-momentum vector by

$$I_a = i_a + j_a, \qquad (1, 1)$$

the relative energy-momentum vector by

$$S_a = (m_2 i_a - m_1 j_a)/(m_1 + m_2). \qquad (1, 2)$$

These definitions entail two identities

$$(m_1 + m_2)\,c^2 = \frac{I^2}{m_1 + m_2} + \frac{m_1 + m_2}{m_1 m_2} s^2, \qquad (2, 1)$$

$$0 = \frac{2m_1 m_2}{m_1 + m_2}(I.s) - (m_1 - m_2)s^2, \qquad (2, 2)$$

which are equivalent to equations (4), (5), (6) of Born and Fuchs.

The total energy-momentum has a time vector character, whereas the relative energy-momentum has a space vector character. The two individual rest masses, being constants of the motion, must be functions of the eight dynamical variables I_a and s_a:

$$c^2 (m_1 + m_2)^2 = I^2 + 2s^2 + 2\sqrt{s^4 + (I.s)^2}, \qquad (3, 1)$$

$$c^2 (m_1 - m_2)^2 = I^2 - 2\frac{s^2 I^2 - (I.s)^2}{s^2 + \sqrt{s^4 + (I.s)^2}} \qquad (3, 2)$$

As regards the centre of mass, which has completely been lost sight of in the communication referred to, I suggest that the proper thing to consider is a centre of inertia rather than a mass centre. The former must be defined with the aid of the bi-vectors of energy and momentum, i_a—or rather inertia and momentum, i^a—and radius vector, g^a. The components of this bi-vector are given by the determinants of the matrix

$$\begin{vmatrix} i^{(0)} & i^{(1)} & i^{(2)} & i^{(3)} \\ g^{(0)} & g^{(1)} & g^{(2)} & g^{(3)} \end{vmatrix}, \text{ say } A^{ab} = \begin{vmatrix} i^a & i^b \\ g^a & g^b \end{vmatrix}. \qquad (4, 1)$$

Take the sum of the bi-vectors of two particles, or of any number of particles, and we shall have the bi-vector

$$M^{ab} = \Sigma_{(n)} A_n^{ab}, \qquad (4, 2)$$

with six components, of total moment of momentum. Three of these components (for $a = 0$) define the moment of inertia relative to the origin.

The *inertia centre* must be defined as the *locus of origins* in time-space such as to make the moment of inertia vanish. To make the definition invariant, we require the moment of inertia to vanish in a Lorentz frame where the total energy-momentum vector is directed purely parallel to the time axis, so that *there is no resultant momentum*. Thus

$$M^{0b} = 0, \quad (b = 1, 2, 3) \qquad (4, 3)$$

In all other frames, that is, for a system of free particles showing resultant momentum, *we shall then find* a moment of inertia or, say, *a polarization of inertia*.

For any number of particles, first define $I^a = \Sigma_{(n)} i_n^a$. The determinants

$$P^{abc} = \Sigma_{(n)} \begin{vmatrix} g_n^a & g_n^b & g_n^c \\ i_n^a & i_n^b & i_n^c \\ I^a & I^b & I^c \end{vmatrix}, \qquad (5)$$

will represent the components of the tri-vector of *internal moment of momentum, multiplied by the magnitude of I*.

The dynamical variables here given were first published in 1927[1], and an illustration of the polarization of inertia is offered in the example of a rolling hoop[2] and a rotating ring[3].

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Teyler's Stichting,
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April 23.

[1] *Physica, Ned. T. Natuurk.*, **7**, 330 (1927). Fokker, "Relativiteitstheorie" (Groningen: Noordhoff, 1929).
[2] *Physica, Ned. T. Natuurk.*, **1**, 35 (1921).
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WE regret having overlooked Prof. Fokker's publications on the subject of the mass centre in relativity. His definition of the centre of inertia does not coincide exactly with our definition of the mass centre. Which definition is to be preferred depends, of course, on the use which can be made of it.

Our purpose was to separate from the Hamiltonian of a system of two particles that term which corresponds to the motion of the system as a whole, and to do it in such a way that the new variables form canonically conjugate pairs. We have shown how this can be done for two free particles by introducing the total momentum **P** and the internal momentum π; the canonically conjugate variables are **R** and ρ, as mentioned in our previous letter, though we did not give explicit expressions. Here **R** is to be interpreted as representing the position of the mass centre.

We have compared the two definitions and found that the mass centre coincides with the centre of inertia in the Lorentz system in which the total momentum vanishes. The two centres are therefore to some extent equivalent.

Although we readily agree that Prof. Fokker's definition is formally much more elegant, we cannot see that it is helpful for the quantum mechanical problem which we had in mind.

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Properties of Cytochrome *c*

A STRONG solution of pure cytochrome *c* obtained by the method which we have previously described[1] shows in the oxidized state an absorption spectrum of the parahæmatin type. In a very much higher concentration and in a thick layer this compound reveals the two additional feeble absorption bands at about 695 mμ and 625 mμ discovered by Yakushiji[2]. The absorption spectrum of oxidized cytochrome *c* changes with the hydrogen ion concentration[2,3]. In this respect, cytochrome *c* resembles other trivalent hæmatin compounds such as methæmoglobin, parahæmatin and hæmatin. It is known, for example, that a parahæmatin compound has a characteristic absorption spectrum only within a certain limited range of hydrogen ion concentration[4]. On acidifying it or on making it alkaline the absorption spectrum of parahæmatin changes respectively to those of free acid and free alkaline hæmatins.

Although in acid solution cytochrome *c* shows an absorption spectrum similar to that of a free acid hæmatin with a characteristic band at 625 mμ, in a strongly alkaline solution, instead of showing the spectrum of a free alkaline hæmatin, it shows the spectrum of a parahæmatin.

On reducing cytochrome *c*, in either strongly acid or strongly alkaline solution, a compound is invariably obtained with the typical absorption spectrum of reduced cytochrome *c*. The absorption spectrum corresponding to that of a free hæm of cytochrome *c* has not so far been observed.

Interesting changes in the absorption spectrum of cytochrome *c* can be observed by treating it with sodium dodecyl sulphate (S.D.S.), a powerful surface active substance previously used in connexion with the study of other proteins[5]. On mixing 1 c.c. of a strong solution of *c* with 0·1 c.c. of 5 per cent neutralized solution of S.D.S., the absorption spectrum of parahæmatin is rapidly replaced by that of acid hæmatin. However, sodium hyposulphite reduces this compound, not to the ordinary reduced cytochrome *c*, but to a derivative showing two feeble and more diffuse bands at 563 mμ and 530 mμ, of which the first is stronger than the second. This derivative is autoxidizable, and forms with carbon monoxide a stable compound with absorption bands at 562 mμ and 532 mμ, the second band being now as strong as the first.

The effect of S.D.S. on cytochrome *c* is reversible, as after removing this reagent by dialysis cytochrome *c* reverts to its original state. On the contrary, S.D.S. added to a colloidal heart muscle preparation containing the complete cytochrome system clarifies this preparation and irreversibly destroys all the components of the system except *c*.

The absorption spectrum of the divalent derivative of *c* obtained in this way resembles that of a free hæm. On the other hand, the fact that it cannot be separated from its protein by either fractional precipitations, adsorptions or ultrafiltration shows that the hæm nucleus is still bound to the protein.

This derivative can therefore be considered as a hæm-protein compound, in which the protein has probably lost its connexion with the iron although it remains still linked with the porphyrin.

A similar compound can be obtained from methæmoglobin not treated with S.D.S. but acidified until the bands of acid hæmatin appear. On reduction with sodium hyposulphite this derivative, instead of forming hæmoglobin or hæmochromogen, gives a compound with the absorption spectrum of a hæm. On the other hand, when methæmoglobin is treated with S.D.S. it turns at once into a parahæmatin, which on reduction gives an ordinary globin hæmochromogen.

These observations strongly support the view that the protein and the prosthetic group in cytochrome *c* as well as in other natural hæmatin-protein compounds are bound by means of several links of very unequal stability and which are affected reversibly or irreversibly by different factors modifying simultaneously the general properties of these compounds.

The nature of these links in cytochrome *c* is, however, far from being understood, and this is not surprising considering how very little is known of the nature of links uniting hæm with globin in the hæmoglobin molecule.

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May 13.

[1] Keilin, D., and Hartree, E. F., *Proc. Roy. Soc.*, B, **122**, 298 (1937).
[2] Yakushiji, E., *Acta Phytochimica*, **10**, 127 (1937).
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A Crystalline Albumin Component of Skeletal Muscle

THE intracellular protein components of skeletal muscle are known generally as myosin, globulin *X*, myogen and myoalbumin. Myosin, the globulin which is probably directly related to the contractile process, is the major component, according to analyses carried out on rabbit and fish muscle. The remaining components have not been well characterized as individual proteins. For this reason it seemed desirable to attempt the crystallization of muscle albumin (myogen), adopting the technique employed by McMeekin[1] for the separation of the serum proteins.

