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CONTENTS

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VETERINARY EDUCATION IN GREAT BRITAIN

In a leading article in *Nature* of January 8, 1944, the existing constitution and powers of the Royal College of Veterinary Surgeons, and the system of training and examination of British veterinarians was outlined. The key position of the veterinarian in the future, invested, as he must be, with the care of animals upon which our meat, egg and milk supplies depend, was then emphasized, and the interdependence of veterinary medicine and the agriculture from which we derive other vital food supplies was also pointed out. The desirability of a much closer association between the veterinary and the medical professions was also discussed. In the same issue of *Nature*, reference was made to a paper by Major J. M. Smith, in which he made very clear the vital part played by the veterinarian in the affairs of the British Colonies.

A Committee on Veterinary Education in Great Britain was appointed in 1936 by the Government, and issued its first report in 1938. In 1943 the same Committee was asked to reconsider its first recommendations, because, as the Minister of Agriculture wrote to Dr. T. Loveday, vice-chancellor of the University of Bristol, who is its chairman, there have been since 1938 great changes in the position and prospects of agriculture in Great Britain. The Government, wrote Mr. Hudson, intends to maintain after the War a healthy and well-balanced agriculture as an essential and permanent feature of its national policy; and livestock, especially dairy herds, will need adequate care. The best possible training for the veterinarian of the future, continued Mr. Hudson, is therefore of vital importance to agriculture, and substantially greater numbers of veterinarians will be required. The Committee has in consequence met again, and its second report has now been issued (London: H.M. Stationery Office, 6*d*. net), and will presumably go before Parliament for discussion.

The Committee emphasizes that its revised recommendations are intended to secure, not merely an efficient system of training for the veterinarian, but also what it considers to be the best possible training. It also emphasizes that the revised recommendations are based on the assumption that British agriculture will, in fact, be maintained in a healthy and prosperous condition, "and will not be allowed to fall back into the state of uncertainty and depression which progressively prevailed between 1920 and 1939". The revised recommendations do not supersede those of the Committee's first report, except in certain important and possibly controversial particulars; and the main conclusions of the first report are printed in Appendix I for comparison. A point strongly emphasized by the Committee is the urgent need for inquiry into the growing evil of unqualified veterinary practice, a recommendation to which effect has just been given (*Nature*, July 22, p. 111).

There should not be—indeed, there is not—in the mind of anyone who has given even a thought to the cost of animal disease in Great Britain alone, any doubt of the need for veterinarians, or of the financial saving which expansion of their work could effect. Appendix III of the report gives details of the national loss due to various diseases of farm livestock. The Committee estimates that the total cost to the nation is not less than thirty million pounds a year, and rightly considers that the bulk of this loss is preventable, but only if much more money is spent on veterinary training.

Dealing with the future demand for veterinarians, the Committee revises its earlier estimate that about 150 veterinarians would be required annually between 1938 and 1942 and 115 afterwards. Actually 571 veterinarians qualified in the years 1940, 1941 and 1942, without causing unemployment in the profession. The Ministry of Agriculture and Fisheries, bearing in mind its plans for the future expansion of the State veterinary service and the Government's use of the services of private veterinary practitioners, now estimates a demand for 220 veterinarians a year for about ten years, with a possible reduction to 150 a year later. The reasons given by the Committee for the increasing demand for veterinarians are the increasing appreciation by the farmer and the public that the veterinarian is the guarantor of the nation's food supply; the fact that the Government seems to be aiming at a quarterly examination by veterinarians of every dairy herd in the country (it is estimated that about $2\frac{1}{2}$ million dairy cattle, which is about 80 per cent of all the dairy cattle in Great Britain at present, get no regular veterinary supervision); extension of veterinary supervision of meat production and of its control on the way to the market; and increases in the requirements of owners of riding horses and small animals. Most of the witnesses consulted agreed to this figure of 220; but others, including the Royal College of Veterinary Surgeons, hesitated to do so, partly because they feared that the Government's present policy would not be carried on and partly because they feared that the unqualified practitioner might reduce the work of qualified men.

The Committee does not think that qualified men from Eire will come over to practise in Great Britain in sufficient numbers to affect the demand, and it recalls that most of the veterinarians practising in British Colonies are trained in Great Britain. This Colonial demand will, the Committee thinks, increase rather than diminish, because, as the control of the major diseases of livestock in the Colonies, which has occupied and is now occupying the attention of Colonial veterinarians, becomes established, other diseases which have been masked by these major diseases will need attention, and these are likely to require more men for their control. Because the progress of pastoral Colonial peoples depends largely upon adequate production of dairy and other livestock products, this branch of the work of the veterinary profession is likely to become increasingly important. The Committee's recommendations are therefore framed on the estimate of 220 veterinarians a year for ten years, and it sees no reason at all why this demand should fall to 150. It is suggested, in fact, that the figure 220 may prove to be too low. In support of this view, the report includes a table based on information supplied by the Allied Post-war Requirements Bureau, which shows that the number of veterinarians per million of the larger domestic animals is 94·4 in Great Britain, 98·8 in France, 123 in Norway, 140 in the Netherlands, 148 in Denmark, 149 in Germany, and 247·8 in Switzerland. In the United States the corresponding figure is only 60, but much farm stock in that country is kept under ranch conditions; further, reforms in veterinary education and increases in the numbers of veterinarians are now being urged and planned. The table indicates that the number of veterinarians per million of the population in the United States is twice as great (109) as it is in Great Britain (50·2) and the United States figure compares favourably with the corresponding figures cited for other European countries.

The rest of the report deals with the number and location of the veterinary schools, the functions of the Royal College of Veterinary Surgeons, the licence to practise, the association of veterinary training with the universities of Great Britain and with finance. The training of 220 veterinarians a year cannot, the Committee decides, be accomplished by the expansion of the existing four veterinary schools at London, Edinburgh, Liverpool and Glasgow. Eire and its veterinary school at Dublin are not considered. The ideal size for a veterinary unit is, the Committee concludes, one which will provide thirty graduates a year, and all the universities consulted agreed to this figure. The Liverpool school cannot expand beyond this, which it now achieves. The existing Glasgow College is inadequate. If thirty men a year are allocated to this school, which would become an integral part of the University of Glasgow, the London and Edinburgh schools would have to produce 160 graduates a year between them, which would mean about 1,000 students in these two schools combined. The Committee considers that this is too many. Complaints of overcrowding are already universal, and the Committee agrees that they are well founded. It suggests that the number of students at the London school should be limited to 325, and at the Edinburgh school to 275, and that the field stations attached to each school, recommended in the Committee's first report, and again emphasized in this second one, should relieve the pressure on these schools by providing most of the clinical training. London and Edinburgh should then be able to supply a hundred veterinarians a year.

Provision would then be required for sixty more, and the Committee proposes the establishment of two new colleges, one at Bristol and one at Cambridge. There would thus be six veterinary schools in Great Britain, each with a field station and preferably with a hospital for large animals. Veterinary students would receive farm pupilage for not less than six months in the care of normal livestock and also would spend at least six months with a practising veterinarian. There would be provision, in the normal estimates of each school, for continuous research, and bursaries and graduate scholarships would be provided. It is rightly emphasized that these should be of sufficient value to enable the recipients to take a full part in university or college life. Private endowment of veterinary education and the work of the Veterinary Educational Trust are also commended.

The reasons for the selection of Cambridge and Bristol as the sites of these two new centres need not be set out in detail here. At Cambridge the veterinarian would be in contact with experts in all the branches of science and the arts, and also with the various agricultural institutes there. At Bristol a veterinary college would, the Committee thinks, be well placed to serve the area south and west of a line drawn between Aberystwyth, Worcester, Swindon and Weymouth. A veterinary school in Wales was considered and urged by the Welsh Council of Agriculture ; but the Committee felt that each veterinary school should be in close touch with a large and important grazing district, should be able to establish a field station within easy reach, should have suitable accommodation for the pre-clinical years, should be in a centre possessing good medical and agricultural schools and should be remote from other veterinary schools. Although Cardiff and Aberystwyth both fulfil some of these requirements, the Committee concluded that Bristol could best serve south-western England and central and south Wales, while Liverpool could serve north Wales. Not everyone will agree with the Committee's rejection of the claims of Wales to its own veterinary school. The Committee says that, if the demands of the future require more centres, the claims of Wales will have to be considered. Many will think that they should be satisfied now, one reason being that Wales, like Scotland, presents rather special veterinary and agricultural problems which should be studied at such a Welsh centre.

The requirements detailed by the Committee for the choice of sites for veterinary schools are, however, intimately bound up with one of the most important of the Committee's recommendations. This is the Committee's view that the best possible training for the veterinarian can only be obtained by persuading the universities to undertake the responsibility for it. This recommendation is an extension of the recommendation in the Committee's first report that there should be a close connexion between veterinary education and the universities. It involves far-reaching changes, some of which are not, as recent correspondence in *The Veterinary Record* shows, acceptable to many members of the veterinary profession. The Committee's ideal is that veterinary schools should become parts of universities in the same sense as medical schools. This is already so in Liverpool. The Committee is satisfied that the following conditions should apply to all university schools of veterinary medicine. The necessary money should be provided by the State ; the degree in veterinary medicine given by the university should become a registrable qualification ; and the university should have a measure of control over the instruction given, and over the university examinations held, similar to that "generally exercised in the case of medical degrees".

While the Committee "favours the idea" that the universities concerned should establish new faculties of veterinary medicine, it does not make any definite recommendation on this point, because "so much depends on the conditions prevailing at each individual University". Many will regret the lack of decision in this matter. If veterinary education is to be undertaken by the universities at all, it must certainly be given, from the very beginning, an equal status with medicine, agriculture or any other university study which constitutes a faculty. It would be emphatically insufficient, for example, to create a department of veterinary medicine within, or subordinate to, any other faculty. The veterinary profession can only be given its legitimate place in any university by the creation of a faculty of veterinary medicine of full status, the affairs of which would be governed, like those of other faculties, by the veterinary staff in co-operation with other university teaching officers. In no other way would it be possible for the veterinary teacher as well as the veterinary student to take their full part in university life and to experience its full effects. By administering and teaching in a full veterinary faculty the veterinarian would, moreover, be in the best position to introduce effectively into the university those new problems and new spheres of work which could be such valuable additions to university studies. This contribution which veterinarians can bring to the universities is too easily overlooked. It has a very real national importance and no university can afford to neglect it.

While it is clear that the Committee desires the creation of faculties of veterinary medicine of independent status, it is no less clear that it emphasizes its further recommendation that university degrees in veterinary medicine shall be registrable qualifications. There is a lack of clarity in the report on this point which requires elucidation. The Committee recommends that university degrees in veterinary medicine shall be registrable by the Royal College of Veterinary Surgeons and by that College alone ; and it also recommends that the Royal College shall continue its own examinations and shall continue to grant the diploma of M.R.C.V.S. on the results of these examinations, which would presumably be held only in those existing veterinary colleges which do not, for one reason or another, become constituent parts of universities. There would thus be two possible veterinary qualifications—a university degree in veterinary medicine, and the diploma of M.R.C.V.S. granted only by the Royal College of Veterinary Surgeons on the results of its own examinations. The Committee's recommendation is that the Royal College of Veterinary Surgeons should be the only body legally empowered to register either or both of these qualifications, and to grant a licence to practise veterinary medicine. The recipient of a university degree in veterinary medicine would therefore have to register with the Royal College of Veterinary Surgeons, just as the recipient of a university degree in medicine or surgery must place his name on the Medical Register before he can practise.

It would further be necessary, the Committee thinks, to create a body independent of the universities which would be empowered to secure a minimum standard of qualification to practise veterinary medicine. It is proposed that the Council of the Royal College of Veterinary Surgeons should be given this power. The College would therefore control both the education of veterinarians and their licence to practise. Its constitution would be widened and it would be given powers similar to those granted to the General Medical Council by the Medical Acts of 1858 and 1886, the relevant portions of which are quoted in Appendix VI of the Committee's report. These Acts would empower the new Council of the Royal College of Veterinary Surgeons to appoint inspectors who would have the right to attend, and report on, the examinations held at any centre, and to ask for details of the courses of instruction provided. If either these courses or the examinations were not considered adequate, the Council of the College could report to the Privy Council, which could declare that such courses or examinations should not qualify for a registrable qualification in veterinary medicine. The new Council's authority would also extend to veterinary schools which are not parts of universities.

It would thus seem that the Royal College of Veterinary Surgeons would retain all reasonable control of the profession. Some veterinarians have said that the proposals of the Committee involve the relinquishment by the College of the sole control over the educational standards of the veterinary profession in Great Britain which it now exercises; but other veterinarians have replied to this that, in actual fact, the College does not at present exercise this control. It controls only the examinations, and has no control over the instruction given in the existing veterinary colleges, nor any over the time which is given to the study of individual subjects in them.

Objections have also been raised to the Committee's proposal to bring into the new Council of the Royal College of Veterinary Surgeons certain persons who are not veterinarians. Here it should be emphasized that precisely four, and four only, of the thirty-three members of the new Council need not be veterinarians. The Committee does not, let it be noted, say that these four must not be veterinarians. They are to be appointed by the Crown; and no doubt the Crown will appoint, if not veterinarians, then men who have shown themselves to be sympathetic to the veterinary profession or to have contacts with it which have given them an understanding of its problems and aspirations. The profession itself is, moreover, to be given the majority vote in the new Council; for seventeen of the thirty-three members would have to be freely elected by the profession precisely as the whole Council is now elected. The other twelve would be nominated by the universities and the veterinary colleges which would teach and grant the single registrable qualification. Twenty-nine members of the new Council would be veterinarians and a majority of the whole Council would have to be freely elected by the profession. If such a Council could not safeguard every vital interest of the profession, then the profession itself would alone be to blame. It is worth remembering, also, that the report of this Committee is not a series of edicts from which there is no appeal. It is a number of recommendations based on evidence taken from veterinarians themselves and from teachers of veterinarians, as well as from educational experts all over Great Britain; and these recommendations are put forward for calm discussion in Parliament and elsewhere.

The Committee was specifically asked to devise plans for the best possible training for the veterinarian, having regard to the anticipated expansion of the profession, and it believes that university training alone can effect this. There will be few who will not agree with this view. Many veterinarians are already taking university degrees of one kind or another as well as their veterinary training. This means, as the Committee points out, that they have to take two or more courses, with the corresponding examinations, and must thus waste much time. One result, however, is that increasing numbers of veterinarians are learning by experience the advantages of university life, and most of them will be strongly in favour of the Committee's insistence on university education. They are by no means uncritical of the universities. No progressive mind is. Most people who have given any thought to the universities desire reforms of one kind or another. It is, in fact, one of the most valuable results of university education that it teaches men the folly and sterility of stagnation and satisfaction.

Veterinarians, moreover, like all men of science, must, as members of scientific research teams, experience that cultural effect of practical scientific work which teaches men to sink their own desires and differences and to pull their full weight for the achievement of a common aim. They may think that this is enough; or even that it is better than a university education. But surely the best university education is essentially an extension of this spirit, not only into the non-scientific world, but also into the social unit, the nation and finally the world. Men experiencing it cannot fail to become, as the Committee suggests, better men. "Universities," wrote Dr. John Murray in the *Sunday Times* (May 7, 1944), "can only vivify each new generation by witnessing to the common body of culture"; and he rightly pointed out that, in an age of specialism, we must compensate for specialism by common study carried out in a community. The logic of events, he writes, is making the universities the meeting ground of the youth of Britain and of every other land; it is making them "agencies of mutual understanding, organs of a world spirit of amity and conciliation". The veterinarian should be included in this Parliament of Youth, for his work has a vital place in the development of civilization. Dr. Murray thinks that the future of the universities may lie, not in great cities, but in small ones, in old and historic places, in the countryside where there is continuity with the past, in "places such as Oxford was and Cambridge still is". It is not irrelevant to add to these the Exeter from which Dr. Murray writes, and where he presides over an educational community which draws to its happy atmosphere students from all over the world. It seems a pity that this College, situated as it is in the middle of one of the greatest agricultural districts of England, cannot be given a part in the training of the veterinarians whose services that district must have. Would it not be possible, for example, to link it with the new centre at Bristol in some form or other ?

