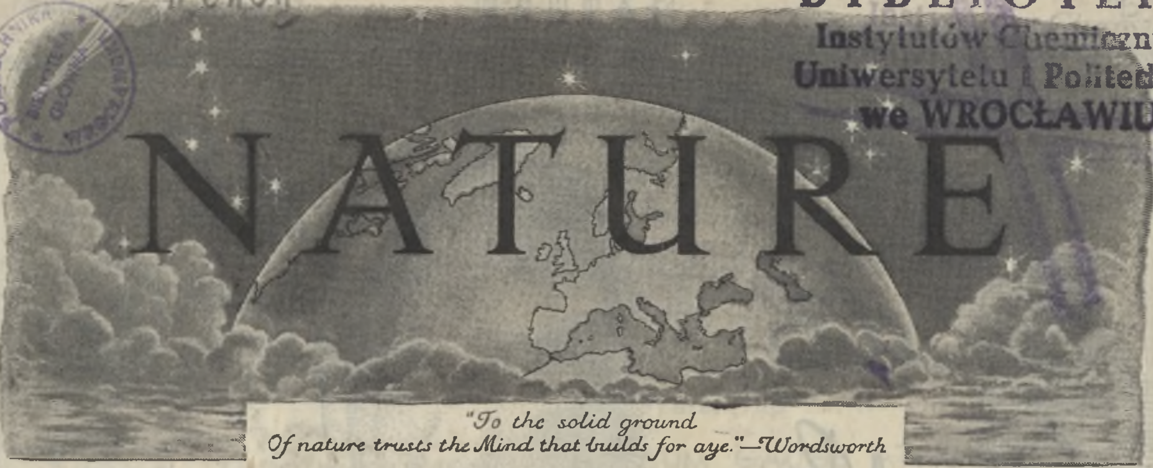

Vol. 156, No. 3966 SATURDAY, NOVEMBER 3, 1945 ONE SHILLING & SIXPENCE

NATURE

No. 3966 SATURDAY, NOVEMBER 3, 1945 Vol. 156

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Editorial and Publishing Offices
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831
Telegrams: Phusis Lesquare London
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T. G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2
Telephone: Temple Bar 1942
The annual subscription rate is £4 10 0, payable in advance, Inland or Abroad.

ARMY EDUCATION

EDUCATING THE EDUCATORS

A CENTRAL institute for the ambitious scheme of education in the British Army has recently been opened at Eltham Palace, Kent (see p. 527)—an occasion which gives rise to certain thoughts and queries about the nature and progress of this all-important aspect of present-day army life. As Major Hawkins, the chief instructor at the new School, states in his article, this "infant which was perfectly conceived some months ago, is now going through all the pangs of infancy". The same can be said of army education in general, for though there have been some attempts at it for several decades, they have been of a rather minor character and so many new projects have arisen *de novo* in recent years that one might say the general scheme of army education is still in its infancy. In bringing up any infant, too many advisers might leave both parents and child in such a state of confusion as to cause disaster; nevertheless, it is to be hoped that the parents of this infant will look for criticism from as many authorities as possible and for a long time to come, for there are many authorities on adult education outside the Army. Furthermore, if the various new schemes for education in the Army are based on sound principles, we may visualize army education in due course proving to be one of the most important of all projects in adult education. In this connexion it is gratifying to note that a number of H.M. inspectors (Ministry of Education) are to give the army education authorities the benefit of their experience and criticism after spending some time examining army education in the field. We trust, however, that these specialists will bear in mind that they are dealing with an experiment in adult education and not school teaching—for there is considerable difference between the two.

This immediately raises a very important point. It is to be hoped that the army authorities will always bear in mind that the principles and practice of education as accepted and applied in all good schools in Britain are not altogether suitable for education in the Army. Neither can army education be compared with university education, not even, we think, in the new 'formation colleges'. The logical corollary to this is that a school teacher is not necessarily the best choice for an army education officer. This must be mentioned, for too often it has appeared to be tacitly assumed that if there is a former school-teacher in an army unit, then he is the obvious choice for dealing with education in that unit. It should be borne in mind, however, that when appointing officers to take over responsibility for education among such a heterogeneous group as an army unit, a former school teacher, though experienced and probably well informed in the principles and practice of education of the child, may not be gifted with the tact, common sense and human understanding so essential when dealing with men. Very different methods of attracting an audience and in presenting the material are required; furthermore, the immediate and ultimate aims are very different also. This is important, for in due course we hope to see the majority of army men genuinely wishing to attend the classes arranged for them ; then, and only then, will it be possible to eliminate the objectionable practice of rounding up a sufficient number of men to make up an audience, especially in the case of a visiting civilian lecturer. This practice can never ensure that the right men have been given the chance to derive whatever benefit there might be in attending such lectures. Neither is it calculated to encourage a visiting lecturer to agree to giving his services again. It all boils down, as will be evinced again further on, to the great need for preparing and tending the ground beforehand, and this can be done only by carefully selected education officers who in their turn have the sympathetic guidance and assistance of their seniors.

This raises the more general question of choice of personnel for tackling the problem of army education. The War Office and the Army have the benefit of the advice and help of certain qualified educationists both at the War Office itself and in the Central Advisory Council for Education in H.M. Forces. Individual specialists, too, have given assistance. But, in spite of what Major Hawkins claims in his article, we suspect that army education is all too frequently the victim of that 'red tape' with which the War Office and army life in general are so notoriously fettered. Advice and suggestions are, of course, essential : but it is not much use seeking these if they are to be carried out by army personnel who are not equipped with the necessary knowledge and experience or, worse still, who are periodically meeting the stumbling block of indifference on the part of their senior officers. We would therefore ask : Is the War Office satisfied that all senior officers concerned with army education are qualified in the modern principles of the science of adult education and able to appreciate, understand and carry out the proposals made by those specially qualified to make them ? If not, then it seems desirable that the War Office should carefully scrutinize the methods and routine adopted in appointing and promoting army officers to carry out this work.

Of course, it must be realized that the Army is not primarily an academic institute, and army education must dovetail into the other aspects of army life. But such a realization is essential not only among the critics of army education but also among the army educationists themselves, lest the latter bite off more than they can chew and, indeed, trespass on the preserves of others. In war-time, educational schemes must be constantly under revision and subject to modification, sometimes even cancelled in face of more urgent needs—all with understanding and without complaint from the army educationists. In peace-time, this aspect of the problem cannot be so acute ; but always must there be sympathy and complete understanding by the senior officers in charge of a unit, including its education officers. They must at any rate recognize the importance of army education, even if they are unable to take part in it, and thus give every facility within their power to the educationists under their command. Some senior men do so, and, in the field, the encouraging influence of their obvious interest in what is going on is so profound as to inspire not only the education officers but also the men to give of their best and to be on the constant look-out for new ideas.

Alas, on the other hand, other senior men seem merely to accept the educational side of army life as a necessary nuisance wished upon them. This is a pity, for then the orders are given and no further interest shown, leading to discontent and bitter feeling among the men who are doing their best for the cultural and technical education of the troops under unfortunately trying conditions. Furthermore, such indifference causes irritation among visiting specialist lecturers who are willing to help the War Office in its commendable attempts to raise the standard of education among our troops. This complaint has sometimes been viewed differently, and visitors have been accused of demanding the 'red carpet to be laid down for them'. We doubt if this accusation can be made against many visiting lecturers ; they are probably merely resenting the superior and indifferent attitude which greets them—and rightly so. It is now well known that in an attempt to assist soldiers in retaining and expanding their educational and cultural horizons during the War, the War Office has given facilities to civilian specialists who have agreed to visit the various units at home and overseas to talk to, and have discussions with, the men in the field. There is no doubt whatever that provided the problem is tackled in the correct manner, such a lecturer receives a sincere welcome from most officers and men. But it must be recorded that at times, before getting at the men themselves, it has proved necessary to break through the obstacles of indifference and misunderstanding presented by senior officers. It is to be hoped that in due course the War Office will see its way clear to rectify this deplorable situation ; for it is undesirable that the indifference of a few senior officers should entail the men losing those cultural contacts they clearly desire through visiting lecturers being discouraged from giving their services. It should be made clear by the War Office to all senior officers that army education is to be taken seriously, and not merely treated as one means of giving the men something to do during quiet periods, or as a Cinderella among the multitudinous activities of modern army life.

The task of the Army Educational Corps is to "inspire and organize education in the Army". But the Army's teachers cannot carry out this tremendous and commendable project unless they are qualified by training or experience or both to do so, neither can they be expected to give of their best unless inspiration comes to them in the form of sympathy and practical assistance and interest from their seniors. Also, though in due course we might reasonably expect army education to be organized and carried out within its own ranks, there should always be a welcome for the visiting civilian lecturer. To this end, army education officers *in the field* should be encouraged to make contact with all academic institutions within the vicinity of their units, and thus enable more direct cultural contacts to be made between the Army and the civilian educational bodies.

These observations from education in the field must be taken into consideration if army education is to be viewed in its correct perspective and a true value assessed. Periodically, for example, there is published a statistical account of single lectures and courses of lectures arranged for H.M. Forces by the Central Advisory Council. This conveys only one aspect of the whole movement. What is also required by those interested is a mass observation of these lectures in action ; returns concerning the number of men and women voluntarily attending such lectures might cause some lifting of eyebrows. (Lectures attended under compulsion cannot reveal very much in this connexion.) The reactions of the men themselves, too, would tell a valuable tale—one more valuable than a mere record of number of lectures arranged. The figures given by Sir Ronald Adam, adjutant-general to the Forces, in his speech at the opening of the new School, should be interpreted with the same reserve. According to Sir Ronald, about half the units in commands at home, 66 per cent of the field force units in the C.M.F. and 70 per cent of the Rhine Army have begun to implement the education scheme for the release period. Notwithstanding the difficulties of materials, printing and transport, already nearly a million text-books and books for unit and command libraries have been dispatched to formations and units. These figures are impressive, and the authorities are to be congratulated on their zeal. It is not for us to discourage such work this end by raising hares; nevertheless we are still disturbed about the other aspect of all this. Is the War Office satisfied that so far as is humanly possible the right men are in charge of the schemes in the field, and have the best men been chosen for seeing that the maximum benefit is derived from the reading of those million books ?

A similar point of view may be adopted concerning the masses of literature published in the form of pamphlets. The fact that so many hundred thousand A.B.C.A. pamphlets have been published and dispatched reveals little more than the commendable enthusiasm of the authors of them and the efficiency of the army and other authorities in conceiving and devising them. It is the receiving end which really counts, and when one sometimes hears that a pamphlet has been indifferently handled in an officers' mess and then given to one man with orders to 'mug it up' and give a lecture on it the next day, we wonder whether a little more propaganda among the officers in charge and some 'education of the educators' might not so enhance the value of the pamphlets as to render them more commensurate with the time, paper and money spent on them. A bigger harvest might be reaped if one could be sure of the best education officers being left to decide which pamphlets his men need most and then applying for them at some central depot.

Clearly the opening of the permanent home of the Army School of Education at Eltham Palace is symbolic of the ambitious plans being formulated by the authorities in the War Office. In order that the projects envisaged may be assured of complete fruition, it would be as well to be sure that the machinery in the field is well oiled with enthusiasm among the education officers and sympathy and understanding from their seniors.

It seems therefore not only desirable but even essential that the main criteria in the choice of an army education officer should be academic qualifications in the principles and practice of adult education, the personal quality of leadership, and a background of educational experience and good record. We would place leadership as paramount among these. Military record and length of service should come very low in the scale of qualifications. We reiterate that the Army is not an academic institution ; but where cultural, vocational and technical training is being practised, that training must rank high. It must not be treated with indifference or as of little importance, and all stumbling blocks must be removed. It is good in this connexion to read that at the courses to be held at Eltham Palace "Army Educational Corps officers are to be joined on various courses either by the unit education officers who are concerned with the fine details of the scheme in the units themselves, or by commanding officers who are responsible for seeing that good educational facilities are being provided for men and women under their command". At such courses, the main effort should be directed towards imbuing these officers with enthusiasm : they can easily be *ordered* to provide the facilities, but if they do so with an offhand lack of interest, condescendingly and with a show of indifference, then more harm than good will be done. For this great scheme to succeed, at any rate, in the field, young, enthusiastic and well-trained educationists are required ; and their enthusiasm must be encouraged by the all-important sympathetic understanding and vigilance of their seniors.

ORIGIN OF UNIFORMITY

Social Learning and Imitation

By Neal E. Miller and John Dollard. (International Library of Sociology and Social Reconstruction.) Pp. x+284. (London : Kegan Paul and Co., Ltd., 1945.) 15*s*. net.

MOST past studies of learning have been concerned with the acquisition of intellectual or motor habits and skills. The learning process has been studied, so to speak, in a social vacuum. With the subject of imitation, text-books have usually dealt casually, explaining it in terms of current theory, nativistic, 'associationist' or, more rarely, in terms of learning. Familiar phenomena are the ones most liable to be lightly passed over, and it is perhaps just because imitation is so pervasive and universal a process that its significance has been overlooked.

In the present volume we meet the first serious attempt at an experimental approach to imitation. The authors take a new path. They expound the 'reinforcement' or 'reward' theory of learning as applied to (i) learning by imitation and (ii) learning to imitate. This theory is derived directly from the studies of Pavlov, Thorndike, and Watson which have recently been synthesized by Prof. Clark Hull in his "Principles of Behaviour". Unless the reader is conversant with Prof. Hull's work, there is much that he will fail to appreciate in the present volume.

The argument follows the so-called 'hypothetico-deductive' method employed in other publications of the Yale Institute of Human Relations. In theory, this means postulating a small number of plausible assumptions from which certain principles are deduced; experiments are then designed to test whether the principles are in accord with the facts. The actual plan adopted by the authors was as follows. First they familiarized themselves with applying learning theory to social and imitative behaviour, mainly of children in everyday life. A preliminary list of relevant variables was then drawn up which were manipulated in experiments. This led to a refinement of theory, which was applied to such topics as leadership, crowd behaviour, lynching, and diffusion of culture.

Four factors are singled out as operative in learning: drive, response, cue, and reward. All these must be present before learning can take place. 'Drive' means motivation; unless the subject is impelled to act, no learning can take place at all. Likewise, the 'responses' for the act of learning must form part of the psycho-physical equipment of the learner. 'Cues' are distinctive signs which elicit the correct responses. Finally, that response is learned which has been rewarded. Reward reinforces the response by reducing the drive.

The authors distinguish three kinds of imitative behaviour which they name (rather awkwardly) 'same', 'matched-dependent' and 'copying', respectively. In 'same' behaviour, two or more persons react identically (for example, buying tickets) in response to stimulation by the same cue. In 'matched-dependent' behaviour only the leader is able to read the relevant cues, the followers more or less blindly following suit (as in crowd formation); in 'copying', however, the copier knows when his response approximates to that of the leader or model (as in learning a new language). All three kinds of imitative behaviour conform to the same hierarchical conditions. In other words, they are all expressions of subordination to others, in respect of age, status, skill, or intelligence.

The experimental results illustrate various ways in which imitation generalizes. Thus if subjects are rewarded for copying one leader and not another, they will learn to imitate the first and not the second. Imitation spreads from one leader to another similar one, from one situation to a similar one, and from one motivation to another. This is a different way of saying that the prestige of leaders generalizes to other leaders, or to other situations or motivations. None of these results is startling, but all are in accord with common sense. The cumulative evidence indicates that imitation is learned and is controlled by the social conditions which reward it.

The chapters with the most compelling interest at the present time are those on crowd behaviour and lynching. By explaining these in terms of learning theory, they are integrated within experimental psychology. This applies to the effects of all the known factors influencing crowd-behaviour, including inter-stimulation, proximity, numbers, anonymity, prestige of leaders, repetition of stimuli, 'vicious-circular' reactions, emotionality, and uncriticalness. Nearly all these are exemplified in lynching.

The analysis of a lynching helps us to understand one of the pressing problems of to-day, namely, human potentialities for organized brutality on a mass scale. We have seen from the disclosures of the concentration camps that despite deeply rooted humane traditions, a considerable number of individuals who are not psychopaths can 'learn' to execute a programme of sadism with a callousness which challenges belief. In lynching we have a comparable phenomenon, though it is of brief duration and produced in conditions of mass excitement. Thousands of peaceful, law-abiding villagers behave collectively in a way which individually they would abhor. The striking feature which emerges from both 'horror' camps and lynching is this: variation in *potential* brutality is much narrower than in *actual* brutality. Beneath the skin we are much more alike than we appear to be on the surface. Moreover, beneath the smooth civilized exterior the primitive energies are still untamed. Thus it is easier for imitation to be learned and to spread rapidly in undisciplined emotional behaviour. Imitation reduces individuality of response and increases uniformity. If we are to have a stable and humane order, we must look to the 'models of prestige' which evoke widespread imitation.

This is not an easy book to read, and not simply because it makes severe demands on the reader's capacity to follow a series of intricate discussions. Often one has to read a paragraph several times, only to be rewarded by what seems to be a commonplace. It was the authors' professed aim to make their exposition at once rigorous and informative to the non-specialist. If they have discharged the first part of their task with distinction, they have not succeeded so well in the second part. It is to be regretted that with the exception of the last two or three chapters the style of the book will limit its appeal to the specialist.

JOHN COHEN.

IN SEARCH OF RIGOUR

The Foundation of Phenomenology

Edmund Husserl and the Quest for a Rigorous Science of Philosophy. By Prof. Marvin Farber. Pp. xi+585. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1943.) 33*s*. 6*d*. net.

FROM the University of Buffalo there is beginning to flow, as from a watershed, a determined stream of philosophical enterprise, likely, given time and circumstance, to gather momentum as it goes. Prof. Marvin Farber, in this book, the latest venture of the School of Philosophy and Phenomenological Research, has put scholars everywhere in his debt for a labour of love—for and on behalf of Edmund Husserl—difficult to value too highly. It should be said at once that the author is not prepared to accept all Husserl's doctrines without reserve, nor is the nexus of students with whom he is associated ready (as he wrote to me recently) to set up a patron saint in advance to preside over their deliberations. The position is in fact wholesomely fluid. Further, there is no attempt to erect German philosophy in general upon a pedestal: on the contrary, it is found to be unsatisfactory in a variety of ways. This may be due in part to a strife of schools, all too common in Europe, but luckily seldom encountered in the United States. All that is asked is that no hasty judgments should be passed upon such a complex theme as Husserl's pattern of thought. Indeed, to be irresponsible here would be more than ungracious.

So much for the background. We are now invited to contemplate Husserl as 'historically conditioned', the founder of a scientific outlook akin to a *philosophia perennis*, albeit at the same time pliable enough for progress. Additionally, he appears with all the fire and zeal of the Hebrew prophets, in sure and certain hope that his radicalism is well founded, his mission to mankind essential. In this he resembles our own McTaggart, who used to say that the study of philosophy is the most urgent task for every thinking person to tackle, for without it our deepest cravings remain unsatisfied.

In a work so erudite as that now under review, it is agreeable to be allowed occasional glimpses of the personalities of Husserl and of those chosen few to whom was given some measure of his friendship. As a help to the reader's understanding, too, these intimacies are valuable, and are not to be taken merely as light touches. For example, the word-portrait of Brentano, at once sacerdotal and learned, brings vividly before one the deep impression that his lectures must have made upon Husserl, and how he determined to forsake mathematics forthwith (in spite of having worked with Weierstrass) in quest of a truly rigorous philosophy.

Much of the text is of necessity devoted to critical surveys of such monumental works as the "Philosophy of Arithmetic", "Prolegomena to Pure Logic", and "Logical Investigations". Of these it is scarcely profitable to attempt an analysis here; preferable perhaps to select a few outstanding features of Husserl's work as a whole, and to discern his purpose. One such characteristic is his ability to make or discover distinctions. It is a major concern of the phenomenologist. Physically, it is akin to using an optical instrument of increased resolution rather than one of extreme magnification. The master's Freiburg period demonstrated this, when someone at his lectures remarked that to sit under him was to find 'new eyes' in philosophy. As a corollary, a warning hand is laid upon the artificial simplicity, so beloved of the superficial and the slick. Complexity rather than the reverse is to be expected: yet a foundation of experience is seldom lacking.

Again, Husserl seems to hark back to his earlier mathematical substratum in stressing the power of the conception of invariants. This now means much more than a method of dealing with transformations; it connotes the 'necessary general form' of all constructive thinking.

Of all the ways which Husserl follows in order to distil his purest thought, perhaps the most remarkable is the establishment of the *epoché* (ἐποχή). He proposes this in place of the universal doubt of Descartes. Thus the world is eliminated (*ausgeschaltet*); which done, transcendental consciousness remains as the phenomenological residuum. The act of so-called 'bracketing' is probably not exactly what the English mind is intended to understand by it. Rather we might think of such judgments as 'waived', since by this term is suggested the possibility of switching in again when the particular need for the process is over. Husserl would probably never have gone so far as to suggest that his eliminated quantities were entirely beyond recovery.

Time and again we find the philosopher in the evening of life returning to the fray, clarifying and deepening his message, yet never doubting that his system contained within itself the essentials of a pre-suppositionless structure, unrelenting in radicalism and veneration for rigour.

Husserl was not to escape some of the barbarities of the Third Reich. Declassed and ignored, he was nevertheless able to write "I prove *sub specie æterni* my right to live". F. IAN G. RAWLINS.

COMPARISON OF ENZYME AND IMMUNE REACTIONS

Immuno-Catalysis

By Prof. M. G. Sevag. Pp. xv+272. (Springfield, Ill., and Baltimore, Md.: Charles C. Thomas; London: Baillière, Tindall and Cox, 1945.) 4.50 dollars.

NEAR the end of the nineteenth century, Ehrlich first directed attention to the similarity between enzyme and immune reactions on the basis of their highly specific character. "Immuno-Catalysis" examines this similarity in the light of modern work, and, further, puts forward a detailed case to support the view that the formation of a specific antibody in response to the introduction of a given antigen fulfils all the criteria of enzyme-catalysed systems, suggesting that antigen (catalyst) merely directs the formation from serum globulin (substrate) of antibody (product), which in the immune reaction acts as a specific enzyme inhibitor.

The work is divided into five parts entitled: Part 1, antigens as biocatalysts; part 2, antibody as a specific enzyme inhibitor; part 3, anti-enzyme immunity; part 4, immunity against bacterial enzymes; part 5, the problem of antibody formation against respiratory enzymes. Part 1, in attempting to decide upon the mechanism of antibody formation, necessarily deals with the chemical and physical properties of antibodies and their relation to the serum globulins, with the different theories of antibody formation, and makes some mention of the problem of serological specificity. It is shown that the available evidence favours the idea of the enzymatic action of antigen in stimulating antibody formation.

Part II is concerned, in detail, with the factor of specificity in immune and enzyme reactions, discussing the well-known work of Landsteiner, Avery and others using modified antigens, and with the analogy between enzyme inhibition and antigen-antibody association. Although Parts 1 and 2 contain a strong case for the antigen-catalysed formation of antibody and for the inhibitory action of antibody in the immune reaction, I feel that the case could in parts have been improved by the omission of some of the elementary material, for example, Section B of Part 1 dealing with simple types of chemical reaction, and by a more expanded treatment of the lesser known aspects of immunity, such as anti-antibodies.

Part 3 deals in detail with the question of anti-enzyme immunity, discussing the objections to the existence of anti-enzymes and the importance of non-specific adsorption of proteins, as well as the effect of pH change on enzyme – anti-enzyme combinations. The remainder of this part, and also Parts 4 and 5, form a collection of experimental data on the formation of antibodies and immunity against different enzyme systems. Although the critical analysis and presentation of all relevant experimental data is essential in establishing the nature of antibody formation and reactions, it is felt that this part of the work might well have been separated as an appendix from the main arguments which occur in the first half of the book.

The book is well supplied with references, has a good index (index and references occupying more than forty pages), and is well produced. It should be useful to specialists and non-specialists alike.