A CRYSTALLINE ALBUMIN FROM RABBIT MUSCLE. (*c*. × 260.)

The crystalline albumin eventually obtained from rabbit muscle was crystallized from ammonium sulphate solutions of molarity 2·7–3·1 (65–75 per cent saturated) adjusted to *p*H 5·8 with sulphuric acid. Crystals identical in form have been obtained both from the potassium chloride extract employed by Edsall[2] for the preparation of myosin and also from muscle press juice. They consist of thin colourless plates, birefringent in polarized light, and exhibiting a pronounced sheen on agitation. The protein readily denatures on heating to 50°, by shaking, or by reducing the acidity to *p*H 5. Its iso-electric point is near *p*H 6.

Sedimentation and diffusion experiments on the crystal sample shown in the accompanying figure have been carried out through the kindness of Dr. E. J. Cohn, of the Harvard Medical School. They indicate a molecular weight of 155,000, a value which is provisional until other samples have been analysed.

During the course of this investigation, carried out in the summer of last year at the Woods Hole Marine Biological Station, Mass., Baranowski[3] reported from the laboratory of Parnas the crystallization of two albumins, myogens *A* and *B*. These he obtained from that fraction of press juice precipitating between 40 and 60 per cent saturation with ammonium sulphate. Myogen *A*, crystallizing in the form of hexagonal bipyramids, was studied in some detail, and Gralén[4], from sedimentation and diffusion experiments, assessed its molecular weight at 150,000. Myogen *B*, on the other hand, was sometimes fortuitously obtained from the mother liquors, and no method could be given for its preparation. Although our albumin separates at somewhat higher ammonium sulphate concentrations than those employed by Baranowski, it seems probable from his description that myogen *B* and our protein may be identical. To none of these albumins has any physiological activity as yet been assigned.

Further studies on the albumin will shortly be resumed.

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April 22.

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Thyroid Gland and Potassium Metabolism

IN experimental thyrotoxicosis as well as in Graves' disease, there is a marked disturbance of the carbohydrate metabolism. The sugar tolerance is often lowered and glycosuria may develop. Griffiths[1] reports that in cases of Graves' disease a high-grade insulin insensitivity may be found, and that such insensitivity is diminished by thyroidectomy. It is also well known that after administration of thyroid gland or thyroxine the liver glycogen disappears and cannot be restored by administration of sugar[2].

In recent years a close correlation has been found between potassium metabolism and carbohydrate metabolism[3]. It was now established that in experimental thyrotoxicosis the carbohydrate metabolism and the potassium metabolism are both affected. This is especially true with regard to the potassium and carbohydrate content of the liver. The liver of normal white rats contains about 1·7 per cent potassium. Administration of thyroid hormone causes a rise in liver potassium to 3–5 per cent and more, varying with the degree of thyrotoxicosis.

As with adrenalectomized animals, the hyperthyroidized animals are very sensitive to a high potassium intake. A food rich in potassium produces in hyperthyroidized animals a rapid fall of the body weight, loss of appetite, accompanied by a high degree of excitability and finally death.

It seems that, besides the adrenal cortex, the thyroid gland is also involved in the regulation of the potassium metabolism.

I. ABELIN.

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University of Berne.
May 4.

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Effect of Radiations on Bacteriophage C_{16}

IT has been shown previously[1] that the effect of X-rays on phages is in relation to particle size, as determined by ultra-filtration and ultra-centrifugation analysis: the larger the particle size, the greater is the sensitiveness of the phage to radiation.

We have undertaken a quantitative analysis of this phenomenon, and are dealing here with the effect of different radiations on phage C_{16} (F. M. Burnet)[2], which is active on dysentery bacillus Y_{6R}. Its diameter, as determined by Elford and Andrewes, is 50–75 mμ.

The following radiations have been used: (1) monochromatic X-rays of 17 kv. (K_α line of molybdenum); (2) non-monochromatic hard X-rays (D.C., 200 kv.); (3) total radiation of radon + active deposit, dissolved in the phage suspension. The effects on the phage were followed by the plaque count method, which

D (r units)	N/N_0	$\sigma = \frac{-\log_e N/N_0}{D}$	$N/N_0 = e^{-\bar{\sigma}D}$ (calc.)
X-rays 17kv.			
$5{\cdot}0 \times 10^3$	0·83	$3{\cdot}72 \times 10^{-5}$	0·89
10^4	0·80	$2{\cdot}23 \times 10^{-5}$	0·80
$3{\cdot}0 \times 10^4$ (2 exp.)	0·56	$1{\cdot}92 \times 10^{-5}$	0·52
$4{\cdot}0 \times 10^4$	0·40	$2{\cdot}29 \times 10^{-5}$	0·41
$6{\cdot}0 \times 10^4$	0·35	$1{\cdot}75 \times 10^{-5}$	0·26
$7{\cdot}5 \times 10^4$	0·24	$1{\cdot}90 \times 10^{-5}$	0·19
$9{\cdot}0 \times 10^4$	0·16	$2{\cdot}03 \times 10^{-5}$	0·14
		$\bar{\sigma} = 2{\cdot}22 \times 10^{-5}$	
X-rays 200 kv.			
10^4	0·79	$2{\cdot}35 \times 10^{-5}$	0·775
$2{\cdot}0 \times 10^4$	0·64	$2{\cdot}23 \times 10^{-5}$	0·60
$4{\cdot}0 \times 10^4$	0·42	$2{\cdot}71 \times 10^{-5}$	0·36
$6{\cdot}0 \times 10^4$	0·21	$2{\cdot}58 \times 10^{-5}$	0·22
$7{\cdot}5 \times 10^4$	0·15	$2{\cdot}53 \times 10^{-5}$	0·15
$9{\cdot}0 \times 10^4$	0·075	$2{\cdot}85 \times 10^{-5}$	0·10
		$\bar{\sigma} = 2{\cdot}54 \times 10^{-5}$	
Radon (α-particles + β-rays)			
$5{\cdot}2 \times 10^4$ (2 exp.)	0·86	$2{\cdot}88 \times 10^{-6}$	0·79
$7{\cdot}3 \times 10^4$ (2 ,,)	0·70	$4{\cdot}88 \times 10^{-6}$	0·71
$11{\cdot}1 \times 10^4$ (1 ,,)	0·51	$6{\cdot}05 \times 10^{-6}$	0·59
$12{\cdot}2 \times 10^4$ (2 ,,)	0·58	$4{\cdot}37 \times 10^{-6}$	0·56
$17{\cdot}7 \times 10^4$ (2 ,,)	0·45	$4{\cdot}51 \times 10^{-6}$	0·44
$23{\cdot}3 \times 10^4$ (3 ,,)	0·28	$5{\cdot}45 \times 10^{-6}$	0·33
$37{\cdot}6 \times 10^4$ (2 ,,)	0·14	$5{\cdot}20 \times 10^{-6}$	0·17
$52{\cdot}5 \times 10^4$ (3 ,,)	0·09	$4{\cdot}60 \times 10^{-6}$	0·08
		$\bar{\sigma} = 4{\cdot}69 \times 10^{-6}$	

practically corresponds to counting the number of active particles present in the samples[3].

The results, shown in the accompanying table, may be summarized as follows:

(1) For all the radiations used, the proportion N/N_0 of active particles diminishes exponentially as dose D increases:

$$(1) \qquad N/N_0 = e^{-\sigma D}.$$

It will be seen from the table that the values N/N_0 experimentally found are in very good agreement with those calculated on the assumption of an exponential law.

(2) The effect of radiations on phage is a function of the dose $D = I.t$, and does not depend on its components I (intensity) and t (time of exposure).

(3) The doses of X-rays being expressed in r units ($lr = 2 \times 10^9$ ions/cm.^{3} in air), equal doses of different wave-length rays produce the same effect.

(4) With α-particles a dose[4] seven times larger than with X-rays must be used in order to produce the same effect.

These results can be explained in terms of the 'target hypothesis'[5], in the following way.

A phage particle is inactivated by a single 'hit', as shown by the exponential inactivation rate. The independence of the wave-length in the case of X-rays shows that this hit is an elementary ionization process (single ionization, or (Jordan[6]) small groups of 2·2 ions in the average).

The relationship (1) allows us to calculate the value of σ. If we express the doses in ions (or in ion groups) per volume unit, σ has the dimensions of a volume ('action volume'): all the ionizations produced in this theoretical volume—and those only—are effective. In the case of X-rays the action volume has a radius of 14 mμ (doses expressed in ions) or 18 mμ (doses in ion groups). With α-particles the radius is reduced to 7·5 mμ (doses in ions).

In comparing the dimensions of the phage particles, as determined by ultra-filtration and ultra-centrifugation, with the calculated action volume, it should be borne in mind that the latter are by themselves but expressions of probability: we may imagine, for example, an action volume σ',n times larger, in which an ionization process is followed by inactivation with a probability $p = 1/n$; ($\sigma = p\sigma'$).