Another aspect of the Committee's report remains for comment. The Committee adopts, on more than one page of its report, what some will consider to be an insufficiently firm attitude to the universities. The Committee, for example, "strongly urges" the universities giving registrable veterinary qualifications to include practising veterinarians among their external examiners, and to consult the Council of the Royal College of Veterinary Surgeons when they are appointing them. The College, of course, insists on the inclusion of veterinary practitioners as examiners in the clinical subjects, and many will think that the universities should be plainly told that they must establish a rule so obviously essential. Elsewhere the Committee says that it is "encouraged to believe" that one of the universities concerned "might be prepared to establish a School of Veterinary Medicine" such as the Committee proposes and to grant a degree in veterinary medicine, subject to the conditions which have been mentioned above. Of another university the report says that the Committee understands "that the university would not be adverse in principle" to its proposals. The position at another university centre is described as "exceptional". The remaining two universities have, however, expressed their willingness to carry out the Committee's proposals. There would thus appear to be a need for a reminder that all universities, jealous as they must be of their independence, also have a public duty in a matter of such national importance as this.

There is a spirit abroad among the young men of to-day which will not brook anything but a progressive spirit among its educational leaders. Certainly the veterinary profession has demonstrated that there are among its leaders men who are progressive, able and mellowed by a culture which extends beyond their own science and art. They have proved themselves to be wise administrators as well as first-class practitioners of their profession. They are, like the medical men, determined to uphold their just rights, but they are not willing to do this obstinately or to refuse that patient but firm conciliation which has always been the mark of the ablest men throughout the centuries. They are aware, like the leaders of the medical and other professions, that conciliation, reasonableness and wise judgment are required of all responsible men at a time when the whole world is being reconstructed on a basis of good-will and the best possible service by all for the greatest good of the whole. It is not to be expected that the authorities of British universities will be any less conscious of their national responsibilities, nor any less willing to reach a speedy and just solution of the relatively minor difficulties presented by the recommendations of this report.

THE SUPREMACY OF REASON

'42 to '44

A Contemporary Memoir upon Human Behaviour during the Crisis of the World Revolution. By H. G. Wells. Pp. 212. (London : Martin Secker and Warburg, Ltd., 1944.) 42*s*. net.

MR. WELLS is indefatigable, and advancing years seem in no way to diminish the output or readiness of his pen. This "Contemporary Memoir" consists of two parts with three appendixes, the sequence and relation of which are by no means so apparent as they might be. Even the sedulity which Mr. Wells demands of his reader at the point of his preface might well fail to reveal a common theme or dominant *motif*. Moreover, only part of the book is new—how much even one with the full range of Mr. Wells's more recent writings in front of him might not be able to say with any certainty—and the high price will scarcely dispose a reader to excuse the compilation of so much material from previous writings without at least some biographical reference. Evasiveness or indefiniteness on this point is not confined to his own writings, for in this matter Mr. Wells is thoroughly inconsistent. Sometimes he provides a complete reference to a book that has interested him, but he quotes several pages from what is presumably General Smuts's address to the South African Institute of Race Relations in January 1942 without bothering to insert the line that would help a reader who wished to confirm his quotation or consult the full text to trace the New Africa Pamphlet No. 2, "The Basis of Trusteeship", in which that speech has been printed.

What might be overlooked in the journalist can scarcely be condoned in a more serious study that claims to be an autobiography of ideas, in some ways continuing, supplementing and expanding Mr. Wells's earlier "Experiment in Autobiography". Moreover, as giving the mature views of Mr. Wells as philosopher summing up his position after a life-time of work and study, the book might be placed in the philosophical class. That claim may indeed be contested, for if Mr. Wells is a true philosopher, can his irrepressible vitality and imagination ever allow him to be mature ? There are serious passages in the book and flashes of the brilliant and imaginative writing we expect from him. For the most part, it is journalism —inconsistent, sometimes irrelevant, even dogmatic or bullying, but always Mr. Wells, as when the kindly *aria* in praise of Beatrice Webb breaks the thundering notes of the grand *oratorio* of the private —or is it the public ?—hates of Mr. Wells which occupy so much of the second part of the book. Mr. Wells tries hard at times ; but his comments are seldom as detached as they purport to be. They are usually lively, often intemperate—as he readily admits—and sometimes stimulating and suggestive, which after all is one reason why this author is read.

In the first part of the book, Mr. Wells discusses the reasons for the recrudescence of cruelty in this modern world, and ends on the optimistic note that the idea of a new world based on a universally valid declaration of equal human rights is now making headway against every device of its antagonists. In this part Mr. Wells is happily irrelevant, and in view of the warning to the reader in his preface, one may well wonder whether he has not started off by deliberately making his argument obscure, or whether in some Puckish mood Mr. Wells has not written the whole book as a test for reader or reviewer to see what they would make of it. Certainly this first part completely falsifies the claim on the wrapper that it is detached from immediate contemporary political and social developments. Did Mr. Wells make that claim himself with his tongue in his cheek, or does he also need deliverance from the writer of 'blurbs'?

The idea of a declaration of the universal rights of man is the most substantial feature of the second part of the book. Entitled "How We Face the Future", and promising to study the drama of John Ball and Richard II in modern dress, its exposition of the idea of the universal rights of man proves but the overture to the oratorio of hate. Beginning with the Communist Party the tempo quickens and the stops are pulled out as Mr. Wells indulges in his dislikes of the War Office, Mr. Alexander, President Roosevelt, General de Gaulle, Sir Samuel Hoare and Lord Vansittart, culminating with Sir Richard Acland and the Roman Catholic Church as a grand finale.

There is nothing scientific in all this, but the objects of Mr. Wells's dislikes appear to him to have a common feature in being obstacles to the penetration of a scientific spirit and outlook into public affairs. It is obscurantism and prejudice, whether professional, political or religious, that arouse his wrath. His tirade against the Admiralty in the section "Invention and Professionalism apropos the U-boat War" is inspired by the Admiralty's apparent reluctance to examine thoroughly an idea for the use of the helicopter; but Mr. Wells prejudices what appears to be a *prima facie* case for searching official inquiry by his loose reference to "hundreds" of battleships.

The three appendixes to the book are, first, a thesis accepted by the University of London for the doctorate of science "On the Quality of Illusion in the Continuity of the Individual Life in the Higher Metazoa, with Particular Reference to the Species *Homo sapiens*"; second, a memorandum on the relation of mathematics, music, moral and æsthetic values, chess and similar intellectual elaborations to the reality underlying phenomena; and, third, a memorandum on survival. The last is a reiteration of Mr. Wells's conviction, so long and consistently and sincerely expounded, that the survival of man and of civilization depend upon our overcoming the stupid and uncritical resistance to thought and inquiry. Knowledge or extinction, he maintains, is the only choice for man. He has no use or place for the emotions or for tradition: reason and the intellect must be the sole controlling factors. Exactly how science alone is to reorganize human affairs for a new and happier adaptation of our interests and emotions to the state of affairs which the brighter factors of our life have brought about is not clear.

Mr. Wells, though intensely individualistic himself, and with the faculty for looking at things at unusual angles, does not believe in individualism, and the main theme of his present thesis is that the integrality of the individual is a biologically convenient delusion. Personality is an illusion; yet, he argues, it is compatible with an impersonal overriding intelligence. But how in default of leadership and personality a new and broader education system throughout the world is to issue in a federated political and economic order and a common fundamental law of human rights, in which a great impersonal society with an unprecedented range of variability is to develop, is never explained. The nearest approach to an explanation is the comment, in a chapter on "The Propaganda of World Unity", that such bodies as the Combined Raw Materials Board, the Production and Reserves Board, the Food Board, the Middle East Supply Centre, which we have already been obliged to set up for war purposes, must be developed for the establishment of world order when hostilities cease, and that from them world control of the new order must spring. Beneath the shelter of these world-wide settlement commissions and their over-riding powers, and so long as the universal rights of man are respected, national governments, great and small, can continue to develop the idiosyncrasies of their various nations and peoples, freely and securely.

Mr. Wells's chief hope is this functional line of advance, and his undying confidence in the supremacy of reason is as conspicuous as the sincerity of his passion for reform.

This is not one of Mr. Wells's great books, and no one should read it as an introduction to his work. But in a book that insists so strongly on the illusion of personality, it is Mr. Wells's own personality that is dominant, sincere and forceful. If his cosmic imagination is only evident here and there, and his philosophy uncertain, there is enough of the real Wells in this testament of impatience to redeem its shortcomings for those who measure it against earlier and finer books which have set the standard of judgment. R. BRIGHTMAN.

FOURIER SERIES

Fourier Series

By G. H. Hardy and W. W. Rogosinski. (Cambridge Tracts in Mathematics and Mathematical Physics, No. 38.) Pp. viii+100. (Cambridge: At the University Press, 1944.) 8*s*. 6*d*. net.

THIS important new Cambridge tract is concerned with the modern developments of the *mathematical* theory of Fourier series. The character of this theory was radically altered during the decade 1900–10 by three fundamental discoveries: (1) the Lebesgue integral (1902–6); (2) the Fejér theorem (1904); (3) the Riesz-Fischer theorem (1907).

For any function $f(x)$ defined uniquely in the interval $(-\pi, \pi)$ to possess a Fourier series, it is sufficient that

$$\int_{-\pi}^{\pi} f(x)\, e^{inx}\, dx$$

should exist for all integers n including zero.

Lebesgue's definition of the integral, considerably more comprehensive than those which had preceded it, brought an immediate extension to the class of functions possessing Fourier series, and it has by now almost entirely superseded the older integrals in the mathematical treatment of this and allied subjects.

The classical ideas of convergence had been investigated thoroughly in regard to Fourier series by Dirichlet and others, and had shown themselves to be insufficiently powerful to deal satisfactorily with the problems that had arisen. In this connexion, Fejér (using Cesàro's process of summation by arithmetic means) succeeded in establishing the fundamental result that any function which is continuous or possesses simple discontinuities gives rise to a Fourier series which is (uniformly) summable $C,1$ to the 'correct' sum.

The combination of these two new ideas produced the now famous Fejér-Lebesgue theorem, which shows, in modern language, that summability $C,1$ is a 'Fourier-effective' process; that is to say, it sums the Fourier series to the 'correct' sum almost everywhere. This, it is worthy of note, is in marked contrast to classical convergence; in fact, Kolmogoroff has recently demonstrated the existence of Fourier series which are *nowhere* convergent.

F. Riesz and E. Fischer, working independently, were finally able to formulate a precise converse of the old formal result known as Parseval's theorem (1799). The existence theorem bearing their name is to the effect that, if $\sum_{n=1}^{\infty}(a_n^2+b_n^2)< \infty$, there exists a measurable function, with an integrable square modulus (that is, a function of the Lebesgue class L^2) with these numbers as Fourier constants, and furthermore that the partial sums of the Fourier series converge *in mean* to this function. With reference to this it should be observed that the Lebesgue integral plays an indispensable part in the proof; in fact, the theorem is *false* for any definition of the integral narrower than that of Lebesgue.

With these fundamental ideas in view, the reader will find in this tract an admirably lucid and precise account of most of the major developments which have taken place during the last forty years. The authors have used the Lebesgue definition of the integral throughout, at the same time indicating those theorems which remain true, *mutatis mutandis*, if Riemann or Cauchy integrals be used. To say that a given trigonometrical series is a Fourier series is to say that a certain set of integral equations has a solution, and the meaning of such a statement plainly depends on the type of integral used. A definition wider than that of Lebesgue, for example, would in general increase the class of functions possessing Fourier series, just as a narrower one would decrease it.

After a preliminary chapter consisting principally of introductory concepts, there follows a discussion on orthogonal systems of functions of L^2. Any theorem proved for a series of such functions is true *a fortiori* for an *ordinary* Fourier series in virtue of the orthogonality of the sequence $\{e^{inx}\}$, and this affords an interesting (and indeed valuable) logical approach to the theory. In most cases such theorems on Fourier series are admittedly deducible by independent (though not necessarily more elementary) methods and, where possible, the authors have provided alternative proofs.

The standard tests for convergence, those of Dini, Jordan, de la Vallée Poussin and Lebesgue, and their relation one to another, are then dealt with, and their analogues for the conjugate series (not necessarily itself a Fourier series) are also provided.

Following Toeplitz, the authors then investigate the application of generalized summation processes to trigonometrical series; in particular the Cesàro and Abel methods, both possessing positive kernels, are shown to be Fourier-effective.

Finally, a chapter dealing with 'uniqueness' theorems is supplied, culminating with the result of de la Vallée Poussin that if a trigonometrical series converges, except possibly in an enumerable set, to a finite integrable function, then it is necessarily the Fourier series of that function.

The entire tract is a model of clarity and precision, the authors having spared no pains to ensure that the reader shall never be at a loss to follow them, even through their most intricate arguments. It is true that there are one or two paragraphs (for example, in the proof of Gergen's modified form of Lebesgue's convergence test, and again in the construction of a Fourier series which diverges almost everywhere) where the logic is convincing, but where a little explanation of the reasons underlying the mode of building up the argument would aid comprehension; but for this omission we must doubtless blame the severe compression, without which it would have been impossible to display such a wealth of valuable material within the short space of a hundred pages.

This tract cannot fail to be of inestimable value, particularly as a 'curtain raiser' to Zygmund's standard treatise.

J. H. Pearce.

AUSTRALIAN ORCHIDS

The Orchids of New South Wales

By the Rev. H. M. R. Rupp. Pp. xv+152. (Sydney: National Herbarium, Botanic Gardens, 1943.) 9*s*. net.

When the first handbook of the New South Wales flora was published in 1893 it contained descriptions of one hundred and seventy-three orchids, whereas in the work under review the Rev. H. M. R. Rupp provides descriptions of no less than two hundred and forty-eight. The large majority of these orchids are terrestrial species, only fifty-two being epiphytes, and they include a number of interesting genera, among which may be cited Prasmophyllum and Cryptostylis. Of the former, rather more than half the eighty known species are dealt with here, while of the latter twenty species are known and three occur in New South Wales. In all the members of these two genera the inferior ovary, instead of exhibiting the half-twist through 180°, as in most orchids, undergoes a complete twist during development so that the flower has a normal orientation but is reversed compared with most orchid flowers. One naturally thinks of the analogy with the leaves of Alstroemeria, where most species exhibit a twist of the base that brings about complete reversal, while in a few an edge-on position of the leaf is assumed as the leaf-base only undergoes a half-turn. The changes, both anatomical and morphological, which accompany such complete reversal, may be profound, and the fact that these ensue, rather than, what would appear simpler, namely, complete suppression of twisting, suggests a sort of momentum in evolution, since further genetical changes in the same direction appear to be more readily achieved than such as would be accompanied by a reversion to the ancestral condition.

The text of this work furnishes keys to the genera and species, and descriptions of the latter, accompanied by an account of their distributions. The twenty-three full-page figures illustrate the habit and floral structure of some of the more important types. The first descriptions of more than thirty of the species of this region we owe to the author, which gives some indication of the extent to which this aspect of systematic botany in New South Wales is indebted to his studies.

The Rev. H. M. R. Rupp belongs to that honoured band of gifted amateurs who have devoted their leisure to taxonomic studies, and the present volume is a valuable contribution to the new Flora of New South Wales to which the author looks forward.

E. J. Salisbury.

WILLIAM GILBERT AND THE SCIENCE OF HIS TIME*

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THIS four hundredth anniversary of William Gilbert's birth† offers an occasion for a brief review of his influence on the science of his time (apart from medicine), and of his researches and book on magnetism and electricity, the firm base of his enduring fame.

These researches, extending over about eighteen years**, might seem ample to occupy the leisure of so eminent and active a physician. But the Elizabethan physicians were notably versatile, as Bacon thus remarked :

"For in all times, in the opinion of the multitude, witches and old women and impostors have had a competition with physicians. And what followeth ? Even this, that physicians say to themselves, as Solomon expresseth it upon an higher occasion, 'If it befall to me as befalleth to the fools, which should I labour to be more wise ?' And therefore I cannot much blame physicians, that they use commonly to intend some other art or practice, which they fancy, more than their profession. For you shall have of them antiquaries, poets, humanists, statesmen, merchants, divines, and in every of these better seen than in their profession." ("On the Advancement of Learning", Book II, Section X, 2, 1605.)