P. JOHNSON.

THE IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

THE Imperial College of Science and Technology came into existence as the result of the federation of three colleges already established in South Kensington, namely, the Royal College of Science, the Royal School of Mines and the Central Technical College of the City and Guilds of London Institute. One of these, the Royal College of Science, and in particular its Chemistry Department, may be said to have originated in the Royal College of Chemistry which was opened in George Street, near Oxford Street, in October 1845 (see p. 524). Thus although the Imperial College of Science and Technology was not incorporated by royal charter until 1907, this year is appropriately regarded as the centenary of the College, and it was marked by a great gathering in the Albert Hall on October 26, attended by their Majesties the King and Queen, the Chancellor of the University of London (the Earl of Athlone), and the Vice-Chancellor (Prof. D. Hughes Parry).

Lord Rayleigh, chairman of the governing body of the Imperial College, surveyed briefly some of the activities of the College; his full address is printed elsewhere in this issue (p. 520). His Majesty the King, whose words were broadcast by the B.B.C., then spoke:

THE Queen and I have listened with special interest to the account which Lord Rayleigh has given of some aspects of the work of the Imperial College since its foundation. His position as a former professor and as chairman of the governing body qualify him to speak of this subject.

We have heard something of the way in which the College has carried out the intentions of those who shaped it. I speak now as its Visitor, and as its Visitor I recall the interest taken by my family, not only in the Imperial College since its foundation in the reign of King Edward VII, but in its three constituent colleges ever since the first beginnings which we celebrate this evening. The Royal College of Chemistry, at its inception in 1845, had as its president my great-grandfather, Prince Albert. He showed the same concern for the well-being of de la Beche's School of Mines, and as president of the Royal Commissioners for the Exhibition of 1851 he gained for science and the arts that great site on which, with other institutions, the Imperial College now stands.

It is, I think, now generally accepted that the idea of the great International Exhibition of 1851 was started by the Prince Consort personally, and that he took a large share in carrying it out. At the time, it had to face serious opposition in the Press, and while a Royal Commission took formal responsibility, the industrialists hung back and did not give the necessary support. The Prime Minister, Lord John Russell, had anxious consultations with his colleagues, and as a result it was arranged that Dr. Lyon Playfair should become a 'special commissioner'. The Prince had some slight acquaintance with Playfair and, before appointing him, means were found to improve it. Eventually the Exhibition was a financial success, and left a large surplus in the hands of the Commissioners, which they spent (mainly at the instance of the Prince and Dr. Playfair) in purchasing the South Kensington site.

Lyon Playfair, the Queen bids me remind you, bore the name of her family, with which he was connected through his mother, Margaret Lyon: and indeed his school holidays had been largely spent in the manse at the Queen's old home, Glamis Castle. As Lord Rayleigh remarked in passing, he heads the distinguished list of your professors of chemistry, having held that position in the Government School of Mines, prior to its incorporation with the Royal College of Chemistry.

But while it is interesting thus to recall the past, my own concern as your Visitor is with the Imperial College of to-day, and as your Visitor I take pleasure in the contributions it has made to total victory. Lord Rayleigh has touched on some in the fields of applied entomology and preventive medicine, and I am well aware that he could—had time allowed—have pointed to equally impressive victories won by your other departments in other fields. I know that the success of our D-day invasion was in great part due to engineers trained in your City and Guilds College, and I know, moreover, that Imperial College has contributed to victory not only by research but by its training of men who go from it to all parts of my Empire. Thus we have heard much, lately, of uranium; for rare materials such as this, no less than for commoner sources of power like coal and oil, the search goes on unceasingly throughout vast areas, and many of those who carry it out have received their training in the Royal School of Mines.

Justifiably we take pride in the achievements of British science and technology during these last years of total war. But with that pride is mingled apprehension, as we reflect on the ever-increasing power that science is giving to a world so prone to use power for evil ends. The atomic bomb, especially, gives food for sombre thinking: it greatly reduced the toll of human lives in the war now ended, but dare we hope that this new discovery will henceforth be controlled for the general weal? I say to you students here assembled—men and women who will soon be going out from Imperial College to your work in the world—on you and others of your generation rests a burden of responsibility greater than men of science have known before; not only to apply your knowledge and training to the service of mankind (that has been done, and well done, by generations that have preceded you), but so to act in the light of that knowledge and training that science may not again be used to destroy.

Dr. R. V. Southwell, rector of the Imperial College, made the following reply :

It falls to me to render to Your Majesty—speaking both for staff and students—most hearty thanks that you, our Visitor, have been pleased to grace this celebration with your royal presence. That Her Majesty has been pleased to accompany you completes our happiness—and gives, perhaps, especial gratification to women members of a college in which, though at all times outnumbered, they have never seen themselves as a 'forlorn hope'. Thrice within living memory we have had proof of royal interest in the growth of our constituent colleges : never before have we been favoured with the presence both of our King and Queen.

To deserve that interest and favour has been and will be our aim. Your Majesty has spoken of our history, and of famous men that we delight to praise : though that history is short by English standards, it is a history of which we think we may be proud, and we believe that its last six years—when their story can be told—will not be judged unworthy of the years that have gone before ; and because we think our College has contributed not unworthily to victory in war, we are hopeful that in years to come it will further no less worthily the ends of peace. Your Majesty is served with equal loyalty in diverse ways : our best service, as we believe, will be to spend our energies in promoting science and technology by study, teaching and research.

I have not thought it would be your pleasure to hear from me the tangled story of our evolution. Reviews that aim to be exhaustive are apt as well to be exhausting, and I would beg leave now for only one remark. It is a happy feature of that story that it starts from an act of Your Majesty's great-grandfather; its second chapter now begins with this mark of Your Majesty's favour. It was the Prince Consort who in 1845 presided over the council of that College of Chemistry from which, by a line occasionally devious, the Imperial College traces its descent ; it was by his personal intervention that von Hofmann was secured to be its first professor ; and it was he who in 1846 laid the first stone of its new building in Oxford Street : a stone that lies here, waiting to be again embodied in our chemistry buildings. It was his unsparing effort that ensured success for the Exhibition of 1851, and thereby the means of realizing his own far-sighted vision of a great metropolitan centre for the promotion of the sciences and arts. No college owes more to its founder than ours to him.

Had his wide views been general, our problems now would be less hard ; for then on his splendid ground-site, buildings would have risen in ordered sequence, and Imperial College, chartered in 1907, would have been a federation of colleges that not only were adjacent in the fields of science but lay within the same London borough. As has turned out, though two have buildings that adjoin to form a well-placed whole (and here I would recall that the first stone of each was laid by Your Majesty's grandfather, as Prince of Wales in 1884 and in 1909 as King Edward VII), the third—our Royal College of Science—has its departments scattered widely. It is our hope that not many years will pass before it too has buildings that conform with an ordered plan ; but the time has still to come, and as yet we have no place where we may beg Your Majesty to lay this stone, that it may rest from its wanderings. Yet we have craved that some record may remain within our College—to be seen by those that will come after—of Your Majesty's presence with us here ; and to that end we have started to prepare a book, to tell of our College's origins, of its evolution in the hundred years now ended, and of what was done to mark this first centenary. It will tell as well of the appeal that we have made in recent months for funds wherewith to foster, in the future, a fuller and more corporate college life ; and it will record the names of donors who have responded. We would beg Your Majesty to append your name to this record as our Visitor, so that men of our College may read, in years to come, of the signal favour shown to us this evening : favour for which all we who are here assembled tender to Your Majesties our humble and hearty thanks.

We print below some tributes to the influence of the Imperial College, which we have received from distinguished senior members of the College :

Sir Richard Gregory, Bt., F.R.S., Editor of *Nature*, 1919–39 :

When I went to South Kensington in 1886 it was as a 'science teacher in training' at the Normal School of Science, now the Huxley Building of the Royal College of Science. As the original name signifies, the school was a place for the practical training of teachers in elementary science, so that they could conduct courses of instruction in day and evening classes under the Science and Art Department. In physics, the first year's work consisted almost entirely in the making of apparatus, from thermometers to galvanometers, with the necessary linear or angular graduations for measurements with them.

To those of us who intended to become science teachers, this course was admirably suited ; for in those days few ready-made physical instruments were available in any schools. Vernon Boys, who was in charge of the physical laboratories, was thus able to impress upon hundreds of students the value of making use of the simplest materials in the art of experimentation, of which he was an acknowledged master throughout his life.

This was also the spirit of the completed course of physics (Parts II and III) which I took with Prof. Boys, while he was producing the extremely fine quartz fibres for use in physical instruments. Its purpose was not so much to load the mind with facts as to stimulate independence in methods of scientific research. While I was taking the advanced course, Prof. (afterwards Sir Arthur) Rücker was appointed to the chair of physics at the College, and it was he who began the developments of the subject to the high university standard in teaching and research for which the College is now world-renowned.

As one of the oldest students of the original Normal School of Science, I welcome this opportunity of paying grateful tribute for what it did to give us sound ideas on scientific methods and meanings. We were justly proud of the school in those days of Victorian science and were given additional honour when it became the Royal College of Science, and later a constituent part of the Imperial College of Science and Technology.

After my student days, my direct association with the teaching of research was as an assistant to Sir Norman Lockyer in the Department of Astronomical

Physics and the Solar Physics Observatory. This determined my whole career, for in 1893 I became Sir Norman's assistant on the staff of *Nature* and succeeded him as Editor in 1919. With these early recollections in mind, and knowing the high scientific standing of the members of the staff of the Imperial College since my days, it would be almost a presumption for me to add my testimony to its greatness. I shall, however, always cherish in my heart the influence the College has had on my life, and entertain with pride the feeling that I once played a minor part in the work of a branch of this great centre of scientific learning and research.

DR. W. H. ECCLES, F.R.S., formerly professor of applied physics and electrical engineering, City and Guilds of London Technical College:

In the closing years of the nineteenth century, when I was admitted to the Royal College of Science, I found it a well-established and bustling community. Nearly all my fellow-students seemed to be remarkably mature and responsible beings who had already had experience in science-teaching, in works or in laboratories. They, rather than the staff, created the atmosphere of the College, which might be described as one of altruistic utilitarianism; many of them were reading science in order to assist industrial progress, each in his original walk of life. Moreover, the wise men who had made the College syllabuses had fostered this atmosphere in advance by ensuring that the instruction should be on a Baconian not a Platonic basis.

Active discussion with one's fellow-students showed that this strong orientation toward usefulness intensified the desire to read 'pure' science, a desire which merely gave expression to the spreading opinion that the important changes in industry would henceforth come from accurate measurement and the scientific method rather than from the method of the craftsman, and that new processes and even new industries could spring only from new scientific discoveries. Men like Armstrong, Judd, Huxley and Magnus had been preaching this doctrine for some twenty years, and had aided in setting up at South Kensington not only the Royal College of Science, but also the School of Mines and the Central Technical College of the City and Guilds of London Institute, all of which are now components of the Imperial College.

The gratitude I feel for my five years of opportunity at the Royal College of Science (plus occasional lectures at the Central) is deepened by the assessment I obtained there of the functions of science in the modern world. A new and broader meaning was given to the word 'technology' which, according to the dictionary, is the 'science of the industrial arts', but which now appeared to be 'science *for* the industrial arts, existing and to come'. If only there had been at the Royal College of Science research courses in the application of modern science to problems in nascent industries, I should have departed even more indebted to the College; as it was, I became one of Marconi's assistants and was launched on the practical world in that way.

Looking back at the careers of my contemporaries at the College, I find that nearly all of them took up the task of introducing science, in one way or another, into industrial affairs; I know of many who have done much for industry. May the modern Imperial College be increasingly successful in moulding such pioneers.

SIR WILLIAM JARRATT, formerly Comptroller-General of Patents, Designs and Trade Marks:

It is an appreciated privilege to be allowed to join the chorus of congratulations on the Imperial College centenary celebrations. During the years 1887–90, when I was a student at the College, the changes that were occurring included the amendment of the name and status of the Normal School of Science to the Royal College of Science, and I well remember my delight that my leaving certificate was signed by that great controversialist Huxley, the dean of the School and College, and by the founder and first editor of *Nature*, Sir Norman Lockyer, better known to readers of *Punch* as 'Noman Luckier'.

In those years research posts, either in industry or at universities, were not plentiful, and in consequence many students became science masters or took posts in the Civil Service such as Patent Office examinerships. With Government encouragement, however, the importance of research became increasingly recognized, and more students availed themselves of the opportunities to follow up scientific research. It is a matter for congratulation that during this development the College authorities have never ceased to recognize that side by side with scientific research, long-term or otherwise, the industrial development and the social conditions of Britain necessitate the application of the results of research, and that this industrial application is stimulated by a strong patent law such as we fortunately possess. The best results from scientific research can scarcely accrue to the State without some such form of guarantee to those enterprising industrialists who take financial risks in applying to industry the results of research.

As the years have passed it has been a pleasure to watch the steady development of the College and its increasing influence among the forces that have retained for Great Britain its position in the forefront of scientific progress. I desire to congratulate heartily the College authorities on their magnificent record.

CONTRIBUTIONS OF THE IMPERIAL COLLEGE TO THE CONQUEST OF DISEASE*

By the RIGHT HON. LORD RAYLEIGH, F.R.S.

ON an occasion like this it is natural to take stock of the work we and our predecessors have been able to accomplish since the first beginnings of the College a hundred years ago. But this work covers so wide a range, and so many different specialities in all branches, from physics and engineering on one side to zoology on the other, that in the course of a short address one cannot even glance at all aspects of it. Looking for some fairly comprehensive topic to which a good many of our departments had contributed, I was struck by the victories which had been won over the agencies of disease. It might appear at first sight that this was a matter of medical science, with the obvious comment that none of our departments deals with that subject. Important though the medical applications are, these investigations have been developed rather from the point of view of physics and chemistry. But there is no need to emphasize professional aspects of this kind.

* Introductory address for the Centenary Celebrations on October 25.

These problems are so vital to all of us that we must use any and every method to solve them, and accept help from any quarter. The civil engineer would at one time have said that entomology had nothing to do with him. Nevertheless, he was defeated in the attempt to make the Panama Canal until he had accepted the help of the entomologist in dealing with yellow fever, and the mosquitoes that transmit it.

Our efforts have recently been concentrated on overcoming our human enemies. Formidable though these have been, there is another class of enemies whose methods are very different, but whose fundamental purpose is for the most part the same, namely, to promote their own well-being at the expense of ours. They are to be found among certain of the lower forms of life, the microbes, which are primarily responsible for fevers and infection, and the insect bearers of disease, which play an equally important if not quite so insidious a part in conveying the microbes to the scene of action. It is only in modern times that these enemies have been recognized as such: and even now many people talk glibly about microbes with little or no understanding of how we have learnt that they are of the essence of disease, that they are in the food we eat, the water that we drink, and the air we breathe. Not only are the lower forms of life constantly lying in wait to attack life and health, but they are also formidable competitors for our food supply, and can rarely be altogether prevented from taking their toll of it.

The late Sir Alfred Keogh, director and reorganizer of the Army Medical Service, and afterwards rector of the Imperial College, told me an incident which may serve to illustrate this. The scene was the Army Council, of which he was, of course, the only medical member. He urged the introduction of certain hygienic measures, explaining briefly the reasons for them. Not much was said by his more purely military colleagues, but one of them, a general who had distinguished himself greatly in the South African War, came up to him afterwards and said: "I was very glad to support you in what you wanted done; but, tell me as man to man, do you really believe in microbes ?" Keogh, rather at a loss for words, could only insist on his coming to see them for himself.

I will now try to sketch in outline how this belief gradually forced itself on the scientific world, illustrating the story as far as possible by the investigations made in the Imperial College.

It had become widely recognized that the spread and multiplication of fever cases had many points of resemblance to the spread and multiplication of living beings. Thus each species of plants or animals multiplied according to its own kind; and fever cases did the same. Smallpox gave rise to smallpox and to nothing else; typhoid fever gave rise to typhoid fever and to nothing else. The infection starting from a single case could give rise to an unlimited number of others, and putrefaction was one single phenomenon, whether it occurred in the wounds of the living, or in dead bodies of men or animals.

On the other hand, observation seemed to show that exposure to the air was the essential condition for putrefaction. For meat broth, boiled to expel air and sealed up in glass flasks, would remain clear and free from putrefaction for an indefinite period. If the sealed flask was opened to admit air, putrefaction quickly set in. The same thing is now familiar to everyone in cans of tinned meat. This remains good indefinitely until it is opened and the air is admitted. These contrasting facts appeared to Tyndall's generation very contradictory. There appeared to be no doubt that putrefying animal matter was swarming with life, for it could be observed under the microscope that this was the case; and since there was no obvious source for this life to have come from, many were of opinion that it must have been generated in the putrefying matter. This question was, in fact, whether there was spontaneous generation of life or not. No question could be of greater importance. It was urged by some that since life existed on the earth, it must have come into existence since the earth was formed; and if this had happened once, it was reasonable and in accordance with the scientific habit of mind to assume that it would happen again in similar circumstances: and they thought it obviously did happen under observation when meat became putrid. Tyndall, however, was not satisfied by this reasoning; and I will try to give an account of his contribution to the subject.

In his researches on radiant heat, and in his experimental lectures at the Royal Institution and at this College, he had been in the habit of making use of the electric arc to throw out a concentrated beam of light, and he observed how the track of the beam could be traced by the way in which it illuminated the dust particles in the air. Most of us are now pretty familiar with this, because of the searchlights used in war. It was not so commonplace then, and I may recall that the only source of current for the electric arc, or at any rate, the source in general use, was a primary battery of forty or fifty Grove cells, very tedious and troublesome to set up and maintain. Tyndall tried whether he could not get rid of the dust in air. He found this difficult at first, but ultimately succeeded by filtering the air through tightly packed cotton-wool. When he did this, he found that the track of the beam became invisible, and the air through which it passed was, as he expressed it, optically empty.

He prepared specimens of broth from various kinds of meat and fish, and boiled them in order to kill any living matter they might contain. Then he found that such broths would putrefy when they were exposed to ordinary air, but not when they were exposed to air which had been freed from dust, and which showed no motes in a concentrated beam of light. Ordinary air caused putrefaction. Dust-free air did not. These simple tests went far to resolve a great and fundamental question. The putrid broth which had been exposed to the open air was soon found to be swarming with living matter, visible as such under the microscope. Where did it come from in the first instance ? Was it generated in the liquid ? That was the opinion of one prominent school of thought; but Tyndall's experiment showed that if all living matter was killed by boiling, exposure to the air would not generate any more. Life only comes from life, and however much appearances may at first sight suggest the contrary, it is not generated anew under our eyes.

Tyndall's researches ran to a great extent parallel with the famous investigations of Pasteur, with whom he was in touch. Without prejudice to workers elsewhere, we on the present occasion naturally dwell on the contribution of our professor, made by a method entirely his own, which led him to important discoveries in other directions also; for example, the artificial imitation of the blue sky, and its optical peculiarities—far enough, one might think, from problems of infection, disease and the origin of life.

Bacteria are not only very small, but also they are colourless, and it is only after they have been stained that it becomes reasonably easy to investigate or even see them. It is found that one class of bacteria will take up one class of stain, exemplified by methyl violet, and other bacteria will take up a different class of stain, exemplified by fuchsin, which is red. The reason for this is somewhat obscure, but whatever the reason, the fact is very helpful in distinguishing between the various bacteria. I have entered on this subject because I wished to recall that the aniline dyes used for this purpose, and also for such minor purposes as colouring our clothes, carpets, curtains, cushions, had their origin in this College in 1856, when W. H. Perkin discovered mauve. He was not a professor, but a student under Hofmann, and was only eighteen years old. He immediately took the matter up commercially, though Hofmann did not encourage this, and Perkin himself had never even been inside a chemical factory before. It sounds like a fairy tale, but he made a fortune out of it, and retired to pursue his studies in pure science.

I have mentioned methyl violet and fuchsin. These were among the discoveries of A. W. Hofmann, who succeeded Playfair as professor and by whom Perkin was trained. It may be a little confusing to be told that the first aniline dye was discovered by the youthful pupil and the later ones by the professor, but so it was.

The famous name of Hofmann, who was brought here by the personal influence of the Prince Consort, leads to another aspect of our main topic. Much anxiety had been caused in the early sixties of the last century by the questions of the purity of water supply and of the disposal of sewage. Pure water in great cities is now almost taken for granted. This has not always been so. When Catherine of Aragon came to England as a bride, she was warned not to drink water in England as it was not fit to drink, and as regards the low-lying land of the southern counties this was doubtless quite true. Coming to a much later period, I can remember, probably about 1885, when I made as if to help myself to a glass of water in the waiting room at Liverpool Street Station, that I was warned never to drink water in such places! The warning may have been somewhat out of date, but not by much, for surface wells were still in use in some parts of central London as late as 1867, when the water from them was found on analysis to be disgustingly polluted, and quite unfit for human consumption.

Hofmann first gave attention to the subject of water analysis at the same time that he was at work on the aniline dyes, but he had scarcely got his teeth into the problem before he left Britain for good and was succeeded in his professorship at the College by Sir Edward Frankland, who took up the question with great vigour, and examined anew for himself the various methods of analysis which had been in use, with the result that he found that on some of them, at least, little reliance could be placed.

I ought to explain more clearly what is meant by water analysis in this connexion. We are not, of course, speaking of mineral or medicinal water but merely of drinking water; and the vital question is, Has it been contaminated by contact with foul matter? Very little definite was known about micro-organisms at that time. But Frankland already considered it more than probable from the history of past outbreaks of typhoid fever in various places that the infection could be carried by drinking water, and that a specific poison associated with this disease must exist. For bad though the position was, it was only exceptional specimens of foul water that gave typhoid fever, so that foulness was not enough by itself. No one, however, knew at that time what this agent was, or how to test for its presence; and indeed, we have no very practicable direct test of this kind even now, though we understand a great deal more about what the source of mischief is and how to guard against it.

In the absence of a direct and easy test as to whether the water is actually infected, we have to fall back on indirect tests as to whether it has been exposed to contamination, and these are found in seeing how far the water contains ammonia and nitrates. These substances are harmless enough in themselves, but they contain nitrogen, and as Frankland proved in detail, it is usually pretty certain that they got their nitrogen from highly undesirable sources. So an analysis for these tells us a great deal as to whether the water can be trusted.

Having established these and other methods, he put them extensively into practice, and examined the water in London and in various parts of England. The result was broadly to confirm that there was a very great difference between surface water from the Thames and Lee Valley for example, and that from deep wells sunk in the chalk or the greensand. The test of analysis on the lines explained showed that the shallow-well water in the Thames Valley, though it might look and taste quite good, was really little better than filtered sewage.

The idea prevails rather widely that we can readily decide whether a sample of drinking water is safe by looking for the presence of typhoid bacilli. Unfortunately, to look for the typhoid bacillus in drinking water is like looking for a needle in a haystack. It might succeed in the case of extreme contamination, but it is not easy enough or certain enough to be a practical procedure. Bacteriological examination is of the greatest value, but like the chemical methods it only leads to general conclusions, and by no means supersedes those methods.

The development of our knowledge of bacteria is by far the greatest contribution ever made to the study and prevention of disease; for it has given us not only the modern mastery of infectious diseases, but also has made possible the great advances in surgery. I have tried to bring home to you that our College has had its fair share in their development. But we must now turn to another subject, kindred to this one, and of comparable importance. That is the control of insect pests.

Man flatters himself that he is the 'Lord of Creation'; but the insects do not show themselves impressed with this point of view, and usually go on their own way, hostile to man, and treating his pretensions with very little respect. It has always been known that some species, such as the scorpion and the tarantula spider, might on occasion be dangerous; but it is only in comparatively recent times that we have understood how many and how formidable are our enemies in the insect world.