However, the fact that the calculated action volume is smaller in the case of radiations which produce a very dense ionization (α-particles), shows that the action volume corresponds to a really existing 'sensitive volume'[6]. When the distance between two ionizations is smaller than the dimensions of this sensitive volume, a part of the ionization process is ineffective for the biological action: correspondingly more energy must be absorbed, in order to produce the same effect. The sensitive volume will have, as lower limit, the dimensions of the action volume calculated for hard X-rays, and will be equal to it, if $p = 1$.

On the other hand, in the case of the very densely ionizing α-particles, it seems reasonable to think that the collision of such a particle with the sensitive volume is surely an effective 'hit'. Then, if we express doses in α-trajectories per surface unit, the value of σ from relationship (1) gives us the cross-section for this collision. The cross-section would have a radius of about 50 mμ. Deducting from that the radius of the ionization column produced by the α-particle (about 20 mμ; Jordan[7]), we find for the sensitive volume a radius of 30 mμ, in rather good agreement with the radius of the phage particles as given by ultra-filtration.

On the whole, our results tend to prove that phage inactivation is an elementary quantic process. They are in agreement with the view that phages, as well as certain viruses, are monomolecular structures: the inactivation should be conceived as a quantic transition of such a molecule. In this respect, our results are closely similar to those obtained by Timofeeff-Ressovsky[8] on gene radio-mutations in Drosophila.

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Paris.

F. HOLWECK.
S. LURIA.

Institut du Radium,
Laboratoire Curie,
Paris.
May 4.

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[6] *Arch. ges. Virusfors.*, **1**, 1 (1939).
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Nitrogen Fixation in the Rice-Field Soils of Bengal

IT has been proved by several workers by means of pure culture experiments that fixation of atmospheric nitrogen may take place by the activity of some algæ, specially members of the group Myxophyceæ. On the mucous sheath of most of these algæ bacteria are generally present quite abundantly. Many of these are found to be Azotobacter, Clostridium and other nitrogen-fixing bacteria which are ordinarily distributed in the soil. Pure culture technique has been employed by recent workers to find out whether the bacteria and the various algæ by themselves independently or jointly (symbiotically) carry on nitrogen-fixation work.

Kossowitsch[1], using pure cultures, came to the conclusion that nitrogen-fixation could not be carried out by the algæ by themselves, but only when contaminated by bacteria, and suggested a symbiotic relation. Similar conclusions were arrived at by Bouilhae[2], Bouilhae and Giustiniani[3] and Schramm[4]. On the other hand, Molisch[5] isolated a pure Nostoc which could grow in a nitrogen-free solution. Allison and Hoover[6], Allison, Hoover and Morris[7] and Copeland[8] have ascribed power of nitrogen fixation to Nostoc, and to other Myxophyceæ. In India, the presence of algal scum in water-logged paddy fields has been found by Sen and others[9], working with alluvial soil of Faridpur, Bengal, to be associated with increase in nitrogen content. All workers agree that the agency responsible for fixation of nitrogen in these soils is of a biological nature. Recently Fritsch and De[10] and De[11], using bacteria-free unialgal cultures of certain Myxophyceæ isolated from soil samples taken from Faridpur rice fields, came to the conclusion that a considerable quantity of atmospheric nitrogen was fixed by some of these Myxophyceæ and even when these were mixed with Azotobacter, the amount of nitrogen fixed did not increase ; hence they concluded that the bacteria play a relatively unimportant part in nitrogen-fixation in the rice-fields.

Working with soil samples from the same paddy fields of Faridpur, sent to me by Sir Bryce Burt, I came to somewhat different conclusions[12]. I found that quite a considerable amount of nitrogen was fixed by the Azotobacter isolated from the mucous sheath of the algæ growing on these soils and that the amount of nitrogen fixed did not increase when the contaminated algæ were put in the culture flasks. From observations in the paddy fields, I conclude that the algæ play a relatively unimportant part in a direct manner in fixing atmospheric nitrogen in the rice fields, but indirectly this action is of the highest importance.

When the algæ die, they provide an enormous mass of growth medium on which these bacteria thrive so well. The limited number of bacteria present in the mucous coat of these Myxophyceæ now start rapidly multiplying. The conditions for growth are very favourable at this time and a large quantity of nitrogen is now fixed by these well-known nitrogen-fixers, leading to the increase of nitrates in these soils. When under favourable conditions the algæ were multiplying, much of the nitrate formed was utilized by the algæ themselves. It is only after the death of the algæ (and it may be mentioned that they die *en masse* when the water begins to dry up and the fields are not flooded any more after the crop has been harvested) that this rapid multiplication of bacteria takes place leading to the enormous increase of soil nitrates. Thus the action of these algæ in the matter of nitrogen-fixation in the rice-fields of Bengal is, I believe, indirect, the bacteria being primarily responsible for the fixation of the atmospheric nitrogen.

H. CHAUDHURI.

Botany Department,
University of the Panjab,
Lahore. April 22.

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[2] Bouilhac, R., *C.R. Acad. Sci.*, **123**, 828 (1896)
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Salt Accumulation and Plant Respiration

THE recent discussions in NATURE between Lundegårdh[1,2] and Hoagland and Steward[3,4] have shown that Lundegårdh's conclusions, based on his own experimental results, are not acceptable to Hoagland and Steward, who have used other types of plant material and a different technique. While it would be surprising if the results obtained with one type of plant material could be replicated exactly for other types, Lundegårdh's suggested mechanism may be applicable to other tissues ; Hoagland and Steward do not succeed in disproving Lundegårdh's interpretation of his data. In view of the fact that Hoagland and Steward found it necessary to suspend

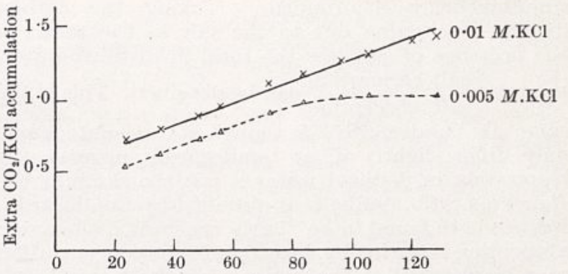

Fig. 1.

judgement on the reality of the anion respiration coefficients on which Lundegårdh's conception largely depends, the following data are of interest.

Recent work in this laboratory on cut carrot tissue under controlled conditions gives qualitative support to Lundegårdh's conclusion that there is a definite relationship between the amount of salt accumulated and the extra carbon dioxide evolved. The relationship, in carrot tissue, differs quantitatively from that obtained by Lundegårdh with other plant material. According to Lundegårdh's interpretation

$$R_T = R_G + kA,$$

where R_T is the total respiration, R_G is that respiration which occurs independently of the mechanism of ion absorption and kA is the anion respiration which is a multiple, k, of the anion absorption A. In the work done in this laboratory with carrot tissue, the net amounts of different metallic chlorides accumulated and the total carbon dioxide evolved were

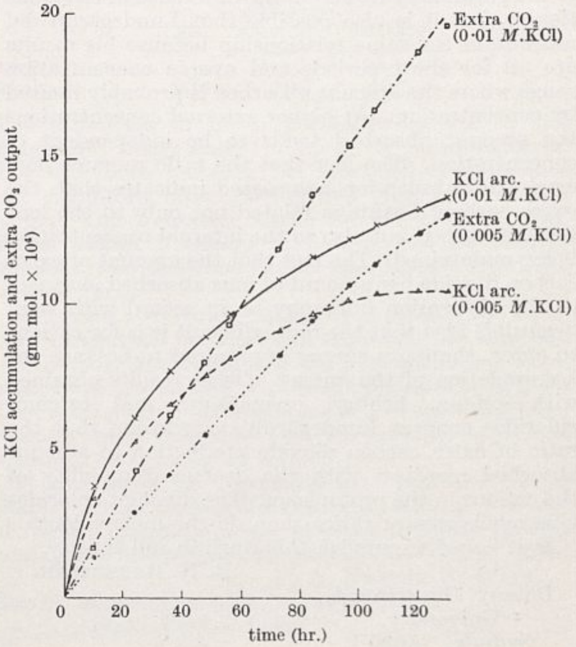

Fig. 2.

THE KCl ACCUMULATION AND EXTRA CARBON DIOXIDE OUTPUT FOR TWO COMPARABLE SETS OF TISSUE, UNDER CONTROL CONDITIONS, ONE IN 0·01 *M*.KCl AND THE OTHER IN 0·005 *M*.KCl. ACCUMULATION FROM THE MORE DILUTE SOLUTION CEASED WHEN ALL THE KCl WAS ABSORBED AFTER ABOUT 120 HOURS.

simultaneously determined. Taking the carbon dioxide production due to the salt as the total in the presence of salt less the total in distilled water, the ratio $\frac{\text{salt respiration}}{\text{salt absorption}}$ can be obtained. This is the same as Lundegårdh's k though its absolute value may differ slightly if, as Lundegårdh suggests, the respiration in distilled water is not the same as the R_G. This ratio, unlike that obtained by Lundegårdh, has not been found to be "fairly constant if the anion absorption is varied by variation in the concentration of a single salt". The ratio varies both with concentration absorbed and with time.