Gilbert shared this versatility to an exceptional degree, while yet adorning his profession. In his early days he had given much time to experiments on chemistry, "attaining to great exactness therein"††: this indeed was a natural extension of his work as a physician. He was also an ardent student of astronomy, and the first Englishman to accept and propagate the revolutionary views of Copernicus (1473–1543) and Bruno (1547–1600) on the motions and the nature of the celestial universe.

Medicine, chemistry, astronomy, magnetism and electricity—indeed, his range of studies was wide ; and although these sciences (except astronomy) were still in their rudiments, their literature was already great. The invention of printing by movable type, in 1453, had led by Gilbert's time to the appearance of printed copies of the principal ancient authors. Already booksellers had set up their trade in London. Gilbert was doubtless a good customer, eagerly buying and reading the classical, medieval and modern books as they appeared. Most of them, like Gilbert's own book, "de Magnete", were in Latin, either original or translated, thus obviating, for the learned men of that time, the curse of Babel, and making Europe a republic of learning.

To illustrate the wealth of Gilbert's learning, let us note a selection from the authors quoted in "de Magnete" :

Among the Greeks, they include the fathers of medicine, Hippocrates (*c.* 430 B.C.)* and Galen (A.D. 131–201) ; the philosophers Empedocles (*c.* 500–430 B.C.), Plato (427–347 B.C.) and Epicurus (342–270 B.C.) ; the historian Plutarch (*c.* A.D. 45–120) ; the astronomers Thales (*c.* 624–565 B.C.), Aristarchus (*c.* 310–230 B.C.), Hipparchus (*c.* 190–120 B.C.) and Ptolemy (*c.* A.D. 170) ; the mathematicians and scientists Pythagoras (born *c.* 582 B.C.), Anaxagoras (488–428 B.C.), Aristotle (384–322 B.C.) and Hero (*c.* A.D. 100)†. Among the ancient writers of Latin, he quoted Lucretius (*c.* 95–55 B.C.), Pliny (A.D. 23–79), Tacitus (A.D. 55–120) and St. Augustine (A.D. 354–430).

His medieval references include Geber the Syrian (*c.* 850), Rhazes the Persian (865–925), Avicenna of Bokhara (980–1037) and others who wrote in Arabic ; Albertus Magnus (1206–1280), Roger Bacon (1214–1294), Thomas Aquinas (1227–1274) and Petrus Peregrinus (whose famous "Epistola" was written in 1269).

Among the moderns, as reckoned in Gilbert's time, he quoted Cardinal Cusa (1401–64), Copernicus (1473–1543), Fracastor (1483–1543), Paracelsus (1493–1541), Agricola (1490–1555), Cardan (1501–76), Fallopius (1513–62), Oviedus (who wrote a "History of the East Indies", 1525), Stevinus (1548–1600), Tycho Brahe** (1546–1601), and three contemporaries, Robert Norman, William Borough and William Barlowe, who wrote on magnetism in English.

These authors were philosophers, physicians, theologians, mathematicians, astronomers, biologists, metallurgists, navigators and historians. Some were quoted only in the astronomical chapter with which "de Magnete" concludes, but most of them had something to say about magnetism. This is not surprising, because in the magnet Nature affords her simplest example of a field of force of notable intensity surrounding objects that are of moderate size, fairly available and widespread, and easy to handle. This was bound to attract notice and comment by writers of all kinds, and to be used by theologians, philosophers and poets as a basis for theories and analogies, by the early physicians as an ingredient of strange potions, and by magicians as a tool to impress the ignorant, as well as by navigators and landsmen in the form of the compass.

Many of those who wrote of the magnet did so only by hearsay, and to the wonderful truth was added a fantastic growth of fable and error, such as that the loadstone's magnetic power was dulled at night ; that when weak it is revived if bathed in goat's blood ; that it has the power to reconcile husbands to wives, and brides to husbands ; and that if pickled in the salt of a sucking fish it gains the power to pick up gold from the deepest wells.

In writing "de Magnete", the first substantial modern scientific treatise, giving a systematic account of magnetism, Gilbert wished to clear away the current errors as well as to establish the truth. He found, in fact, far more to condemn than to retain in his predecessors' writings on magnetism, and he did not scruple to castigate the errors and false theories even of the greatest among them. For example, he says that to the one sole magnetic property, attraction, known to the ancients††, "were added certain fragments and falsehoods : which in the earliest times, no less than nowadays, used to

* Address delivered at a commemorative meeting held by the Royal Society of Medicine on April 5.

† According to the reckoning (which is not certain) of the late Prof. Silvanus Thompson.

** See p. xi of de Mottelay's introduction to his (the first) English translation of "de Magnete". The basis for the mention of eighteen years is presumably Edward Wright's statement, in his 'encomiastic preface' to "de Magnete", that the magnetic philosophy had been "kept back not till the ninth year only (as Horace prescribes) but already unto almost a second nine".

†† Quotation given by de Mottelay, in his introduction, p. xxv ; the source is not stated.

* Most of the dates here given are taken from Singer's "A Short History of Science" (Oxford, 1941).

† Though neither Euclid (*c.* 330–260 B.C.) nor Archimedes (287–212 B.C.) were mentioned.

** But Gilbert's other famous astronomical contemporaries Galileo (1564–1642) and Kepler (1571–1630) are *not* mentioned.

†† In this and later quotations from "de Magnete", I follow (almost completely) the English translation published in 1900 for the Gilbert Club, and printed (250 copies only) by the Chiswick Press.

be put forth by raw smatterers and copyists to be swallowed of men. As for instance, that if a loadstone be anointed with garlic, or if a diamond be near, it does not attract iron. Tales of this sort occur in Pliny, and in Ptolemy's *Quadripartitum*; and the errors have been sedulously propagated, and have gained ground (like ill weeds that grow apace) coming down even to our own day, through the writings of a host of men, who, to fill out their volumes to a proper bulk, write and copy out pages upon pages on this, that and the other subject, of which they knew almost nothing of their own experience. Such fables of the loadstone even Georgius Agricola himself, most distinguished in letters, relying on the writings of others, has embodied as actual history in his book *De Natura Fossilium*". ("de Magnete", Book I, Chapter 1.)

"Almost nothing of their own experience," Gilbert here says, and it is the kernel of his criticism. The importance of experiment is expressed with equal clarity and firmness in his comments on the writings of those whom he revered, as in this passage:

"Thomas Aquinas, writing briefly on the loadstone in Chapter VII of his *Physica*, touches not amiss on its nature, and with his divine and clear intellect would have published much more, had he been conversant with magnetic experiments". (Book I, Chapter 1.)

Experiment, where experiment is possible, is the keynote of Gilbert's philosophy; thus, as he says in his preface:

"we have proposed to begin with the common magnetic, stony and iron material, and with magnetical bodies, and with the nearer parts of the earth which we can reach with our hands and perceive with our senses; then to proceed with demonstrable magnetic experiments. . . . For after we had . . . seen and thoroughly examined many of those things which have been obtained from mountain heights or ocean depths, or from the profoundest caverns and from hidden mines: we applied much prolonged labour on investigating the magnetical forces: . . . Nor have we found this our labour idle or unfruitful; since, daily during our experimenting, new and unexpected properties came to light".

This method is now a commonplace of science, but in Gilbert's time ancient authority was the basis of truth for all but a challenging few, like Gilbert and Galileo. Hence Gilbert had no bright anticipations of the reception his book was likely to gain. Why should I, says he:

"expose this noble philosophy, which seems new and incredible by reason of so many things hitherto unrevealed, to be damned and torn to pieces by the malediction of those who are either already sworn to the opinions of other men, or are foolish corrupters of good arts, learned idiots, grammatists, sophists, wranglers, and perverse petty folk". (Preface.)

His appeal was therefore, avowedly, to the few:

"But to you alone, true philosophizers, honest men, who seek knowledge not from books only but from things themselves, have I addressed these magnetical principles in this new sort of philosophizing. But if any see not fit to assent to these self-same opinions and paradoxes, let them nevertheless mark the great array of experiments and discoveries (by which notably every philosophy flourisheth), which have been wrought out and demonstrated by us with many pains and vigils and expenses. In these rejoice, and employ them to better uses if you can". (Preface.)

The need for a much more active and extensive use of the experimental method was urged by Francis Bacon, in his "Advancement of Learning" and other books, published after Gilbert's death, but probably influenced by Gilbert's example. Thus, writing from the point of view of a man of affairs, regarding the steps that needed to be taken to advance learning, after noting that books, maps, globes, astrolabes, botanic gardens, and dead bodies for anatomy were among the needs for which there was already some provision, Bacon says:

"there will hardly be any main proficience in the disclosing of nature, except there be some allowance for expenses about experiments; whether they be experiments appertaining to Vulcanus or Daedalus, furnace or engine, or any other kind. And therefore as secretaries and spials of princes and states bring in bills for intelligence, so you must allow the spials and intelligencers of nature to bring in their bills; or else you shall be ill advertised.

"And if Alexander made such a liberal assignation to Aristotle of treasure for the allowance of hunters, fowlers, fishers and the like, that he might compile an history of nature, much better do they deserve it that travail in arts of nature". ("Advancement", 2, 10, 11.)

Gilbert, however, paid his own expenses for experiment, and was content to go his own way, in advance of his time. His independence of mind was shown in "de Magnete" and also in other ways. The title page gives *first* his own name, before that of the book. Then comes a preface to the "candid reader", written, as my quotations will have shown, in a proud confident tone. Contrary to the custom then and for two centuries more, he made no dedication to a patron. In this, as in his experimenting, he practised what Bacon afterwards preached but did not practice; for Bacon, in the "Advancement of Learning", addressed, rather fulsomely, to James I, wrote:

"Neither is the modern dedication of books and writings, as to patrons, to be commended: for that books (such as are worthy the name of books) ought to have no patrons but truth and reason. And the ancient custom was to dedicate them only to private and equal friends, or to entitle the books with their names: or if to kings and great persons, it was to some such as the argument of the book was fit and proper for: but these and the like courses may deserve rather reprehension than defence". (Book I, Sect. III, 9.)

Gilbert, indeed, almost reversed the custom of dedication, by publishing, next after* his own preface to the candid reader, an encomiastic preface "To the most eminent and learned man Dr. William Gilbert, a distinguished Doctor of Medicine amongst the Londoners, and Father of Magnetic Philosophy". This was written by Edward Wright (1558 ?–1615), a noted Elizabethan mathematician and teacher of astronomy and navigation.

As a scientific author Gilbert showed many virtues. Though "de Magnete" had no index of subjects or authors, Gilbert included an ample index of chapters (without page numbers). The treatise is divided into six books, comprising 115 chapters, so that the list of chapter titles gives a clear and full indication of

* In de Mottelay's English translation of "de Magnete", the order of the two prefaces is reversed; no reason for this erroneous order is given.

the contents and structure of the book. It is a substantial work containing about 120,000 words, and is well illustrated with ninety woodcuts (not numbered) of diagrams and pictures of loadstones and apparatus. It also contains a glossary of eighteen new scientific terms that Gilbert found it convenient to introduce. The book contains no footnotes, but an interesting innovation was the use of marginal stars, of two sizes, to indicate the discoveries and experiments described, "according to the importance and subtlety of the matter" (Preface); there were twenty-one large stars and two hundred small ones; most though not all of these starred experiments and discoveries were originated by him. This notably individual feature of the book is of great interest as showing Gilbert's estimation of the relative value of his experiments.

Experimental Work on Magnetism

Gilbert's "de Magnete" made three great contributions to science; the first was the ordering and extension of magnetic knowledge, on the basis of experiments originated or verified by himself. The second was the ordering and extension of electric knowledge, in the same way. The third, and in my opinion the greatest, was his conception of the earth itself as a great magnet.

Gilbert had a great predecessor among writers on magnetism, Petrus Peregrinus, who in 1269 wrote a famous letter to a friend, of which many manuscript copies were made, until it was printed in 1558. In this letter Petrus clearly stated that the loadstone has two unlike poles, and showed how to find and recognize them by means of small auxiliary needles laid on the loadstone. Petrus had a fancy to shape his loadstones spherical, like the earth and the celestial bodies, and to mark on them lines of magnetic direction like meridians joining the two poles. At either pole a small needle will stand perpendicular. One pole seeks the north, and the other the south. Like poles repel, unlike poles attract each other. Iron can be magnetized by the touch or stroke of the loadstone, thus acquiring the loadstone's attractive, repulsive and directive properties. When a loadstone is cut in two, a pair of opposite new poles appears, one on each part, so that each becomes a complete magnet, with two opposite poles.

This letter by Petrus, firmly based on experiment, is a magnificent scientific classic, despite some fallacies of perpetual motion in its second part, of which the author himself seemed doubtful.

Petrus wrongly thought that the magnetic compass pointed to the *true* north. He ascribed this to celestial influences exerted from the whole heavens, not only from the celestial poles; he did not attribute it, as many others did, to the 'nautical' or pole star, for he knew that this was not at the true celestial pole.

After his time, it became known that the magnetic compass does not point to the true north, and gradually knowledge was accumulated about the distribution of this magnetic declination, which varies from place to place. The first discoverers of the magnetic declination are not known.

Then in 1581, Robert Norman, a maker of compasses at Limehouse, discovered the magnetic dip of a magnetized needle perfectly balanced before magnetization. He examined and studied this discovery with great ability; in particular, he concluded from it that the earth, not the sky, controls the direction of the magnet, and he showed that the earth did not *attract* the magnet but only *turned* or directed it.

These were the foundations on which Gilbert built. He mentions Petrus and Norman several times, though more often to condemn their few errors than to praise their great merits. He refers to "a little work, fairly learned for the time, going under the name of one Petrus Peregrinus, which some consider to have originated from the views of Roger Bacon, the Englishman of Oxford" (p. 5): Norman he described as "a skilful seaman and ingenious artificer, who first discovered the dip of the magnetic needle" (p. 8).

Of Gilbert's twenty-one big-star experiments, two were electric and nineteen magnetic; of the two hundred with small stars, twenty-nine were electric and a hundred and seventy-one magnetic.

My time permits only brief mention of even the big-star experiments. Gilbert experimented with loadstones and magnets of many shapes, but like Petrus he specially favoured the spherical form, which he called a terrella. On this, again like Petrus, he marked the lines of magnetic direction from pole to pole; these he named "magnetic meridians". He also marked the "magnetic equator" midway between the poles, and intermediate circles of "magnetic latitude", such as the arctic and tropical. Whereas Petrus he had merely *laid* little magnetic needles on his round loadstone, Gilbert *pivoted* his, each on a little stand, and showed that between the equator, where they lie parallel to the surface, and the poles, where they stand perpendicular, the needles rest inclined. In this he saw a parallel to the magnetic dip on the earth, discovered by Norman; with bold imagination, overstepping an enormous disparity of size, he leapt to the conclusion that the compass needle turns northward, and dips, because to the earth it is what his pivoted needles were to the terrella, and hence that the earth itself is simply a great spherical magnet. To quote his own words (in translation): "The magnetic dip (which is the wonderful turning of magnetic things to the body of the terrella) in systematic course, is seen in clearer light to be the same thing upon the earth. And that single experiment, by a wonderful indication, as with a finger, proclaims the grand magnetic nature of the earth to be innate and diffused through all her inward parts". (Book VI, Chapter 1.) This conclusion, which is the foundation of the science of geomagnetism, has never been seriously contested, though we still do not know *why* the earth is magnetic.

Gilbert's further developments of geomagnetism were not so successful. He ascribed the compass declination, or departure from the true meridian, to the inequalities of the earth's solid surface on land or under the sea, and he concluded that near either coast of a great ocean the needle should turn somewhat landwards. This was disproved nearly a century later by Halley (1656–1742). Further, Gilbert concluded that without cataclysmic changes, such as the submergence of the fabled continent of Atlantis, the magnetic declination at each place must remain for ever constant; this was disproved in 1635 by Gellibrand, a Gresham professor, from fifty years of compass observations in London.