The man of science feels intuitively that definite facts about Nature always have their value, but he does not always find it easy to convince the man in the street of this. If there was any branch of science where it appeared difficult, it was perhaps in entomology. The insect pests are our enemies in innumerable ways. We have only just begun serious warfare against them, and the successes which have been won in the last few decades are but a fraction of those that may fairly be expected in the decades to come; moreover, our victories over them have a permanence and finality that cannot be hoped for in victories over human enemies. The great strength of our insect enemies has been that for long we did not understand that they were our enemies at all. That lesson once learnt is not likely ever to be forgotten while our civilization endures. But it was not learnt easily. The critics who make merry at the expense of scientific pursuits have seldom been more confident or more utterly wrong than in this instance. For example, Thomas Shadwell, a well-known playwright, published in 1676 a play called "The Virtuoso", in which he satirized the naturalist of the day as Sir Nicholas Gimcrack, whom he described as follows: "A coxcomb, he has studied these twenty years about the nature of lice, spiders, and insects . . . no man upon the face of the earth is so well seen in the nature of ants, flies, humble bees, earwigs, hoglice, maggots, mites in cheese, tadpoles, newts, spiders, and all the products of the sun by equivocal generation. This foolish virtuoso does not consider that one bricklayer is worth forty philosophers".

We know now that malaria is transmitted by anopheline mosquitoes, dysentery by the common house-fly, typhus by the louse and plague by fleas. The case of mosquitoes and malaria is of special interest, because it is not just any mosquito but the particular species of anopheles which is recognizable by 'walking on its head'. The recognition of facts like these is in the process of conquering the tropics for civilization, and I think we may fairly claim that it has been proved that if anyone is a 'coxcomb' it is not the naturalists who concern themselves with these insects, but the critics who affect to despise them for doing so. I do not say this in any spirit of self-complacency, having myself, many years ago, been unsympathetic to a friend who concerned himself with the close study of fleas infecting various animal species.

In view of facts like those I have mentioned, the Zoology Department of the College under Prof. J. W. Munro has, of recent years, paid special attention to the subject of economic entomology, and has built up a large body of knowledge about insect pests and how to combat them; and when the War came its staff and resources have been used to the full in protecting stocks of grain from insects and rats, and in combating the mosquitoes, flies, and other even less pleasant insects which infect our troops with malaria, yellow fever, sleeping sickness, typhus and plague.

Typhus, there is good reason to believe, killed more people than all the weapons of war during 1914–18. We can scarcely say as yet whether a similar statement would hold for the present War; but most people find it difficult to realize the true bearing of facts of this kind. Many, it may be suspected, picture the horrors of war mainly in terms of bayonet charges and the like, as in the pictures of Napoleon's campaigns; and, indeed, these are arresting enough: but they only show a minor aspect of the terrible reality. The louse, we now know, is far more deadly than the bayonet.

The successful attack on insect pests has, however, depended to a great extent on the possession of a suitable insecticide to use against them. Supplies of pyrethrum were largely cut off by the entry of Japan into the War, and attention was turned to a new insecticide, D.D.T. Neither this substance itself nor the application as an insecticide is entirely new, but its value has been explored much more fully than before, and it has been used on an unprecedented scale. It is practically without smell, and is very persistent. Thus, when sprayed on walls at a suitable concentration it kills any fly alighting on them up to a period of three weeks. A bed sprayed with it is fatal to bed bugs for three hundred days, and clothing dusted with it is safe from lice for a month, even after several launderings. Impressive though these results are, it is not claimed that D.D.T. is a final solution of all insecticide problems or that it puts all other insecticides out of court.

As we have seen, the insect pests in many cases convey dangerous or deadly infection by their bite, and as we have seen, much is being done to cut off the sources of infection as well as to destroy its insect conveyors. It cannot, however, be claimed that full success has yet been attained in either direction, supposing that the invader has got past our defences, and has effected a lodgment in the human body. Can we still hope to attack him? Obviously this is a much more difficult matter, and for long it appeared almost hopeless. We can attack micro-organisms or insect enemies with all sorts of more or less poisonous disinfectants such as carbolic acid or D.D.T. when they are outside the human body, but when they have effected a lodgment inside it their position becomes far stronger; for we cannot in general attack the enemy without endangering the friend in whose body he has ensconced himself. You see, then, how difficult the problem is. Light has come from the recent development of penicillin, which while harmless to the patient is poisonous to the invading micro-organisms. Penicillin is the product of a plant mould, and the romantic circumstance is that nearly all the penicillin in use, which is saving lives and relieving anxious hearts all over the world, is the progeny of the single small spot of penicillin mould originally observed by Sir Alexander Fleming. The preparation of concentrated penicillin from it is a matter of no small technical difficulty, and with this and the question of its chemical nature our Organic Chemistry Department under Prof. I. M. Heilbron is vigorously occupied. But our hopes go much further than this. Penicillin is obtained at present from the natural plant source, just as, for example, indigo and a host of other economic products were obtained from plant sources. There is, of course, the difference that indigo is grown in the fields, while penicillin is grown in bottles. But indigo is now made in the chemical factory instead of being obtained from the plant, and the hope is that penicillin may also be produced synthetically, and much more easily and cheaply than now.

Before we try to build up the structure of the penicillin molecule we must, in the first place, have an accurate knowledge of its ultimate composition. That is to say, we must know what kind of atoms, and how many of each, go to build up the structure. That step has now been achieved, but it is by no means enough in itself. To picture what a house is like it is not enough to know what quantities of bricks, slates, timber and so on have been used in building it. You must know how they are arranged. You want an architect's plan. That is what we are trying to make for the penicillin molecule. When the elucidation of the plan of the penicillin molecule made by Nature in the plant has been completed, it will in all probability be possible to build up the same structure in the laboratory by the methods of synthetic chemistry, and even to go further by modifying the structure so as to extend its applicability.

THE ROYAL COLLEGE OF CHEMISTRY

By Dr. E. FRANKLAND ARMSTRONG, F.R.S.

THE centenary of the founding of the Royal College of Chemistry in October 1845 is an occasion on which we may well take stock of its influence on the progress of pure and applied chemistry in Britain.

The story of the hundred years is a story of men and not of laboratories—of professors and disciples, of enthusiasm and of hard work for its own sake. Laboratories are never large enough or sufficiently equipped—perhaps in Britain they never will be—but the great man rises superior to his physical surroundings or handicaps and the student is surely all the better fitted to face the future when not pampered. Latent powers are best evoked by sufficient severity of circumstances, as the long history of our race bears abundant testimony.

In the 1840's things were changing; a nation of countrymen was slowly turning into a nation of townsmen. It was an age of movement, of traffic on canals faster than the coaches on the roads, and on steam railways faster still. It was an age of wheels, wheels at the pit head, spindles in the cotton and woollen mills. The pace of life was quickening on every side.

In 1842 all England was agog: that great man Baron von Liebig was on tour in the industrial Midlands and North. The tour was personally conducted by none other than Lyon Playfair, who took care that Liebig should meet the most influential people and impress on them the national importance of the new science of experimental chemistry. Such a triumphal tour made its influence felt in all the chief centres of Great Britain. At the end of his visit, Liebig is reported to have said "England is not the land of Science"; a hundred years later there is still very much to be done before we can claim to be entirely free from this reproach.

Liebig's tour helped to direct attention to chemistry and make it a popular science, for it must be remembered that at this time it was very seldom that any students desired to become chemists. The Pharmaceutical Society claims that the first laboratory open to students was one under its auspices with Fownes as teacher. This would be in the early '40's, and he was the author of a text-book "Fownes' Chemistry". Jacob Bell, the then president, would have made the pharmacy into an *Apotheke*—not a druggist or a fancy goods store—had he been listened to. There were already courses at University College and King's College, London, in which chemistry was taught as part of the training for other professions. The promoters of the Royal College of Chemistry sought, however, to do something new by founding an institute in which chemistry would be studied for its own sake apart from professional requirements. It was anticipated that the students who came there would make chemistry the occupation of their lives and enlarge its boundaries by research in the laboratory.

The first effort of the enthusiasts, inspired by Liebig's visit, was to attempt to found a Davy College of Practical Chemistry within the Royal Institution. This effort did not succeed, but it led to further meetings and so the Royal College came into being. Two men share the credit for its foundation, Sir James Clark, the Queen's physician, and the Prince Consort. The Prince Consort was at that time president of the Society of Arts, in the affairs of which he took an active part, often presiding at council meetings. His contact there with men of science must have supplemented his personal interest in these matters and he was eager to lead the nation to take science seriously. But a new college of this kind could not have been created unless there had been a strong popular feeling in its favour. All depended now on securing the right leader. The advice of Liebig was sought; Fresenius and Will both refused, Hofmann was dubious about accepting, as failure of the new college would retard his career in Germany. Once again the Prince Consort intervened, and it was thanks to his efforts that Hofmann was given two years leave of absence from Bonn so that he might, if necessary, at once re-enter on his career in Germany. The choice was a happier one than anyone knew. Hofmann became not only the greatest research leader of his day; he evinced many other attributes which contributed to the success of the new enterprise.

Hofmann made a start in the temporary laboratories at George Street, Hanover Square, in October 1845. A year later it was possible to commence work in the new building in Oxford Street backing on Hanover Square. There were twenty-six students in the first course, among them E. C. Nicholson, F. A. Abel and, above all, Warren de la Rue, who more than anyone else helped Hofmann. Others were Henry How, Thomas Rowney, C. L. Bloxam, Robert Galloway.

The second batch of students brought thirty-seven more, including C. B. Mansfield and George Merck, F. Field, H. M. Noad, Bransby Cooper and John Blythe. It is to be noted that Hofmann's rising fame soon attracted his own countrymen to his laboratory, particularly as his private assistants, who included Peter Griess, the discoverer of the diazo reaction, and Martius. Other distinguished names of this early period were Crookes, Spiller, Tookey, Reginald Morley, Groves, Ansell, Church, Matthew Johnson, H. M. Witt, H. McLeod, Valentin, Barrett, Bassett, Vacher, O'Sullivan and Reynolds.

From its earliest beginning the duty of the College has been to produce men, leaders in their chosen walk in life. The professors, by their example, precept and teaching, encouraged a progeny keen on enlarging the boundaries of knowledge, able in their turn to teach and inspire a later generation. Science for its own sake, unfettered and unrestricted, must still be the keynote of its activities, even though to-day science has its practical applications to the daily avocations and health of the people and in the development and progress of industry. Unfortunately, the nation at large is barely science conscious, and it will remain indifferent until science, particularly scientific method, is more widely taught in the schools.

In 1851 the Government School of Mines and of Science Applied to the Arts was founded in Jermyn Street, with Playfair as its professor of chemistry. Some confusion exists about Playfair's post, which need not be discussed here. He retired in favour of Hofmann when the two colleges were incorporated in 1853 as the Metropolitan School of Science Applied to Mining and the Arts, which in 1863 had its name changed to the Royal School of Mines. In spite of the official incorporation, the Royal College maintained some measure of independent existence and continued to confer its own diploma until it moved to South Kensington in 1872, where it became part of the Normal School of Science in 1881. At the same time the departments of biology, physics and applied mechanics went there from Jermyn Street. The building in which they were all housed became known later as the Huxley Building.

In the wake of the 1851 Exhibition, and fostered by the newly created Department of Science and Art, a demand spread throughout Britain for instruction in science subjects—given mainly if not almost entirely in evening classes—among which chemistry was predominant, physics, botany and geology also attracting many students. These classes, promoted or recognized by the Department of Science and Art, were financed largely during many years by payments based on the success of the students in its examinations. To meet this demand for more advanced instruction, yearly a number of selected junior teachers of, and promising students from, recognized classes received free education and maintenance in the College after its removal to South Kensington in 1872.

In 1881 the name of the college was changed to the Normal School of Science, and in 1890 to the Royal College of Science, to mark enlargement and consolidation of its scope and functions—among which from its earliest days was a special reference to the applications of chemistry to "the Arts and Manufactures". Its students could be classified under the headings: fee-paying, exhibitioners; teachers in training (Science and Art Department); and, between *c.* 1886 and 1902, Inland Revenue and Excise (customs) officers taking either the one- or the two-year course in chemistry. The academic year was divided into two and not three terms and in each term only one subject was studied; chemistry, with some mathematics, being taken by all associateship students in their first term as the initial subject of their course.

Hofmann resigned and went to Berlin in 1865; he was succeeded by Edward Frankland. Edward Thorpe succeeded Frankland in 1885 and five years later the title Royal College of Science was born. William Tilden followed Thorpe in 1894. Frankland received the K.C.B.; Thorpe and Tilden were knighted in recognition of their services to chemistry.

The changes of name of the College are somewhat bewildering. In fact, for some thirty years, during 1851–81, there was a conflict of divergent aims and interests between the party led by Huxley and the Science and Art Department, which wanted a great metropolitan school embracing all branches of applied science, and the mining school opposition which did not want to see the development of the Jermyn Street school hampered. It was in reality a conflict over lack of space, a basic trouble which will always be true of a growing college.

On the foundation so truly laid by the Prince Consort, the edifice built by Hofmann has endured a hundred years. Founded in days when chemistry could scarcely be called a science, no fairy tale can match the wonders of the progress of chemistry and of the dye industry which it is the proud boast of the College to have originated. The torch borne in turn by Hofmann, Frankland, Armstrong, Thorpe, Tilden, Japp, Wynne, Morgan and so many more still burns as brightly. The laboratories of the Royal College have sent out into the world men who have given us clean water, dyestuffs, and brought progress to every branch of pure and applied chemistry. Those who have taught have handed the ideals on to their students, who have in time permeated to every university in the land. A genealogical tree to-day would show few chemists who do not claim descent in some way from Hofmann or one of his three successors.

Although the first discovery of benzene is properly attributed to Faraday, it was Hofmann who, needing aniline, the key substance of the dyestuff industry, for his researches and hampered by the very small yield obtainable from indigo by distillation with alkali, discovered in 1845 how to convert benzene into nitrobenzene and reduce this readily to aniline. To-day we should still regard this as the most important reaction in organic chemistry. Thereupon Mansfield was set to work on benzene in the Oxford Street laboratory, and not only separated it from coal tar and showed how it could be prepared on the large scale, but also emphasized that it could be procured to any extent from this hitherto waste product.

Very soon afterwards, the aniline colour industry came into existence with Perkin's discovery of mauve in 1856, followed soon by an anthracene industry and an azo colour industry. Synthetic dyestuffs had arrived. All these centred around the College of Chemistry—the men who made them possible were Hofmann, Perkin, Griess, Nicholson, Simpson, Maule. Hofmann did his best to raise up an English tree of organic chemical industry, and for a while it grew apace. He was perhaps the first to urge that while capital can do much, capital directed by the lights of science may accomplish much more.

One of Hofmann's talents was his faculty of gauging the powers and special qualifications of those who studied under him. All who worked with him were stirred to enthusiasm, and failure to produce results was a real personal grievance. My father has written that "he made the student his personal instrument —no one has ever been more avaricious of results and he was always carried forward by this desire". Frankland, who succeeded him, had no such tendency; he had peculiar difficulty in getting behind the students' work and finding out what had been done. Only those could work effectively with Frankland who needed little, if any, guidance. He let his students handle things for themselves and so gain an intuitive understanding of the method of discovery. His manner of lecturing was the very antithesis of Hofmann's, but his lectures were more impressive on account of the wealth of fact and the attention he gave to the experimental side. He was both a pioneer of research and of structural formulæ, and undoubtedly England's greatest chemist of his time.

In 1868 Frankland became a member of the Royal Commission appointed to inquire into the pollution of rivers and the domestic water supply of Great Britain. More than anyone else, he is responsible for giving us pure drinkable water, since he discovered that slow percolation through porous soil effected the oxidation and destruction of organic matter with great rapidity. His most famous pupil was H. E. Armstrong, who went to the College in Oxford Street just as Hofmann was leaving. Armstrong had two years and a term there, the last year or more being spent in the private laboratory working on the revision of the methods of water analysis.

Armstrong left Frankland late in 1867 to work for two and a half years with Kolbe in Leipzig. He has written that the return of a prodigal son from Germany was then a novelty; owing to Hofmann being in London and Liebig no longer an attraction, the habit of studying chemistry in Germany had ceased among English students: it set in again, but only gradually, owing to the enforced emigration of holders of research scholarships awarded by the Royal Commission of the 1851 Exhibition.

Armstrong worked first at the London Institution and then took the leading part in the establishment and development of the Finsbury and Central Colleges. His research school at South Kensington was worthy of the traditions of Hofmann and Frankland, and such men as Wynne, Kipping, Pope, Forster, Lowry, Heller, Rich, Renwick, Rodd and many others developed there. In the main, its students went into the chemical industry, and almost without exception they have distinguished themselves by playing a leading part in their chosen industry and its development.

T. E. Thorpe came to the College as its third professor of general chemistry and technology in 1885 from Leeds. Whereas his predecessors had been essentially organic chemists, Thorpe's interests lay in the inorganic and physical sections of the subject. He was a polished writer and also administrator and publicist. Thorpe had other wide scientific interests, taking part in eclipse expeditions and the magnetic survey of Britain. Some of his scientific work at the College concerned the determination of atomic weights—of silicon with J. W. Young, of gold with A. P. Laurie—while phosphorus compounds were studied with J. W. Rodger, Hambly and Tutton. He left to become the director of the Government Laboratories. Small in stature, he was a man of outstanding virility, and his example quickened the spirit of a band of devoted students and staff. Thorpe came back to the College on Tilden's retirement for three years to tide over the period until the Imperial College had come fully into being.

The Chemistry Department in Thorpe's days was housed in the Huxley Building in one large lecture theatre, two analytical laboratories designated North and South on the third floor, a long corridor-like room on the second floor facing west used for research, and several private rooms. The fittings and equipment, doubtless installed in 1872, were already old-fashioned. It is worth while pointing out how quickly a chemical laboratory grows out of date—a new one is required at least every thirty years. It is perhaps desirable to consider whether palatial and costly solid buildings should be erected for such purposes, or whether more simple structures would not be more practical and economical. They could be rebuilt every ten or fifteen years and kept continually up to date.

In 1894, W. A. Tilden from the Mason College, Birmingham, followed Thorpe. Much of his time was devoted to teaching and administrative duties, including that of dean (1905–8), and his own experimental work, largely concerned at that time with a systematic study of specific heat, was interrupted. His earlier researches had been in organic chemistry, notably the first discovery of the polymerization of isoprene to rubber, work in which M. O. Forster, then his private assistant, had a hand. Tilden's period covered a transference of the Chemistry Department from the Huxley Building to its present domicile in Imperial Institute Road: the design, construction and fitting of the new laboratories involved much of his time.

H. B. Baker succeeded Sir Edward Thorpe as professor of chemistry on the latter's retirement in 1912 and the opportunity was taken to found separate chairs of physical and organic chemistry to which J. C. Philip and J. F. Thorpe respectively were appointed in 1913. The Department was thus well equipped to deal with chemical problems arising out of the First World War, in the investigation of which it took no small share. With the return of peace, Baker resumed his study of the influence of complete dryness on the physical and chemical properties of solids, liquids and gases. On his retirement in 1932, he was succeeded by H. V. A. Briscoe, a former student (1906–9) and member of the staff, who came from King's College, Newcastle-upon-Tyne, and on the retirement of J. F. Thorpe in 1940, I. M. Heilbron of the University of Manchester succeeded to the chair of organic chemistry, the chairs of chemistry reverting to two in number after the death of J. C. Philip in 1941.

In the building up of the great school of chemistry at South Kensington, the non-professorial members of the staff had a large share: some gave long and devoted service, while others in due course accepted professorships elsewhere. Only a few names can be mentioned in the space available; those omitted are in no sense forgotten by their students.

F. R. Japp was chosen by Frankland in 1878 to take charge of the Research Laboratory which was then being established, and to devote his whole time to the supervision of the research students. In 1881 he was promoted assistant professor. Japp had worked abroad with Kekulé and Anschütz; he spent twelve years in London, where he gathered around him a large number of able and enthusiastic students, and research was prosecuted with great activity. Finally he went to Aberdeen and founded there a school of advanced chemical study.

W. P. Wynne succeeded Japp; he had been a student at the College during 1881–85, and then joined H. E. Armstrong at the Central, where for many years they were jointly engaged on studies of the constitution of naphthalene derivatives and of the many isomeric naphthalene intermediates for dyes; the manufacture of these and of the derived dyestuffs, alas, was by then largely in German hands. He returned to the College as assistant professor in 1891, but left in 1902 to go to the Pharmaceutical Society and in 1904 became professor at Sheffield.

A. E. H. Tutton came to the Normal School as a student in 1883 and, after work on the oxides of phosphorus in collaboration with Thorpe, began about 1892 the measurement and description of the crystals of organic substances prepared in the Chemical Laboratory. Self-taught in the subject, crystallography became the dominant passion of his life, and for forty years he investigated the effect produced on crystal form and physical properties by the replacement of one element by another in a series of allied compounds. In 1895 he became H.M. Inspector of Schools (Technical), Board of Education.

G. T. Morgan was a student at Finsbury under Meldola. He first went into the dye industry at Huddersfield for five years, and entered as a student at the Royal College under Tilden in 1894. There he quickly passed to the staff and began a varied research programme indicative of the width of his future interests. He stayed there until his appointment to Dublin in 1912. Four years later he went to Finsbury and in 1919 to Birmingham, becoming in 1925 the director of the Chemical Research Laboratory instituted after the War of 1914–18 as part of the

Government scheme for promoting industry on scientific lines. Morgan inspired a large number of students, a high proportion of whom went into industry; and he turned his attention continually to new fields of investigation, showing remarkable versatility. Diazo reactions of aromatic diamines; organic compounds of phosphorus, arsenic and antimony; high-pressure reactions; base exchange materials; synthetic resins; low-temperature tars, were only a few phases of his activities. Few men have done more than Morgan to carry the torch kindled by Hofmann along the highways of England, and to take chemical knowledge and scientific method into the lives of many as teacher, colleague and friend.

M. O. Forster likewise started at Finsbury, then went to Würzburg, where he took his degree and came back to the Central as Salters' Company Research Fellow. He came to the Royal College as demonstrator in 1895, being promoted assistant professor in 1902, a post he held until 1913. Forster carried out a brilliant series of organic researches from the College and was an inspiring influence there. He went to British Dyes during a troubled period, was later first director of the Salters' Company's Institute of Industrial Chemistry and four years later went to Bangalore as director of the Indian Institute of Science, where he did outstanding work for Indian science.

J. C. Philip, an Aberdonian and a pupil of Japp, studied under Nernst in Göttingen, and after a year with H. E. Armstrong at the Central gave a course of lectures in physical chemistry at the Royal College at the invitation of Tilden; he became lecturer there in 1900, assistant professor when Thorpe returned to the chair in 1909, and professor of physical chemistry, a new appointment, in 1913. From then until his death in 1941, Philip was responsible for this all-important subject. He was a teacher of great ability, and did much to establish a school of research in physical chemistry in the College during a period of very rapid growth of this branch of science.

J. F. Thorpe was a student of the Royal College in 1892–93, but developed largely under the influence of Auwers in Heidelberg and of W. H. Perkin, jun., at Manchester. He came back to the College when the chair of organic chemistry was created there in 1913, and there attracted and inspired a following of staff and research students in part because of his remarkably neat and effective technique. Under his leadership, research in organic chemistry flourished in spite of the interruption caused by the First World War. J. F. Thorpe later devoted the greater part of his time to administrative work and to Government committees, but the school continued to flourish under his assistants, among whom were included Ingold, Linstead, Farmer and Kon.

The College has played its part also in the provision of standard chemical literature without which the progress of research would be greatly hampered. The famous "Thorpe's Dictionary of Applied Chemistry" was first published in 1890 in three volumes: in its compilation, Sir Edward Thorpe had the assistance of many of the College staff besides outside collaborators. A second edition in five volumes began to appear in 1912, and a third in 1921. The First World War emphasized the value of the work and the need for a further revision. This was undertaken by J. F. Thorpe and M. A. Whiteley, thus maintaining the association of the "Dictionary" with the chemistry staff at South Kensington. It has become clear that pure science and technology cannot be divorced in a dictionary, so that the fourth edition of "Thorpe" now in progress is much wider in scope. Begun by Sir Jocelyn Thorpe and Dr. Martha A. Whiteley, it is being continued by a board of editors of which Prof. I. M. Heilbron is chairman, Dr. H. J. Emeléus a member, with Dr. Whiteley as editor and Dr. A. J. E. Welch as assistant editor.

Chemists are not unmindful of the important services rendered by A. J. Greenaway (1871–81) as sub-editor of the *Journal* and *Abstracts of the Chemical Society* over a period of forty years.