It is seen (Fig. 1) that the ratio increases from 0·75 in the early stages to 1·5 in the later stages and remains constant only when, as in the case with the 0·005 *M*. solution, all the salt has been absorbed from the external solution. The reason for the increase in the value of the ratio is to be found in the decreased rate of accumulation of the salt with time. The rapid initial accumulation, followed by a lower rate of accumulation which changes only slightly over a long period, has been established as characteristic of carrot tissue (Briggs and Robertson)[5] and is similar to that obtained with high salt barley roots (Hoagland and Broyer)[6]. The respiration, having reached its maximum within two hours of the addition of the electrolyte, decreases negligibly during the rest of the experiment (Fig. 2). In the case of the lower concentration of salt, the carbon dioxide production remains high in spite of the fact that all the salt has been absorbed. From these results it is clear that the salt respiration cannot be expressed as a linear function of A; it could be expressed as a function of A and t.

The difference between this result and that of Lundegårdh may be due to the difference in the plant tissues, but it is also possible that Lundegårdh did not obtain the same relationship because his results are all for short periods and over a concentration range where the amount absorbed is probably limited by concentration. At higher external concentrations the amount absorbed tends to be independent of concentration. The fact that the ratio remains high even after absorption has ceased indicates that the extra carbon dioxide is related not only to the ions being absorbed but also to the internal concentration being maintained. The fact that the amount of extra carbon dioxide per amount of ions absorbed increases as the absorption falls may be in accord with Lundegårdh's idea that the more difficult it is for cations to enter, the more energy is required to balance the accumulation of the anions. Other results obtained with sodium, lithium, magnesium and calcium chlorides confirm Lundegårdh's conclusion that the ratio of extra carbon dioxide production to amount absorbed increases with the decreased mobility of the cations in the protoplasm. The divalent chlorides give much greater ratios than do the monovalent.

It is hoped to publish this work in full shortly.

R. N. ROBERTSON.

Botany Department,
University,
Sydney. April 1.

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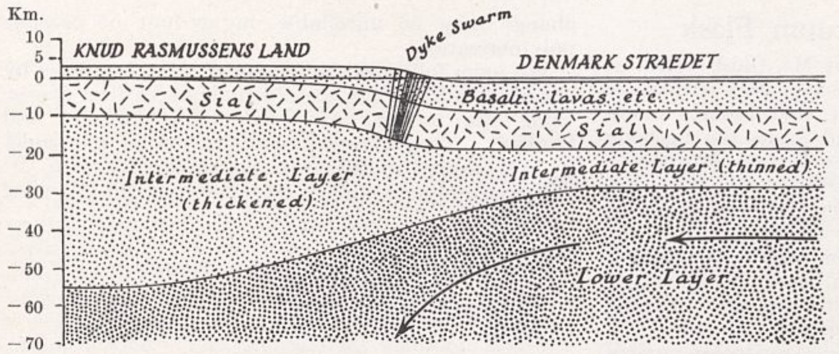
Epeirogenic Earth Movements in East Greenland and the Depths of the Earth

SATISFACTORY geological evidence that the earth's crust has undergone powerful vertical movements unaccompanied by horizontal compression has seldom been obtained, and Daly[1] has recently given it as his opinion that such movements have not been sufficiently well proved to be taken into consideration in attempts to understand the nature of the earth's interior. During recent expeditions to East Greenland geological mapping has shown that the coastal mountains from lat. 66–70° N. were produced by a powerful, and geologically rapid, vertical uplift. Between the Denmark Strait and the adjacent mountain belt of East Greenland the relative vertical movement of the crust amounted locally to at least 3½ km. and was but little less over the whole stretch of 800 km. Such a displacement must be regarded as a major tectonic feature of the earth's crust and merits brief description as the full account, prepared for a Danish journal, cannot be published at present.

In late Cretaceous times much of this part of East Greenland was at about sea-level and some marine Senonian sediments were laid down. These were succeeded by the extrusion of basalts which, in places, accumulated to a thickness of at least 7 km. During middle Eocene times powerful uplift took place which gave rise to what is now the highest part of coastal Greenland, while down-sinking of the area to the east gave the Denmark Strait. The rocks between these regions of opposite radial movement were bent into a flexure. During the flexuring a dense dyke swarm[2] was injected which allows the age of the earth-movements to be fixed and shows that tension then existed in the upper crust. Folding, overthrusting or other evidence of compression are entirely lacking. The widespread and powerful radial earth-movement in East Greenland, which may be described as epeirogenic since there is no evidence that it was a secondary result of tangential compression, emphasizes by its magnitude the importance of vertical crustal movements of the kind which take place without tangential compression.

Phenomena of this kind must either be left unexplained or some hypothesis must be advanced involving the deeper layers of the earth. Since so little is known about the depths of the earth a range of hypotheses is possible. For this particular case du Toit[3] has suggested one which is based on the paramorphic principle, but while this might explain the downsinking of the Denmark Strait where a great thickness of basalts accumulated, it cannot account for the uplift of the adjacent land which was also covered by basalts, though less thickly. A more satisfactory hypothesis seems to be that of migration of subcrustal material followed by adjustment to isostatic equilibrium. This view was suggested when the dyke swarm was briefly described[4], and part of the uplift was explained as a result of migration of the lower part of the sial layer. If, however, the whole of the vertical movement is to be accounted for by migration of material in depth, then it is necessary to postulate a greater movement of some subcrustal layer than was previously suggested.

At the time of these movements in East Greenland, the crust was capable of tension fracturing, at any rate where the dyke swarm was developed, and compressive forces were nowhere sufficient to cause



folding or thrusting in the visible part of the crust. The dykes occupying the tension fractures are of basaltic composition indicating that basic magma and not acid was then available. The change from a crustal layer, capable of being thickened or thinned by flow, to an overlying layer which remained unaffected is likely to have taken place where there was a sharp change of composition. For these reasons it seems likely that during the epeirogenic movement in East Greenland an intermediate layer of basaltic composition was changed in thickness, while the overlying sial layer remained unaffected (see accompanying illustration). The migration of material may have been effected by the drag of convection currents in a lower layer ; several indirect lines of evidence, recently summarized by Gutenberg[5], now suggest the existence of such currents.

The process described above is capable of producing by direct sinking an ocean basin such as the North Atlantic, and yet it is not at variance with the theory that the earth's crust is in isostatic equilibrium. New evidence for the hypothesis that the North Atlantic has been formed in part by direct sinking is provided by the recent work on submarine geology and topography summarized by Field[6].

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Department of Geology,
University of Reading.
April 26.

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[2] Wager, L. R., and Deer, W. A., *Geol. Mag.*, **75**, 39 (1939).
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Surnames, Intelligence and Fertility

In a recent communication[1], Prof. R. A. Fisher and Dr. Janet Vaughan showed that a significant racial difference in blood-group frequencies could be detected in a sample of Liverpool donors by comparing with the whole group those possessing characteristically Welsh family names. This has prompted me to make a similar comparison for intelligence, as estimated by a mental test, in the case of a practically complete sample of school-children living in the city of Bath. The results may be of interest in view of the scarcity of observations made under conditions likely to ensure a fair comparison of racial groups. Furthermore, it has sometimes been suggested that Welsh immigrants in English cities tend to be of lower average intelligence and greater fertility than the native populations ; in this connexion see, for example, Cattell[2].

The sample of Bath school-children consists of those whose dates of birth fell between September 1, 1921, and August 31, 1925, inclusive, and who were living within the city boundaries on July 27, 1934. Extremely few children escaped the ascertainment and mental testing ; full details have been published[3]. The scale used was the Advanced Otis and the results are expressed in terms of an 'Index of Brightness', or *I.B.*, which is simply a device for adjusting scores so as to allow for varying age at test. The norms were established on the group itself. The number of children is 3,361.

For the selection of Welsh family names I am much indebted to Mr. B. S. Bramwell, of the Society of Genealogists. In a paper[4] in which he made certain interesting racial comparisons he used family names for differentiating groups. He gave a list of 33 characteristically Welsh names. Of these, 24 are represented in the index of Bath children : Davies, Edwards, Evans, Francis, Harris, Hughes, James, Jenkins, Jones, Lewis, Lloyd, Morgan, Morris, Owen, Parry, Phillips, Powell, Price, Pritchard, Richards, Roberts, Thomas, Williams and Willis. To increase the numbers I submitted to Mr. Bramwell a further list of names taken from the Bath index. Of these he selected ten : Griffiths, Howell, Howells, Humphries, John, Owens, Probert, Pugh, Rice and Vaughan. The number of children bearing these family names is 213, 6·3 per cent of the whole group.

Comparison with the remainder of children bearing Welsh family names.

	No.	Mean Otis *I.B.*	Standard deviation	Standard error of mean
Welsh family names	213	102·9	36·4	2·5
Remainder	3148	99·8	34·7	0·6

The difference in mean performance, 3·1, is not significant, being only 1·2 times its standard error. The difference between the standard deviations is not significant either, being less than its standard error. The frequency curve for the children with Welsh names is closely similar to that for the remainder, and does not depart significantly from the normal form.