Gilbert, though a great reader and a devoted experimenter, was no recluse. His friends included not only physicians, astronomers and mathematicians, but also sailors, to whom there are many references in "de Magnete"; for example, in Book III, Chapter 1, on the compass direction, he writes that certain facts "have been pointed out to me and confirmed by our most illustrious sea-god, Francis Drake, and by another circumnavigator of the globe, Thomas Candish". Gilbert hoped that his experiments and discoveries would add to the already great usefulness of the magnetic needle to mariners. The Dutch scientist Stevinus had pointed out that when the distribution of the magnetic *declination* had been well observed in many parts of the earth, it should conversely be a help to mariners (knowing their latitude) in determining their *longitude*; Gilbert shared this hope, though he knew that the distribution was not simple, and he added the new proposal that the magnetic *dip* would enable mariners to find their *lattitude* when astronomical observation was impossible. But both these ideas proved fruitless, owing to the irregular distribution of the earth's magnetism, and its constant slow change. Before this became clear, Briggs, the introducer of *common* logarithms (to the base 10), had spent much wasted labour on calculations of the magnetic dip in different latitudes, on the basis of a rather fantastic geometrical construction proposed by Gilbert, with no real foundation either in experiment or theory.

Passing from these, Gilbert's faulty additions to his most brilliant discovery, let us consider briefly his experimental work in pure magnetism and pure electricity. In these he greatly extended the range of substances known to be magnetic or electric. He also distinguished very clearly between magnetic and electric actions, and added many important details, some of them quantitative, to our knowledge of both.

He attained to the conception of what we now call the magnetic field surrounding a magnet, or, in his words, its "orb of virtue". He attained also to the conception of what we call uniform intensity of magnetization, showing that the magnetic influence of a terrella is not something emanating only from the poles, but is an aggregate effect of all its parts. He disproved the asserted anti-magnetic influence of the diamond by assembling no less than seventy excellent diamonds, in the presence of many witnesses, around loadstones and magnets, without any observable magnetic change. (Book III, Chapter 13.)

He found that the magnetization of a body can be destroyed by heating it to redness, but that heated iron, in cooling, acquires a small intensity of magnetization in the north-south direction, from the earth's magnetic field. He observed that soft iron, even without heating, becomes slightly magnetized by the earth's field, either slowly, over many years, or more rapidly if it is hammered while lying north and south. He showed also that a sheet of iron can partly screen the space on one side of it from the magnetic field or action of a loadstone on the other side.

He showed that a magnet could support a much greater weight of iron if soft iron caps were put over its poles.

He improved instruments of magnetic observation, including Norman's dip needle; and he collected data as to the compass direction* in different regions.

Work on Electricity

Gilbert's work on electricity is given, almost as a digression, in one chapter (Book II, Chapter 2), entitled "On the Attraction of Amber, or more truly, on the Attaching of Bodies to Amber"; this chapter also describes various experiments on what we now know as surface tension. Silvanus Thompson, who was an enthusiastic reviver of Gilbert's memory, summed up his experimental discoveries in electricity as follows:

(1) The generalization of the class of *Electrics.* (2) The observation that damp weather hinders electrification. (3) The generalization that electrified bodies attract everything, including even metals, water and oil. (4) The invention of the non-magnetic versorium or electroscope. (5) The observation that merely warming amber does not electrify it. (6) The recognition of a definite class of non-electrics. (7) The observation that certain electrics do not attract if roasted or burnt. (8) That certain electrics when softened by heat lose their power. (9) That the electric effluvia are stopped by the interposition of a sheet of paper or a piece of linen, or by moist air blown from the mouth. (10) That glowing bodies, such as a live coal, brought near excited amber discharge its power. (11) That the heat of the sun, even when concentrated by a burning mirror, confers no vigour on the amber, but dissipates the effluvia. (12) That sulphur and shell-lac when aflame are not electric. (13) That polish is not essential for an electric. (14) That the electric attracts bodies themselves, not the intervening air. (15) That flame is not attracted. (16) That flame destroys the electrical effluvia. (17) That during south winds and in damp weather, glass and crystal, which collect moisture on their surface, are electrically more interfered with than amber, jet and sulphur, which do not so easily take up moisture on their surfaces. (18) That pure oil does not hinder production of electrification or exercise of attraction. (19) That smoke is electrically attracted, unless too rare. (20) That the attraction by an electric is in a straight line toward it.

Few substantial advances on Gilbert's work in pure magnetism and electricity were made for more than a century. The quantitative laws of magnetic action, sought by Halley in 1687 and later without much success, were first established by Coulomb (1736–1806) by means of his torsion balance (1785). The first notable advance beyond Gilbert in electrical knowledge was made by Otto von Guericke (1602–86), burgomaster of Magdeburg, the inventor of the air pump; he constructed the first electrical machine, namely, a globe of sulphur, which when rotated, while a hand was pressed upon it, became electrically charged. He also showed that there are two kinds of electricity, and that bodies charged with the same kind repel one another, whereas Gilbert knew only of electric *attraction*.

Astronomy

The last Book (VI) of "de Magnete" is mainly astronomical, and is of great interest for its long serious argument in favour of the Aristarchean and Copernican hypothesis that the earth rotates, rather than that the sun, moon, planets and stars all revolve daily round the earth. Gilbert supplied an additional argument of his own, finding in the geomagnetic axis a real terrestrial feature with which the daily rotation is associated, whereas in the common view the axis of rotation was not terrestrial but celestial. He asserted that the magnetic axis remains invariable in the earth, but that, with the earth, it turns round the pole of the ecliptic, thus causing the precession of the equinoxes. He makes only brief mention of the earth's orbital motion (see "de Magnete", p. 232, Gilbert Club edition, 1900). He seems to attribute the daily and precessional motions partly to the earth's magnetism. Since his day it has become clear

* S. P. Thompson, in "Gilbert of Colchester" (*J. Inst. Elec. Eng.*, 1903), states that Gilbert also collected observations of dip, but I know of no authority for this statement. "de Magnete" appears to contain not one numerical value of the dip, not even quoting Norman's observation of it, in London.

that the geomagnetic axis does not coincide with the earth's axis of rotation, and is not quite constant; we incline nowadays to attribute the earth's magnetism partly to its rotation, rather than vice versa. Newton later showed that the precessional motion of the earth's axis is due to gravitational and dynamic causes, independent of geomagnetism.

Despite his advanced philosophic outlook, Gilbert was not free from the then prevailing belief that the stars influence mundane affairs (Book VI, Chapter 8). He believed that just as "Nature has taken care, through the earth's soul or magnetic vigour", to incline its axis to the pole of the ecliptic, so that the orbital motion produces the succession of the seasons, so also "the stars shift their rays of light at the surface of the earth through this wonderful magnetical inflection" (or precession) of the earth's axis. "Hence", he said, "come new varieties of the seasons of the year, and lands become more fruitful or more barren; hence the characters and manners of nations are changed; kingdoms and laws are altered, in accordance with the virtues of the fixed stars as they culminate, and the strength thence received or lost in accordance with the singular and specific nature of each. . . ."

Gilbert's interest in astronomy was shown by his authorship of a second considerable treatise, left in manuscript at his death, and not published until by the care of a brother it was printed in Amsterdam in 1651. Its title, translated from the Latin original, was "On our Sublunary World, a New Philosophy". Though it contains several references to "de Magnete", it made no further contributions to magnetism. It expounded the then revolutionary astronomical views of Bruno, whom it cites, and is largely an anti-Aristotelian discussion on astronomy, meteorology and the tides.

Gilbert did not live long enough after the appearance of his masterpiece, "de Magnete", to learn fully whether its reception was better than he had pictured in his preface. On the whole it was well received, though the astronomical part was disclaimed by some who accepted the magnetic discoveries; among these were Gilbert's friend Barlowe, and also the Jesuits, by whom the last Book (VI) was regarded as heretical. But greater men, including Gilbert's younger contemporaries Kepler and Galileo, wrote of "de Magnete" with high praise. This judgment has been endorsed by posterity, and as the centuries have rolled on, the fame of Gilbert has stood firm, as a great pioneer of magnetic and electric experiment, and as the father of the sciences of geomagnetism and electricity.

WILLIAM GILBERT: HIS PLACE IN THE MEDICAL WORLD*

By SIR WALTER LANGDON-BROWN

FULLER'S "Worthies" has a charming account of William Gilbert. He did not know him personally, for Gilbert had been dead five years when Fuller was born. But he had talked to people who had known him. This prompted him to write as follows: "William Gilbert was born in Trinity Passage in Colchester, his father being a Counsellour of great Esteem in his Profession, who first removed his family thither from Clare in Suffolk, where they had resided in a gentile Equipage some Centuries of Years. He had (saith my informer) the clearness of Venice glass without the Brittleness thereof, soon ripe and Long Lasting in his Perfections. He commenced Doctor in Physick, and was Physician to Queen Elizabeth who stamped on him many Marks of her favour, besides an Annual Pension to encourage his Studies. He addicted himself to Chemistry attaining to great exactness therein. One saith of him that he was Stoicall, but not Cynicall, which I understand; Reserv'd but not Morose, never married, purposely to be more beneficial to his Brethren. Such was his loyalty to the Queen that as if unwilling to survive, he dyed in the same year with her 1603. His stature was Tall, Complexion Cheerful, an Happiness not ordinary in so hard a Student and Retired a Person. He lyeth buried in Trinity Church in Colchester under a plain Monument. Mahomet's tomb at Mecca is said strangely to hang up, attracted by some invisible Loadstone; but the Memory of this Doctor will never fall to the ground, which his incomparable book 'de Magnete' will support to Eternity."

It is difficult to enlarge this admirable miniature without spoiling it. Also it is difficult to make use of Silvanus Thompson's excellent account of Gilbert without shameless plagiarism. This was written for the tercentenary of Gilbert's death celebrated at Colchester in 1903. Mr. Puryer White, of St. John's College, kindly lent me the copy belonging to the late Sir Robert Scott, formerly Master of the College, which is enriched with notes by the Master's hand, drawn from the College records concerning Gilbert's career. From these it is clear that he matriculated in May 1558. If the commonly accepted date for Gilbert's birth of 1540 is correct, this would make him eighteen when he entered, which would be rather old for those days. Hence, doubts have arisen, and dates ranging from 1540 to 1544 have been given; hence also, our justification for celebrating the quatercentenary of his birth in 1944. After graduation he was elected to a fellowship, his name being spelled Gylbert on the roll. Here again, we meet with a discrepancy in the record. Sir Robert Scott states that he was admitted on Sympson's foundation, but Bass Mallinger, a former learned if eccentric librarian and historian of the College, states "Fisher's statutes of 1530 had relieved all 'physic fellows' from the obligation of taking orders, but the statutes of 1545 had limited such exemptions to two, a proviso which continued in force until 1860. Notwithstanding this restriction, however, the sixteenth century saw three successive Presidents [of the Royal College of Physicians] elected from such 'physic fellows' of St. John's. These were—Richard Smith 1585; William Baronsdale 1589, and the eminent William Gilbert 1600. The last representative of this group was Dr. Henry Thompson, Consulting Physician to the Middlesex Hospital, who died in 1897." The present Master of St. John's College, Mr. E. A. Benians, tells me that the list of distinguished physicians who studied there in the sixteenth century was due to Bishop Fisher's insistence on encouraging the study of Greek in the College, which, despite Erasmus, encountered opposition elsewhere; and on Greek the revival of medicine was believed to be based from Linacre onwards.

The probable explanation of the apparent discrepancy is that Gilbert was elected in the ordinary way, but as he did not take orders, had to become 'physic fellow' or resign his fellowship within the stated time.

* Address delivered at a commemorative meeting held by the Royal Society of Medicine on April 5.

After taking his M.A., Gilbert acted as examiner in mathematics, and in 1569 became senior bursar at St. John's. In the same year, he was admitted M.D. and was senior fellow. In the next year he terminated his twelve years of residence in college and went abroad, travelling in Italy for three years. Not much is known of this, but from his writings it would appear that he drew inspiration from such medical men as Cardan, Fallopius and Frascatorio. He had a great repugnance to the teachings of Paracelsus and Albertus Magnus, and scoffed at Arnoldus de Villanova of Salerno. In 1573 he returned to England, as Silvanus Thompson says, "a pronounced hater of shams and quackery, a champion of the experimental method and an outspoken enemy of all those who merely relied on the authority of great names".

He did not return to Cambridge, but having been elected a fellow of the Royal College of Physicians, settled in London in Wingfield House on St. Peter's Hill, which ran from St. Paul's churchyard to Upper Thames Street, crossing what is now Queen Victoria Street just to the east of the College of Heralds. Thus he was close to the first College of Physicians, which had been Linacre's own house. Here he formed a learned society which met at his house, and they laid before Queen Elizabeth a scheme for the foundation of an Academy of Natural Philosophy which was to have been a real University of London. Nothing came of it, and the "Invisible College" did not arise for about half a century. Thus Gilbert stimulated experimental science in Britain before all Bacon's theoretical contributions to the subject. Bacon indeed repeatedly refers to him with respect in the "Novum Organum" and elsewhere.

His success in practice was rapid. In 1577 he was granted arms, which are now carved in relief in the North Court of St. John's College. From 1581 until 1590 he was a censor, and from 1587 until 1592, treasurer of the College of Physicians. He served a second term as treasurer from 1597 until his election to the presidential chair. In the year of the Armada he was one of four physicians to inquire into an epidemic that had broken out in the Royal Navy. Lancelot Browne, William Harvey's father-in-law, was another, while a third was Wilkinson, who preceded Harvey as physician to St. Bartholomew's Hospital. Gilbert had many professional associations with Lancelot Browne, who succeeded him as president of the College ; considering this and the family tie between Browne and Harvey, it seems probable that the latter learned something of Gilbert's outlook. This may have been the source of information for Harvey's statement that Gilbert spent £5,000 on his researches—a large sum in those days.

In 1589 the College of Physicians decided to compile a Pharmacopœia, and Gilbert was on the committee for carrying this out. Its publication was, however, delayed until 1618. On this Silvanus Thompson remarks : "If it had appeared in his lifetime, he would not have sanctioned the inclusion of Emplastrum divinum of Nicholaus, consisting of powdered loadstone made up with wax, oil, litharge and various spices, for in *de Magnete* he had denounced the prescription in unsparing terms as an evil and deadly 'recommendation of an abominable imposture' ". For, as Gilbert said, "It is when whole that the loadstone draws. . . . The application of a loadstone for all sorts of headaches no more cures them (as some make out) than would an iron helmet or a steel cap." On the positive side, he was a great believer in iron as a fine powder steeped in the "sharpest vinegar" and dried, for the treatment of anæmia. He said that "it restores young girls when pallid, sickly and lacking colour, to health and beauty". He also advised iron for enlarged spleen ; Hale White suggests that malaria then being very common in England, the patients improved because it benefited the accompanying anæmia. He was very sarcastic about many ridiculous claims made for remedies, saying : "Thus do the smatterers cross swords together and puzzle inquiring minds by their vain conjectures".

Dr. Charles Singer suggests that Gilbert's interest in experimental science was aroused by meeting Giordano Bruno who was in England during 1583–85, at Elizabeth's court, probably in the company of Sir Philip Sidney. But Gilbert did not become a Court physician until the year after Bruno's martyrdom, and that he did not frequent the Court much before is indicated by the dismay shown by his little group of scientific friends who met at his house on St. Peter's Hill when he was appointed physician to the Queen. They feared, and as the event proved, justifiably, that the removal to Whitehall would break up their coterie, and their researches would languish. Still, it is quite possible, considering the fashionable nature of Gilbert's practice, that he would have known Sir Philip Sidney and have met Bruno, even if not at Court. As evidence of the kind of practice he had, we find the Earl of Shrewsbury writing of him to a friend, [he is] "a sensible man ; therefore seek to be acquainted with him and be very friendly of him". Then again, in January 1597, Gilbert attended Lady Cecil at Hatfield in her last illness. An unpleasant incident occurred during his visit ; one of her jewels was missing and a Robert Wisson (or Weston) was charged with the theft. He was in attendance on Gilbert nominally as his servant, but it would appear he was probably Gilbert's nephew ! However, all must have ended well, for we find Gilbert attending Lord Burghley on his death-bed a year later.