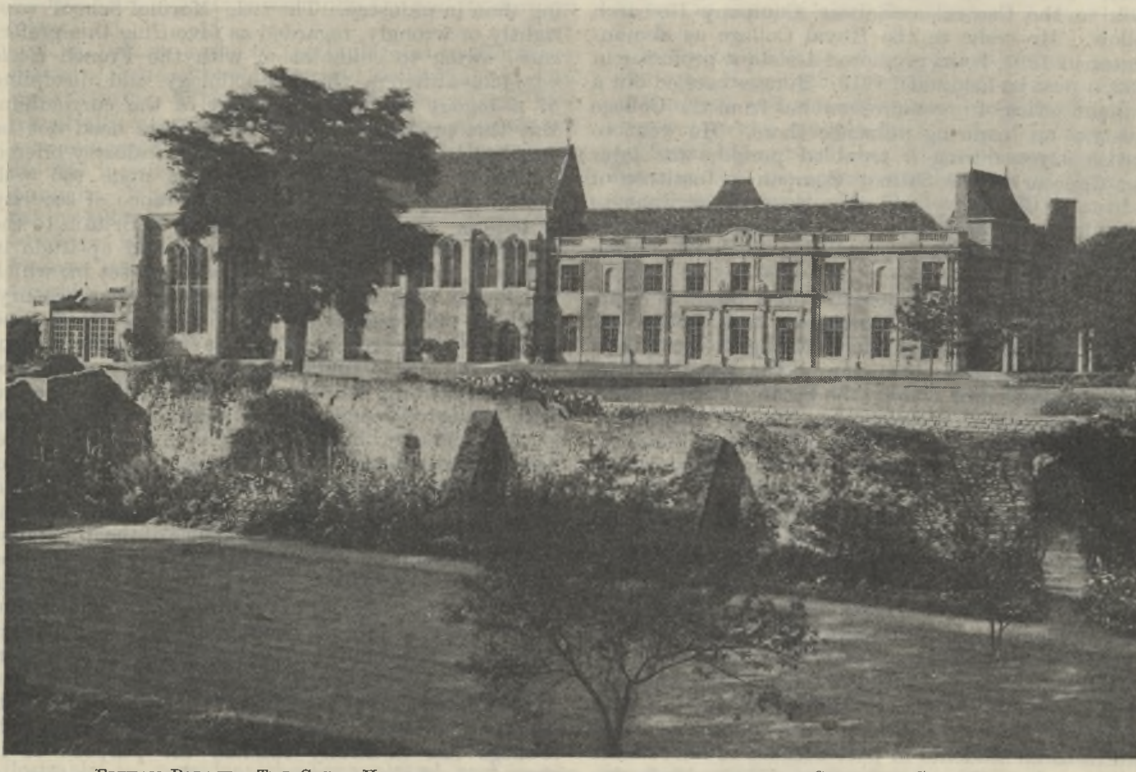
Examination of the "Register of Old Students of the Royal College of Science" confirms the impression that, in the closing years of last century, associates in chemistry found employment more easily in teaching than in industry. The title 'Normal School' was, rightly or wrongly, regarded as favouring this preference, owing to connotation with the French *Ecole normale*, although the methodology and discipline of pedagogy never formed part of the curriculum. But this preference for teaching posts need not be ascribed to predilection, as chemical industry offered relatively few openings and these none too well remunerated, with little or no assurance of security of tenure. But with the awakening of Britain to the growing need of scientific training and aptitude in industry, an improvement in prospects set in, which quickened with the growth of the present century. With the outbreak of the First World War, widespread deficiencies were revealed, and the supreme importance of research in so fundamental a subject as applied chemistry, woing to its manifold aspects in connexion with explosives, coal, oil, metallurgy, pharmaceuticals, plastics, fabrics, food products, etc., could no longer escape recognition. Then followed the establishment of the Department of Scientific and Industrial Research, with its research associations of manufacturers, and to-day cogent evidence of the imperative need of chemistry is witnessed by urgent advertisements in the daily and technical Press and combing of the Central Register for chemists. In its contribution to the yearly academic output of some four hundred first-class honours graduates in chemistry shortly before the outbreak of the present War, and their absorption in teaching and industry, it may be claimed without fear of contradiction that the College has faithfully fulfilled the purpose of its founders—that of promoting the application of chemistry to the "Arts and Manufactures".

THE ARMY SCHOOL OF EDUCATION, ELTHAM PALACE

By Major T. H. Hawkins

Another chapter in the development of adult education in Great Britain has been begun with the opening of the new Army School of Education at Eltham Palace in Kent. To those who believe that the main cultural impact on adults is social rather than strictly educational, the choice of this historical setting with its rich associations will give real pleasure.

The Palace dates far back into history. In the time of Alfred there was "a goodly residence amidst these estates" and the dwelling and demesne are mentioned in the Doomsday Book. Edward the Confessor found spiritual calm at Eltham, and the abode was of sufficient magnificence to support the whole court of Henry III on various occasions. Edward I and II both lived for a while in this Kentish Palace, and in their time the stewardship was entrusted to Antony Bek, Bishop of Durham, who not only beautified the place, but sited and built the moat and its walls in 1300. Much of this work is extant, as is the original stone bridge built in 1396 by command of Richard II. In the reign of Edward IV the Great Hall, with its superb hammer-beam roof, was built, and since 1479 this building has stood, almost the hub of the realm in the time of Henry VII and Henry VIII, both of whom lived at Eltham, until during the Parliamentary Wars the whole estate was razed, all but the hall itself, the timbered roof and stout walls of which offered shelter to herds of cattle.



ELTHAM PALACE. THE GREAT HALL AND NEW BUILDING FROM ACROSS THE MOAT. COPYRIGHT *Country Life*.

Little restitution was effected until 1911, the Hall remaining only a rallying point for historians and painters; but in that year some repairs were made by the Ancient Monuments Department. In 1933 the lease was acquired by the Courtauld family; the Hall was restored, new wings added, and decrepit and extraneous dwellings which had encroached upon the estate were pulled down. About a year ago the lease was generously returned to H.M. the King.

Enough has been said to show that an atmosphere has been provided in which the spirit of education can unfold in the noblest of traditions. But what of the content of the educational programmes that are to be devised and carried out in the new school? This can be appreciated only by considering the background of the educational work of the Army as a whole. Before the defeat of Germany, arrangements had been made whereby every man and woman in the Army should, as soon as was practicable, be given opportunities to do six hours educational work each week. This was to be run by the Army for the Army and in the King's time. The Army Educational Corps was to be responsible for the general administration and supervision of the scheme; but in units the responsibility for organizing the educational work devolved upon commanding officers and unit education officers. The Education Branch at the War Office was charged with providing books, materials and equipment, and with drawing up necessary schedules of accommodation.

With the defeat of Germany it was decided by the Army Council that, in those units where it was possible, this Army Education Scheme should be implemented from July 1, 1945. This was carried out and, since that time, an increasing number of units, both at home and overseas, has inaugurated extensive educational schemes in their units. A recent estimate, for example, suggests that about 65 per cent of the units in one District in Great Britain is carrying out the Army Education Scheme, in full or in part, as originally propounded. In B.A.O.R., C.M.F. and M.E.F. many difficulties have been encountered in addition to those which have been faced by units at home; but in these theatres, too, the task of providing opportunities for educational activities is being tackled with good results.

This, briefly, is the picture in which the opening of Eltham Palace as an Army School of Education acquires significance. However near to perfection was the gigantic Army Education Scheme as planned by the War Office Education Branch, until it was tried out in practice it could not be anything but a paper scheme. Experience has already shown that in many respects the planned scheme had laid too great emphasis on what the men and women ought to demand and not, in fact, what they have demanded. The original pattern for developing the scheme which had been devised by the War Office has, in many cases, been superseded by arrangements which the units consider to be improvements on any scheme which could emanate from the War Office. In short, the infant which was perfectly conceived some months ago is now going through all the pangs of infancy.

What does the War Office do in such cases ? Many observers labour under the belief that any deviation from orthodox War Office programmes on the part of military units is tantamount to quick extinction for the individuals concerned. However much this may be true of some War Office Departments, it is certainly untrue of the Education Branch, and units have been left to develop educational schemes which would best suit their local conditions. This has led to improvisations and experiments which have enriched the scheme as a whole, and, whenever possible, new ideas and suggestions have been incorporated into the general scheme and made available for the use of other units.

Here lies one of the main purposes of the new Army School of Education. From time to time Army Educational Corps officers are to be brought in for short courses to discuss the practical difficulties which are being met with in the field and whether they are being surmounted and by what means. Most of these officers will be drawn in from home commands, but occasionally they will be joined by officers from overseas theatres, and, lest their discussions tend to concentrate too severely on the supervisory and administrative difficulties, these Army Educational Corps officers are to be joined on various courses either by the unit education officers who are concerned with the fine details of the scheme in the units themselves, or by commanding officers who are responsible for seeing that good educational facilities are being provided for men and women under their command. The interchange of ideas between those who are concerned with running the scheme on the ground and those who have planned and are responsible for the broad principles of the scheme, as well as the general details of administration, should be of great service to the soldiers and auxiliaries who are anxious to make use of the opportunities provided.

Nor can a scheme which aimed to provide educational facilities for at least six hours weekly to some four to five million adults be carried out without a large administrative and organizing staff. About a year ago the Army Educational Corps began to expand rapidly, but even apart from the expected wastages through demobilization, the number of officers in the Army Educational Corps is still very inadequate to carry out effectively their difficult role. The number of candidates who are anxious to transfer to the Corps is fortunately very high, and another of the duties of the new School is to provide courses whereby suitable applicants may be graded and assessed as to their suitability for transfer. This is done by testing their ability in organizing and instructional technique, by their contributions to discussions and the work of the School as a whole, as well as their general demeanour. Again, the interplay of ideas between those transferred and those already experienced in army education in the field should be of considerable value to the new entrants to the Army Educational Corps.

Even then the functions of the School are not exhausted. In some theatres of war, particularly India, some Army Educational Corps personnel have been primarily concerned with the teaching of English to Indians and of Urdu to British personnel, and have had little chance of finding out the tremendous developments in army education during the later years of the War.

These individuals have often been overseas for periods of not less than seven years and, when they come home, feel an urgent need for 'refresher' courses where they might be brought up to date with the latest developments in army education. For these, Eltham Palace also makes provision.

So far, one course only has been held, and its success augurs well for future arrangements. The discussions between those already experienced in army education and who are anxious to share their experiences with similar individuals, those who are keen to become members of a Corps which has won good report during the War, and those whose experiences have been in other directions and who need re-orientating, have already shown the value of such a School and the interest that will accrue to it with each successive course.

One of the sessions, which should be of considerable use to adult education, is that in which officers discuss the Army Education Scheme and its carry-over to the national educational system. It is well known that, before the War, the vast majority of the adult population had been unattracted by any of the educational movements which, on the whole, had been providing sustenance only for those already converted. Bound up with this was the fact that most of the classes provided were too academic and paid too little regard to the variety of human interests. Further, there had been an unsatisfactory and unnecessary division between vocational and non-vocational subjects. From the early days of the War, Army educationists had adopted a different policy and, from the beginning, sought to provide educational opportunities not for the few but for the many. Their role as proselytes has taken them up many gum-trees ; but the spirit in which the work has been tackled has led them to attempt experiments and improvisation which have often opened new doors to the education of adults.

The new technique which has been most successful is the use of the informal discussion method for stimulating initial interest in what might, to the group, be a new subject. Another is the use of visual aids, and, already, both in direct teaching and in information rooms, the Army has set up a standard of which it is rightly proud. The value of residential education for adults has been argued persuasively by, among others, Sir Richard Livingstone, and there is no need to repeat the advocacy.

In the many hundreds of residential courses which the Army has run, considerable experience has been gained not only in the organization of such courses but also in framing programmes which would be most effective in the short periods available. Other work which has long since passed the experimental stage has been done for patients in hospitals and convalescent homes and for soldiers under sentence in military prisons and detention barracks. So, too, has the remarkable work in basic education which has succeeded in transforming the lives and values of many former illiterates. At present, experiments in the use of educational broadcasts are being made and their progress is being carefully noted.

The discussions on all these topics have been framed so that officers can make concrete suggestions from their own army and civil experience as to the most suitable means of transferring these new devices in adult education to the civil education system. Army educationists are well aware that during the War a new interest in adult education has been built up and they are anxious that this interest shall be directed into useful channels before it evaporates; hence the need for careful deliberations before the mass of men and women are demobilized and for quick action afterwards.

The Ministry of Education is fully alive to the need for the immediate capitalizing of this newly gained interest in education by adults, and it is pleasing to report that here, too, Eltham Palace is to play a useful part. At the time of writing, more than a score of His Majesty's Inspectors are attending a short course to learn the main principles of the Army Education Scheme. Very shortly they will go to commands at home and overseas to see how effectively the Army Education Scheme is working on the ground. After a few months of this field work, they will come together again, their recommendations collated and transmitted to the Ministry for any action that is thought desirable.

Eltham Palace has been on the map for some five hundred years. Its significance in history, like good wine, needs no bush. In contemporary affairs it has acquired a new meaning. That lies in the choice of the Palace as an Army School of Education with the clear recognition that worthwhile education deserves a home where it can prosper and flourish.

The Army Council is to be congratulated on securing this magnificent building for what will now become the permanent home of the Army Educational Corps. On October 25 it was officially opened by the Parliamentary Under-Secretary of State for War, Lord Nathan. He was supported by General Sir Ronald Adam, the Adjutant-General to the Forces, and many other distinguished men and women. The first Commandant of the School is Lieut.-Colonel W. S. Beddall.

OBITUARY

Prof. F. Vejdovský

Six years ago it was noted in these columns that Prof. F. Vejdovský, the distinguished Czech zoologist, was then about to celebrate his ninetieth birthday (see *Nature*, **144**, 276, 1939; with portrait). It is now learned, with regret, that he died shortly afterwards, so the following additional notes may interest his numerous friends and colleagues all over the world.

František Vejdovský was born at Kouřim (Bohemia) on October 24, 1849. After passing through the Latin School, he matriculated in the philosophical faculty (natural sciences) of the Charles University of Prague, and took his doctor's degree in 1876. In the same year he became assistant to Prof. A. Frič at the Zoological Institute. Next year (1877) he was appointed lecturer in zoology at the College of Technology (Prague). In 1879 he held the post of lecturer in zoology and comparative anatomy in the University, becoming extraordinary professor in 1884. In 1892 he was elected professor of zoology, comparative anatomy, and embryology, and thereafter continued to direct the Czech Zoological Institute until 1921, when he retired as professor emeritus. His period of office covered, therefore, the rebuilding and reorganization of the Institute, and the War of 1914–18. In addition, he was dean of the philosophical faculty in 1895–6, and Rector Magnificus of the Charles University during 1912–13. For many years he was president of the Royal Society of Sciences of Bohemia, and remained honorary president of the Zoological Society of Czechoslovakia until the day of his death. Various other societies in France, Belgium, Poland, Russia, Jugoslavia, and the United States long ago enrolled him as a member; while England, represented by the University of Cambridge, conferred an honorary doctorate upon him on the occasion of the Darwin Celebration in 1909.

For more than half a century Vejdovský was the revered *doyen* of Czech zoologists, and by his own work and his teaching exercised an enduring influence on the development of zoology in his own country. His influence was also deeply felt abroad. Most of his own researches dealt with various groups of invertebrates (Protozoa, Porifera, Turbellaria, Annelida, Nematoda, Crustacea, etc.), and were morphological, cytological, embryological, and systematic. They cover an unusually extensive field. He was especially interested in spermatogenesis, and problems connected with the centrosome and chromosomes, but also devoted much study to freshwater hydrobiology. On these and other matters he published some ten large treatises and more than a hundred other memoirs in Czech, English, French, German, and Belgian periodicals. His most important works are the "Thierische Organismen der Brunnenwässer von Prag", and the discovery of the remarkable crustacean *Bathynella* (1882); the "System und Morphologie der Oligochaeten" (1884); his classical researches on *Gordius* (1886 and onwards); "Zrání, oplození a rýhování vajíčka" [Maturation, fertilization and cleavage of the ovum] 1886; "Entwicklungsgeschichtliche Untersuchungen" (1888-93); "Neue Untersuchungen über die Reifung und Befruchtung" (1907); "Zum Problem der Vererbungsträger (1912); and his final work (in English) entitled "Structure and Development of the 'Living Matter' " (1926–27).

This last book embodies Vejdovský's ultimate conclusions and opinions on many problems of cytology—on spermatogenesis, reduction, the structure of chromosomes, cytoplasmic inclusions, the origin of the centrosome, and the organization and genetic continuity of cell-constituents generally. It is a big volume of 360 pages with 24 double plates (containing 579 figures admirably drawn by his own hand), and is a notable achievement for a man nearing his eightieth birthday. Much of this work was done during the War of 1914–18, under extreme difficulties, and its completion and publication—in a foreign language—afford convincing evidence of its author's industry and erudition.

Vejdovský died at Prague on December 4, 1939. Shortly before his death, his ninetieth birthday was celebrated by the publication of a *Festschrift* to which many of his colleagues, friends, and pupils contributed. It is an octavo of over six hundred pages, with a portrait and full bibliography of his publications, and entitled "Sborník prací vydaný k 90. narozeninám Prof. Dr. Františka Vejdovského Královskou českou společností nauk a Čs. zoologickou společností v Praze [Collection of works edited for the 90th birthday of Prof. F. Vejdovský by the Royal Czech Society of Science and the Czechoslovak Zoological Society of Prague]". It forms vols. VI–VII of the Proceedings [Věstník] of the Zoological Society for the year 1938–39 (Prague, 1939). As yet only one copy of this volume—surely unique in the annals of zoology—appears to have reached England.

CLIFFORD DOBELL.

[None of the vacancies in these columns relates to a Man between the ages of 18 and 50 inclusive or a Woman between the ages of 18 and 40 inclusive, unless he or she is excepted from the provisions of the Control of Engagement Order, 1945, or the vacancy is for employment excepted from the provisions of that Order.]

MIDDLESEX COUNTY COUNCIL EDUCATION COMMITTEE

ACTON TECHNICAL COLLEGE, High Street, W.3

Applications are invited for the following full-time Appointments:

LABORATORY STEWARD FOR CHEMISTRY. A knowledge of chemistry up to National Certificate Standard (or Intermediate B.Sc.) and previous experience desirable. Proficiency in glass working an advantage.

LABORATORY STEWARD FOR PHYSICS. An elementary knowledge of Physics essential. Ability to undertake simple instrument repairs an advantage.

In both cases duties include the care of apparatus and the preparation of material for class and demonstration use. Ability to train and control the work of the junior laboratory assistants essential. Salary £200 by £12 10s. 0d. increments to £250 per annum (inclusive of bonus) in each case according to experience.

LABORATORY ASSISTANTS. Matriculation standard desirable. Facilities will be given for further study. Scale of wages 30s. 0d. plus 8s. 0d. war bonus per week at 16, rising to £150 per annum plus 23s. 0d. per week war bonus at 21.

In each case duties will commence as soon as possible. Duties may be divided between full-time day, part-time day, and evening classes. Applications should be sent to the Principal without delay, together with details of training and experience, and with references. Applications should be in not later than November 14, 1945.

T. B. WHEELER,
Chief Education Officer of the
Middlesex County Council.

CITY OF LIVERPOOL

APPOINTMENT OF DIRECTOR OF MUSEUMS

(Comprising the following Departments each under a Keeper:
Geology, Botany, Vertebrate Zoology, Invertebrate Zoology, Ethnology, Shipping and Archæology.)

The Council of the City of Liverpool invite applications for the appointment of Director of Museums at a salary of £900 per annum, increasing to £1,000 per annum after two years' service.

The age of applicants must not exceed 50 years.

Applications submitted by persons at present engaged on national service and unable to take up the post immediately will receive consideration.

The appointment will be subject to the provisions of the Local Government Superannuation Act, 1937, and the Standing Orders of the City Council, and will be determinable by three calendar months' notice on either side.

Forms of application and particulars of the Duties and Conditions of Appointment may be obtained from me, and applications, accompanied by copies of three recent testimonials, must be addressed to me, endorsed "Director of Museums" and received on or before Friday, November 30, 1945.

W. H. BAINES,
Town Clerk.
Municipal Buildings,
Dale Street, Liverpool, 2.

INTERNATIONAL FELLOWSHIPS FOR WOMEN GRADUATES, 1946-7

The *British Federation of University Women* announce:

I.F.U.W. Fellowship £250 (preference to candidates in Science).
H. M. Kirby Fellowship $1,500.
Virginia Gildersleeve Fellowship $1,500.
Ohio State Fellowship $1,500.
A. H. Reinhardt Fellowship $1,500.

The Fellowships are to be used for a year's research, preferably in some country other than the holder's. Candidates should have been engaged in research for at least one year.

M. Reilly Award $500 (to further in any way approved research project).

Rose Sidgwick Memorial Fellowship, $2,000, to be used for a year's postgraduate study in the U.S.A. Open to women graduates, native of Gt. Britain, who should not be over 35 years old.

Application forms and regulations from Research Applications, B.F.U.W. Ltd., 17A, King's Road, S.W.3. Completed applications due November 15, 1945.

Physics Laboratory. Young Assistant Laboratory Attendant required immediately. Apply stating wages and experience, if any, to Secretary to the Governors, Royal Holloway College, Englefield Green, Surrey.

CITY OF LEICESTER EDUCATION COMMITTEE

LEICESTER COLLEGE OF TECHNOLOGY AND COMMERCE

Principal: L. W. KERSHAW, O.B.E., B.Sc., A.M.Inst.C.E.

DEPARTMENT OF MATHEMATICS

Applications are invited for the post of FULL-TIME LECTURER IN MATHEMATICS.

Industrial experience, or interest in industrial problems will be regarded as an additional qualification, as also will scientific or other interests likely to give vigour and originality in teaching methods.

Salary will be in accordance with the Burnham Scale, including increments for industrial, research and teaching experience.

Application, by letter, giving full particulars of qualifications, training and experience and accompanied by copies of two recent testimonials and giving the names of two referees, should be addressed, as soon as possible, to the Principal of the College.

H. S. MAGNAY,
Director of Education.

SUDAN GOVERNMENT

The GEOLOGICAL SURVEY requires a DRILLING ENGINEER for service in the Sudan, on the operation of Drilling Plant and well digging under the direction of the Government Geologist. Candidates should have had appropriate University training or its equivalent and at least three years' experience in Drilling for water. Age 30 to 45 years.

Appointment would be on Short Term Contract with an initial period of twenty-four months. Rate of pay £E.800 to £E.1,500, according to age, experience and qualifications. (£E.1=£1 0s. 6d.) Free passage on appointment. Strict medical examination. At present there is no income tax in the Sudan. Separation or Special War Allowance payable when eligible.

Write quoting C.2855A to Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, for application form which must be returned completed by November 26, 1945.

NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING

A temporary post, for one year in the first instance, is open for a biochemist with a good knowledge of bacteriology to work on the degradation of long-chain hydrocarbons by micro-organisms. Salary £450 or higher according to qualifications and experience.

The appointment will be made as soon as possible after the date of this advertisement. Apply to Secretary, National Institute for Research in Dairying, The University of Reading, Shinfield, near Reading.

THE ROYAL SOCIETY

SCIENTIFIC PUBLICATIONS GRANT

The Council of the Royal Society invites applications for grants from the Parliamentary Grant-in-aid of Scientific Publications. This grant-in-aid is provided for the assistance of scientific publications in the United Kingdom, particularly but not exclusively those of scientific societies and institutions. Applications should be typewritten and should reach the Assistant Secretary, The Royal Society, Burlington House, London, W.1, not later than November 15, 1945.

UNIVERSITY OF ABERDEEN

APPOINTMENT OF UNIVERSITY ASSISTANT IN CHEMISTRY

Applications are invited for the post of Assistant in the Department of Chemistry. The Assistant will require to have a special knowledge of Physical Chemistry. Salary £300 to £350 according to qualifications, and the Assistant will take up duty on December 1, 1945, or earlier if possible.