In regard to fertility, taking as a measure the number of living full brothers and sisters (at the time the information was obtained), the Welsh children have an average of 2·46 sibs, while the remainder have 2·59. The difference is not significant. (Full data have recently been published[5] on the fertility of Welsh migrants in the city of Oxford.)

It can safely be concluded that whatever racial characteristics distinguish the Bath citizens who are of Welsh origin, a lower average level of general intelligence and a higher fertility are not among them.

J. A. Fraser Roberts.
Burden Mental Research Department,
Stoke Park Colony,
Bristol.
May 7.

[1] Nature, **144**, 1047 (1939).
[2] Cattell, "Psychology and Social Progress", pp. 53, 96, 99, 102, 125–26 (1933).
[3] Roberts, Norman and Griffiths, *Ann. Eugenics*, **8** (1938).
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[5] Daniel, *Sociol. Rev.*, **31** (1939).

History of the Vacuum Flask

WHILE fully accepting all that Mr. Gabb writes in NATURE of June 1 about matters of fact within his knowledge, I am still of opinion that Lennox made the first vacuum test tubes and flasks by methods of his own. Those I saw on his bench were transparent (unsilvered), and, having watched both him and Muller at work, I consider that he was quite as capable of doing it as Muller.

My father's assistant, Gordon, who was working at the Royal Institution at the time, clearly stated to me that Lennox arrived at his methods by trials which he, Gordon, had witnessed.

Mr. W. J. Green, of the Royal Institution, writes to me (May 2, 1940):

"Mr. Heath [Dewar's second assistant] told me quite definitely that Lennox made the first vacuum vessels in the laboratory, and further that he passed on his methods to outside people who were asked to supply in addition to what the laboratory could make."

RAYLEIGH.

Terling Place,
Chelmsford.
June 2.

Photolysis of Acetaldehyde

IN a recent paper on the high temperature (300° C.) photolysis of acetaldehyde[1], it is suggested that earlier work[2] based on measurements of pressure change may be unreliable on account of possible polymerization.

We have followed the course of this photolysis by chemical analysis for acetaldehyde at various stages, using the method of Friedemann, Cotonio and Shaffer[3]. The rate of decomposition of the aldehyde measured in this way agrees exactly with the observed pressure change, as is shown in the following example:

Initial acetaldehyde pressure: 100 mm. Temperature: 300° C.

Time (min.)	Observed pressure change (mm.)	CH_3CHO decomposed (by analysis)
0	0	0
1	+ 6·7	6·8
2	+ 12·8	12·7
3	+ 17·3	17·1
4	+ 20·5	21·0
5	+ 25·0	25·0

These results, coupled with the fact that a pressure increase of practically 100 per cent is observed on prolonged irradiation, shows that no appreciable polymerization takes place under these conditions. There is hence no reason to doubt the accuracy of the earlier work.

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Department of Physical Chemistry,
Oxford.

[1] Grahame and Rollefson, *J. Chem. Phys.*, **8**, 98 (1940).
[2] Mitchell and Hinshelwood, *Proc. Roy. Soc.*, A, **159**, 32 (1937).
[3] Friedemann, Cotonio and Shaffer, *J. Biol. Chem.*, **73**, 342 (1927).

Points from Foregoing Letters

Using a new oil-drop method, T. H. Laby and V. D. Hopper have made a new determination of the electronic charge. They claim for the results a probable error one third of that of Millikan's determination, and state that it agrees with the value of the electronic charge by the X-ray method to the accuracy with which the viscosity of air is known.

A. D. Fokker, after indicating the dynamical variables for a system of two particles in relativity theory, presents Lorentz-invariant definitions for the centre of inertia and for the internal moment of momentum of a system of any number of free particles.

On treating cytochrome *c* with sodium dodecyle sulphate (S.D.S.) D. Keilin and E. F. Hartree find that a derivative is obtained which can be considered as a hæm-protein compound, in which the protein has probably lost its connexion with the iron although it remains still linked with the porphyrin. The effect of S.D.S. on cytochrome *c* is reversible, as after removing this reagent by dialysis cytochrome *c* reverts to its original state.

K. Bailey reports the crystallization of an albumin from rabbit muscle. Although obtained independently, it may be identical with the myogen *B* which Baranowski has occasionally obtained in the mother liquors of myogen *A*.

E. Wollman, F. Holweck and S. Luria have subjected a bacteriophage to the effects of various forms of radiation. Their results lead to the conclusion that inactivation of bacteriophage by irradiation is a quantum effect, and that the phage is a monomolecular structure.

Referring to recent work suggesting that certain algæ, particularly algæ from Indian rice fields, are able to fix atmospheric nitrogen, H. Chaudhuri states that his own work leads to the view that bacteria, living in the mucous sheath of these algæ, are responsible for nitrogen fixation.

R. N. Robertson, working on salt accumulation and respiration in cut carrot tissue, finds that the ratio of carbon dioxide produced in the presence of salt to the amount of salt absorption varies with concentration of salt absorbed and with time. His work supports Lundegårdh's views in relation to ionic absorption.

L. R. Wager describes a powerful Eocene flexure of the earth's crust which has recently been found in East Greenland. He suggests that it has resulted from variation in thickness of an intermediate layer of basaltic composition under the influence of convection currents.

In the high temperature photolysis of acetaldehyde C. J. Danby finds that the course of the reaction as followed by chemical analysis agrees exactly with the observed pressure change, which therefore gives an accurate measure of the reaction rate.

RESEARCH ITEMS

Shamanism in the South-West United States

An account by Isabel T. Kelly of shamanism as practised by seven of the original fifteen bands of the Southern Paiute (*Anthrop. Rec.*, 2, 4, Univ. California Press, 1939) is based on field observations occupying eleven months in 1932–34. They are sufficiently full to permit formulation of a characteristic Paiute pattern, while bringing out local specializations. The outstanding common features may be outlined as follows. Shamans of either sex derive their powers from dreams, usually unsolicited. They confer with a familiar spirit, sometimes human, more frequently animal, from which they receive songs and instruction for curing. Neither powers, songs nor office are inherited. Sickness is attributed to intrusion of a material object or a ghost, or less commonly to soul loss. The last is cured by pursuit and restoration of the lost soul, the two former by sucking and song. All bands distinguish between the rattlesnake shaman and the general practitioner, and some recognize numerous other specialists. Paucity of material makes it difficult to place Southern Paiute shamanism with respect to that of either the Great Basin or other adjacent areas. Object intrusion is nearly universal in western North America in contrast to the relatively infrequent ghost intrusion. Emphasis on the guardian spirit is reminiscent of central California, while the idea of soul loss calls to mind Southern California. The closest specific resemblance is with the Havasupai. The difficulty of delimiting Southern Paiute with respect to surrounding areas is perhaps as significant as any other fact in evaluating it as characteristically Basin.

Aluminium Dust in Silicosis

Silicosis, the lung disease to which stone cutters and others who work in dusty trades are subject, has been noticed to develop in rabbits exposed to air containing moderate concentrations of fine quartz particles. In the *Bell Laboratory Records* of April, it is stated that this is completely prevented if there is as little as one hundredth as much aluminium dust as silica in the air breathed. This preventive action was discovered at the McIntyre Porcupine Mines, and has been ascribed to an extremely thin coating of an aluminium compound deposited on the silica particles. The action of the aluminium is sufficiently curious and important to justify a fuller understanding of the nature of the film which it forms upon quartz particles. Dr. Frary, director of the Aluminium Research Laboratories, suggested that the answer might be forthcoming if a study were made of electron diffraction patterns. In experiments carried on by L. H. Germer and K. H. Storks, a beam of high-speed electrons was passed through thin films of silica which had previously been exposed to aluminium and water at body temperature. The diffraction patterns obtained showed a layer of aluminium hydrate less than one millionth of an inch thick on the silica. Although extremely thin, this layer is sufficient to prevent the silica from injuring the lungs. Two very striking photographs are shown of electron diffraction patterns, one of aluminium hydrate on silica and the other of silica alone.

Medical Uses of Radium

There are probably not many who have been consecutive readers of the seventeen yearly reports, "Medical Uses of Radium", published by the Medical Research Council since 1923. They are interesting in retrospect as showing the gradual emergence of radium treatment from a qualitative to a quantitative basis, and in bringing to the reader the conviction that radium, properly used, is a valuable agent in the treatment of cancer and several other non-malignant conditions—witness the statistical data, evidently prepared with great care, which figure throughout the text of the current report (Spec. Rep. Ser. No. 236). The research side of this work under the ægis of the Council has grown year by year; only to enumerate the titles of the research work of different centres will give an idea of the way in which the science and art of radium treatment are being strengthened. These lines of investigation include studies upon artificial radioactivity, irradiation of gels and the polymerization of liquids, biochemical effects of radiation, the dependence of biological effects upon the wave-length, the concentration of radon at which it becomes harmful, the production of mutations in Drosophila and the formation of malignant growths in the rabbit as a result of prolonged radiation—such are the varied researches contributing to the growth of this subject.