Gilbert retained his association with his native town of Colchester by the possession of the family residence of Tymperleys in Trinity Street after his stepmother's death in 1589. He resided there occasionally and became one of Colchester's leading citizens, though it is not known whether he practised there. He was always proud of his association with Colchester, and styled himself "Colcestiensis" on the title page of his great book.

In 1600 Richard Hakluyt published the third and last volume of his "Voyages", and in the dedication to Sir Robert Cecil he stated : "I was once minded to have added to the end of these my labours a short treatise which I have lying by in writing, touching 'The curing of hot diseases incident to travelers in long and Southerne voyages', which was written in English, no doubt of a very honest mind by one M. George Wateson. . . . But being carefull to do nothing herein rashly I showed it my worshipfull friend M. doctor Gilbert, a gentleman no lesse excellent in the chiefest secrets of the Mathematicks (as that rare Jewel lately set fourth by him in Latine doth evidently declare) than in his own profession of physicke ; who assured me, after hee had perused the said treatise that it was very defective and imperfect and that if hee might have leisure, which that argument would require, he would either write something thereof more advisedly himselfe or would conferre with the whole College of the Physicians, and set downe some order by common consent for the preservation of her Majesties subjects". But this scheme he never carried out. Mr. Benians kindly lent me a facsimile copy of this treatise edited by Dr. Singer. It is certainly "very defective and imperfect" though it contains some interesting references to treatment by liver for intestinal disorders (Did he encounter sprue, one wonders ?), to the value of fresh and not salted meat for scurvy, and most interesting of all, to his use of a strong infusion of pepper ? For it was not until less than twenty years ago that the richness of pepper in vitamin C was demonstrated.

Dr. Singer identifies the author with George Whetstone, the poet and swashbuckler who in 1578 wrote a crude play, "Promos and Cassandra", the original of Shakespeare's "Measure for Measure". From 1587 he disappeared from sight until the publication of this treatise in 1598, and it is fair to assume that it was during this interval that he went on the voyages which provided the material for his ideas on tropical and marine diseases.

On the death of Dr. James, Gilbert became, as already stated, physician to Queen Elizabeth ; the patent gives his salary as £100 a year. He does not appear to have accompanied her on her many tours through the country, by which she spared her own pocket and conferred distinction on so many bedrooms. Her Court physicians seem to have been expected to give her New Year presents and we find that on the last new year she lived to see, Gilbert's gift was "one pott of Orange flowers and another of green ginger", while in return he received 13¾ oz. of gilt plate, so he did not do so badly on the exchange. He must have had some trying times with her, for in her latter days much success had brought with it many illusions ; and as Ben Jonson remarked to Drummond of Hawthornden, "she never saw herself after she became old in a true glass". The temperament thus displayed led to terrible scenes in her last illness, in which Gilbert attended her. The description is well known. "She alternated between fits of rage and periods of silence and stupor. She railed at her physicians and her counsellors, refusing food, refusing physic, and refusing even to rest. Shortly before the end, she sat obstinately on her cushions outside her chamber, in spite of all the endeavours of ladies of the bed chamber to induce her to go to bed".

In the British Museum there is a long roll upon which Camden, the herald, has drawn in ink a representation of the funeral procession of the Queen. In this is a group of four men walking together, labelled Clerks of Parliament and Doctors of Physic. One of these, with pointed beard, ruff and hat, as in the engraved portrait of Gilbert by Clamp, leaves little doubt as to identity.

It has been repeatedly stated that Queen Elizabeth left Gilbert a pension and that he was the only man mentioned in her will. Silvanus Thompson points out that as she is not known to have left a will, the granting of a pension must remain in doubt.

Gilbert was appointed physician to James I, but did not live long enough to enjoy that office as he died on November 30 O.S., 1603. As Silvanus Thompson speaks of this being his sixtieth year, he evidently accepts the date of his birth as 1544. It would seem likely that he died of plague, which we know was then rife. The best account of the epidemic will be found in Thomas Dekker's book, "The Wonderful Yeare 1603, showing London lying Sicke of the Plague". "Every house," he says, "lookt like St. Bartholomew's Hospital." Many that "would have been glad of a bed in an hospitall, and dying in the open fields have been buried like dogs. . . . Never let any man ask me what became of our physitians in this massacre—they hid their synodicall heads as well as the prowdest. Galen could do no more than Sir Giles Goosecap" ; and so on in the approved euphuistic mode. But Gilbert neither fled nor hid himself. Michael Hicks, who had been secretary to Queen Elizabeth, wrote to the Earl of Shrewsbury thus : "I heard as I was writing here of that Dr. Gilbert the physician is dead who was my neighbour at St. Peter's Hill. He was a learned physician and an honest. The sickness is greatly diminished in London, and the citizens do return in great numbers". The association between these two sentences points to plague as the cause of death.

Gilbert lived a bachelor and died a wealthy man. Besides money, he bequeathed to the College of Physicians his library, globes, instruments and cabinet of minerals ; but all these were lost in the Great Fire of London except a few folio volumes, which cannot now be identified.

In 1904, the year after the Colchester celebration of the tercentenary of Gilbert's death, an interesting document was discovered bearing his autograph and seal. Owing to Mr. Puryer White's kindness, I can tell the whole story from the records of St. John's College. Dr. Fenn having succeeded to the ownership of Alston Court, Nayland, found therein boxes of old documents. Among them was a power of attorney executed by Gilbert in favour of Robert Middleton, his attorney. The ink in some parts had eaten its way through the paper, leaving the words like charred stencils in the thin, yet finely made paper. He communicated his discovery to his cousin, G. D. Liveing of St. John's. Apparently the house at Nayland had belonged to their great-grandfather, who had been executor to Thomas Bayles, whose forbears had succeeded to Middleton's practice at Colchester. The witness to the document was Gilbert's brother, Ambrose, who founded two scholarships at St. John's. The value of the document is enhanced by the rarity of William Gilbert's autograph, only two others being known—one on a medical certificate addressed to Lord Walsingham, now in the Record Office, the other discovered by Silvanus Thompson in a book which belonged to Gilbert when at St. John's ; also by the fact that it is sealed with Gilbert's own signet ring, carrying his crest, a half-eagle with wings displayed. Prof. Liveing, in communicating the discovery to the College, makes this interesting comment. "The spelling of ordinary English words had not crystallized in Elizabeth's reign, much less that of names, and it was certainly [so] common at that time to spell the same name in two or more different ways in one document that I have concluded that it was done purposely so that nothing might turn on the spelling to invalidate it". Colchester has always pertinaciously adhered to the spelling Gilberd, and as it appears thus at the head of this document, the city is apparently justified.

It may be of interest to look for a moment at the background of Gilbert's life in Cambridge and London. In both, active changes were occurring. At the universities, and particularly at Cambridge, the concentrated interest in theology which had formed the main study of scholasticism was declining. The active developments in the State were making a demand for the sons of the gentry to play their part in the social system of the country and its government. So they went to the university to acquire some general culture. There was a risk that the new enthusiasm for deeper study and research "would be elbowed out of existence by endeavours to gratify the wish for a higher education which would suit a young gentleman desirous of making his mark in some recognized public or professional capacity and which should not take up too much of his time". This risk was materially increased by the introduction of a system by which school and college elections were influenced in favour of the well-to-do against the poor; more especially the best prizes—fellowships—were awarded in obedience to mandates obtained in devious ways from the Court. For the first time a university education had a social value, which led to a different type of student and a more riotous way of living. So much so that Caius, who had done his best to promote the new learning, began to wonder whether his benefactions had been wisely bestowed. It is, by the way, curious that though Caius and Gilbert were contemporaries at Cambridge, separated only by the length of Trinity Street, there is no record of any association between them. It strengthens my expressed belief that Caius was more interested in institutions than in individuals. We can set against this an undoubted spread of a genuine love of learning, while the following century was the most active in the intellectual life of Cambridge until the latter half of the nineteenth. Still, one must admit that in the Elizabethan period there was a change from a home for poor scholars to a more mundane life—a change which has in varying degrees persisted and which this century has been trying to overcome. There is indeed a danger of the pendulum swinging too far the other way.

As to the position of the medical world at that time, A. W. Ward says, "The physician's profession . . . was being disentangled on the one hand from that of the clergyman . . . and on the other hand from the trade of the apothecary . . . and from that of the barber, who united to his main function those of the dentist, and yet others. . . . The pretensions of both physicians and surgeons to a knowledge of which they fell far short were still a subject of severe censure; but little or nothing was said in or outside the profession against what was still the chief impediment to the progress of medical science—its intimate association with astrology".

On these dangers, both at the university and in the medical profession, Gilbert's influence was salutary. His insistence on observation and experiment, his scorn for reliance on mere authority, his hatred for shams and quackery, were not without their effect. In the conditions laid down for the teacher of medicine in the Academy he visualized, but which never came to fruition, it was stated, "He was never to allege any medicine of any kind, but that he was to declare the reason philosophical of every particular, and he was to show how the medicine was made and all the instruments used in making it. . . . The physitian was continually to practise with the Natural Philosopher to try and search out the riddles of Nature." Note here an anticipation of Harvey's injunction. Gilbert has been called the first English Copernican, and without transgressing beyond my particular thesis of Gilbert as a physician, I would urge that this made him particularly suited to combat the pestilential influence of astrology on medicine, from which Jean Fernel of Paris was just emancipating himself.

"Q." has spoken of "men, who with the splendour of the Renaissance in their eyes, supposed themselves to be working all the while upon pale and borrowed shadows". Thus Linacre looked to the past for the revival of learning; Caius faced both ways; but Gilbert steadfastly looked forward, and thus he may be acclaimed the first of English modern men of science, and was so recognized by the succeeding generation. For Sir Thomas Browne described him as the Father Philosopher who discovered more in terrestrial magnetism than Columbus or Amerigo ever did by it, while Dryden said of him, "Gilbert shall live till Loadstones cease to draw".

REFERENCES

Hale-White, Sir Wm., "Bacon, Gilbert and Harvey" (London, 1927).

Moore, Sir Norman, Wm. Gilbert, "Dictionary of National Biography".

Munk, Wm., "The Roll of the Royal College of Physicians", Vol. 1 (London, 1878).

Thompson, Silvanus P., "Gilbert: Physician" (Chiswick Press, 1903).

CEREAL DISEASES

By W. C. MOORE

THE important place of cereals in the war-time food production programme, and the urgency of increasing both acreages and yields, have inevitably thrown into prominence the problems of failure and loss through disease. A good deal of attention has been given to these problems during the war years, and the time is appropriate to take stock of the position. For this purpose the Association of Applied Biologists recently devoted one of its general meetings to a symposium on cereal diseases, which was held at the Imperial College of Science and Technology, with the president, Prof. W. Brown, in the chair.

In his introductory remarks Mr. W. C. Moore referred to the surveys of plant diseases organized by the Ministry of Agriculture and Fisheries since 1917. These enable one to form a fairly clear picture of the relative importance of different cereal diseases; but the time is now ripe for concerted efforts to determine the significance of disease more precisely and in terms of loss of yield or in cash value. More than fifty diseases have been listed on cereals in England and Wales, and of these at least seven are of some economic importance—wheat bunt (*Tilletia caries*), take-all (*Ophiobolus graminis* and its var. *Avenae*), eyespot (*Cercosporella herpotrichoides*), yellow rust (*Puccinia glumarum*), mildew (*Erysiphe graminis*), leaf spot of oats (*Helminthosporium Avenae*) and leaf stripe of barley (*Helminthosporium gramineum*). To these must probably be added the various deficiency diseases about which little is yet known. Yellow rust is the most injurious of cereal rusts, but only about once in ten years is it sufficiently bad (as in 1943) to reduce yields by more than an estimated 5–10 per cent. Black rust is usually late and local; but occasionally, probably when large numbers of uredospores are blown over from the Continent in June or July, an epidemic such as occurred in 1940 develops. Bunt bids fair to repeat its behaviour after the War of 1914–18 unless care is taken. In the early '20's about a third of the seed wheat samples were bunted. A steady improvement followed, and in 1940 the figure was as low as 1·2 per cent; but the number of badly bunted crops reported in the last three years strongly suggests that the disease may again be on the increase, in spite of the great advances made in seed dressing. Fortunately, ergot need give rise to no alarm in Britain. It becomes prominent only when cool, wet weather prolongs the normally short flowering period, and these conditions have been fulfilled very few times in the last twenty-five years.

Those who have not personally studied biologic specialization in fungi are often bewildered by, or even sceptical of, the multiplicity of physiologic races found among rust fungi. All modern British work on biologic specialization in cereal rusts has been carried out under the supervision of Prof. F. T. Brooks, and the authoritative survey he made of the subject was both illuminating and stimulating. The races of each rust are determined by their behaviour on a limited number of differential host varieties in the seedling stage when grown under constant environmental conditions. The complexity of the problem is exemplified by the fact that nearly two hundred physiologic races of *Puccinia graminis tritici* and more than a hundred of *P. triticina* have been defined abroad, chiefly in the United States. Nothing is known about the particular races of *P. graminis tritici* that occur in Britain, but a number have been distinguished in *P. triticina*, *P. anomala* and *P. coronata*. At least two races of yellow rust are found here, and a comprehensive survey for further races is needed after the War in order that the relative susceptibility of common wheat varieties to them can be determined. Certain difficulties are inherent in the work. Genetic purity of the differential races and of the rust cultures is essential, the cultures must be kept in isolation and free from contamination, and constant environmental conditions must be maintained. In view of the extreme biologic specialization in cereal rusts and the possibilities of further changes by hybridization and gene mutation, Prof. Brooks doubts whether further study along the usual lines will be really profitable except in relation to plant-breeding programmes. To the plant breeder the discovery of physiologic specialization is of paramount importance. He need not concern himself with all the races described, for many of them behave as single groups in the field; moreover, the discovery of mature plant resistance has greatly eased matters. None the less, new virulent races may develop at any time, and the position can be safeguarded only by continued close co-operation between pathologists and plant breeders.

Dr. W. A. R. Dillon Weston reviewed the history of cereal diseases in East Anglia during the past twenty-one years and explained how their prevalence and intensity have been influenced by improvements in seed treatment. In 1923 copper sulphate was the chief material used for disinfecting seed wheat against bunt. A few farmers used formalin, and afterwards copper carbonate came into prominence for a time, but in the early '30's these were gradually displaced by the organo-mercury seed dressings. This was an event of outstanding importance. The new compounds provided an effective means of controlling the stripe diseases of barley and oats, which had up to then been responsible for much pre-emergence blight and thin stands. As a result the balance has gradually shifted; leaf blotch of barley (*Rhynchosporium Secalis*), for example, which is not seed-borne and therefore not prevented by seed treatment, has become more noticeable as the prevalence and intensity of leaf stripe has declined. Oat smut, at one time prevalent and intense in most crops, is now less evident. On the other hand, the most recent trials with various organo-mercury dusts have shown that they are not all equally effective, and this aspect of things was considered in its relation to the voluntary scheme, recently inaugurated by the Ministry of Agriculture and the Department of Agriculture for Scotland, for the official approval of insecticides and fungicides marketed under brand names for the control of plant pests and diseases. Particular emphasis was laid on the need to assess the efficiency of the products by field tests. Cereal rusts are not normally serious in East Anglia, and take-all, at one time rampant on many farms, cannot now be considered a major problem.

Dr. R. W. G. Dennis discussed the occurrence of cereal diseases in Scotland, where the position is somewhat different from that in England and Wales. Oats are the most important cereal crop, and the seedling blight phase of leaf spot is still the most important disease—in 1942 more than half of 260 samples of seed taken at random showed from 5–42 per cent infection with Helminthosporium. Tribute was paid to the pioneer work of D. G. O'Brien, whose efforts to put dry seed dressing on its feet in west Scotland had resulted in the sale in 1932 of sufficient organo-mercury dust to dress two million bushels of grain or about half the oats sown in Scotland that year. The use of seed dressings is now general in the west and to some extent in the north, but on the best Lothian soils and elsewhere in the east little benefit is derived from their use, even with heavily infected grain. Species of Fusarium, especially *F. nivale*, and pre-emergence rotting due to soil fungi are also responsible for thin stands of oats sown under poor moist conditions or in wet soils. The virtual disappearance of oat smuts in Scotland occurred before seed dressings came into use and has been attributed to the introduction of 'regenerated strains' of oat varieties and to increased care and selection of seed crops. In the wetter districts of the west and north take-all is prevalent in oats following old pasture and is common elsewhere if oats are taken more than two years in succession. Crown rust is usually scarce, though extensive outbreaks occur at long intervals. Wheat diseases are of little importance apart from eyespot, which is widespread in the Lothians, Fife and Morayshire; bunt is scarcely ever seen and brown rust (*Puccinia triticina*) is unknown in Scotland.