H. J. BUTCHART,
The University, Aberdeen. Secretary.

WOOLWICH POLYTECHNIC, S.E.18

The Governing Body invite applications from Honours Graduates for the post of Lecturer in Chemistry. Salary in accordance with the Burnham Technical Scale. Details of appointment and forms of application may be obtained from the Secretary, to whom they should be returned by November 16, 1945.

UNIVERSITY COLLEGE OF HULL

Applications are invited for the Headship of the Department of Zoology. Salary on the scale £750—£20—£850 with superannuation benefits under the F.S.S.U. Particulars may be obtained from the Registrar, to whom applications must be made by November 17.

UNIVERSITY COLLEGE OF HULL

Laboratory Steward required in the Department of Botany, to commence duty as soon as possible. Wages £5 a week, rising to £6 by annual increments. Applications to the Head of the Department of Botany, from whom further particulars can be obtained.

UNIVERSITY COLLEGE OF SWANSEA

The Council invites applications for the post of Assistant Lecturer in the Department of Engineering. Salary £400 per annum. Candidates should possess a good degree in Engineering of a British University. Further particulars may be obtained from the Registrar, University College, Singleton Park, Swansea, by whom applications must be received on or before November 26, 1945.

Routine Chemist for Trinidad, British West Indies. Applications are invited for the above permanent post by a firm producing and refining petroleum products. The duties involve supervision of routine field testing and other semi-routine laboratory work, such as Core Analysis; Testing Crude-Water Emulsions, Cement and Barytes; Simple Water Analysis and water plant control tests, charcoal analysis of field gases, gas solubility and high pressure viscosity determinations.

Qualifications: Age 21–40. Honours degree in Science preferred. Experience desirable. Salary £450–£750 p.a. plus war bonus at present rate £225 p.a.

Write quoting F.5055XA to Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, for application form which must be returned completed by November 16, 1945.

A Research Association invites applications for Abstractors (male or female) for the Intelligence Section. Their duties will consist mainly of abstracting and summarizing technical and scientific papers in shipbuilding, marine engineering, naval architecture and general physics and engineering, and also of dealing with technical enquiries relating to published material in these fields. Ability to translate from German, French and/or Russian would be an advantage. A degree in engineering or physics is desirable, but persons without degrees but suitably qualified otherwise will also be considered.

Appointment will be made within the range £250–£500 according to age and qualifications. Superannuation under F.S.S.U.

Write quoting C.2856XA to Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, for application form which must be returned completed by November 26, 1945.

Government of India. Urgent vacancy exists for an Assistant Examiner of Questioned Documents.

Qualifications: Age not below 21 or above 24 years on May 1, 1945; good science degree (preferably Honours); very good knowledge of physics and chemistry; good theoretical and practical knowledge of photography; exceptionally good eyesight.

Permanent pensionable appointment subject to two years' probation. Commencing pay Rs. 400 a month plus overseas pay Rs. 150 a month (equivalent to £495 p.a. approx.) rising to Rs. 1,250 a month plus overseas pay £30 a month in 20th year (equivalent to £1,485 p.a. approx.). Free passage to India and, if confirmed in appointment, further passages for purposes of leave. Overseas pay and leave passages admissible only to appointee of non-Asiatic domicile.

Write quoting F.5101A to Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, for application form which must be returned completed by November 26, 1945.

Vacancies exist for (1) a Graduate Physical Chemist with an aptitude for scientific research to work on the permeability of packaging materials and packages to gases. A knowledge of gas diffusion and gas analysis an advantage. (2) A Graduate Physical Chemist with an aptitude for scientific research to work on the physical and chemical properties of adhesives used in the packaging and printing industries. An interest in rheology and surface chemistry an advantage. Initial salaries between £275 and £500 p.a. according to qualifications and experience. Superannuation under the F.S.S.U. Applications stating age, qualifications and previous experience to Director of Research, Printing and Allied Trades Research Association, Charterhouse Chambers, Charterhouse Square, London, E.C.1.

Department of Agriculture for Scotland. VACANCY FOR LIBRARIAN (TEMPORARY). Candidates should have sound knowledge of library work and high standard of education. Some agricultural knowledge is desirable and a degree or diploma in agriculture or other scientific subject will be an added qualification. *Duties*: Charge of Department's library, classification and cataloguing of library material, collation of incoming material and dissemination of digests of books and articles on agricultural subjects to the various divisions of the Department. *Headquarters*: Edinburgh. *Salary*: £300 to £600 per annum (male), £240 to £480 per annum (female), according to age, qualifications and experience, plus War Bonus, £60 per annum (male), £48 per annum (female). Applications should be forwarded to the Regional Appointments Officer, Regional Appointments Office, Ministry of Labour and National Service, 5, Rothesay Terrace, Edinburgh, quoting Reference No. 352 M.

Laboratory Assistants, men or women, for work in pharmacological laboratories. Applicants should hold a diploma of the Institute of Medical Laboratory Technology. Applications, stating age, qualifications, and accompanied by copies of two testimonials should be addressed to the Secretary, The Wellcome Laboratories of Tropical Medicine, 183, Euston Road, London, N.W.1.

Technical Writer required, good knowledge of instrument manufacture and modern electronic apparatus; experience in preparation of catalogues and servicing manuals essential; permanent post. Apply stating age, qualifications, salary, etc., to Muirhead & Co., Ltd., Elmers End, Beckenham, Kent.

The British Leather Manufacturers' Research Association has under consideration the appointment of a Senior Physicist to organize and collate investigations on the physical properties of leather.

Candidates should have an honours degree or its equivalent, with physics as the chief interest, and a sound knowledge of chemistry. An appreciation of the significance of biological structure in relation to physical qualities, or a knowledge of the physics of fibres and fibre weave, would be an added advantage.

The post is open to men or women of British nationality between the ages of 30 and 45. The initial salary will be between £500 and £750, according to qualifications and experience, with prospects of further advancement, and the post will carry benefits under the Federated Superannuation System for Universities.

Applications should be addressed to the Director, 1–6 Nelson Square, London, S.E.1.

Pharmacological Assistants, men or women. Applicants should hold B.Sc. degree in biological subjects, or pharmaceutical qualifications. Applications, stating age, qualifications, and accompanied by copies of two testimonials should be addressed to the Secretary, The Wellcome Laboratories of Tropical Medicine, 183, Euston Road, London, N.W.1.

Applications are invited for the post of Laboratory Assistant in the Division of Histology, Royal Veterinary College. Some knowledge of histological technique desirable. Applications, stating age, experience and pay required, should be sent to the Bursar, Royal Veterinary College, Camden Town, N.W.1.

University of Cape Town invites applications for post of Lecturer in Department of Physiology. The salary scale is £450 x 25/500 x 50/675 per annum. The lecturer will be required to teach in practical classes of human and experimental physiology, and to take part in the routine lecturing of the department. He will also be expected to do research work. He must have scientific qualifications in Physiology. A medical qualification would be a recommendation.

The lecturer must become a member of the University Teachers' Superannuation Fund. Successful applicant will be expected to assume duty on March 1, 1946, or as soon as possible thereafter.

Write quoting F. 5050X to Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, for application form, which must be returned completed by November 24, 1945.

Bacteriologist required for research on Antibiotics. Duties will involve taking charge of, and developing, existing new Bacteriological Laboratory, London. Experience of animal testing will be an advantageous qualification. Salary £400/600 according to qualifications and experience. Applications, with full details of career, experience, etc., to Box 427, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Microscopes, of all descriptions, only a few available, second-hand, perfect condition. Send details of your requirements, enclosing 3d. stamp.— Telephone or correspondence only. Chards, Forest Hill, S.E.23 (Spring Park 1628).

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NEWS and VIEWS

Prof. W. T. Astbury, F.R.S.

In 1928 the Worshipful Company of Clothworkers of the City of London made a grant of £3,000 a year to the University of Leeds for research purposes. Never has a grant been more fully justified, for it resulted in the appointment of Dr. W. T. Astbury as lecturer in textile physics and induced him to take up the study of proteins. A scholar of Jesus College, Cambridge, Astbury had acted as assistant to Sir William Bragg, first at University College, London, during 1921–23, and then at the Davy Faraday Laboratory of the Royal Institution during 1923–28. At Leeds, therefore, X-ray studies of hair, wool and related fibres claimed his immediate attention, and the main features of the molecular structure of the keratins were defined in two papers published in the *Philosophical Transactions of the Royal Society* in 1931 and 1933. The industrial importance of this and other work was recognized by the award of the Gold Medal of the Worshipful Company of Dyers in 1934, and the Warner Memorial Medal of the Textile Institute in 1935. Its implications in the biological field were even more profound : assisted by generous grants from the Rockefeller Foundation since 1933, he utilized his concept of folded and extended polypeptide chains, derived from the examination of unstretched and stretched wool fibres, to obtain a structural interpretation of the denaturation phenomenon, and, later, to identify the keratins, myosin, fibrinogen and fibrin as belonging to the same group of proteins.

The extent and importance of Astbury's work on the structure and stoichiometry of the proteins have been recognized by the award of the Actonian Prize of the Royal Institution in 1935 and the Sc.D. of the University of Cambridge in 1937 ; by his promotion to reader in textile physics at the University of Leeds in 1937 ; and by his election to the fellowship of the Royal Society in 1940. This year he has had the distinction of being the Croonian Lecturer of the Royal Society, and the many admirers of his work will now rejoice to know that the University of Leeds has elected him to the chair of biomolecular structure, which was instituted in his honour.

Royal College of Physicians : Medal Awards

The following awards have recently been made by the Royal College of Physicians :

Moxon Medal to Sir Alexander Fleming, for his work on penicillin, as an outstanding contribution to therapeutics and clinical medicine. This award, which is not restricted to British subjects, is made to the person who is deemed to have most distinguished himself by observation and research in clinical medicine.

Weber-Parkes Prize and Medal to Prof. Eugene L. Opie, professor of pathology, Cornell University, New York, for his work on the pathogenesis of pulmonary tuberculosis. This Medal is awarded every third year for the best work done whether in Great Britain or abroad upon some subject connected with the etiology, prevention or treatment of tuberculosis.

Baly Medal to Prof. S. A. S. Krogh, of the Zoophysiological Laboratory, Copenhagen, who has made outstanding contributions to our knowledge of the capillaries and of related physiological problems in cellular nutrition and respiration. This award is made every alternate year to the person who shall be deemed to have most distinguished himself in the science of physiology, especially during the two years immediately preceding the award, and is not restricted to British subjects.

Fifty Years of X-Rays

In the history of science there have been few more unexpected and few more fruitful discoveries than that made by Wilhelm Konrad Röntgen on November 8, 1895, and described not many days after in his paper "Über eine neue Art von Strahlen" read to the Physico-Medical Society of Würzburg. Copies of the paper reached England early in 1896, and *Nature* of January 23, 1896, contained a translation of it. By those fortunately in possession of the necessary apparatus, Röntgen's experiments were repeated with delight and wonder, and not only that, they were put to very good purpose. In Berlin, on January 20, 1896, a medical man had with the new methods detected a glass-splinter in a finger, and at Liverpool on February 7, Dr. C. T. Holland found by X-rays a bullet in a boy's hand. None had received news of the discovery with greater interest than Sir Arthur Schuster, who in his book "The Progress of Physics during Thirty-three Years", published in 1911, tells how his laboratory was inundated by medical men with their patients, among whom was a ballet dancer whose trouble had been diagnosed as bone disease but who all the time had a needle in her foot. In April he and his assistants were called to Nelson, Lancashire, to a woman who had been shot by her husband and whose head Schuster explored with the new rays. There was no opposition to the application of Röntgen's discovery, as there had been to those of Lister and Pasteur, and medical science and surgery have benefited universely from it. Even after two world wars, it may be that X-rays have saved more lives than bullets have destroyed.

Medical aspects, however, are a small part of the story, for Röntgen's work influenced all physical studies. In the jubilee number of *Nature*, November 6, 1919, Sir Ernest Rutherford, as he then was, wrote that the discovery "marks the beginning of a new and fruitful epoch in physical science in which discoveries of fundamental importance have followed one another in almost unbroken sequence". Sir William Bragg said much the same thing, and none did more than these two distinguished men to further the use of X-rays for unfolding the secrets of Nature. Röntgen was born at Lennep, in the Ruhr, on March 27, 1845 (see *Nature*, March 24, 1945, p. 351), and was thus in his fifty-first year when he achieved fame. In 1894 *Nature* had referred to his collaboration with August Kundt, but he was then little known. His single observation, however, wrote his name indelibly in science, and among his rewards was the Nobel Prize of 1901. Before 1895 he had worked at Würzburg, Strassburg and Giessen and had returned to the first in 1885. His latter years were spent at Munich, first as director of the Physical Institute and from 1919 in retirement. He died there on February 10, 1923, having seen others reap a rich harvest from the seed he had sown.

Research in Britain on Atomic Energy

It was announced by the Prime Minister on October 29 that the Government, acting in accordance with a recommendation from the Advisory Committee on Atomic Energy, has decided to set up a research and experimental establishment covering all aspects of the use of atomic energy. The station will be at Harwell airfield, near Didcot. Responsibility for research on atomic energy, which hitherto has rested on the Department of Scientific and Industrial Research, is to be transferred to the Ministry of Supply, and the Tube Alloys Directorate which dealt with such matters is accordingly being transferred to the Ministry. The whole of the cost of research in this connexion will fall on the Government. In reply to a question asking whether this change of control means that the Government is more concerned with the weapon value of atomic energy than its production value, Mr. Attlee remarked that this was not so, and that the Ministry of Supply is engaged in civilian production as well as production for the Services.

On October 30, Mr. Attlee stated in the House of Commons that he is to visit President Truman in Washington "to discuss with him and the Prime Minister of Canada the problems to which the discovery of atomic energy have given rise"; Sir John Anderson, chairman of the Advisory Committee on Atomic Energy, is to accompany him in an advisory capacity.

French Association for the Advancement of Science

THE French Association for the Advancement of Science held a large and enthusiastic Congrès de la Victoire in Paris during October 20–26. This was the first assembly of its kind to be held since 1939, the usual annual meetings having been suspended during the period of the War. At the invitation of the Association, delegates were present from Great Britain, the United States, Canada, the U.S.S.R., Argentine, Switzerland, Belgium, Sweden, Norway, Czechoslovakia and Rumania. About fifteen hundred members of the Association and the delegates were present at the opening meeting in the Great Hall of the Sorbonne on Saturday, October 20. The president of the Municipal Council of Paris opened the proceedings with a welcoming speech, which was followed by discourses delivered by Prof. Joliot-Curie and Prof. Justin-Besançon, president of the French Red Cross.

Prof. Henri Piéron, who had been elected president of the Association at the Liège meeting in 1939, delivered his presidential address after the chief delegates had paid tribute to the vitality of French science and its renewed vigour, in the addresses presented by them. The British Association delegation was headed by its president, Sir Richard Gregory, who read the address sent by the Association; the other delegates from Great Britain were Sir Thomas Holland and Dr. W. Campbell Smith, members of the Council of this Association, Sir Edward Appleton and Prof. E. N. da C. Andrade, with Lady Gregory representing the lady members. The inaugural meeting lasted from three to six o'clock in the afternoon.

The twenty-two sections met separately or jointly in six scientific institutions during the week, and with full programmes of papers. Sir Edward Appleton gave a lecture on the ionosphere on the afternoon of October 22 to a joint meeting of three sections, and he and Prof. Andrade afterwards made two short broadcasts at the request of the radio officer attached to the British Embassy. A reception was given on the evening of October 24 at the Hôtel de Ville and there was a banquet on October 25 at the Salons Vianey. At the general assembly on October 26, the president and other officers of the Association for the ensuing year were elected and other official business transacted. On the same evening the British Ambassador and Lady Diana Duff Cooper gave a reception at their official residence to the foreign delegates and officers of the Association and other distinguished representatives of scientific societies in Paris.

Middle East Field Biology

THE presence of numerous amateur and professional zoologists among the British Forces in the Middle East countries during the War has resulted in a considerable amount of field biology being carried out in those countries, much of which is now being published. The anti-locust work of British units and frontier defence forces also aided. The Zoological Society of Egypt has issued numerous special bulletins to accommodate these original observations, mainly upon ornithology. Bull. 7 issued in 1945 contains Shamseddin Halfawi's "Notes on Birds from Western Saudi-Arabia". Bull. 6 contains bird notes from Lower Egypt (autumn, 1943), and from Amriya, Egypt (July–October 1942), and a list of migrants seen in Egypt, the western desert and Tripolitania, while special supplements to this bulletin were devoted to papers on Palestine and Syria, and to the migration of the white stork. Bull. 2 contains valuable notes on the birds of Suez, and Bull. 5 has notes on bird migration across the western desert and Libya. Especially interesting are the bird notes from the Daedalus lighthouse in the Red Sea, augmented by the British keeper at the lighthouse, as they supplement some of the earlier work of Meinertzhagen in the First World War.

The Army itself has published much through its Middle East Biological Scheme, organized from G.H.Q. to collect specimens for the British Museum, and with naturalists' clubs in Baghdad, Jerusalem, Damascus and Cairo publishing regular bulletins. Collecting expeditions have been organized through the scheme over periods of several days or weeks at Lake Tiberias, Lake Huleh, Mt. Cassius in Syria, etc., the Anti-Lebanons have been surveyed, and several expeditions have been made in the Euphrates valley, bringing up to date "The Survey of Iraq Fauna" published by the Bombay Natural History Society (1915–19), with the work on birds, mammals, insects and reptiles in Mesopotamia collected and studied by soldier naturalists in Mesopotamia during the First World War.

History and Philosophy of Science

PRIOR to 1939, the Departments of the History and Philosophy of Science and of the History of Medicine at University College, London, which were the only departments of their kind in Great Britain, provided either full-time or part-time postgraduate courses of one and two years. On an average the department accommodated 30–35 students. With the full return of University College to London this autumn, the Department has been reopened. It is hoped shortly to make an appointment to the post of professor and head of the Department, which is at present vacant; but, in the meantime, courses in the history of science are being provided by members of the pre-war staff. Although the session commenced on October 1, arrangements have been made whereby intending students will be able to commence the first year's course so late as January 1946 without loss of opportunity.

Diseases of Cereals

Correct diagnosis is of prime importance for the successful prevention and control of plant disease, and considerable confusion is frequently caused by the loose use of terms such as 'blight', 'rust' or 'mildew'. The Ministry of Agriculture has accordingly published Bulletin No. 129, compiled by W. C. Moore, entitled "Cereal Diseases" (London: H.M. Stationery Office. 1*s*. net), which should prove of great value to all interested in the cultivation of these crops, whether it be the farmer, scientific adviser or student of agriculture. It provides simple, accurate and, in a number of cases, illustrated descriptions of the diseases of cereals that occur in Great Britain, together with the measures that should be taken to prevent or control their incidence. The diseases causing the most damage are yellow rust, bunt of wheat, leaf spot of oats, leaf stripe of barley, take-all, eyespot, mildew and manganese deficiency disease; but even these vary in intensity from season to season and in some years others are of equal importance. A farmer experiencing trouble with cereal crops is urged to seek advice from his County War Agricultural Committee, and a list of provincial advisory centres and advisory mycologists is appended from whom help may be obtained.

Californian Marine Algæ and Grasses

E. Yale Dowsen has compiled a most useful "Annotated List of the Marine Algæ and Marine Grasses of San Diego, California" (*Occas. Papers, San Diego Society of Natural History*, No. 7, March 1945). This is intended primarily for the amateur, and is simplified as much as possible. Directions are given for collecting, preserving and examining marine algæ, and there are also keys to genera and list of species with habitats, notes on marine grasses, a glossary of terms and a bibliography. With this little manual much may be accomplished by anyone interested in these plant groups.

Royal Society of Edinburgh

The following have been elected officers and members of council of the Royal Society of Edinburgh: *President:* Sir W. Wright Smith; *Vice-Presidents:* Dr. Alan W. Greenwood, Dr. E. Hindle, Dr. David Russell, Prof. R. J. D. Graham, the Right Hon. Lord Cooper, Prof. J. W. Heslop Harrison; *General Secretary:* Prof. James Kendall; *Secretaries to Ordinary Meetings:* Prof. E. T. Copson, Prof. A. Holmes; *Treasurer:* Sir E. Maclagan Wedderburn; *Curator:* Dr. John E. Mackenzie; *Councillors:* Lieut.-Colonel W. F. Harvey, Prof. A. E. Trueman, Prof. J. Walton, Prof. T. Alty, Mr. J. Morrison Caie, Sir Robert Muir, The Hon. Lord Birnam, Prof. E. P. Cathcart, Prof. A. Gray, Dr. J. Russell Greig, Dr. W. A. Harwood and Prof. C. M. Yonge.

University of London

The following appointments have been made by the University of London: Dr. A. I. Richards, special lecturer in social anthropology at the London School of Economics, has been appointed to the University readership in anthropology tenable at the School as from October 1. Dr. Margaret Read, lecturer in social anthropology at London School of Economics and since 1940 head of the Colonial Department at the Institute of Education, has been appointed to the University readership in education tenable at the Institute of Education as from October 1.

Dr. James Henderson, lecturer in mathematics at King's College, London, has been appointed academic registrar of the University as from January 1, 1946, in succession to Colonel S. J. Worsley, who has been appointed principal of the College of Estate Management.

The following doctorates have been conferred: D.Sc. on Robert Brown (Imperial College); D.Sc. (Eng.) on C. M. White (Imperial College); D.Sc. (Eng.) on Norman Davey.

Announcements

The Nobel Prize for Medicine for 1945 has been awarded jointly to Sir Alexander Fleming, of the University of London, Sir Howard Florey and Dr. E. B. Chain, of the University of Oxford, for their work on the discovery and utilization of penicillin.

Sir John Boyd Orr has been appointed the first director-general of the United Nations Food and Agricultural Organization.

Dr. H. Lipson, of the Cavendish Laboratory, Cambridge, has been appointed head of the Department of Physics in the Manchester College of Technology in succession to Dr. W. H. Taylor.

Prof. L. P. Garrod, professor of bacteriology in the University of London, is visiting Belgium to lecture on penicillin to medical audiences, at the invitation of the University of Louvain and under the auspices of the British Council.

The British Association announces the reopening of the Charles Darwin memorial rooms at Down House, Downe, Kent, daily excepting Fridays, from 11 a.m. to 5 p.m. The exhibits were uninjured during the War, and since they were last on view a number of additions have been made.

The Council of the Geological Society of London has accepted an offer made jointly by the Anglo-Iranian and the Burmah Oil Companies to provide a fund of £750 per annum, for an initial period of seven years, to be used to defray the costs of an instructional tour for about twenty students taking honours courses in geology at various universities and colleges. Each tour will probably extend over three weeks and will include visits to classic geological sections. It will be arranged to supplement the field instruction normally provided by the universities.

Dr. E. W. Gudger, Department of Fishes, American Museum of Natural History, New York City 24, N.Y., states that the "Bashford Dean Memorial Volume: Archaic Fishes" is now complete in Articles I–VIII, plus index, introduction, two title pages and two tables of contents—for binding as Parts I and II. Those who receive such material regularly from the American Museum are invited to apply for any parts which may be missing. Duplicate lithographed plates of the segmentation of the egg (2) and of the genital system of *Bdellostoma* (4) are also available.