Teart Disease in Cattle

A large area of pasture in central Somerset and smaller areas elsewhere have been known for more than a century to cause scouring in ruminants, especially cows in milk and young stock. Such land in known locally as 'teart'. During the past four years an intensive study of the problem has been made by W. S. Ferguson, A. H. Lewis and S. J. Watson, and their results are now published in Bulletin No. 1 of the Jealott's Hill Research Station (Imperial Chemical Industries, Ltd.), Bracknell, Berks. The cause of teartness is the presence in the herbage of molybdenum, which is highest in green leafy material, particularly clovers and Yorkshire fog, considerably less in hay and very low in dead or frosted herbage. The land, therefore, can only be grazed with safety during the winter, and 'improvement' of the pasture only aggravates the trouble owing to the increase in clover. Scouring, however, can be entirely cured and prevented by feeding or drenching the stock with copper sulphate. 2 gm. per cow per day or 1 gm. for young stock is sufficient. Experiments conducted in America show that copper sulphate fed continuously at the above rates for a long period is not likely to have any harmful effect on stock. Experiments are in progress to see if the addition of copper compounds to the soil would be equally effective. As teartness increases under neutral or alkaline conditions, basic slag and lime should not be used; but sulphate of ammonia and ammonium phosphate fertilizers can be applied with safety. Reduction of teartness is also obtained by ploughing out and reseeding, and many of the affected pastures are being converted into arable land at the present time. Shallow ploughing is suggested to avoid bringing up the more teart subsoil.

Fauna of the Belgian Cretaceous

IN a recent memoir ("La Transgression albienne et cénomanienne dans le Hainaut", *Mém. Mus. Roy. d'hist. nat. Belgique*, No. 89 ; 1939) Dr. R. Marlière gives a monograph of the fauna of the Meule de Bracquegnies, followed by an account of the characters, distribution and stratigraphical relations of the Albian and Cenomanian deposits of Hainaut. The Meule de Bracquegnies rests on Carboniferous or Wealden, and is overlapped by Cenomanian and Turonian deposits ; its fauna was described by Briart and Cornet in 1868, and the present author makes many additions to their work. Except for the absence of ammonites, the fauna resembles closely that of the Blackdown Greensand, which is of the age of part of the Upper Gault. The lamellibranchs and gastropods, which form almost the entire fauna, are such as would live on the continental shelf in water of no great depth ; they include some dwarfed forms, which, in connexion with the almost entire absence of cephalopods, brachiopods and echinoderms, suggests some peculiarity in the composition of the sea water or in the nature of the sea floor.

Flora of the Belgian Lower Devonian

THE oldest fossil plants are scrubby little things that would scarcely be looked at twice if they came from a later formation, yet their study has been characterized by the utmost care and determination of the investigator to make the specimens yield every shred of information, and one might add by first-rate photography. The first account, apart from some piecemeal work, has just been published of the Lower Devonian flora of Belgium, and it at once makes it one of the richest (with about 25 species) and best known of its period ("Végétaux Éodévoniens de la Belgique", by F. Stockmans, *Mém. Mus. Roy. d'hist. nat. Belgique*, No. 93). Really well preserved plants like those of the Rhynie Chert have yet to be found in the Lower Devonian, but many interesting new points are added in this paper to the knowledge of these little-known types, particularly to Taeniocradia, in which sporangium-like organs are described. Petrified axes of the seaweed-like Prototaxites and with it, as usual, the enigmatic sphere Pachytheca (held by some to be a fish's eye and some an alga) are described from this region also, but they do not seem to occur much in association with undoubted land plants.

Classification of Pears

IN a preliminary report (*J. Pom. and Hort. Sci.*, **18**, 52 ; 1940) M. B. Crane and D. Lewis have described a system for the classification of cultivated pear varieties, based on the morphological characters of leaves and shoots. The characters used have been shown by breeding experiments to be genetically controlled, and though some of them show seasonal variations, they can be used with confidence when the range of variations is known. Leaf-margin, midrib, shoot-hairiness and shoot and leaf colour are the characters concerned. Spur-leaf margins may be toothed, serrate-crenate, or entire. Leaf midrib may be glandular or without glands, the mean number per leaf being characteristic for a variety. Shoots may be red-purple or green, and hairy, sparsely hairy or glabrous. Leaves are either green or pale green. All these characters are reliable and not affected by rootstock. It is hoped eventually to include flower and fruit characters in the classification.

Irregular Division of the Centromere

C. D. DARLINGTON (*J. Genetics*, **39**, 351–361 ; 1940) has analysed the chromosomes of species of Fritillaria and shown that chromosomes with telocentric centromeres arise by a transverse division of the centromere in a two-armed chromosome. Such telocentric chromosomes may give rise to iso-chromosomes by the chromatids opening out to form a two-armed chromosome. The author discusses the effect of these phenomena on the mechanical properties of the chromosome.

Infra-Red OH Band and Association

WITH different concentrations of ethyl alcohol in CCl_4 or CS_2, the variations in location and intensity of the bands near 3 μ have been investigated at various temperatures by J. Errera and his collaborators (*J. Chem. Phys.*, **8**, 63 ; 1940). The band (3638 cm.$^{-1}$), due to single molecules, shows no alteration in intensity with concentration changes but increases in intensity at higher temperatures, whilst the band ($\simeq$ 3300 cm.$^{-1}$), due to polymeric molecules, increases in intensity with increased concentration and diminishes with increased temperature. With concentrated solutions (2–8 per cent C_2H_5OH), increased temperature causes a new band at 3520 cm.$^{-1}$ to appear, due to dimeric molecules. On the other hand, with dilute solutions (< 1 per cent C_2H_5OH) practically no polymeric molecules are present and at high temperatures the dimerides break up to single molecules, and the spectrum shows diminution in the intensity of the dimeric band and increase in the intensity of the monomeric band. By cooling dilute solutions down to $-5°$ the band due to polymeric modifications reappears. At concentrations less than 0·12 per cent C_2H_5OH, only single molecules appear to exist. From the spectroscopic data the concentrations of the various species have been estimated. The mechanism involved in the association cannot be satisfactorily formulated ; nor can it be decided whether the association occurs as a result of electrostatic effects or from hydrogen bonding. The effect of adding acetone or pyridine to CCl_4 or dioxan solutions of C_2H_5OH has also been investigated. The spectra of these ternary mixtures exhibit bands due to single and double molecules, and to polymolecular complexes and addition compounds of C_2H_5OH with acetone or pyridine. The behaviour of solutions of HDO in D_2O and in various organic and inorganic media has been studied for the same spectral region.

The Electron Microscope at Toronto

THE electron microscope developed in the McLennan Laboratory at Toronto was described in the *Canadian Journal of Research* (A, **17**, 49 ; 1939). This paper contains a short and valuable summary of the results of other workers at the date of publication. The instrument is there described in some detail, and the problem of the steadiness of the high-tension supply is discussed. In this paper a limit of resolution of 200 A. was inferred. A more recent report on the microscope, by E. F. Burton, J. Hillier and A. Prebus (*Phys. Rev.*, **56**, 1171 ; 1940), claims a resolving power of better than 60 A. This improvement is apparently largely due to the control of the illuminating beam of electrons, and the limit of resolution appears to be imposed to a large extent by the nature of the specimens rather than by instrumental factors.

A CENTURY IN THE FOREST LIFE OF NEW ZEALAND

ONE hundred years ago New Zealand had 63 million acres of forest ; within eighty years it had been reduced to 12 million. Her woodlands had suffered the fate of those of so many other lands—they had been cut and mangled for immediate gain without any thought of the future. But unlike most lands where this had happened, the New Zealand people awoke to the danger of lost woodlands, and some thirty or forty years ago they decided to change their policy of total destruction for one of preservation and reconstruction. It came gradually, there being a period of overlapping with exploitation and replanting going on side by side. The policy to-day is wholly to preserve and replant.

New Zealand is in the fortunate position that not one part of her forests is inaccessible. The woods are within easy reach of shipping. This contributed in great measure to bring about exploitation, but this same feature will be of inestimable value when she comes to market her timber under a controlled policy.

For several years now the New Zealanders have led the world in the matter of tree-planting. In seven years alone 400,000 acres were planted. In one year 100,000 acres were planted, which is probably a record for the world. Altogether New Zealand possesses nearly a million acres of young forest.

What helped afforestation most in New Zealand was the discovery of the remarkable growth of certain introduced softwood trees. A pine which came from Monterey, California, namely, *Pinus insignis* or *radiata*, was the most remarkable of them all. This tree produces mature timber at 18–30 years of age and pulp wood at 12–14 years of age. The timber of mature trees is equal to the best Baltic pine, and has proved of immense value in making packing cases for dairy produce. It can also be pulped to make paper. One tree which was felled, aged forty-five years, fetched the very high price of £55.