Take-all of wheat is widely distributed in England, but becomes troublesome only in wet seasons and on light soils overlying chalk or limestone, where the rotation is too short. The form on oats is restricted to those areas—Wales, the north-west and north of England, and Scotland—where oats is the chief cereal crop. Mr. S. D. Garrett, whose work on this disease has thrown so much light on the wider and more fundamental problems of root rot caused by fungi, discussed the factors affecting the behaviour of take-all in different soils and seasons. Growth of the runner hyphæ of Ophiobolus along the host roots is favoured by good soil aeration and by an alkaline reaction of the soil. In poorly aerated or acid soils the growth of the hyphæ may be controlled by accumulation of respiratory carbon dioxide at the root surface, with which is associated a reduction in the partial pressure of oxygen. In well-aerated soils carbon dioxide must diffuse rapidly away from the root zone, and in alkaline soils a high proportion of the carbon dioxide is transformed into bicarbonate. Light-textured soils also favour take-all inasmuch as they are usually poor in nitrogen and often other plant nutrients, and deficiency in the main nutrients hinders recovery from attack by curtailing the production of new secondary roots to replace those destroyed by the fungus. In Australia phosphate is usually the missing nutrient, in England nitrogen. The exceptional severity of the disease in certain southern counties of England in 1942 may have been due in part to leaching-out of nitrates by abnormally heavy rainfall in January. Survival of Ophiobolus in infected root and stubble residues is mainly dependent on an adequate supply of nitrogen from the soil, which encourages fresh hyphal growth.

For some years Miss M. D. Glynne has made a special study of eyespot in wheat and barley, and the account she gave of this disease revealed how closely it is bound up with lodging in these crops. Less eyespot occurs on light, well-drained soils than on heavy, wet ones, and the climate of the west and north of Britain favours attack by it more than conditions in the south and east. Yet, because oats are highly resistant and the disease increases with the frequency of wheat and barley in the rotation, eyespot is more prevalent in the eastern than the western half of southern England. In a thin crop the individual affected straws begin to fall over among the upright ones from the end of June, giving the condition known as 'straggling'. If the affected crop is a heavy one general lodging is likely to take place sooner or later in long-strawed varieties. In a survey carried out in 1941, lodging caused by eyespot was about as common as lodging due to non-parasitic causes. In addition to direct loss from the disease there may be indirect loss as a result of lodging. Experimental work has shown that in a field with about 60 per cent severe infection, yield is reduced by 30 per cent and there is a marked increase in the amount of tail corn; if lodging occurs the loss is much greater or even complete. Such losses can be minimized by sound rotation or by using short-strawed varieties and feeding them well.

Dr. F. R. Immer, professor of genetics in the University of Minnesota, was warmly welcomed as a visitor at the meeting, and in the general discussion that followed he referred briefly to the programme for plant breeding in relation to disease that is now under way in Minnesota. He expressed surprise at the wide differences in cereal disease problems in Britain and the United States; but entered a word of warning against underestimating the real effect and the potentialities of common but apparently harmless diseases.

NEWS and VIEWS

Research Fellowships at British Universities

THE directors of Imperial Chemical Industries, Ltd., have offered to provide eighty fellowships at nine universities in Great Britain, to be held by senior workers in certain sciences. The scheme is announced to operate for an initial period of seven years, and the fellowships will be of the average value of £600 a year, though the universities will have power to determine the emolument for each particular appointment. The subjects to which the fellowships are to be devoted are laid down as physics, chemistry and the sciences dependent thereon, including chemotherapy. The administration of the scheme rests wholly with the universities, which will select and appoint the fellows, subject only to such conditions as to duties and tenure as the universities themselves impose. No conditions whatever are attached by I.C.I. to the tenure of these fellowships. The fellows will be members of the university staffs, and will be concerned only with the duties laid upon them by the universities. Their primary work will lie in research; but they must also take some part in university teaching. It is intended not to relieve the universities from the cost of maintaining any part of their normal work, but to enable them to add to what they already do. The universities to which this offer has been made comprise the larger metropolitan universities and those which have a close geographical relation to the main centres of the Company's production. Twelve fellowships have been offered to the Universities of Oxford, Cambridge and London, eight to the Universities of Glasgow, Edinburgh, Manchester, Birmingham and Liverpool and four to the University of Durham.

The purpose of the directors of Imperial Chemical Industries, Ltd., in instituting this scheme is to strengthen the general provision in British universities for scientific teaching and research. It is intended to implement the Company's view that academic and industrial research are interdependent and complementary, and that substantial advances in industry cannot be looked for without corresponding advances in academic science; and the main purpose is the strengthening of university scientific departments in whatever way each university thinks to be best. A rational policy of this character, together with a wise selection of men both as regards capabilities and tenure of office, will lead, it is thought, to the emergence of a body of men capable of taking high academic or industrial positions, thereby advancing academic and industrial research. This it should certainly accomplish, for the scheme is so wide in its scope, and the universities are given so free a hand in its working, that most of the limitations usually inherent in trusts and endowments are avoided. The task is now before the selected universities, while preserving scrupulously their independence, so to select recipients of these fellowships as to justify the belief in the importance of university research which has led to their establishment.

The Society for Cultural Relations

THE Society for Cultural Relations between the Peoples of the British Commonwealth and the U.S.S.R., known more widely by its briefer title S.C.R., has just completed its first twenty years of activity and has issued a concise and very interesting report on its work during the period. It is difficult now to recapture the atmosphere of 1924, when the sufferings caused by the Revolution and the Civil War were still fresh in people's minds, and only relatively few recognized the importance of trying to understand what was going on in Russia and of breaking down the barriers that threatened to isolate that country from the Western world. A small but distinguished group of people founded the Society and organized an exhibition of Soviet art, books and magazines; a Science Section was formed under the chairmanship of Sir Richard Gregory and a Press Committee of British and Russian journalists met. Later, various other sections were formed and the Society steadily increased in membership. Each year has seen new developments, and since the War both the status and the influence of the Society have been heightened; it has been recognized that only by keeping exclusively to the one purpose of fostering cultural relations can the Society hope to make a wide appeal. It now has a good library and a panel of lecturers, and it is prepared to deal with inquiries coming within its ambit. We wish the Society continued success in the important and difficult tasks that will confront it in the post-war years.

Indian Famine Inquiry

THE Government of India has announced the following names of the chairman and members of the famine inquiry commission: Sir John Woodhead, Finance Member of the Government of Bengal 1932–1937, Governor of Bengal during June–November, 1939 (chairman); Mr. S. V. Ramamurti, adviser to the Governor of Madras and formerly director of agriculture, Madras; Dr. W. R. Aykroyd, director of the Nutritional Research Laboratory, Coonoor; Khan Bahadur Mien Afzal Hussain, formerly principal of the Agricultural College, Lyallpur; Sir Manilal B. Nanavati, president of the Indian Society of Agricultural Economics, deputy governor of the Reserve Bank of India during 1936–1941, and an authority on sociological and agricultural problems; Mr. R. A. Gopalaswami (secretary), assisted by Rai Bahadur D. N. Maitra.

Higher School Certificate Biology

THE content and form of the traditional syllabus for the Higher School Certificate examination are frequently influenced by the older point of view that biology, botany and zoology are intellectual disciplines unrelated to ordinary life, and, further, that anything relating to human beings lies in the province of anatomy and physiology in the medical curriculum. Modern opinion is that such studies are closely interwoven with our own lives and that, while they may serve as an introduction to subsequent professional or university courses, they should also form, because of their method and content, an essential part of the education of the ordinary citizen. Some progress has been made in this direction by slight emendations or re-interpretations of existing syllabuses; but a Joint Advisory Committee for Biology was set up by the University of Cambridge in June 1943 to recast thoroughly the syllabuses for the Cambridge Local and Oxford and Cambridge Schools examinations. The Committee included representatives of the teaching profession and of the University of Cambridge, and also had the advice of one of H.M. inspectors of secondary schools, members of the University of Oxford, the Matriculation and School Examinations Council of the University of London, and the Central Welsh Board.

The resulting syllabuses, quite new in content and outlook, are not regarded as definitive, but criticisms are invited and it is proposed to issue a revised edition if, when they have been given a trial, it is found that modifications are necessary. The syllabus of each subject is fully set out and, in zoology, detailed notes explaining the intention of the various parts of the syllabus are provided. The content is arranged for a course extending over two school years and assumes that 450 periods each of forty minutes are available. A useful feature of the report is that each subdivision of a subject is followed by a suggestion of the approximate number of periods that should be devoted to it. These suggestions, if followed in a reasonable and not slavish manner, should result in a well-balanced course without overweighting particular parts and at the same time allow latitude for individual circumstances. In the opinion of the writer of this note the syllabuses are a welcome improvement on most of those at present in effect and decidedly a move in the right direction, particularly if more attention is given to the individual practical work of the pupils: but—the proof of the pudding is in the eating. Copies of the report can be obtained from the Cambridge University Press, 200, Euston Road, London, N.W.1, price 6*d.* (7*d.* including postage).

Apprenticeship and the New Education Bill

SOME strong criticisms of the raising of the school-leaving age envisaged under the new Education Bill are given in a recent pamphlet on "Apprenticeship for a Skilled Trade" by Mr. F. Twyman, managing director of the well-known optical firm of Messrs. Adam Hilger, Ltd. (London: Charles Griffin and Co., Ltd. 5*s.* net). Thus he says, "Besides tending towards the disappearance of skilled craftsmen and arresting the development of individual boys, the proposed deferment of the school-leaving age will lessen the productive capacity of the nation just at a time when it should be increased". Mr. Twyman speaks in no uncertain terms against the views of those who seem to regard it as self-evident that, schooling being a good thing, the longer it is continued the better; and he claims that there is a general neglect of the fact that at the age of fourteen many normal boys become impatient of learning unless they see some useful result. He believes that the skilled trades can best be satisfactorily recruited through a scheme of apprenticeship commencing at fourteen years of age under which boys would enter the trade with part-time day release to attend school, varying from two days a week at fourteen to one day at eighteen years of age. The scheme would be based upon the following four main premises: (1) industry needs more good craftsmen; (2) these can only be attained by apprenticeship; (3) the apprenticeship contract must embody a curriculum; (4) independent inspection must be provided to ensure that the terms of the contract are fulfilled.

There is good sense in much of what Mr. Twyman says about the need for realism in modern education, and he would probably be surprised to find that a large number of educationists agree with him; indeed, his proposed scheme of apprenticeship is essentially educational in character, since the young apprentice, instead of wasting his early years in making tea and running errands, would from the start learn practical subjects in the works under strict supervision. Mr. Twyman's essay certainly suggests a valuable scheme for co-operation between school and industry, which should fittingly be examined at the present time.

Bureau of American Ethnology

IN spite of its increasing concern with the war effort, the Bureau of American Ethnology still manages to carry out some of its normal activities (Sixtieth Annual Report: June 1942 to June 1943.

Pp. 10. Washington : Gov. Printing Office). Although the general policy is not to undertake field work during the War, special circumstances made it advisable to make a preliminary investigation of a site in the Agate Basin, East Wyoming. This yielded points of general Yuma character, but of relatively recent date. Dr. Stirling, chief of the Bureau, took charge of a further National Geographic Society – Smithsonian Institution Expedition to southern Mexico, which continued excavations at La Venta. Publication continued, and it is good to hear that the great "Handbook of South American Indians" is three-quarters complete. Three bulletins were issued, and eight were in the press at the end of the year. Members of the staff were active in promoting inter-American co-operation, and with this end in view the Inter-American Society of Anthropology and Geography was formed. A quarterly journal, *Acta Americana*, is to be issued. Specifically war-like activities comprised the preparation of various Smithsonian Institution War Background Studies and publications of the Ethnogeographic Board, besides the answering of numerous questions from the armed forces.

Ophthalmological Research at Leeds

ON the recommendation of a special committee, the Council of the University of Leeds has adopted a scheme for the establishment of an Ophthalmological Research Centre. As soon as the necessary funds are available, the Council will proceed to the appointment of research fellows to work on special problems concerned with the prevention and cure of blindness and other diseases of the eye. X-ray equipment, the recently installed electron microscope and other facilities will be made available for the work in the University. The maintenance and development of the Centre will be in the hands of an Ophthalmological Research Advisory Committee.

Officers and Trustees of Science Service

THE following have been re-elected officers of Science Service, the American institution for the popularization and interpretation of science : president, Dr. E. G. Conklin ; vice-president and chairman of the Executive Committee, Dr. Harlow Shapley ; treasurer, O. W. Riegel ; secretary, Watson Davis. Dr. Otis W. Caldwell, of the Boyce Thompson Institute for Plant Research and general secretary of the American Association for the Advancement of Science, and Max B. Cook, promotion editor of Scripps-Howard newspapers, have been elected to the Board of Trustees, which is now constituted as follows, the bodies represented by the trustee being indicated in brackets : Dr. Otis W. Caldwell, Dr. Edwin G. Conklin, president of the American Philosophical Society, and Dr. Henry B. Ward, University of Illinois (American Association for the Advancement of Science) ; Dr. Warren H. Lewis, Wistar Institute of Anatomy and Biology, Dr. R. A. Millikan, California Institute of Technology, and Dr. Harlow Shapley, director of the Harvard College Observatory (National Academy of Sciences) ; Dr. C. G. Abbot, secretary of the Smithsonian Institution, Dr. Ross G. Harrison, chairman of the National Research Council, and Prof. Hugh S. Taylor, Princeton University (National Research Council) ; A. H. Kirchhofer, managing editor of the *Buffalo Evening News*, O. W. Riegel, Washington and Lee School of Journalism, now on war leave with the Office of War Information, and Neil H. Swanson, executive editor of *Sun* papers (journalistic profession) ; Max B. Cook, Frank R. Ford, editor, Evansville Press, and H. L. Smithton, executive agent of the E. W. Scripps Trust (E. W. Scripps Estate).

Night Sky in August

FULL moon occurs on August 4d. 12h. 39m. U.T., and new moon on August 18d. 20h. 25m. The following conjunctions with the moon take place : Aug. 14d. 20h., Saturn 1° N. ; Aug. 20d. 03h., Venus 2° S. ; Aug. 20d. 19h., Mercury 8° S. ; Aug. 21d. 04h., Mars 4° S. In addition to the above, the following conjunctions also take place : Aug. 13d. 13h., Venus in conjunction with Jupiter, Venus 0·6° N. ; Aug. 26d. 15h., Mercury in conjunction with Venus, Mercury 6·1° S. Mercury reaches its greatest eastern elongation on Aug. 10. The planet sets at 20h. 38m., 19h. 51m. and 18h. 38m. at the beginning, middle and end of the month respectively. Venus is too close to the sun to be favourably observed, setting about half an hour after sunset during the month. Mars, Jupiter and Saturn are not well placed for observation, though Saturn is becoming visible in the early morning hours, rising about midnight towards the middle of the month. The Perseid meteors reach their maximum on Aug. 10–12.

Announcements

AT a meeting of the Council of the Institute of Fuel, held this month, it was announced that Dr. E. W. Smith has agreed to continue in office as president for a further period of twelve months, that is, until October 1945. It was also announced that the Melchett Medal for 1944 has been awarded to Dr. J. G. King, director of the Gas Research Board, in recognition of the outstanding work he has done in recent years during his long connexion with the Fuel Research Station at Greenwich ; and that Mr. H. L. Pirie, one of the honorary secretaries of the Institute of Fuel since its inception, has been made an honorary member.