Reference was made in *Nature* of October 27 (p. 502) to the commemoration of the anniversary of the discovery of X-rays. The joint meeting of all the participating societies will be held at the Phoenix Theatre, Charing Cross Road, London, W.C.2, on November 9, at 3.30 p.m., instead of at the Central Hall, Westminster, as originally arranged. There will also be a small exhibition of historical apparatus in the Reid Knox Hall of the British Institute of Radiology, 32 Welbeck Street, London, W.1, during November 8–10 (10 a.m.–6 p.m.).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

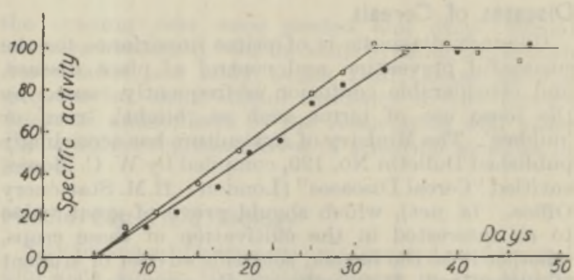
Life-Cycle of the Red Corpuscles of the Hen

THE life-cycle of the mammalian red corpuscles is not known with certainty. Values varying between 30 and 200 days are recorded. One would expect the problem to be easily solved by making use of an isotopic indicator, that is, by labelling the corpuscles. In trying to find a suitable indicator, great difficulties are encountered due to the fact that almost every compound present in the corpuscles is renewed at a comparatively rapid rate. Only such labelled molecules which have a longer life-time than the red corpuscles in which they are located can be used as indicators. Iron atoms incorporated with hæmoglobin molecules remain unchanged during the life-time of the red corpuscles[1]. Hahn and his colleagues[2], however, found that the iron atoms contained in the debris of the hæmoglobin of decayed corpuscles are preferentially used in the formation of new corpuscles. This fact makes radioactive iron unsuitable for the determination of the life-cycle of the red corpuscles.

We found desoxyribose nucleic acid phosphorus to be a suitable indicator for the determination of the life-cycle of nucleated corpuscles. In contradistinction to desoxyribose nucleic acid molecules present in various organs, those found in the red corpuscles of the hen are not renewed at an appreciable rate. In experiments *in vitro*, in which hen blood was shaken in an oxygen atmosphere in the presence of labelled sodium phosphate, no active desoxyribose nucleic acid was found to be formed, in contradistinction to other active phosphorus compounds. Furthermore, activity was absent in the desoxyribose nucleic acid present in the circulating red corpuscles of the hen up to five days after administration of radioactive phosphate.

Hen corpuscles, labelled by their active desoxyribose nucleic acid content, can be used in two different ways. We can administer, for example, labelled phosphate to the hen, and after the lapse of a week replace part of the corpuscles of a second hen by labelled corpuscles of the first one. When taking blood samples at intervals, we can determine what percentage of the transfused corpuscles is still present in the circulation of the hen. In a note to be published later, we shall communicate the results obtained in such experiments. In this note we shall describe another method in which, by avoidance of blood transfusion, the uncertainty about the equality of the life-time of the transfused corpuscles and the endogenous corpuscles can be eliminated.

In the latter method, labelled phosphate is administered twice a day to the hen in such quantities that the plasma phosphate is kept at a constant or almost constant level of activity. The active phosphate penetrates into the marrow and participates in the formation of the nucleic acid of the corpuscles, which thus become labelled. The percentage of labelled corpuscles will increase with time, and finally the circulation will contain labelled corpuscles only; thus the activity of 1 mgm. corpuscle desoxyribose nucleic acid phosphorus will be equal to the activity of 1 mgm. marrow phosphorus and 1 mgm. plasma phosphorus respectively.



LIFE-CYCLE OF THE RED CORPUSCLES OF TWO HENS. ABSCISSÆ: DAYS AFTER START OF EXPERIMENT; ORDINATES: SPECIFIC ACTIVITY OF DESOXYRIBOSE NUCLEIC ACID PHOSPHORUS EXTRACTED FROM THE CORPUSCLES SECURED AT DIFFERENT DATES.

The results of such experiments are shown in the accompanying graph, which makes it clear that in the first five days the nucleic acid present in the corpuscles is inactive. This may be interpreted by assuming that, in the first phase of the experiment, corpuscles containing inactive nucleic acid reach the circulation, and that it is about five days before corpuscles containing labelled nucleic acid are given off by the sinusoids to the circulation. The maturing of the corpuscles in the marrow thus takes about five days. The graph also shows that, after the lapse of about thirty-three days, the maximum value of the activity of the desoxyribose nucleic acid is reached. Taking into account that in the first five days no labelled corpuscles intrude into the circulation, the life-time of the red corpuscles will be 28 days. It is of interest finally to note that the results obtained indicate that all or almost all corpuscles present in the circulation have a similar life-time.

We wish to express our cordial thanks to Prof. Niels Bohr, director of this Institute, and to Prof. August Krogh and Dr. Albert Fischer in whose laboratories the investigation was continued while the Institute of Theoretical Physics was under enemy occupation.

G. HEVESY.
J. OTTESEN.

Institute of Theoretical Physics,
University, Copenhagen.

[1] Hahn, P. F., Bale, W. F., Ross, J. F., Hettig, R. A., and Whipple, G. H., *Science*, 92, 131 (1940).

[2] Hahn, P. F., Bale, W. F., and Balfour, W. M., *Amer. J. Physiol.*, 135, 800 (1941–42).

Departure of Long-Wave Solar Radiation from Black-Body Intensity

IN some recent experiments of great interest and importance, both Reber[1] and Southworth[2] have succeeded in detecting and measuring solar radiation in the short-wave end of the radio spectrum. The wave-length employed by Reber was 187 cm., while the three wave-lengths used by Southworth, although not precisely specified, were of the order of 10 cm. and less. In both series of experiments it was found that the intensity of solar radiation approximately conformed to that emitted by a black body at a temperature of 6,000° K. In another series of experiments of somewhat allied character, Jansky is reported to have been unable to detect solar radiation using a longer wave-length of 14·6 metres, although his apparatus was sufficiently sensitive to detect the electromagnetic radiation, which he discovered in 1931, coming from the vicinity of the Milky Way.

The object of this communication is to point out that there is evidence from radio reception experience, dating from the period of the last sunspot maximum, which suggests that during periods of marked solar activity, the sun occasionally emits radiation in the radio spectrum greatly in excess of black-body radiation corresponding to 6,000° K. Reber and Southworth do not appear to have observed these effects, possibly because their work was conducted during the present period of sunspot minimum.

My attention was first attracted to this phenomenon of abnormal solar radiation by Mr. D. W. Heightman (Amateur Station *G6DH*), who described hearing in 1936 a hissing sound when receiving in the range of 10–40 Mc./s. Other amateur observers sent me further excellent reports, from which I concluded that the noise was due to the emission of *electromagnetic* radiation from active areas on the sun. The noise was heard only in day-time and was often the precursor of a catastrophic fade-out associated with a bright eruption on the sun. It will be recalled that such fade-outs are due to marked intensification of *D*-layer ionization caused by outbursts of ultra-violet light from active solar areas ; and it is natural to associate the radio noise heard before the fade-outs with the same areas. On the frequency band of 10–30 Mc./s. this temporary *D*-layer ionization is usually sufficient to attenuate the solar radiation which causes the noise ; though from our knowledge of the magnitude of such attenuation, which varies as λ^{-2}, I should expect that extremely short-waves would make the single journey through the layer with only slightly diminished strength and so be detectable both before, and throughout, the fade-out.

It is possible to get some quantitative idea of the enhancement of the short-wave radiation from the sun on such occasions, for it is easy to show that the black-body radiation (although recently detected on extremely short waves) would be quite undetectable on the type of receiving aerial used in ordinary short-wave reception. The flux of solar energy received at the earth's surface is given by F, where

$$F = \frac{2\pi kT}{\lambda^2}\left(\frac{r}{R}\right)^2 \Delta f \text{ (ergs, cm.}^{-2}\text{, sec.}^{-1}\text{)} \quad . \ . \ (1),$$

where k is Boltzmann's constant, T the effective solar temperature, λ the wave-length, r the radius of the sun, R the earth-sun distance, and Δf the frequency-acceptance band. Now if we receive such radiation using tuned half-wave dipoles as aerials, the power absorbed is proportional to λ^2 (Δf being kept constant). Therefore, with aerials of this type, the solar noise should be *independent* of wave-length. In fact, the received power is given by p, where

$$p = 0{\cdot}41kT\left(\frac{r}{R}\right)^2 \Delta f \quad . \ . \ . \ (2)$$

Now it is easy to show that this power is only about 10^{-4} of the receiver noise associated with earth-surface temperature and, for that reason, solar radiation does not obtrude in wireless receivers of ordinary type.

When extremely short waves are used, however, it is possible to employ directive aerial systems (for example, parabolic mirrors) of large power gain G_r, and when such a system is appropriately oriented towards the sun, the value of p is increased by the factor G_r. It is therefore clear that to detect solar black-body radiation at *any* radio wave-length, it is necessary for the aerial power gain (relative to a half-wave dipole) to be of the order of 10^4. But with the wave-lengths used in long-distance reception, an aerial array giving a power gain of this order would be of prohibitive size ; and in the cases of amateur reception cited above, the value of G_r cannot have been much greater than 4. It is therefore clear that during the periods when the noise was observable, the intensity of the solar radio flux from the active area was about 10^4 times that associated with the black-body radiation from the disk as a whole.

During the next period of sunspot maximum (1948–49), it should be possible to examine more fully the frequency spectrum of these additional radiations both before, and during, fade-out conditions, since sensitive receivers in the micro-wave region are now available. Indeed, with centimetre-wave sets using very large mirrors, and thus narrow cones of energy acceptance, it should be possible to examine one particular section of the sun's disk at a time and so roughly to locate the active areas. It should, however, be mentioned that, so far as the ordinary black-body radiation is concerned, once the cone of energy acceptance of the aerial system just accommodates the solid angle subtended by the sun's disk, there is no point in increasing the mirror size further ; for any additional power gain effected by such an increase is then just compensated by the reduction in the area of the solar disk which can be 'seen' by the 'radio-telescope'.

EDWARD V. APPLETON.
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24 Rutland Gate,
London, S.W.7.
Sept. 24.

[1] Reber, *Astrophys. J.*, 100, 279 (1944).
[2] Southworth, *J. Franklin Inst.*, 239, 285 (1945).

Indexes of Data for Identification Purposes

FOR the purpose of identifying crystalline solids three indexes have been initiated. (1) The Barker index of morphological data (derived from measurements of interfacial angles on single crystals) was outlined in his book "Systematic Crystallography" (1930) and reviewed by Spiller and Porter[1] in 1939. It will include all crystals (other than cubic, to which the method is not applicable) in Groth's "Chemische Krystallographie", which was completed in 1918. These number some 7,300. To these may be added the (probably small) number of compounds studied goniometrically since 1918. (2) Data on the refractive indexes of upwards of a thousand substances have been collected by Winchell in "The Optical Properties of Organic Compounds"[2]. (3) The index of X-ray diffraction data[3,4] sponsored by the American Society for Testing Materials and the Institute of Physics covers some 2,500 substances, including those in the supplement now in preparation.

Since the professed object of these indexes is that they will facilitate the identification of unknown substances, they must first be judged from this purely utilitarian point of view. Two questions immediately present themselves, namely, how often is anyone faced with the problem of identifying a solid substance, and how useful are these indexes for the purpose, and/or how useful are they likely to become within a reasonable time ? We may assume that problems of identification are likely to be confined almost entirely to industrial or analytical laboratories. Also, something of the chemical nature of the substance will generally be known. Now the number of organic compounds known is of the order of 250,000 and of inorganic compounds probably some 40,000. With the above numbers in view, it is clear that at present the chances of identifying an *unusual* substance with the help of any available index are negligible. In the case of organic compounds, a really comprehensive index is obviously out of the question. Anyone tackling a specific identification problem in a specialized field would be more likely to succeed by taking X-ray photographs of a number of related compounds, particularly as the compound may not have been prepared before. It is also clear that unless the task of expanding these indexes is taken very seriously, more comprehensive compilations including other physical properties would be of greater practical value, assuming always that this problem of identifying unknown substances is sufficiently important to justify the labour involved.

Now although the X-ray index is likely to grow much more rapidly than the other two, it suffers from a grave disadvantage. Certain large groups of compounds, for example, complex oxides and sulphides and alloy systems, are notable for their variable compositions and hence variable lattice constants and intensities of reflexions. This is a serious matter in a classification based on the spacings and intensities of lines on powder photographs. It must be remembered that the X-ray index, being purely a 'fingerprint' system which does not add to our knowledge of any physical constants, must be judged solely on its merits as a means of identification. Before much more time and money are spent on such projects it would seem advisable to consider (*a*) the actual or potential practical value of any index, bearing in mind the points raised above, and (*b*) the most desirable form of index, that is, the nature and arrangement of the data therein.

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[1] *Nature*, **144**, 298 (1939).
[2] *Nature*, **154**, 349 (1944).
[3] *Nature*, **149**, 437 (1942).
[4] *Nature*, **150**, 738 (1942).

Hydrogen Overvoltage as a Factor in the Corrosion of Metallic Couples

CONSIDERABLE confusion has been caused in the past by neglect of the influence of the hydrogen overvoltage on the corrosion current between metallic couples in electrolytes.

It would seem that there should be no current flow unless the potential difference on open circuit is greater than the hydrogen overvoltage at the cathode; but that when the potential difference is higher than the overvoltage, the current should depend on the difference between the two.

Work at present in progress confirms this view, and we may quote the case of magnesium alloy and copper in sea water. Copper is far removed from magnesium in the electromotive series and has a fairly low overvoltage. A couple of copper and magnesium alloy should thus give a large corrosion current; this, in fact, has been found to be the case.

By amalgamating the copper with mercury, which has a high overvoltage, and in addition is far from magnesium in the electromotive series, the corrosion current is reduced to a very small value. This value, in fact, is much smaller than that obtained with a magnesium/zinc couple, in spite of the fact that zinc is comparatively close to magnesium in the E.M.F. series.

It may be added that the known effect of surface roughness of the cathode on the overvoltage is found to have the expected effect on the corrosion current.

Where ready access of oxygen is possible, the hydrogen overvoltage is accordingly reduced, and the corrosion current is able to reach a higher value in such localities.

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H. C. COOKS.

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Woking,
Surrey.

Difference Tones

THE interesting question raised by Prof. F. Allen's letter in *Nature* of July 21 is whether the difference tones he observes are present in the air or whether they exist only in the auditory system of the listener. If the loudspeaker to which the two oscillators are connected (whether in series or parallel is only a matter of impedance matching) is strictly linear in its amplitude response, then no combination tones, sum or difference, will be produced. The ear, on the other hand, is far from linear in its amplitude response; so when two high-pitched tones are heard together, the difference tone is often clearly audible while the sum tone may be less easily distinguished or above the limit of audibility, depending on the pitch of the beating tones. However, if the loudspeaker is non-linear, combination tones will be physically present in the air nearby and could be detected by a linear tuned sound analyser. If this is not available it should be possible to feel or even see the low frequency vibration of the loudspeaker diaphragm when the two tones are nearly in synchronism.

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July 25.

Transplantation of the Heart

FOR a number of years, my laboratory has been studying the problem of transplanting the heart of vertebrate animals. In the animal kingdom many necessary prerequisites exist for carrying out this important, and at first sight impossible, operation. The first stage, 1938–42, was my work on cold-blooded animals—frogs and fishes. After a number of experimental variants and the perfection of the operation technique, I succeeded in transplanting to a frog a second heart taken from another animal; I planted the second heart in the same pericardium as the heart of the host. Animals with two hearts showed no differences from control frogs, and experienced biologists invited to examine them were unable to distinguish one from the other. Two-hearted frogs went through the usual nuptial period in spring, and cast their spawn in the ordinary way.

As this series of experiments proved successful, I then began the next series, the purpose of which was to replace the heart of a host animal with that of another animal—a much more complicated task. The operative technique required by this series of operations was also more complicated; but after persistent attempts all difficulties were overcome.

In 1943, I removed the heart from a frog and transplanted another heart into the same pericardium. Two or three minutes after the operation, it was impossible to distinguish the operated frog from control specimens. Some of these frogs lived more than a hundred and ninety days, which is more than six months, and their behaviour did not in any way deviate from normal. In the spring of 1944, they went through a nuptial period which also ended in casting spawn.

Six months later, microscopic examination of blood vessels that had been sewn together showed that they had knitted completely, and that the structure of the heart muscles was normal.

When there are two hearts beating in the breast of one frog, they have entirely different relations to the animal organism. The host's own heart has both neural and humoral connexions with its organism through blood, while for the first thirty-five–forty days the transplanted heart has only humoral chemical connexions; the nerves of the host then begin to grow on to the transplanted heart.

It is also possible to study the action of a number of cardiac medicaments on organisms with two hearts. There is undoubted interest in the question of the length of time taken by the transplanted heart to take root in the host's organism, when the host's nerves grow on to it, and what happens to nerve ganglions inside the heart.

The success of these experiments on cold-blooded animals led me to repeat the experiments on rabbits, cats and dogs. As a preliminary measure, we carefully developed methods of joining the blood vessels of warm-blooded animals; the method we developed is exceedingly simple and rapid—it takes twenty to thirty seconds to perform.

In the first series of these experiments, we developed methods of transplanting the heart into the necks of these animals. In this series of experiments, the second heart had only its right half joined into the host's blood circulatory system. The left half of the heart was not 'in circuit'. This system we called the 'semiclinical' method.

Observations showed that the heart worked well and would live for a long time. The heart retained its own rhythm and had no adverse effect on the blood pressure of the host or its ability to perform work.

For the second series of experiments, after a long search for the correct method, we transplanted hearts into the necks of hosts with both halves, arterial and venous, in circuit with the blood circulatory system. This gave us a complete second heart, 'clinical transplantation', as we called it.

Animals on which we experimented—rabbits, cats and dogs—easily withstood the operation with very small loss of blood and without any visible effect on the work of their own hearts.

Operated animals did not show any shortness of breath, spasms or excessive excitation after operation. They reacted normally to all external exciting agents, such as light, sound and pain.

Transplanted hearts retained their own individual rhythm, which as a rule is slower than that of the host's heart.

A method has been developed for the simultaneous registration on a kymograph of the work of both hearts. This is a valuable method of studying various theoretical problems of heart treatment, humoral and neurohumoral, in warm-blooded animals with two hearts.

After having mastered the transplantation of a second 'clinical' heart in warm-blooded animals, my laboratory is now carrying out long-term experiments for the purposes of keeping animals with two hearts alive as long as possible. Simultaneously, we are conducting experiments on the transplantation of hearts into the abdomen.

NIKOLAI SINITSIN.

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Moscow.
Sept. 9. (By Cable.)

Behaviour of the Common Centipede *Lithobius forficatus*

ALTHOUGH the Chilopoda are a widely distributed order, they have attracted little notice from zoologists. Centipedes are carnivorous, feeding on insects and their larvæ, and occasionally worms and other small animals. The account by F. G. Sinclair in "The Cambridge Natural History" (1895) is still the most comprehensive survey of the group; but recent observations are at variance on certain points. Sinclair describes the breeding habits of *Lithobius forficatus*, and states: "If the male Lithobius sees the egg, he makes a rush at the female, seizes the egg and at once devours it". No reference is made as to the manner in which centipedes recognize their food, but it is implied that the sense of sight is used. Now *Lithobius* is almost invariably nocturnal, and can only be found in day-time underneath stones and piles of dead leaves. That it is negatively phototactic and positively thigmotactic has been confirmed by simple experiments. The eyes are clusters of ocelli, 25–50 in number, present in many groups of Lithobiidæ but absent in some. It would appear unlikely that the sense of sight is used in the recognition of food, and indeed, this has been proved experimentally by painting the eyes with black pigment. Nor is the sense of smell employed. Experimental observations indicate that *Lithobius* hunts for its prey by the sense of touch, which is extremely sensitive. Centipedes appear oblivious to the presence of food unless they happen to touch it with the base of the antenna.

In this connexion, the following extract from the section on "The Scolopendra and the Galley Worm" in Buffon's "Natural History" published January 31, 1782, is of interest: "Of theſe hideous and angry inſects we know little except the figure and the noxious qualities . . . they are covered with hair, and ſeem to have no eyes; but there are two feelers on the head, which they make uſe of to find out the way they are to paſs. . . ." The antennæ are covered with sensory hairs, and are continually cleaned with the maxillæ. The legs are periodically cleaned in the same manner, but less frequently. Removal of the antennæ renders the animals powerless to avoid obstacles; but they may blunder into and eat dead flies, etc., placed in their cage.

Centipedes can live for many weeks without food provided that they are kept in a damp environment. Cannibalism becomes apparent if one of the animals is particularly small or has been injured. After killing its prey, *Lithobius* seeks a soft spot by prodding with the poison claws ; grips firmly with the 2nd maxillæ (sometimes assisted by the poison claws) and gnaws with the mandibles, the muscles of which can be observed through the integument of the head. I have often observed one *Lithobius* snatch at a dead fly being eaten by another centipede. If the attempted robbery proves unsuccessful, the robber may give the other a sharp, but not fatal, nip with the poison claws (maxillipeds) to make it drop its prey. Occasionally two centipedes are to be seen feeding on the same insect.

Lithobius can survive several hours immersion in water. At first it struggles violently, sometimes swimming (like *Nereis*) by a series of rapid flexions ; but its motions soon become sluggish. Centipedes become darker when placed in dry surroundings than in a damp environment. This colour change is not affected by light, adrenaline, etc. ; it also occurs in dead centipedes and is probably a physical change in the integument.

In conclusion, it can be stated that, except the eyes, which do not appear to be of much importance, the sense organs of *Lithobius forficatus* are in the form of hairs, or groups of hairs, each fitting into a cup in the cuticle, and connected with nerve fibres. In consequence, the behaviour of the animal is (with the exception of negative phototaxis which occurs even when the eyes are covered) chiefly governed by reactions to thigmotactic stimuli.

J. L. Cloudsley-Thompson.
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July 21.

Hatching of the Egg of *Ixodes ricinus* L.

The mechanism of hatching in the sheep tick does not seem to have been previously described. When freely laid, the eggs are oval, but deposition in crevices results in a certain amount of flattening. Examination of the egg under the microscope reveals that the brown colour is due to a thin semi-transparent shell, covering the brown internal mass. Each egg is surrounded by a gelatinous secretion produced by Gené's organ. Immediately after oviposition, the individual egg weighs 0·00006 gm.

The pre-oviposition period varies with the season and with the individual, but usually lasts 15–22 days[1]. Prior to hatching, the larva shows very little activity, and the density of the internal contents precludes any detailed observations upon it. Twenty-one to thirty days after oviposition, at 60° F., and a relative humidity of 80, the eggs show an extensive white area of an abbreviated dumb-bell shape, surrounded by the yolk. During the forty-eight hours before emergence, the body of the arachnid comes to fill the egg more completely ; the yolky contents of the gut become apparent, with small interspersed fat globules. Occasionally rhythmic movements of the head are obvious. It is suggested that at this period the larva swallows the amniotic fluid in much the same way as insects do[2]. When this fluid is added to the fatty contents of the gut, the fat globules run together to form large droplets.

At this stage the larva is enclosed in a membrane, the first or 'embryonic' cuticle, which surrounds each limb in an unsegmented sac ; but in view of its smallness the limbs are very much crumpled. The head is flexed ventrally and is not visible from the dorsal aspect. Viewed ventrally, the appendages are closely apposed to one another and to the body generally.

Within twenty-four hours of hatching, the outward form of the egg is changed, becoming longer and thinner. Air enters the egg shell and occasionally some air may be swallowed by the larva. This, however, is not constant and seems to play no essential part in the process of hatching. The enclosed larva extends the posterior part of the body and ruptures the egg shell longitudinally. It is believed that this rupture of the egg shell follows a distinct line of weakness, as similar cleavages have been obtained by the treatment of newly deposited eggs with dilute and concentrated acids.

No air appears to be swallowed after hatching. The posterior end of the body invariably emerges first and the anterior portion of the body may be retained for some hours within the egg shell. Ultimately, by slow movements of the legs, the entire body comes out of the shell and the larva crawls some distance from the remains. At this stage the head is still reflexed, of a very pale almost transparent character, and the legs but lightly sclerotized. The tick remains quiescent with its legs drawn closely to the side and head reflexed for 7–10 days at 60° F. and relative humidity of 80 per cent.

A fuller report on this investigation will be presented elsewhere.

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Control of Foot Rot (*Phoma* sp.) of Flax

With regard to the reference[1] made to the use of 'New Improved Ceresan' for the prevention of foot rot (*Phoma* sp.) of flax, further experimental work has given the following results. Seed with a moisture content below 10 per cent and treated with this disinfectant at the rate of 12 oz. per cwt. showed an adverse effect of the treatment on germination when kept for 18 weeks in hundredweight lots under ordinary storage conditions. Tests made with seeds on porous dishes placed on damp sand showed that the germination of treated seeds was 75 per cent as compared with 95 per cent in the case of the untreated. This adverse effect was also apparent when seeds were sown in soil in the greenhouse. No effect on germination was observed when the seed had been stored for 8 weeks. Seed from the same lot as the above but treated with 'Arasan' at the rate of 12 oz. per cwt. and stored for 18 weeks under similar conditions showed no reduction in germination.