Other trees which were introduced and reacted satisfactorily to the prevailing conditions were yellow pine, Oregon pine and the redwood of California. Certain poplars also have been making good growth.

The rapidity of growth attracted the attention of the business man. Companies were formed to afforest land and quick returns were obtained from the capital invested. Such a thing is almost unique in the history of forestry, timber growing being usually regarded as a State affair, since it means the locking up of capital for such a long time with very little return.

Within the last year or so the New Zealanders have again shown a great deal of wisdom by turning their attention to the trees which are native to the country. They are preserving what forests remain—8 million acres are under State control—and are trying to bring back to them their former grandeur and value.

The most famous natural tree of New Zealand is the kauri pine. Some remnants of it remain. This tree produced some of the best timber the world has ever seen. It also produced the kauri gum, great beds of which still lie in a fossil state in the soil. 15,000 tons of it are mined annually and find a ready market for making paint, varnish and linoleum. The resin from the living tree not only gives gum, but a motor-spirit is also being derived from it now.

There are other native trees such as yellow woods and the Nothofagus, the latter corresponding to the beech of Great Britain. The latter is now being tried on an experimental scale in Britain and is showing great promise. Then there is also the world-famous rimu tree. All these regenerate themselves naturally.

With such success already achieved it is little to be wondered that New Zealand is looking forward to the day when she will be a timber exporting country.

E. V. LAING.

INTERNATIONAL FISHERIES RESEARCH IN THE ATLANTIC*

THE Committee of the Atlantic Continental Slope, on July 16, 1937, formed a sub-committee for the study of a technique concerning researches on the mackerel. Representatives from England, Ireland, France, Portugal and Germany were elected on the sub-committee, which met at the Plymouth Marine Laboratory during December 8–9, 1937. At this meeting discussions took place on : (1) the methods of sampling and selective action of nets ; (2) biometrical data ; (3) food ; (4) age determination ; (5) stages of sexual maturity ; (6) plankton and hydrographical observations ; (7) collection of early metamorphosed stages ; (8) commercial statistics ; (9) other researches.

* Rapport Atlantique 1937–1938 (Travaux du Comité du Plateau continental Atlantique) (Atlantic Slope Committee) publié avec l'aide de Ed. le Danois, Dr.Sc. Directeur de l'Office des Pêches Maritimes, Paris. *Rapports et Procès-Verbaux des Réunions*, **111**, Conseil Permanent international pour l'Exploration de la Mer. Charlottenlund Slot, Danemark. 1939.

Reports on the researches on the mackerel by J. le Gall and J. Furnestin (France), G. A. Steven and P. G. Corbin (England) and G. P. Farran (Ireland) show that progress has already been made along these lines. J. le Gall in France has been working on general and seasonal distribution, physico-chemical conditions, spawning, food and morphological characters. In Appendix I he gives a résumé of the known facts of the concentration before spawning, spawning periods and sexual maturity, growth and physical conditions of the environment. In Appendix II G. A. Steven and P. G. Corbin report on the work at Plymouth begun in 1936. Both French and English vessels participate in the spring drift fishery, from March until the middle of June, off the western entrance to the English Channel. The fish landed in the early part of the season are often thin, due apparently to absence of food supply.

When food is available the stomachs are full and later, when zooplankton is plentiful, the mackerel feed voraciously upon this and still later, after the shoals have broken up and dispersed along the shores of the shallow coastal waters, they feed mainly on small fishes.

In 1937 a series of cruises was made in the area to the west of the mouth of the English Channel to try to obtain information concerning the spawning of the mackerel and dispersal and distribution of the young stages. Results from 1938 and 1939 are incorporated in the account. It was found that the spawning is a protracted one lasting from March until July or even August, with its maximum from mid-April to mid-May. It occurs within the area of the Continental shelf, not over great depths, but mainly well off-shore. From April until July there was a gradual eastward shifting of the locality of spawning accompanied by a diminution in the number of eggs. Later on there is found to be a similar eastward drift and decrease in numbers in the young stages. This change in locality with time is foreshadowed by the movements of the shoals which support the commercial drift fishery based on Newlyn from March to mid-June, although routine examination shows that scarcely any ripe or spent mackerel are landed on the fish market before about the end of May. It appears that fishing takes place not on the actual spawning centres but on the inner (landward) edges of them where the fish that have not yet spawned are located. The spawning period of the individuals is found to be a protracted one. The first indication of the spawning condition is the presence of ripe eggs which appear on the outside of the ovary, widely scattered among unripe eggs. Later these ripe eggs pass into the lumen of the ovary, which, externally, then reverts to an unripe appearance. The ripe eggs are shed and the process recurs, possibly many times, before the ovary is fully spent. For study of age and growth-rate it was found that the otoliths carefully prepared are of more value than the scales. Consequently this otolith method has been adopted. Preliminary work shows as yet no dominating year class. Examination of skeletons for racial characters, not yet fully worked out, indicates that the only variant that can be found—the numbers of the thoracic vertebræ with 'open' hæmal arches—shows some variation from sample to sample.

J. Furnestin in Appendix III shows results chiefly on hydrography and plankton from the entrance to the Channel and waters south of the Irish Sea, and G. P. Farran in Appendix IV deals mainly with the plankton as food for the mackerel.

Besides these researches on the mackerel there are reports by J. le Gall and J. Furnestin on the sardine, plaice, and sand eel, by Fen Hsüeh on Manx herring shoals, by P. Desbrosses on the John Dory and G. P. Farran on surface temperature observations at Coningbeg Lightship on the south coast of Ireland.

AUTOMATIC SERVICE OF LONG-DISTANCE TELEPHONE CALLS

FULL automatic service for toll or long-distance telephone connexions, as they are variously termed, has been in operation in a number of European countries for some years. The administrations and operating companies of countries which have not yet adopted this service are anxiously considering methods of improving their service and reducing its cost. An important paper by W. Hatton, the technical administrator of the Bell Telephone Manufacturing Company at Antwerp, is published in the January issue of *Electrical Communication*, a quarterly journal issued by the International Standard Electric Corporation of New York, U.S.A.

When converting telephone networks of national dimensions from manual to automatic operation, certain problems arise which can be dealt with in a purely technical manner, while others cannot be solved without due regard to the reaction of the telephone subscriber. Signalling over long-distance circuits by voice-frequency currents, automatic regulation of the transmission level and other technical features of long-distance service do not directly concern the subscriber, provided that the final result is satisfactory. The manner in which charges for long-distance service are established and the form in which the monthly or quarterly account is presented are matters which have both technical and administrative aspects, and in which the subscriber is keenly interested.

To operate long-distance service on an automatic basis, calls must be charged automatically, and the method adopted for this must give complete satisfaction to the subscriber. Prior to the introduction of a system of automatic ticketing, first applied in Belgium, there appeared to be no method of charging subscribers automatically for their long-distance connexions, except by means of the message register. This 'message' method, known to the telephone world as 'time or zone' or sometimes as 'multiple metering', has its disadvantages. A summary of these disadvantages shows that some of them are serious and that business organizations would be reluctant to accept a monthly or quarterly bill without particulars of the individual charges for each of their long-distance connexions. In the case of hotels, these particulars would in most cases need to be furnished immediately on demand. The real solution would have to be one which maintains the present situation between the charges for local and long-distance tariffs (allowing each to be developed to suit their separate requirements) and which at the same time provides a record giving the date, the time of day, the duration of call and the cost of the message, preferably printed on a ticket.

From the practical point of view the design of such a system of automatic ticketing must permit of its introduction to existing exchanges with the minimum of modification to the equipment already installed and in operation. The author gives a sketch of such a system in operation in Belgium which seems to be in every way satisfactory. Although this system is quite a recent invention, there are already installed or on order 150,000 lines.

An excellent description is given by Mr. Hatton of the problems that had to be faced in designing an automatic ticketing system in three areas in Belgium, namely, Brussels, Antwerp and Malines. The urban network of Brussels contains fifteen exchanges of the rotary type, some dating back to 1922. The normal capacity is 115,000 lines, and this network furnishes a good example of the manner in which automatic ticketing can be added to existing equipments. The author states that Antwerp, Liége, Charleroi and other Belgian towns will follow the method adopted for Brussels.

The first installation of automatic ticketing was put into service in Bruges in 1936, and was rapidly followed by installations in Ostend and twelve other towns in Belgium. During the period July 1–September 15, 1937, a check of 62,000 ticketed calls revealed 80 tickets, or 0·13 per cent, bearing incomplete or incorrect details, and these results go far to prove that full-automatic methods can be applied to long-distance service with the same success as to local service.

The tickets provide the traffic department with valuable information, and also give a remarkably clear picture of the operating efficiency of the exchange. Each long-distance call is recorded whether it be an effective connexion or whether it results in "busy", "no answer", "wrong number", or "premature release". Equipment faults which might otherwise remain unsuspected and undetected are brought to light by the indisputable evidence of the ticket. Naturally, further developments in this field are to be anticipated. It may prove advantageous to use a small number of high-speed printers which are engaged only at the termination of a call.