THE following have been elected officers of the Institution of Electrical Engineers for the session 1944–45 : *President*, Sir Harry Railing ; *Vice-President*, W. J. H. Wood ; *Honorary Treasurer*, E. S. Byng ; *New Members of Council*, H. Bishop. W. N. C. Clinch, F. C. Winfield, and Dr. R. W. Sillars.

THE Chadwick Trustees are offering an award of £250 for an investigation of the reasonable maximum 'density' range (per acre) for small houses with gardens, suitable especially for the intermediate and outer zones of large towns—with due regard to the amenities essential to a comprehensive town planning arrangement. Applications, in writing, must reach the Clerk to the Chadwick Trustees, 204 Abbey House, Westminster, London, S.W.1, before the end of September, accompanied by evidence of qualifications and a brief statement of the general plan of research proposed.

REFERRING to the review in *Nature* of March 18, p. 327, of "Frontiers in Cytochemistry", the editor, Prof. Normand L. Hoerr, has pointed out that he was incorrectly described as the successor of Prof. R. R. Bensley in the chair of anatomy in the University of Chicago ; Prof. Hoerr is professor of anatomy at Western Reserve University, Cleveland, Ohio.

LETTERS TO THE EDITORS

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

Marine Biological Research in Great Britain

THE coast-line of Great Britain offers an unrivalled diversity of habitats for the study of marine benthic communities. There is a considerable proportion of rocky shore, including the peculiar facies provided by the chalk of southern England; there are many stretches of sand and shingle and numerous inlets affording specialized habitats of diverse kinds. Can it be said that we are playing our part in the biological exploration of the numerous communities thus available to us? Speaking as a botanist, I would answer this question in the negative.

Apart from the valuable work of Lloyd Williams, Margery Knight and Kathleen Drew, the great advances in our knowledge of the structure and reproduction of seaweeds during the last thirty years are almost entirely due to the activities of Danish, French, German and Swedish workers. On the taxonomic side, also, Great Britain has made no serious contribution, comparable to the monumental work of Sauvageau on Sphacelariales or to Kolderup Rosenvinge's important memoir on the Rhodophyceæ of Denmark. I am not qualified to say how far these criticisms apply also to the benthic fauna.

It is true that a considerable number of papers dealing with the general floristic composition of the benthic communities of seaweeds on various parts of the coast of Britain has been published. One may recognize the value of the preliminary data thus obtained; but it may be doubted whether this work has materially added to our understanding of the nature and composition of these communities, since the publication of Cotton's outstanding memoir on the marine Algæ of Clare Island in 1912. Certain of the papers published during the last twenty years have been concerned with the effects of diverse environmental factors, in particular those affecting the littoral communities. More important advances in these directions have, however, been made by Continental workers.

Much of the floristic work is rendered less valuable by the complete or almost complete absence of data regarding diatoms, which play an important part in many littoral and sublittoral communities. Little information is available as to their time of occurrence and distribution, or the part that they almost certainly sometimes play as colonizers. Moreover, the communities occurring near and above high-water mark have usually been but imperfectly studied, despite the biological interest attached to the specialized conditions of their habitat. The only detailed investigation of such communities, so far as I am aware, is that of Anand on those inhabiting the chalk cliffs of southern England. Greater progress has been made with studies on the floristic composition and conditions of existence of the algal flora of salt-marshes, thanks to the excellent work of Sarah Baker and Nellie Carter.

The interrelations of fauna and flora in the benthic zone are subjects of great biological interest. An approach to this aspect of marine ecology has been made by a number of workers in Great Britain, more particularly by zoologists. In the absence of evidence of assistance from a competent algal taxonomist one may feel some degree of diffidence in accepting as complete or altogether reliable the data offered on the floristic side; moreover, as with the purely floristic studies, diatoms are in general left out of the picture. In any event these investigations have scarcely got beyond the fringe of the problems involved. Attention may also be directed to the need for a more comprehensive study of British marine fungal parasites than has hitherto been undertaken.

For the most part the diverse researches referred to above have been carried out by biologists working in universities remote from the site of their investigations. The latter have been effected by means of periodical visits, and all credit must be given for the more or less successful surmounting of the difficulties that are inherent in discontinuous work of this nature. No real progress is, however, to be expected until far better facilities than those at present existing become available. In particular, it is essential that a lead to the investigation of the benthic flora and fauna of the sea be given by an established group of workers, permanently in touch with the problems and expert in special aspects of marine biology. The investigation of the ecological problems that await solution demands a team of workers which should include one or more zoologists, as well as at least two botanists specializing respectively in seaweeds and marine diatoms. Afterwards, one or more physiologists will have to join the team to aid in the solution of the diverse problems relating to growth, nutrition, etc., that will arise. Once such a centre had been firmly established, its activities would rapidly expand by the attraction of research workers from the universities.

It is natural to look to the Laboratory of the Marine Biological Association at Plymouth as the best centre for the development of such work. The very high reputation of this Laboratory and of the members of its staff would encourage the performance of work at a high level of achievement. So far, however, the fundamental research carried on there has been directed in the main to investigations dealing with the pelagic life of the sea, research which has led to results of outstanding scientific importance. If the Plymouth Laboratory is to undertake also the investigation of the marine benthos, a courageous policy will be necessary. To restrict unduly the number of workers detailed for this aspect of marine biological investigation or to limit the necessary facilities would cramp the work at the outset and as likely as not result in failure. In view of its bearings on the elucidation of general biological principles and its possible economic importance, it may not be looked upon as a mere appendage of the work hitherto carried on at Plymouth.

Should other considerations not render feasible such an extension of the scope of the work of the Plymouth Laboratory, it would be better to concentrate research on marine benthic plants and animals at an altogether separate centre. For such a purpose one of the other marine stations already in existence or one of the maritime universities can be envisaged. Alternatively, since it is to be hoped that similar centres may be established in one or more parts of the Empire, especially in the tropical zone, the University of London might appropriately consider the foundation of such a station.

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Self-recovery in Metals

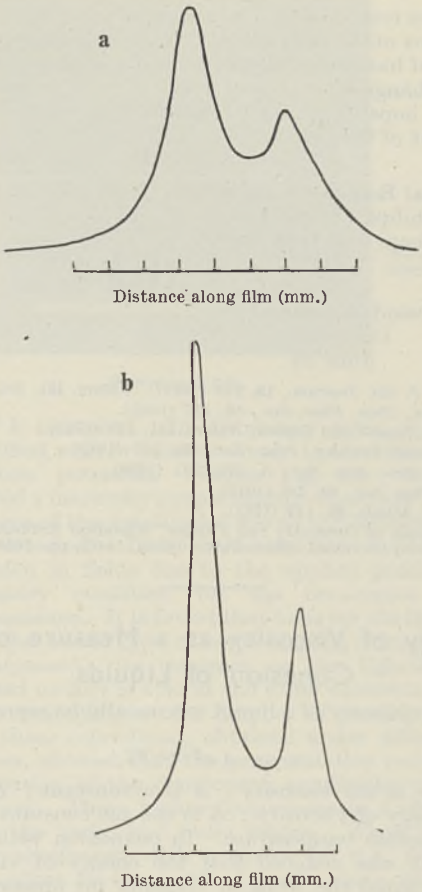
Two theories have been put forward to account for the broadening of the X-ray reflexions given by cold-worked metals. First, the crystals may be broken down into small mosaic elements (fragmentation)[1], or, secondly, they may be so distorted by the stresses (microstresses) present that the lattice parameter varies over a range of values[2]. Recent work seems to indicate definitely that in the case of copper[3], tungsten and α-brass[4] the major part of the broadening is due to the latter effect.

Although it would seem reasonable to extend these results to all metals, a difficulty arises in the case of those such as aluminium which give sharp lines when cold-worked. On the fragmentation theory this would correspond to an unusually large value of the limiting crystallite size; on this account it has been claimed[5] that aluminium is 'self-recovering' at room temperature, the implication being that after cold-working the crystal grains increase so much in size that the broadening they produce is negligible. The microstress theory, however, cannot produce such a ready explanation; at first sight it would seem necessary to assume that no appreciable stresses were present in the cold-worked metal, and this is not in agreement with the known mechanical properties.

Some contribution towards the solution of this problem has been given by the observations of Wilson[6] and Spillett[7] that the broadening of the X-ray lines given by cold-worked aluminium sheet is not negligible. We have verified that this is also true for filings; the accompanying figure shows photometer curves, derived from photographs taken in a 19 cm. diameter camera, for line 420 for unannealed and annealed filings, and it will be seen that there is a considerable difference between the two although the α-doublet is clearly resolved in each case.

It only remains to show that the broadening is of a reasonable order of magnitude. In order to do this, we have compared it with the broadenings given by several other cold-worked cubic metals, and have derived the corresponding value of the internal stress T in each case. We have used the relation $T = E\beta\cot\theta/4R$, where E is Young's modulus, β is the measured broadening, θ is the Bragg angle and R is the radius of the camera. E depends on the indexes of reflexion, but for the present purpose it may be considered as a constant.

Metal	Indexes of reflexion $h\ k\ l$	Radiation	β cot θ (mm.)	T	Ultimate tensile stress
				10^8 dynes/cm.^{2}	
Iron	2 1 1	Iron $K\alpha$	1·11	58·7	30–80
	2 2 0		1·12		
Nickel	3 3 1	Copper $K\alpha$	0·97	53·2	35–120
	4 2 0		0·96		
Copper	3 3 1	Copper $K\alpha$	0·64	23·5	23–47
	4 2 0		0·79		
Silver	3 3 1	Cobalt $K\alpha$	1·06	22·2	23–36
	4 2 0		1·11		
Aluminium	3 3 1	Cobalt $K\alpha$	0·15	3·0	6
	4 2 0		0·17		
Lead	5 3 1	Nickel $K\alpha$	0·20	0·7	1·2–2·1
	4 2 2	Iron $K\alpha$	0·16		



Photometer curve of the 420 line from (*a*) filed aluminium, (*b*) annealed aluminium, with cobalt $K\alpha$ radiation. The scales for ordinates of the curves have been chosen so as to make the areas equal.

The accompanying table shows the values of T for silver, copper, nickel, iron, aluminium and lead, and for comparison are given the values of the ultimate tensile stress for these metals[8]. It will be seen that in each case the two are of the same order of magnitude. Even for lead, which is also supposed to be 'self-recovering' at room temperature, there is a broadening of the X-ray lines of about the right amount.

It does not follow from these results that recovery does not occur in these metals at room temperature; this can be decided only by photographs taken at different times after filing. We have taken such photographs of the metal specimens described above, with the following results.

(*a*) Iron and nickel showed no appreciable change over several weeks.

(*b*) Copper and silver showed quite striking changes; the diffraction broadenings decreased to about half their original values, the α-doublet becoming quite clearly resolved. The change in copper occurred over an interval of about a week and we have followed these changes in detail; but the only data we have about silver are that the X-ray lines were sharper after an interval of several months.

(*c*) Aluminium and lead also showed some change, but in these cases the broadening is so near the limit of experimental error that the effect is not so clear as for silver and copper.

These results cannot be taken as applying to metal in forms other than filings; X-ray photographs of a piece of hammered copper wire, for example, showed little change after several weeks at room temperature.

We hope to publish elsewhere a more detailed account of this work.

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[1] Wood, *J. Sci. Instrum.*, **18**, 153 (1941); *Nature*, **151**, 585 (1943).
[2] Brindley, *Proc. Phys. Soc.*, **52**, 117 (1940).
[3] Stokes, Pascoe and Lipson, *Nature*, **151**, 137 (1943).
[4] Smith and Stickley, *Phys. Rev.*, **64**, 191 (1943).
[5] Wood, *Proc. Roy. Soc.*, A, **172**, 231 (1939).
[6] *Proc. Phys. Soc.*, **54**, 487 (1942).
[7] *J. Inst. Metals*, **69**, 149 (1943).
[8] "Handbook of Chemistry and Physics" (Chemical Rubber Publishing Co., Cleveland, Ohio, 24th edition, 1940), pp. 1656–61.

Energy of Viscosity as a Measure of the Cohesion of Liquids

THE viscosity of a liquid can usually be represented by

$$\eta = A.e^{E_{visc.}/RT},$$

where η is the viscosity; A is a constant; $E_{visc.}$ is the energy of viscosity; R is the gas constant; T is the absolute temperature. In connexion with other work, it was deduced that the energy of viscosity should equal the work of cohesion for unassociated and non-metallic liquids. The work of cohesion has been defined by Harkins[1] as the energy required to form a surface in a liquid and is equal to twice the surface energy. Now if both the energy of viscosity and the work of cohesion are expressed as calories per mole, they are nearly equal for unassociated liquids.

At 20° C. Substance	$E_{visc.}$ cal./mole	Work of cohesion cal./mole
n-octane	2,040	1,928
n-hexane	1,815	1,920
Benzene	2,515	2,322
Acetone	1,668	1,676
Carbon tetrachloride	2,510	2,290
1,2 dibromoethane	2,790	3,056
1,2 dichloroethane	2,320	2,394

For associated and some polar substances the energy of viscosity is greater than the cohesional work. The factor connecting the two quantities varies between 1·5 and 3·5.

At 20° C. Substance	$E_{visc.}$ cal./mole	Work of cohesion cal./mole
Methyl chloride	1,592	948
Methyl alcohol	2,475	1,076
Ethyl alcohol	3,290	1,380
n-propyl alcohol	4,390	1,610
Water	4,150	2,020

The values of $E_{visc.}$ were obtained by graphical differentiation of the ln η versus $1/T$ curves, while the work of cohesion was calculated as twice the surface energy of one mole occupying the surface according to the equation:

$$E_s = 2{\cdot}39 \times 10^{-8}.\gamma.V^{2/3}.N^{1/3},$$

where E_s is the surface energy in calories per mole; γ is the surface tension in dynes per cm.; V is the molar volume; N is Avogadro's number.

Now if the energy of viscosity equals the work of cohesion, it should be proportional to the energy of attraction between molecules. According to prevailing views[2], the attraction between non-polar molecules is inversely proportional mainly to the sixth power of the distance separating the molecular centres. The attraction between polar molecules is said to be inversely proportional to the third power of that distance. The relationship between $E_{visc.}$ and the distance between the molecular centres was tested by plotting log $E_{visc.}$ against log $1/r$, where r is the separation of the molecular centres and can approximately be deduced from the molar volume. The slope of the curve of log $E_{visc.}$ v. log $1/r$ should have a value of 6 for non-polar substances and a value of 3 for polar substances. *n*-Pentane gave a value for the slope of approximately 5·52; 1,2 dibromoethane a value of 5·75; carbon tetrachloride a value of 6·03. On the other hand, methyl chloride, which is a polar substance, gave a slope of 2·89.

Thus $E_{visc.}$, the energy of viscosity, equals the work of cohesion in the case of unassociated substances and is quite generally a measure of the attraction between molecules.

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[1] Harkins *et al.*, *J. Amer. Chem. Soc.*, **43**, 35 (1921).
[2] London, *Trans. Farad. Soc.*, **33**, 8 (1937).

Existence of Time-Dependence for Interfacial Tension of Solutions

IT has been known for some time[1,2] that the surface tension (air–liquid boundary) of aqueous solutions of long-chain compounds decreases slowly over a period of many days before an equilibrium value is reached. This slow decrease cannot be attributed to diffusion of the solute to the surface, for with the usual values of the diffusion coefficient the calculated time of the change should be a very small fraction (about 10^{-7}–10^{-9}) of the observed time[1,3]. With a solute in the aqueous phase, adsorbed at an oil/water boundary, the interfacial tension has been found to reach its equilibrium without a time-lag[3], and it has been commonly assumed that interfacial tension (as distinct from surface tension) is not subject to this slow change.

We have measured interfacial tensions at the interface between water and solutions in hexane of long-chain amphipathic substances. Experiments by a precision drop-weight method[4] showed that the interfacial tension varied with time. The variation has been studied by means of measurements made by the pendent-drop method[5], which allows continuous readings to be made without disturbing the surface.

The interfacial tension has been found to fall, rapidly at first and then more slowly, reaching an equilibrium value after some days. This fall is much slower than can be explained by diffusion to the surface. With lauric acid as the solute, a diffusion coefficient as low as 10^{-22} cm.^{2} sec.$^{-1}$ would be required, instead of the actual value of about 10^{-5} cm.^{2} sec.$^{-1}$. The diffusion to the surface is therefore followed by a process of high activation energy to produce the final state of the surface film. In confirmation of this, the rate at which the final interfacial tension is reached has been found to increase sharply with rising temperature.