When seed having a moisture content of 14 per cent was treated with 'New Improved Ceresan' at the rate of 12 oz. per cwt. and tests made within 14 days, it was found that the germination was reduced from 65 per cent in the untreated seed to 46 per cent in the treated. It should also be stated that in the case of the treated sample an additional 23 per cent of the seeds showed abnormal growth on germinating. The damage caused by treating damp seed has also been demonstrated by sowing seed in soil.

It would therefore appear to be inadvisable to treat flax seed with 'New Improved Ceresan' if the seed has a moisture content greater than 10 per cent. In the case of seed with a moisture content less than 10 per cent, and where 'New Improved Ceresan' is used, a period of not more than eight weeks under good storage conditions should be allowed to elapse between treating and sowing.

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[1] Muskett, A. E., and Colhoun, J., *Nature*, **155**, 367 (1945).

Nature, Nurture and Probability

Since Galton, it is customary to consider that characters are due to nature or to nurture, or to both, and that there is no third cause. From a practical point of view, however, factors of chance can surely be supposed to play a part. To clarify this conception, let me take an example.

A malignant tumour is caused by some single cell or group of cells reverting to the fœtal stage and dividing afresh. If this is due to hereditary factors, we should expect a general tendency in the cells of a given tissue towards malignity. In that case, cancer would appear concurrently at several places. This is not so, however, which is why it is possible to treat cancer operatively. The same holds for the external environment. If this environment caused a tumour to arise, we should also as a rule expect an extensive formation of tumours. It is difficult to imagine environmental factors with an action on a single point.

But there is a third possibility. Let us assume a hereditary disposition to cancer, entailing a tendency towards faulty behaviour of a certain type among the cells, for example, in cell division. Let us further assume that the hereditary tendency towards such faulty behaviour is extremely weak, and that on this account there is, for example, a 1 : 30 probability that an individual may be overtaken by such defection each year when he gets older. This means that, among the extremely large number of cells present, and the very large number of cell divisions in process, the probability for each cell to become a cancer cell is diminutive. If we reckon per individual instead of per cell, the tendency becomes much greater. If it is 1 : 30 a year, this implies that one of a pair of monozygotic twins might get cancer relatively early, while the other would not get it until 30–40 years later. In most cases, then, the second twin in pairs of this kind should die from a disease other than cancer. The difference between monozygotic and dizygotic twins in respect of the occurrence of cancer should therefore be very small. This being so, studies on twins cannot be used to determine the part played by nature and nurture.

The situation can be illustrated by an analogy, which must not, however, be taken too far. Let us assume that, in two large towns, the population has exactly the same heredity and lives in the same environment. Let us assume further that this results in a great infrequency of suicide, so that the probability for such an act in any one year is 1 : 30. If a suicide then occurs in one of the two towns during any given year, it may be many years before a suicide occurs in the other town.

The conception of probability is therefore used at several different points in genetics, primarily in the distribution of the genes over the sex cells, and in their combination, secondly in genotypical asymmetries[1], and finally in certain other characters, where internal processes of a complicated nature are in process. The formation of cancer is an example of this. Similar conditions can also be thought to play a part in mental characters. From this point of view, the result of twin research in mental diseases may appear to some extent doubtful, since when processes of the kind touched on here are involved, the differences between monozygotic twins will be relatively large, and can by no means be taken as a gauge of the influence exerted by external environment.

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Aug. 9.

[1] Dahlberg, G., *Proc. Roy. Soc. Edin.*, B, **62**, 20 (1943).

A Forecast of Solar Activity

I wish to direct attention to the fact that a relatively long period of intensive solar activity seems to be imminent. If this should be the case, the coming years will probably be very suitable for studying possible relations between sunspots and such terrestrial phenomena as are supposed to be allied to solar activity.

While exact predictions of the future course of sunspot numbers are impossible, forecasts with a high degree of probability can be derived from the probability laws of sunspot variations which I have published[1]. These forecasts may be summarized as regards the present new spot cycle as follows:

(1) It can be expected with a probability of 0·95 that the next sunspot maximum will be higher than the previous one, which occurred in 1937. It may be noticed that the height of the maximum of 1937 itself exceeded the heights of the five preceding maxima, which occurred in 1883, 1894, 1906–7, 1917 and 1928. Hence it seems very probable that the next maximum will be the greatest within living memory.

(2) It can be expected with a probability of 0·95 that the next sunspot maximum will occur before May 1948. At the meeting of Section D (Astronomy) of the American Association for the Advancement of Science held on September 14, 1944, S. B. Nicholson, of Mt. Wilson Observatory, reported that solar activity reached its last minimum as late as in April 1944; thus it follows from (1) and (2) that in the new spot cycle the ascent from minimum to maximum will probably be unusually steep.

(3) It can be expected with a probability of 0·98 that after the next maximum, solar activity will decrease so slowly that not until more than five years after this maximum will Wolf's smoothed sunspot numbers fall below a quarter of their maximum value. Such a slow decline has occurred in only four out of the seventeen spot cycles which have been observed hitherto.

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July 11.

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YEAST HEXOKINASE AND ITS SUBSTRATES *d*-FRUCTOFURANOSE AND *d*-GLUCOSE

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ON solution in water, *beta d*-fructopyranose, the only crystalline form of *d*-fructose, exhibits mutarotation which mainly consists in a pyranose ⇌ furanose interconversion[1,2]. In experiments at 0° C. and $pH = 4 \cdot 5$, under which conditions mutarotation proceeds the slowest, it was previously[3] shown that *beta d*-fructopyranose added to a suspension of baker's yeast in 0·1 *M* KH_2PO_4 is unfermentable, whereas *alpha d*-glucose is fermented at the expected rate. Since in any quantitative consideration of the composition of a *d*-fructose solution at equilibrium ($pH = 4 \cdot 5$) open-chain forms (keto-form, enol-form) can be neglected, *d*-fructofuranose, chiefly present in the *beta* configuration, remains as the only fermentable isomer. The non-fermentability of *d*-fructopyranose—obviously due to lack of an OH-group at C_6—rendered possible the determination of the proportion of the furanose form in an equilibrium mixture of *d*-fructose at 0° C.; this proportion was found[4] to be 12 per cent. From this figure and the known differences in mutarotation of *d*-fructopyranose at 0° C. and at 25° C., it can be calculated that an equilibrated *d*-fructose solution at 25° C. contains approximately 22 per cent of the sugar in the furanose modification; it is in this way that the concentrations of fructofuranose given in this report have been derived.

Recent experiments with sucrose as fermentation substrate have justified the aforementioned conclusion, thus confirming a hypothesis first advanced by Hopkins[5]: 0·002 *M* sucrose in phosphate solution ($pH = 4 \cdot 5$) was fermented by baker's yeast at 0° C. with conditions so arranged that 50 per cent of the disaccharide added was already inverted within 70–80 sec. It was found that after fermentation periods of 20 or 40 minutes, approximately equal amounts of *d*-glucose and *d*-fructose are left, in contrast to the preponderance of *d*-fructose in the residual aldehyde-ketose mixture when sucrose is fermented at 25° C.

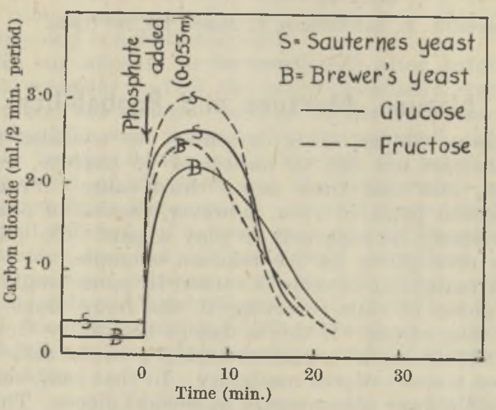
With *Sacch. cerevisiæ* (brewer's top and bottom yeast, distiller's yeast) the ratio of the maximum velocities of the separate fermentations of *d*-fructofuranose and of *d*-glucose at 25° C. is 1·05[6]. It is, however, well known that Sauternes yeast ferments fructose much faster than glucose at any concentration[5,7]. It can be seen from the table that at 25° C. Sauternes yeast ferments 0·019 *M* fructofuranose at a rate 72 per cent greater than that at which it ferments 0·055 *M* glucose; at these concentrations both sugars are fermented by brewery bottom yeast at the same rate. These figures were recently obtained

Relative rates of fermentation by living Sauternes and brewer's yeast in 0·05 *M* KH_2PO_4 at 25° C. (gas phase: nitrogen).

	0·055 *M* Glucose	0·019 *M* Fructofuranose	0·252 *M* Glucose	0·446 *M* Glucose	0·041 *M* Fructofuranose
Sauternes yeast	58	100	64	64	96
Brewer's yeast	88	88	100	100	100

with a pure culture of Sauternes yeast which Prof. R. H. Hopkins, University of Birmingham, kindly procured for me from the Institut Pasteur, Paris.

These differences between brewer's and Sauternes yeasts in their behaviour towards the aldehyde and the keto sugar disappear completely when dried preparations of the yeasts are used. The curves in the accompanying figure show that at 0·053 *M* initial phosphate concentration both with dried brewery and with dried Sauternes yeasts the ratio of the maximum fermentation rates of fructofuranose (0·05 *M*) and of glucose (0·40 *M*) is approximately 1·1.



Rates of fermentation of glucose (0·40 *M*) and of fructofuranose (0·05 *M*) by dried brewer's and Sauternes yeasts (1 gm.) at 0·053 *M* initial orthophosphate concentration. All samples contain 3 mgm. acetaldehyde and 0·3 ml. toluene. Total volume, 10·6 ml. $pH = 6 \cdot 2$. Gas phase: carbon dioxide. Temp. 25° C.

With inorganic phosphate and sugar concentrations high enough to provide optimal conditions for the reaction: 3-phosphoglyceraldehyde + phosphate + cozymaze ⇌ 1,3-diphosphoglyceric acid + dihydrocozymase, the small difference in the maximum rates of fructofuranose and of glucose fermentation by dried yeast preparations is probably due to different rates of the hexokinase reaction with fructofuranose and with glucose. It would appear that in the presence of excess substrate the turnover of the phosphorylation of fructofuranose by hexokinase is about 10 per cent greater than that of glucose. The greater reactivity of fructofuranose with hexokinase reveals itself most noticeably at low concentrations of the substrate. Thus using dried brewery yeast and 0·081 *M* phosphate concentration, with fructofuranose half the maximum velocity was attained at 3×10^{-3} *M* concentration, as compared with glucose at $7 \cdot 2 \times 10^{-3}$ *M* concentration. This is in close agreement with the results of previous measurements[6] showing that the ratio of the dissociation constant of the hexokinase-glucose complex to that of the hexokinase fructofuranose complex is approximately 2.

These results allow of a common interpretation of the initial step in alcoholic fermentation of *d*-glucose and *d*-fructose by different types of yeast, which was previously scarcely possible[8,7,5,6]. In view of the close approach of the maximum rates of fermentation by dried Sauternes yeast of fructofuranose and of glucose (in higher concentrations) the differences in these rates exhibited by living Sauternes yeast are best explained as due to differences in the permeability of the membrane of the living cell for the two sugars. The same enzyme, hexokinase, is concerned in the primary attack on *d*-fructose and *d*-glucose irrespective of the type of yeast. A marked difference, however, exists in the interaction between hexokinase and the two substrates. While all the components of a *d*-glucose solution at equilibrium react with hexokinase, of the various *d*-fructose modifications only that fraction present in the furanose form serves as substrate. This very reactive and labile substance has about twice the affinity of glucose for hexokinase. If fructofuranose and glucose compete for hexokinase, as they do in the fermentation of invert-sugar, the relative rates of disappearance of fructose and glucose from the medium depend on the relative concentrations of fructofuranose and of glucose inside the cell and their relative affinities for the common enzyme. While at room temperature with brewery and baker's yeasts the much higher concentration of the aldehyde sugar within the cell outweighs the greater affinity of fructofuranose for hexokinase ('selective fermentation of glucose'), in the case of Sauternes yeast the greater permeability of the cell membrane of this yeast for fructofuranose plus the higher affinity of this sugar for hexokinase result in the 'selective fermentation of fructose'.

It seems to be noteworthy that *d*-fructose, when taking part in the biological formation of fructose-6-phosphate, fructose-1,6-diphosphate, aldosido <> fructosides and polyfructosides, always reacts in the labile furanose form. This may suggest an interpretation of the central role assigned to *d*-fructose in the metabolism of carbohydrates.

Full details will be presented elsewhere, including a more complete survey of the literature.

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MELLON INSTITUTE OF INDUSTRIAL RESEARCH

ANNUAL REPORT

THE thirty-second annual report of the director, Dr. E. R. Weidlein, to the trustees of the Mellon Institute of Industrial Research, Pittsburgh, Pa., covers the year ending February 28, 1944, and the third year of war research at the Institute. Research and advisory collaboration with the War and Navy Departments grew in scope and value during 1944–45, as well as investigations and other technical help for the War Production Board, Rubber Reserve Company, National Defence Research Committee and the War Metallurgy Committee of the National Academy of Sciences. During the year in question, ninety-four industrial research programmes were in operation, of which fifty-four were multiple fellowships; this does not include seven fellowships the activities of which stopped for the duration of the War. Of the ninety-four fellowships, three have been proceeding for thirty years and four others for twenty-five years; twenty-two have been proceeding for more than ten years, and twenty-seven have been in operation for five years. During the year 1943–44, the Institute's expenditure for pure and applied research amounted to 2,042,385 dollars; 244 fellows were employed, together with 232 research associates and assistants, laboratory assistants and technicians.

From the long list of investigations mentioned in the report it is possible to select only a few for mention. In the physical field an investigation has shown the potential speed of a process for separating gas mixtures by diffusion into a fast streaming vapour. Methods for measuring surface areas of porous adsorbents have been studied critically and a method published for determining thermal conductivities at low temperatures. An investigation on frictional losses in vaned elbows of asbestos ducts has led to these losses being reduced to an absolute minimum. Research on the treatment of dry air-set mortars so as to prolong the period during which they may be stored has led to products which may be stored about four times as long as the present material, and the manufacture of products such as 'Garcrets', 'Garspar', and 'Gartex' has been improved in efficiency. A new process devised for the manufacture of 'Garsand', a promising glass batch ingredient, will form the basis of an extended programme. A combination limestone-lime process which offers substantial saving in many localities has been developed for treating waste pickle liquor, and current investigation indicates that magnetic iron oxide of pigment quality can be obtained from waste pickle liquor by a simple process with low operating costs.

A study of the impurities in nitration benzene indicated that the principal contaminants are naphthenes, some of which have boiling points as much as 20° above that of benzene. A rapid and accurate method has been developed for determining hydrogen cyanide and its derivatives in the gaseous, liquid or solid state, as well as a new process for making guanidine nitrate. Investigations on the rheological properties of tar products have led to the manufacture and introduction of a pitch compound of modified flow characteristics, suitable for protecting metal products such as corrugated roofing and siding, flat and V-crimp sheets and associated constructional accessories. A process has been discovered for vinylnaphthalene, which has promise in plastic technology, and progress has been made in the synthesis of picolines and vinyl derivatives of pyridine and in the oxidation of lutidine and picolines. The synthesis and properties of 1 : 1 : 3-trimethylcyclopentane, a new hydrocarbon, have been described. The identification of some fifty alkylated phenols, based on the properties and X-ray diffraction spectra of their phenyl *iso*cyanate derivatives, has been published. Much attention has been given to the development of improved synthetic lubricants for aircraft instruments, and a high-quality product has been developed. Lubricating oils for watches and similar fine mechanisms are also being investigated, as well as the production of chemicals for improving hydraulic fluids and low-temperature lubricants for the Armed Forces, while collaborative testing of extreme pressure addition agents has been carried out for a Government agency.

A study of the proteolytic enzyme activity in chicken eggs has been concluded and an economic process for drying yeast will soon be in operation. Fundamental advances have been made in the programme on cotton properties, and other investigations in the textile field have covered sizes for knitted hosiery, resin coating for fibres, and new treatments of woollen felts against heat, water, chemicals and abrasion.

Special reference is made in the report to the investigations of the Department of Research in Pure Chemistry on the synthesis of new anti-malarials, particularly the application of the novel hydroxyethylating agents, and a hydroxyethyl analogue of 'Pamaquin' has shown considerable promise. Sulphur derivatives of quinoline have also been prepared, as well as ten new bases of 2-styrylquinoline type in which a modification of Brahmachari's method raised the yield from 2·5 per cent to 80 per cent. Conditions have also been established for the formation of the *p*-dialkylaminobenzylidene diquinaldines, and four new 4-*p*-dialkylaminostyryl-quinolines have also been prepared as well as 6-hydroxyethoxylepidine and the corresponding 6-hydroxy derivatives. The pharmacological properties of the hydroxyethyl-ether derivative of morphine have been determined, and an intensive search made for morphine derivatives free from the medically undesirable side-effects and less liable to cause addiction. The Institute is also participating in the thirteenth revision of the Pharmacopeia of the United States, which is now under way.

Studies of the physical and chemical properties of synthetic racemic menthol have been published, and a method developed for determining iodine in organic compounds. The Institute is also cooperating in an important investigation of chemical methods of analysis for the highly insoluble glass required for ampoules for penicillin and organic arsenicals.

A RADIO NAVIGATIONAL AID

A NOVEL method of position-finding by the aid of long radio waves, applicable to both aerial and marine navigation, has been developed to practical utility during the War by the Decca Record Co., Ltd.

The system uses two or more fixed transmitting stations which radiate signals of constant frequency and amplitude in all directions along the ground. At the receiving point the difference in phase of the waves arriving from two stations is measured, and it is then known that the receiver is on one of a number of hyperbolic curves, which are the loci of points of equal phase difference from the two transmitters. By repeating the observation on the signals from a third station compared with one of the first two, the position on an intersecting series of curves is found, and so the exact location of the receiver is determined. The phase comparison must be carried out on signals of identical frequency, but since only signals of different frequency can be received separately, the transmitting stations operate on different frequencies having a common harmonic relationship, and the necessary restoration to a common frequency for measurement purposes is carried out in the receiver itself.

In the development of the Decca Navigator system, great care has been taken to secure adequate frequency control of the transmitters and also of the reference oscillator in the receiver, which has been designed around radio circuits of high stability. The actual measurement of phase is carried out with a special meter which, by means of a train of gears and suitable indicators, displays a direct reading of the phase difference for transfer to the chart supplied for use with the instrument. Various precautions have been taken to render the whole system free from variations of phase of the signals due to instrumental changes, and the sites of the transmitting stations are selected so as to avoid so far as possible any effect of varying ground conditions on the propagation of the radio waves used. It is claimed that at a range of 300 miles, the navigating system is accurate to about 200 yards, and for shorter ranges it is more accurate still. Much greater ranges are possible for daylight working, but during the night the effect of ionospheric waves superimposed upon the ground waves may limit the range at which the highest accuracy can be obtained.

During the War the system was used by the Admiralty; and it has now been disclosed that it was used from *D*-day onwards to guide the leading minesweepers and landing flotillas. The system is likely to have peace-time applications to both air and marine navigation.

EXCHANGES OF INORGANIC IONS THROUGH LIVING MEMBRANES

THE large differences in concentration of single ions (especially potassium and sodium) between living cells and their surroundings were discussed at the Croonian Lecture of the Royal Society*. These differences are generally maintained by transport work through the surface layer making good the simultaneous diffusion losses.

Membranes differ greatly in permeability as shown by selected examples. The blood vessels of the vertebrate central nervous system in particular show characteristics of permeability approaching those of the surfaces of many cells. They are highly permeable to water and lipoid-soluble substances, but only slightly permeable to crystalloids including ions.

A number of examples were given demonstrating the active transport of ions through membranes composed of cells (plant roots, gills of aquatic animals, intestinal epithelium, etc.) and into (or out of) individual cells (giant plant cells, root cells, erythrocytes, striated muscles, etc.). All the cells studied are freely permeable to water, but the difference between mechanically supported plant cells and naked animal protoplasts was emphasized. The latter must always be in osmotic equilibrium with their surroundings, while the former can build up a surplus pressure by active absorption of ions.

In the case of plant roots, the energy expended in absorbing anions is considerable; but in animal cells the permeability is so slight that the energy exchanges involved in active transport cannot be measured. In several cases the process depends upon the access to glucose or oxygen or both.

In cases where an active transport takes place, the passive permeability can only be measured by means of isotopes and only when special conditions are maintained. Several experiments with isotopes have been recalculated to give absolute permeability figures, and these show for erythrocytes and muscles higher values for sodium than for potassium, a result incompatible with a simple pore permeability, but supporting the Lundegårdh conception of mosaic surface films of the Langmuir pattern.

* Abstract of the Croonian Lecture "The Active and Passive Exchanges of Inorganic Ions through the Surfaces of Living Cells and through Living Membranes Generally", delivered by Prof. August Krogh, For.Mem.R.S., before the Royal Society on October 25. This Lecture should have been given in 1940, but Prof. Krogh was then unable to travel to England.

COSMIC RAYS

ANGLO-FRENCH CONFERENCE IN BRISTOL

An Anglo-French Conference on cosmic rays was organized by the Physics Department of the University of Bristol, with the collaboration of the British Council and of the French Government, which made it possible for about fifteen delegates from Paris and other French universities to attend. The discussions took place in the H. H. Wills Physical Laboratory during September 25–27, and were attended by about sixty physicists, including Prof. F. Joliot, Mme. Joliot-Curie, Dr. P. Auger, Prof. P. A. M. Dirac, Prof. P. M. S. Blackett and Sir George Thomson. The conference was the fourth in the series of international physics conferences in Bristol—others were held in 1935, 1937, 1939—and was one of the first international gatherings of its kind since the War.

The conference was devoted mainly to discussions on cosmic rays and certain aspects of nuclear physics. In his opening remarks, Prof. N. F. Mott, after welcoming the French delegation, stressed the importance of such conferences, and expressed the hope that others of a similar character would follow. They would constitute an important contribution to re-establishing that international collaboration between scientific workers which has been so seriously hampered by the War and is of such decisive importance for the advancement of knowledge and understanding between peoples. During the past five years the work of both French and British men of science has been largely interrupted by the German occupation of France and, in Britain, by preoccupation with short-term war-like applications; the main object of the conference was thus to survey rather broadly the present position in our knowledge of the cosmic rays, and to exchange views on the main problems awaiting solution.

In introducing the discussion on the cosmic rays, Prof. P. M. S. Blackett pointed out the importance of a clear recognition of the difficulties encountered by the present theories of nuclear forces and of high-energy particles. He said that in this field at the moment theoretical physicists are very experimental in their search for a satisfactory formalism, and that until some of the major difficulties have been resolved, experimenters should avoid attaching too much weight to theoretical conclusions.

In a review of researches on cosmic rays carried out during the War, Dr. L. Jánossy said that at sea-level the cosmic radiation consists of at least three components; the soft component consisting of positive and negative electrons, the hard penetrating component of mesons and a very penetrating component of low intensity consisting probably of protons and neutrons. The mesons must be of secondary origin because of the short mean life-time, 2×10^{-6} sec., between their formation and disappearance with the emission of a fast electron.

Wataghin and his co-workers, and, independently, Jánossy and Engelby, have established the existence of showers containing several penetrating particles. The air-lead transition of such showers has also been investigated by Jánossy, and the effects observed can be interpreted as due to the production of mesons by the impact of fast protons and neutrons on the lead nuclei. The magnitude of the effect and other features of the observations are in satisfactory agreement with the theory of Hamilton, Heitler and Peng.