A form of ticket may be produced which can be automatically sorted, and, ultimately, doubtless mechanized-accounting will further dispense with the need for human intervention. Finally, it is anticipated that automatic ticketing will prove immensely valuable in Europe when the development of international long-distance service on a fully automatic basis becomes possible.

ANALYSIS OF FIELD TRIALS

VARIETY testing forms an essential part of the work of the plant breeder and so he needs an adequate technique for the design and statistical analysis of field trials. His requirements in this direction are, however, rather specialized, the prime necessity being a method of comparing a large number of selected lines, though the careful testing of a small number of valuable new strains against standard varieties is also of importance.

Now one of the greatest advances made by modern statistics has been to revolutionize field trial technique. Until recently, however, the development of field designs was largely concerned with manurial and other such trials, where a limited number of treatments are applied and where interactions of these treatments are detectable and potentially of interest. Furthermore, when it was shown that multiple interactions are seldom if ever significant, a new technique, that of confounding, became possible. A design involving confounding purposely sacrifices information on less important interactions, in order to make the main comparisons with more precision.

Clearly all field trials must be based on the same principles as these 'treatment' designs; but the latter in themselves are not fully suited to the plant breeder's work. He often requires to work with large numbers of varieties and has no uninteresting 'interaction' comparisons which may be sacrificed by simple confounding. His requirements have, however, recently received special attention, and appropriate lay-outs have been developed. For example, the quasi-factorial designs, involving a somewhat complicated application of confounding, meet the needs of the plant breeder admirably but are in general of small value to those interested in soil treatment.

Thus it is very appropriate that the Imperial Bureau of Plant Breeding and Genetics should publish a technical communication on the subject of field trials, by an author who has been associated for many years with this branch of statistical work*. The publication is essentially introductory in scope, and the contents have been admirably chosen to fulfil this purpose. The first sections deal with the general principles of yield determination and the measurement of experimental error. Then follow descriptions of the randomized block and Latin square designs, together with details of their numerical analysis. The discussion of the use of the Latin square well illustrates the considerations involved in the choice of a design appropriate to an experiment. Multiple factor experiments are next dealt with and the principles of orthogonality and confounding introduced by a simple example. Finally, the split plot technique, which is especially suited to combined variety and manurial trials, and the quasi-factorial designs are briefly considered. The latter is somewhat complex for introduction into an elementary account, but its inclusion is amply justified by its pre-eminent position among layouts for testing a large number of varieties.

The presentation of the material is adequate, though more open to criticism than is the choice of contents, in that it tends at times to be too technical. For example, the introduction of the terms 'self-conjugate' and 'transformation set' into the section on Latin squares is unnecessary as their meanings are not explained, the reader being referred elsewhere for an account of their use. Thus they do not materially aid the argument and are somewhat terrifying to the beginner. The discussion of the t test in the third section could also be made much more real for the biologist by the use of actual experimental data as illustrative matter, rather than the very artificial example of two varieties with unequal means but exactly equal variances, which is in fact used.

There can, however, be no doubt that plant breeders will find this publication a helpful introduction to the subject of field trials. Nor will its use end there, as the list of more advanced works given, together with short notes on their contents, in the last section, will serve as a guide for later reading and reference.

K. MATHER.

* Field Trials: Their Lay-out and Statistical Analysis. By John Wishart. (Imperial Bureau of Plant Breeding and Genetics, Cambridge.)

SEVENTY YEARS AGO

NATURE, Vol. 2, June 16, 1870

Scientific Education of Women

"THE feature which will probably most clearly mark the year 1869 in the view of the future historian of Education, will be the definite recognition of the rights of women to all the advantages of education accorded to men." This is the opening sentence of an article surveying the position. Reference is made to courses of lectures on physiography, physics and botany given by Huxley, Guthrie and Oliver at South Kensington, and to other courses in London, at Edinburgh, Manchester and Liverpool. The results of examinations based on these courses show that "not only can women compete with men in the qualities essential for severe and successful study, but that in many respects their average attainments are higher than among the working members of a University". The work of the Edinburgh Association, all the teachers of which are professors of the University of Edinburgh, is thought to derive much benefit from its connexion with the University.

As regards medical education, the exclusion of women is considered to be due to the fact that "the teachers and practisers of medicine and surgery form a guild, a professional trades' union, protected and licensed by the Government", who are acting in self-defence.

Circumlocution

A PROVINCIAL druggist [in France] desirous of gathering fox-glove (*Digitalis*) in one of the State forests, applied for permission to the local authority (*garde général local*), offering at the same time to pay an annual sum of six francs for the privilege. The local magnate transmitted the request to his inspector, who forwarded it to the Conservator of the department, who dispatched it to Paris to the Director-General of Forests, who caused it to be sent to the Minister of Finance. The Minister referred to "for study" to the Director-General of Domains, who sent it to the Departmental Director of Domains to be examined by the Registrar. The latter, after examination, pronounced a favourable opinion on the request, and sent it back to the Departmental Director, who forwarded it to the General Director, who, in his turn, dispatched it to the Minister, through the agency of the General Secretary of Finance, who availed himself of the opportunity to make his comments on the matter. Then the unhappy druggist's request was returned to the Director-General of Forests, who sent it to the Conservator, he to the inspector, and the inspector to the *garde général*, who was the original recipient of the request. The authority "to cull simples", at length reached the successor of the original postulant, and at an age when he was too old to herborize.

WELL-WISHERS of the University of Oxford will rejoice to hear that the honorary degree of D.C.L. has been offered to Mr. Darwin. The state of Mr. Darwin's health unfortunately precludes him from accepting the proffered honour, but the scientific naturalists of this and other countries will not the less appreciate the compliment which has been paid to their great leader. It is all the more graceful as Mr. Darwin is not an Oxford, but a Cambridge man, a circumstance which the University of Cambridge seems to have forgotten.

FORTHCOMING EVENTS

[*Meeting marked with an asterisk is open to the public.*]

Tuesday, June 18

AUSTRIAN ACADEMY IN GREAT BRITAIN, at 5 p.m.—Prof. Dr. F. A. Hayek: "The Austrian School of Economics".

Thursday, June 20

CHADWICK LECTURE (at the Chelsea Physic Garden, Swan Walk, S.W.3), at 4 p.m.—Prof. William Brown, F.R.S.: "Plant Disease in Relation to the Public".*

APPOINTMENTS VACANT

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

GRADUATE MISTRESS TO TEACH MATHEMATICS in the English High School for Girls, Istanbul—The British Council, 3 Hanover Street, W.1 (quoting 'Istanbul') (June 17).

ASSISTANT EDUCATION OFFICER—The Chief Education Officer, County Hall, Kingston-upon-Thames (June 19).

ORGANIZER OF AGRICULTURAL EDUCATION FOR THE COUNTY OF SUFFOLK—The Secretary, County Education Committee, Education Office, County Hall, Ipswich (June 21).

GENERAL MANAGER OF THE RIVERS DEPARTMENT—The Town Clerk, Town Hall, Manchester 2 (June 22).

ASSISTANT TO TEACH ENGINEERING SCIENCE, ENGINEERING DRAWING, ETC.—The Registrar, Wimbledon Technical College, Gladstone Road, S.W.19 (June 24).

GRADUATE ASSISTANT MISTRESS TO TEACH MATHEMATICS AND GENERAL FORM SUBJECTS in the Hong-Kong Education Department—The Secretary (I.P.C./C.A.), Board of Education, Alexandra House, Kingsway, W.C.2 (June 24).

ASSISTANT LECTURER IN NAVAL ARCHITECTURE—The Registrar, The University, Liverpool (June 24).

TECHNICAL ASSISTANT TO THE EXECUTIVE OFFICER—The Executive Officer, Rutland War Agricultural Executive Committee, Catmose, Oakham, Rutland (June 25).

STUDENT-DEMONSTRATOR IN BOTANY—The Principal, Royal Holloway College, Englefield Green, Surrey (June 29).

HEAD OF THE DEPARTMENT OF HORTICULTURE—The Secretary, West of Scotland Agricultural College, 6, Blythswood Square, Glasgow (June 29).

PRINCIPAL of the proposed Technical Institute at Delhi—The High Commissioner for India, General Department, India House, Aldwych, W.C.2 (quoting Appointment 1/11G) (June 29).

PROFESSOR OF CHEMISTRY at Raffles College, Singapore—The Secretary, Universities Bureau of the British Empire, 88a Gower Street, W.C.1.

DRAUGHTSMEN GRADE I (Ref. No. A.506) and DRAUGHTSMEN GRADE II (Ref. No. A.507) at South Farnborough, and DRAUGHTSMEN GRADE II (Ref. No. A.508) at Gosport—The Chief Superintendent, Royal Aircraft Establishment, South Farnborough, Hants (quoting appropriate Ref. No.).

REPORTS AND OTHER PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

The Eggs of British Birds. By Colin Matheson. Pp. 26+2 plates. (Cardiff: National Museum of Wales.) 4*d*. [275

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