In a paper on the meson theory, Prof. W. Heitler pointed out that the short-range forces between the nucleons, that is, the neutrons and protons, which are responsible for the fact that the ordinary nuclei are stable structures, can be explained only in terms of a new kind of field, the meson field. Each nucleon is regarded as being surrounded by a meson field analogous to the electromagnetic field in the case of charged particles. In the meson field theory, the mesons, first postulated by Yukawa, are analogous to the quanta of the electromagnetic field theory, but are distinguished in that they may be charged, positively or negatively; that they have a finite rest-mass and a short life-time. Just as in the case of the hydrogen molecule the cohesion of the two component atoms is due to the exchange of electrons between them, the so-called exchange force, so the force between two nucleons is to be attributed to the exchange of mesons between them.

In the development of the meson theory the interaction between mesons and nucleons was first treated in a way analogous to the interaction between electrons and radiation. The results so obtained were, however, in sharp disagreement with the cosmic ray observations. The discrepancy appears to be due to a neglect of terms corresponding to radiation damping. In the electromagnetic case, in treating the interaction between an electron and an electromagnetic field, this term is very small and can be ignored. On the contrary, it appears to be of great importance in the meson theory. Hamilton, Heitler and Peng succeeded in developing a method of taking account of the radiation damping term, and thus obtained reasonable values for the cross-section for processes involving the collisions between mesons and nuclei. In particular, a large body of experimental facts can be accounted for in terms of the emission of mesons in the collisions between nucleons. In this way a satisfactory picture of the main features of the hard component of the cosmic radiation can be drawn, if we assume that the primary particles entering the high atmosphere are protons and neutrons, which soon collide with nuclei and thus generate fast penetrating mesons. The soft component consists of electrons produced by photons in the well-known cascade process involving pair production, but the relation between the soft component and the primary particles is not yet clearly established. The agreement between the theory and the experimental observations on the hard component is remarkably satisfactory when it is considered that the necessary constants in the theory are not arbitrary but have been determined from nuclear parameters by Möller and Rosenfeld.

A. Rogozinsky described experiments to demonstrate the existence of mesons in the extensive Auger showers. Certain of the showers were shown to contain a single penetrating particle. During the discussion, photographs were shown of the end of the track of mesons and the fast electron emitted in their decay, as obtained with the high-pressure expansion chamber developed by the late Prof. E. J. Williams. M. Tsien also showed a scientific curiosity in the form of an expansion chamber photograph obtained by Dr. Ho, a young Chinese colleague. The photograph, taken in a magnetic field, shows a positive electron colliding with an ordinary electron without annihilation in the process; the positron recoils, having given most of its energy to the recoiling negatron. Papers on the height of formation of mesons by A. Fréon, and on the measurement of the mean life-time of mesons by M. Maze, were also given. It is found, on the basis of reasonable assumptions about the energy distribution of the mesons created by an initially isotropic primary radiation, that the height of formation of the mesons observed at sea-level is considerably lower than that point in the atmosphere where the meson component has its greatest intensity. This indicates that the observed mesons have been created at a considerable depth in the atmosphere. The observations of the mean life-time of the mesons obtained by M. Maze is in satisfactory agreement with the work of other observers. The hypothesis of a multiplicity of mesons of different mass seems to be unnecessary.

The discussion on various aspects of nuclear physics was introduced by Mme. Joliot-Curie. By an extension of the methods of Bohr and Wheeler, and using recent experimental values for the mass defects, the stability of isobaric nuclei can be studied in some detail. It is possible to determine from the resulting curves whether the elements formed in the fission process, which give rise to the succession of β-emitting bodies, have an odd or an even mass number. The method also gives valuable information about the energy of the resulting continuous β-ray spectrum.

A review of the present stage of development of the photographic method of making visible the tracks of heavy ionizing particles was given by Dr. C. F. Powell. Suitable emulsions are able to record slow mesons as well as protons, deuterons, α-particles and heavily ionizing nuclear fragments. The energy of homogeneous groups of protons and deuterons can be determined, in the absence of serious background fog due to γ-rays, with an error of the order of $\pm$ 30 ekv., but the energy of an individual particle is subject to errors of $\pm$ 0·3 Mev. In the case of fast protons the orientation in the emulsion of the original direction of motion of the particle can be determined with an accuracy of about 1°.

Some typical results to show the precision obtained with the method were displayed, including measurements on the scattering of fast neutrons by protons and on the angular distribution of the particles resulting from the bombardment of gas targets of the light elements by beams of fast protons and deuterons from the Liverpool cyclotron. The main technical problem remaining to be solved is the improvement in the quality of the emulsions to make possible the employment of unskilled observers in the microscopic examination of the plates.

M. Frilley described experiments on the determination of the wave-length of γ-rays, with especial reference to nuclei of the actinium family, which showed that there are a number of anomalies in the internal conversion coefficients. It has long been known that certain radiations are almost totally internally converted so that they appear with vanishingly small intensity. Frilley showed that the contrary effect also exists in the case of certain γ-ray lines, which appear to produce practically no secondary electrons from the parent atom. No satisfactory theoretical explanation of this phenomena appears to have been found. Other anomalies also occur in the X-ray spectra excited in the radioactive elements during disintegration and studied by different methods. Whereas the differences $K\alpha_1 - K\alpha_2$ correspond well with our general conceptions derived from X-ray spectrography, the corresponding energy differences as deduced from measurements on the internally converted electrons indicate a bigger energy interval.

In experiments on the γ-rays from radium D, Tsien, by measuring the ranges of the photo-electrons produced in the Wilson chamber, has found a radiation of 23·3 ekv. which is equal to half that of the well-known line at 46·7 ekv. The new line is thus partially masked by the second order of the main line in diffraction measurements. He also finds a radiation of 7 kev. which is of lower energy than that of the natural L radiation. Tsien stated that in the cases where one finds abnormally high intensities of the L lines, as in the case of actinium and radium D, this is probably associated with the interaction of the low-energy nuclear electrons ($<$ 20 kev.) with the L shell of the atom in question.

J. Surugue described experiments on the study of the secondary β-rays from the actinium family which is complementary to the work of Frilley on the γ-rays.

Lecoin mentioned that certain trajectories of primary electrons from radium E show abnormally high scattering. Further experimental work on this subject is in progress.

A paper on nuclear isomerism by R. Berthelot dealt with a continuation of Pontecorvo's work on Br^{80}. The metastable level of Br has a period of 4·5 hr. The transition to the ground-level is accompanied by the emission of a quantum of energy 49 kev., which is completely converted internally, and by another of 37 kev. which is partially converted. Berthelot concludes that the metastable level is 86 kev. above the ground-level, the transition to the ground-state taking place in cascade through an intermediate level. The two radiations follow one another within a period of less than $2 \cdot 3 \times 10^{-6}$ sec. The 49 kev. radiation is, in the view of the author, a magnetic octopole, and the 37 kev. line a magnetic dipole, radiation.

In a very interesting paper by Prof. Dupouy, an account was given of an electron microscope using magnetic focusing, which gives very high resolving power. It was mentioned by the author that a new instrument, using protons instead of electrons, is in course of construction in the Collège de France, which it is anticipated will give a substantial increase in resolving power over that at present available.

RECENT EARTHQUAKES

DURING April 1945, three strong distant earthquakes were registered by the instruments at Auckland, Arapuni, Christchurch and Wellington, New Zealand. These occurred on April 15, 19 and 23, the epicentres being unknown until results are to hand from other observatories in the Pacific zone. Six earthquakes were actually felt in New Zealand during the month, the largest being on April 1 with epicentre near lat. 35° S., long. 178° W. The shock on April 7 was felt at Mapua, that on April 17 at Wairarapa and Wellington, and that on April 23 at Masterton.

During the same month, twenty-three earthquakes and tremors were registered on the instruments at Toledo in Spain. The greatest was on April 15, when an earthquake from an epicentral distance of 112·5° registered a full suite of waves, and attained a maximum ground amplitude of 50 μ on the north-south component at Toledo. *The Times* reported an earthquake felt over a wide area in the Province of Alicante on July 2, the shock being felt most strongly near Onteniente, where shocks occurred about three years ago. There is no report of any damage, and further details of this shock are awaited from Spain.

The United States Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, has determined the epicentres of the earthquakes of May 19 and June 3. The former, from the readings of seismograms obtained at sixteen observatories, had an epicentre near lat. 40·2° N., long. 126·8° W., which is off northern California. The latter occurred at 13h. 05·6m. G.M.T. from an epicentre near lat. 8·3° N., long. 82·6° W., which is in Chiriqui Province, Panama.

During April, May and June nineteen earthquakes were registered on the seismographs at King's College Observatory, Aberdeen, Scotland. The strongest of these was on May 19, when an earthquake registered at 15h. 18m. 34s. G.M.T. and attained a maximum ground amplitude at Aberdeen of 20 μ on the north-south component.

At Binstead, Isle of Wight, Mr. E. W. Pollard registered eleven earthquakes during June; his machine was undergoing repairs during June 26 and 27.

CLOSURE AND PARTIAL SEPARATION OF A METALLIC CONTACT

THE problems associated with contacts between nominally clean metallic surfaces approaching and separating normally may be divided into two groups according to whether the path between the surfaces is metallic or gaseous. A paper by Dr. Alan Fairweather (*J. Inst. Elec. Eng.*, 92, Pt. 1, No. 56; August 1945) is concerned with the first of these groups. The field of interest may be further subdivided, as it includes both the phenomena associated with nominally static contacts and those relevant to separating contacts up to the instant when the metallic path between the contacts ceases to exist.

In the first part of the paper, all the effects encountered in the change of resistance with current and mechanical pressure are shown to be predictable on the basis of the existence of contact spots. The extents of resistance changes are directly related to the mechanical pressure. A fresh technique is described, by means of which the existence of the spots may be demonstrated and a lower limit assigned to their number. The influence of the rate of current loading is examined, and further verification of the plastic character of the yielding process is furnished. The measurements described relate to one particular contact material, a platinum iridium alloy, and to one surface finish. They cover much wider ranges of pressures and voltages than are encountered in practice, and permit identification of all the significant events observable in a normal laboratory atmosphere. This range of observations is bounded only by limits at which effects cease to be those relevant to a clean metallic contact. One limit, attributable to surface films, not necessarily due to tarnishing, is encountered at very small pressures and voltages: the other appears at higher voltages which, if exceeded, result ultimately in glowing and fusion of the contact surfaces.

The second part of the paper is concerned with the unequal wear of the two members of a contact pair, termed 'selective erosion' or 'unbalanced erosion'; this is frequently accompanied by a gain of material by one member at the expense of the other. In severe cases one member may develop a large pip while the other produces a corresponding crater: the contacts may then lock together. Hitherto, experience has suggested that such pips and craters occur in a random manner and that neither seems to be associated with a particular contact polarity. The work described presents a new and simplified approach to the problem. It is suggested that, in general, and perhaps more especially when quenching is permissible, unbalanced erosion results from, or can be made to result from, two main causes: first, the molten metallic bridge joining the contacts when only partly separated, and secondly, the arc. The sense of arc erosion is always the same, independent of the metal, whereas that of bridge erosion depends on the sign of the Thomson coefficient of the metal near its boiling point. Thus, metals for which the senses of the bridge and arc erosion are the same can only exhibit one sense of erosion; but those for which they are opposite can exhibit both senses, or even none at all, depending on which effect predominates due to appropriate circuit conditions. This leads to the idea of alloys so designed as to possess a zero Thomson coefficient near their boiling point, which would therefore give equal bridge erosion of both contact members. Progress has been made in the development of such alloys. The remaining unbalanced arc erosion would then be reduced as far as possible by the use of an appropriate quench. Such alloys would, of course, have to satisfy all the conventional requirements for contact materials and, if possible, one more: even with a quench, the possibility of slight residual arcing cannot be neglected, so that it would be desirable, when selecting metals for the development of balanced bridge erosion alloys, to do so from those which do not readily support an arc.

FORTHCOMING EVENTS

Saturday, November 3

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 3 p.m.—Meeting of British and Austrian scientists in support of the restoration of Science in Austria.

Monday, November 5

FARMERS' CLUB (at the Royal Empire Society, Craven Street, Strand, London, W.C.2), at 2.30 p.m.—Prof. T. Dalling: "Sterility in Cattle".

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. M. Spindel and Mr. R. T. Quinn: "Improvements on Portland Cements and Concrete —Past, Present and Future".

Tuesday, November 6

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (at the War Office Cinema, Curzon Street House, Curzon Street, London. W.1), at 1.15 p.m.—Lieut.-Colonel B. Ungerson: "Motion Study Applied to Military Problems" (with Film illustrations).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Dr. A. Müller: "50th Anniversary of the Discovery of X-Rays", (1) "The Background of Röntgen's Discovery".

QUEKETT MICROSCOPICAL CLUB (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. E. A. Robins: "Trawler's Rubbish".

Wednesday, November 7

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. E. F. Armstrong, F.R.S.: "The Influence of the Prince Consort on Science" (Inaugural Address).

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. R. J. Clayton, Dr. J. E. Houldin, Dr. H. R. L. Lamont and Mr. W. E. Willshaw: "Radio Measurements in the Decimetre and Centimetre Wavebands".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Mr. T. W. Goodwin and Prof. R. A. Morton: "The Determination of Carotene and Vitamin A in Butter and Margarine"; Mr. J. L. Bowen, Mr. N. T. Gridgeman and Mr. G. F. Longman: "A Photoelectric Method of Assaying Vitamin A in Margarine".

CHEMICAL SOCIETY (joint meeting with the LOCAL SECTIONS OF THE ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY) (at the Newport Technical College, Newport), at 6.30 p.m. —Dr. E. H. Coulson and Mr. J. L. Jones: "Research on Coal Tar".

Thursday, November 8

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Exhibit and Scientific Papers.

ROYAL COLLEGE OF SURGEONS OF ENGLAND (at Lincoln's Inn Fields, London, W.C.2), at 5 p.m.—Mr. C. Max Page: "A Survey of Fracture Treatment" (Bradshaw Lecture).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. James Gray, F.R.S.: "The Anatomy and Functions of the Brain in Lower Vertebrates", (ii) "Amphibia and Reptiles".

INSTITUTION OF ELECTRICAL ENGINEERS, INSTALLATIONS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m. —Mr. E. C. Lennox: "Street Lighting".

SOCIETY OF INSTRUMENT TECHNOLOGY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6 p.m.—Discussion on "Education in Instrument Technology".

Friday, November 9

ASSOCIATION OF APPLIED BIOLOGISTS (at the Imperial College of Science and Technology (Royal School of Mines), Prince Consort Road, London, S.W.7), at 11.10 a.m. (in the Surveying Lecture Theatre), and at 2.15 p.m. (in the Metallurgical Lecture Theatre)—Discussion on "Factors Controlling Flowering" (to be opened by Prof. F. G. Gregory, F.R.S.).

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Dr. W. K. Slater: "The Contribution of Science to Agriculture in War".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. H. O. Parrack: "Elementary Principles of Plant Organization and Maintenance for Civil Engineering Contractors".

BRITISH ASSOCIATION OF CHEMISTS, ST. HELENS SECTION (at the Y.M.C.A. Buildings, St. Helens), at 7.30 p.m.—Mr. S. W. Norman: "Fractional Distillation, the Theory and its Applications".

Saturday, November 10

BIOCHEMICAL SOCIETY (at the London School of Hygiene, Keppel Street, London, W.C.1), at 11.30 a.m.—Discussion on "The Chemical Basis of Cell Structure and Function" (to be opened by Dr. J. F. Danielli and others).

IRON AND STEEL INSTITUTE (joint meeting with the SCOTTISH BRANCH OF THE INSTITUTE OF BRITISH FOUNDRYMEN) (at the Royal Technical College, George Street, Glasgow), at 3 p.m.—Mr. Basil Gray: "The German Steel Foundry Industry".

THE DISCOVERY OF X-RAYS

50TH ANNIVERSARY COMMEMORATION PROGRAMME

Inaugural Meetings

Thursday, November 8

At the Royal Society, at 11.30 a.m.
At the Royal Society of Medicine, at 4.30 p.m.

Joint Meeting of all Participating Societies

Friday, November 9

At the Phoenix Theatre, Charing Cross Road, London, W.C.2, at 3.30 p.m.—Sir Lawrence Bragg, F.R.S.: "The Scientific Consequences of Röntgen's Discovery of X-Rays".

Medical Meetings

Friday, November 9

At the Royal Society of Medicine, at 10 a.m.

Saturday, November 10

At the Institution of Electrical Engineers, at 2 p.m.

Scientific Meetings

Friday, November 9

At the Royal Institution, at 10 a.m.

Saturday, November 10

At the Royal Institution, at 10 a.m.

Historical Reviews

Saturday, November 10

At the Institution of Electrical Engineers, at 3.30 p.m.

APPOINTMENTS VACANT

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

LECTURERS IN MECHANICAL ENGINEERING in the Department of Engineering of the Cape Technical College, Cape Town, South Africa —The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, quoting C.2861.XA (November 8).

PRINCIPAL OF THE PUNJAB COLLEGE OF ENGINEERING AND TECHNOLOGY, Lahore—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, quoting C.2854.A (November 10).

ENGINEERING ASSISTANT on the staff of the Buildings Department—The County Architect, Kent County Council, Buildings Department, Springfield, Maidstone (November 10).

LABORATORY TECHNICIAN in the Public Health Department—The Town Clerk, Finsbury Town Hall, Rosebery Avenue, London, E.C.1 (November 10).

CHEMIST in the SOILS AND PLANT NUTRITION SECTION at Long Ashton Research Station—The Secretary and Registrar, The University, Bristol (November 10).

ASSISTANT (full-time) to teach MECHANICAL ENGINEERING, WORKSHOP PRACTICE, ENGINEERING SCIENCE, TECHNICAL DRAWING, and MATHEMATICS, in the County Technical School, Newtown—The Director of Education, County Offices, Newtown, Mon. (November 10).

SPEECH THERAPIST—The Director of Education, Stanley Buildings, 3 Caunce Street, Blackpool (November 12).

METEOROLOGICAL OFFICER CADET, Department of Industry and Commerce, Dublin—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (November 14).

DIRECTOR OF INDUSTRIES, Bengal—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, quoting C.2862.A (November 15).

ASSISTANT with qualifications in AGRICULTURE for a survey of Fertilizer Practice in the counties of Kent, Surrey and Sussex—The Secretary, South-Eastern Agricultural College, Wye, Ashford, Kent (November 15).

SCIENCE GRADUATE to teach MATHEMATICS and PHYSICS, and a GRADUATE IN ENGINEERING or equivalent to teach MATHEMATICS with some Workshop Practice, mainly in the Secondary Technical School for Boys—The Principal, Southall Technical College, Beaconsfield Road, Southall, Middx. (November 15).

LECTURER (full-time) IN THE DEPARTMENT OF MECHANICAL ENGINEERING—The Principal, Borough Polytechnic, Borough Road, London, S.E.1 (November 16).

EXECUTIVE ENGINEERS (4) by the Government of Bengal—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, quoting E.2048.A (November 16).

LECTURER (Honours Graduate) IN CHEMISTRY—The Secretary, Woolwich Polytechnic, Woolwich, London, S.E.18 (November 16).

LECTURER IN CIVIL ENGINEERING—The Director, Robert Gordon's Technical College, Aberdeen (November 17).

PRINCIPAL OF THE DEWSBURY MUNICIPAL TECHNICAL COLLEGE—The Education Officer, Municipal Buildings, Halifax Road, Dewsbury (November 17).

MASTER (full-time) to teach ENGINEERING SUBJECTS, including APPLIED MECHANICS and HEAT ENGINES, to Ordinary National Certificate standard, and ENGINEERING SCIENCE and TECHNICAL DRAWING in the Junior Technical School, Newton-le-Willows Technical School —The Divisional Education Officer, The Gables, Crow Lane West, Newton-le-Willows, Lancs (November 17).

HEAD OF THE DEPARTMENT OF ZOOLOGY—The Registrar, University College, Hull (November 17).

ENGINEER AND MANAGER to the Staffordshire Potteries Water Board—The Clerk to the Board, 20 Stafford Street, Hanley, Stoke-on-Trent (November 19).

DEPUTY BOROUGH ELECTRICAL ENGINEER AND MANAGER to the Borough of Willesden—The Town Clerk, Town Hall, Dyne Road, London, N.W.6, endorsed 'Deputy Borough Electrical Engineer and Manager' (November 19).

PSYCHOLOGIST to work under direction of County Psychiatrist primarily for County Child Guidance Service—The County Medical Officer, 4 Barnfield Crescent, Exeter (November 19).

HEAD OF THE CIVIL AND MECHANICAL ENGINEERING DEPARTMENT—The Secretary, Woolwich Polytechnic, Woolwich, London, S.E.18 (November 22).

HEAD OF THE PHYSICS, including TELECOMMUNICATIONS, DEPARTMENT—The Secretary, Woolwich Polytechnic, Woolwich, London, S.E.18 (November 22).

LECTURER IN THE DEPARTMENT OF PHYSIOLOGY, University of Cape Town—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, quoting F.5050.X (November 24).

ASSISTANT LECTURER IN THE DEPARTMENT OF ENGINEERING—The Registrar, University College, Singleton Park, Swansea (November 26).

ABSTRACTORS (male or female) for the Intelligence Section of a Research Association—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, quoting C.2856.XA (November 26).

CITY ELECTRICAL ENGINEER—The Town Clerk, Guildhall, York, endorsed 'City Electrical Engineer' (November 29).

BOROUGH ELECTRICAL ENGINEER—The Town Clerk, Town Hall, Tunbridge Wells (December 31).

ASSISTANT ELECTRICAL AND MECHANICAL ENGINEER by the Government of Iraq for the Basrah Port Directorate—The Ministry of Labour and National Service, Appointments Department, 1–6 Tavistock Square, London, W.C.1, quoting F.A.52.

ASSISTANT LABORATORY TECHNICIAN for the PHYSICS DEPARTMENT —The Warden and Secretary, London (Royal Free Hospital) School of Medicine for Women, 8 Hunter Street, London, W.C.1.

ASSISTANT LECTURER IN THE ENGINEERING DEPARTMENT of the Mining and Technical College, Crumlin—The Director of Education, County Hall, Newport, Mon.

BIOCHEMIST with a good knowledge of Bacteriology to work on the degradation of long-chain hydrocarbons by micro-organisms—The Secretary, National Institute for Research in Dairying, University of Reading, Shinfield, Reading.

HEAD OF THE ENGINEERING DEPARTMENT—The Principal, Technical College, Brunswick Road, Gloucester.

LECTURER (full-time) IN ENGINEERING—The Principal, Walker Technical College, Hartshill, Oakengates, Shropshire.

LECTURER-INSTRUCTOR to teach mainly MOTOR-VEHICLE TECHNOLOGY and REPAIRS, including Electrical Equipment and Repairs—The Principal, Medway Technical College, Senior Departments, Gardiner Street, Gillingham, Kent.

PRINCIPAL OF THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, Trinidad—The Secretary, Imperial College of Tropical Agriculture, Grand Buildings, Trafalgar Square, London, W.C.2.

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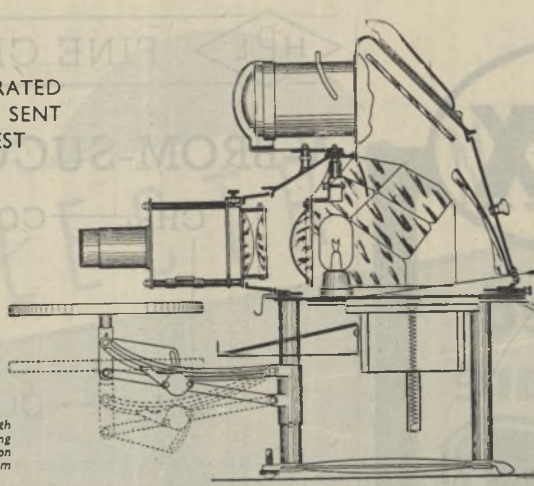

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Printed in Great Britain by FISHER, KNIGHT & CO., LTD., The Gainsborough Press, St. Albans, and published by MACMILLAN & CO., LIMITED, at St. Martin's Street, London, W.C.2, and THE MACMILLAN CO., 60 Fifth Avenue, New York 11, N.Y., U.S.A.—Saturday, November 3, 1945.