The presence of electrolytes in the aqueous phase has been found to alter the interfacial tension – time variation. With this system, where the electrolyte is in a different phase from the surface-active solute, it can exert a direct influence on the interface without altering the diffusion-rate, degree of aggregation, etc., of the solute in the oil phase.

By expanding and contracting the pendent drop, the closeness of packing of the molecules adsorbed at the interface could be varied and *F–A* curves obtained. The interfacial films behaved like insoluble surface films, since a compression of the film did not drive molecules back into solution. Therefore the activation barrier affects desorption as well as adsorption of molecules.

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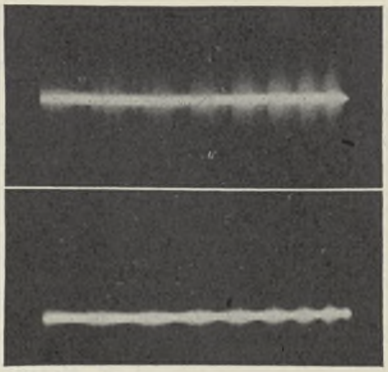
[1] Doss, K. S. G., *Koll. Z.*, **84**, 138 (1938) and **86**, 205 (1939).
[2] Adam, N. K., and Shute, H. L., *Trans. Farad. Soc.*, **34**, 758 (1938).
[3] Alexander, A. E., *Trans. Farad. Soc.*, **37**, 15 (1941).
[4] Ward, A. F. H., and Tordai, L., *J. Sci. Instrum.*, to appear shortly.
[5] Andreas, J. M., Hauser, E. A., and Tucker, W. B., *J. Phys. Chem.*, **42**, 1001 (1938).

Light-Effect in Chlorine under Electrical Discharge: Change of the Wave Form due to Irradiation

Previous work on this phenomenon[1,2,3] showed that a current decrease Δi is produced by irradiation of chlorine and other gases referred to the rectified mean r.m.s. values of i under different conditions; changes in the corresponding current-structure and its time-delineation are revealed by a cathode ray oscillograph[3]. An iron core step-down transformer was introduced in series with an A.C. indicator. Its secondaries were connected to one pair of the deflecting plates in the oscillograph; the other pair was connected to the time-sweep potential. With but a moderate amplifier gain on each of the plate pairs and the usual adjustments, the oscillograph revealed, besides the frequency of the A.C. supply, a remarkably large number of higher frequencies of widely varying strengths; they were not transients but repeatable and characteristic constituents of i the discharge current. It was also striking to observe the sensibly instantaneous and reversible diminution of the amplitudes of these component frequencies, on irradiating the discharge tube, as shown by a typical pair of oscillograms reproduced herewith.

It was observed[1,4] that the production of a change under electrical discharge, chemical or otherwise, for example, the hydrogen chlorine reaction, the activation of nitrogen, its deactivation, etc., requires a minimum threshold potential V_m characteristic of the reaction, its operative conditions such as the frequency n, the temperature, etc. At V_m, the wattage dissipated in the system and i show a rapid rise



In dark.

With irradiation.

Exposure, 2 min.

as V is increased. In elementary gases, V_m may be identified with or related simply to the corresponding Paschen potential. Below V_m, the oscillograph showed a markedly simple current-structure; further, changes of the amplitudes due to the light-effect were not detected. It is considered that ionization by collision in fields due to the applied potential is a necessary condition for the occurrence of this phenomenon. It is found that both for the light-effect and the above type of reactions, V_m diminishes as n is increased; its influence on the light-effect expressed as $\Delta i/i$ is also in the same direction.

An examination of a number of oscillogram pairs like those reproduced, obtained under different conditions, showed that the proportionate reduction on irradiation of the component amplitudes was fairly uniform. These higher frequencies in i represented both the audio and radio ranges. When the latter were eliminated with a series of H.F. filters, the light-effect in the residual audio range was similar to that for the total or unfiltered current. That the above remark applies also to the radio range was indicated by similar results for the light-effect $\Delta i/i$ observed, with and without an amplifier, for i picked up by a moderate size aerial 1–9 ft. distant from the chlorine tube.

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May 8.

[1] Joshi, *Curr. Sci.*, **8**, 548 (1939).
[2] Joshi, Pres. Address, Chem. Sec., Ind. Sci. Cong. (1943).
[3] Joshi, *Benares Hindu Univ. J.*, **8**, 99 (1943).
[4] Joshi, *Trans. Farad. Soc.*, **25**, 120 (1929).

Lanosterol

The problem of the origin and chemical nature of lanosterol—the characteristic substance so far observed only in the wool-grease of the sheep—was originally solved by classifying it as a sterol. Recent evidence[1,2] indicates a more probable connexion with the tri-cyclic terpenes such as α-elemolic acid and with the minor yeast sterol cryptosterol.

Among the oxidation products of cryptosterol are a number of ketonic derivatives which are yellow in colour, probably due to the presence of a chromophore grouping such as —CO—C=C—CO—. Ruzicka[3] has lately obtained similar yellow compounds, for example, acetyl-*iso*-elemendionol acid ester, from the elemolic acids. In continuation of our work on lanosterol[4], we have also isolated a series of yellow ketonic products by the oxidation of lanosterol and its esters with ozone, and with chromic acid. These derivatives include a diketo-alcohol, $C_{30}H_{46}O_3$, m.p. 145°, the corresponding triketone, $C_{30}H_{44}O_3$, m.p. 110° and a compound $C_{27}H_{40}O_4$, m.p. 203°, of which an account will shortly be published.

The formation of these compounds further supports the relationships mentioned, and if the connexion of lanosterol with the tri-terpenes is established, the production, by animal metabolism, of a structural type characteristic of the plant world will provide a problem of biochemical interest.

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June 16.

[1] Bilham and Kon, *J. Chem. Soc.*, 545 (1942).
[2] Wieland and Joost, *Annalen*, 546, 103 (1941).
[3] Ruzicka, *Helv. Chim. Acta*, 26, 1651 (1943).
[4] Dorée *et al.*, *J. Chem. Soc.*, 1562 (1936); 172 and 176 (1941).

Mitochondrial Origin of Cytosiderin (Iron Pigment) in the Liver of Human Pellagrins

DURING the past fifty or sixty years, attempts to reconcile the massive accumulation of iron in various cells and tissues in the body with altered hæmoglobin has led to the universal adoption of the terms 'hæmo-siderosis' and 'hæmochromatosis'. This terminology has focused attention on the metabolism of hæmoglobin and its derivatives, to the exclusion of the consideration of other potential sources of this iron pigment. However, in hæmochromatosis, almost all investigators are agreed that there is no evidence of increased blood destruction to account for the intracellular iron pigment.

By using an improved liver biopsy method, we have studied the liver at the time of admission and during therapy of seventy-six non-European pellagrins, of whom twenty-one were children less than seven years of age and fifty-five adolescents or adults. To date, two hundred biopsies have been performed without any fatalities.

The excellence of the biopsy material allowed us to perform numerous cytochemical studies. In every single liver of the adult and adolescent pellagrins, we noticed, *inter alia*, masses of iron-containing pigment at one stage or another while the cases were under observation. In fact, we regard iron pigment in the liver cell as a constant feature of pellagra in adults, but in children thus far it has not been found under the age of nine years.

The iron pigment arises within the liver cell, appearing first in a region located between the nucleus and the biliary pole of the cell, and corresponding to the position occupied by the Golgi apparatus. Since the pigment arises within the cell, we have named it 'cytosiderin' to distinguish it from the iron pigment derived from hæmoglobin.

By a modification of techniques, we demonstrated simultaneously iron-containing pigment and Sharlach-staining fat in one section, and iron, fat and mitochondria in another. Using such ideal preparations, we felt reasonably certain that the granules of cytosiderin developed from mitochondria which passed through a lipoprotein stage to form combined and free iron. In this transformation the pigment undergoes a series of colour changes from reddish orange to brown or black. All these differently coloured granules contain iron which can be clearly demonstrated by a modified Prussian blue reaction. There is also a reciprocal relationship between the amount of cytosiderin and mitochondria in the cell.

Cytosiderin may be deposited in the liver cells during therapy and may disappear later, or it may be formed in such amounts that the affected liver cell is filled to capacity, disintegrates and liberates its pigment into the sinusoids. Much of it is carried by the Kupffer cells and other histiocytes. The cytosiderin is carried to the portal tracts, and when there is extensive hepatic cytosiderosis, the lymph glands in the porta hepatis and neighbouring regions assume a deep brown colour. With the progress of this disease the portal tracts become thickened, leading ultimately to typical pigment cirrhosis.

We have observed in the same pellagrous patient the complete evolution of pigment cirrhosis from a diffusely fatty liver.

While there is no sexual difference in the incidence of cytosiderosis pigment, cirrhosis is much more common in males.

The demonstration by us that iron pigment may be liberated from intracellular elements, and that cytosiderin may accumulate to such an extent as to lead to pigment cirrhosis, justifies the acceptance of our suggested nomenclature of cytosiderosis as a substitute for hæmochromatosis.

Quite apart from this significant association of cytosiderosis and pellagra, the intimate relationship between fat, cytosiderin, and mitochondria is especially noteworthy. Further studies of these cytoplasmic elements in nutritional deficiencies associated with fatty or cirrhotic livers may lead to a more precise appreciation of the sites of action within the cell of some of the amino-acids, lipotropes and vitamins.

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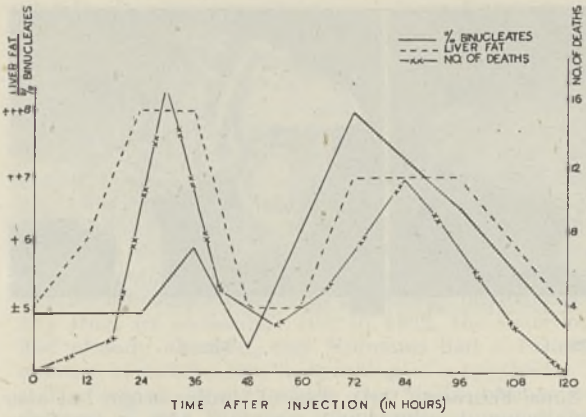
Rhythmic Changes in the Rat Produced by a Single Injection of Chloroform

DURING the progress of an investigation into the effects of various toxic drugs on the cytology and histology of the liver, it was found that after a single injection of a sub-lethal dose of chloroform (0·5 c.c. of 10 per cent solution of chloroform in liquid paraffin) into male rats, the Scharlach R stainable fat in the liver appeared and disappeared in a rhythmic fashion.

Appearing within 12 hours after the injection, the fat gradually increased to reach a very marked concentration between 24–36 hours. Thereafter it rapidly disappeared, falling to a minimum at 48 hours. Little fat was to be seen during the next 12 hours, but between 72 and 96 hours fat was again very abundant, and then disappeared once more. Moreover, the incidence of binucleated cells in the livers increased and decreased together with the fat,



GRAPH SHOWING VARIATIONS IN LIVER FAT, NUMBER OF BINUCLEATED CELLS AND INCIDENCE OF DEATH AFTER A SINGLE INJECTION OF CHLOROFORM.

so that a corresponding binucleate rhythm was obtained.

An identical fat rhythm was also observed in the kidneys of these animals, whereas in the adrenals a rhythm was again found[1], but in this case the fat concentration varied inversely with that in the liver and kidney. Thus peaks in the fat content of liver and kidney corresponded with minimal amounts of fat in the adrenals.

A similar rhythm was observed in guinea pigs. While working on the guinea pigs, it was noted that animals fatally poisoned (4 c.c. of 20 per cent solution of chloroform in liquid paraffin) usually died within 24–36 or 72–96 hours after treatment. Thus of fifty guinea pigs injected with this dose, seventeen died within 24–36 hours, twelve within 72–96 hours and eighteen died either between 36–72 or 96–120 hours; that is, 58 per cent of animals died either within 24–36 or 72–96 hours, 6 per cent survived and the remaining 36 per cent were distributed over all the other intervals giving a U-shaped distribution curve (see graph).

In connexion with these periods of maximum death-rate, it is important to note that Heyd[2], in an analysis of fatalities following biliary tract surgery in man, noted that acute hepatic deaths occurred either 18–36 hours or 4–7 days after operation.

It thus transpires that in response to certain types of injuries there is a rhythmical reactivity involving at least the liver, kidneys and adrenals, in rats, guinea pigs and probably in man. After chloroform poisoning in guinea pigs and rats, this reactivity expresses itself, so far as the liver is concerned, as rhythmic changes in the amount of fat and the number of binucleated cells. There are two distinct periods in this rhythm which are indicated by maximal fat in the liver and kidney, minimal fat in the adrenal and a rise in liver binucleates.

At these periods after the injection of a single dose of chloroform the resistance of the animal is at a minimum, and death is most likely to supervene.

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April 12.

[1] Goldberg, Sylvia, personal communication.
[2] Heyd, C. G., *J. Amer. Med. Assoc.*, **121**, 736 (1943).

'Fluorine-like' Action of Various Substances on the Teeth

IT has recently been reported that various substances besides fluorine are capable of producing altered incremental lines in the dentin of rats' incisor teeth. Weinmann[1] has shown that strontium, injected as strontium chloride, will cause a hypercalcified line in the dentin forming at the time of injection; the effects on enamel formation were much slighter. Wessinger and Weinmann[2] have further shown that manganese and boron have similar effects on both dentin and enamel.

In a previous communication[3], I showed that fluorine would produce an incremental calcified line in the predentin of rats on diets with a low calcium–phosphorus ratio. In a further paper[4], this effect was analysed and it was pointed out that this procedure might form a simple method of testing the effects of other substances on tooth calcification. Certain other substances have now been examined both on rats on normal ratio diets (Ca : P = 1·46) and also on diets with a low ratio diet (Ca : P = 0·27).

Young animals on the normal diet were injected subcutaneously with the substance investigated and killed after two days. This interval was chosen because two days after injection with fluorine, the calciotraumatic line, hypo- and hyper-calcified zones are very clear and easily measured. The following substances were given: sodium fluoride, potassium oxalate, sodium citrate, manganese sulphate, calcium chloride, strontium chloride, disodium hydrogen phosphate, magnesium chloride, sodium molybdate, aluminium chloride, beryllium nitrate, lead nitrate, borax. The dosage was between 100 and 200 mgm. of the element concerned, per kilogram body weight, in all cases where the animals would tolerate this. In some cases (fluorine, beryllium) the dosage had to be greatly reduced. The amounts of oxalate and citrate injected were equivalent in calcium combining power with the fluorine injected.

The results obtained showed that, at any rate in rats on normal diets, a great many substances could produce results similar to those of fluorine. In no case, however, was any effect on the organic enamel found. The following produced a typical fluorine-like effect in the dentin: oxalate, manganese, calcium, phosphorus, magnesium, molybdenum and beryllium; measurements showed that the effects were caused, as with fluorine, at the time of the injection. Strontium and aluminium produced reactions, but unlike those of fluorine; the strontium reaction was a complete cessation of calcification in parts of the dentin. The following had no effect: citrate, lead, boron.

The animals on the low ratio diet were transferred to this diet when between 50 and 60 gm. in weight, and were kept on it for 28 days. They were injected with the same substances (except magnesium chloride) and killed four days later. At the end of four days the fluorine line in the predentin is about 30 μ from the odontoblasts and can be well seen.

The results, using this technique, appeared to be much more selective. Apart from fluorine itself, the only other element which gave an identical continuous line in the predentin was phosphorus. Oxalate and manganese gave faint fragmentary lines. No effect was noted in the dentin or predentin with any of the other substances save calcium, which caused the same healing process to begin as occurs if the ratio of the diet is adjusted[5]. Tetany occurred in the animals

FIG. 1.

FIG. 2.

after injection of fluorine, oxalate, citrate, phosphorus and molybdenum. None of these substances, except fluorine, caused any change in the organic enamel.

While these results need considerable expansion, certain interesting points arise from them. While fluorine acts on both enamel and dentin, the other elements that imitate its action act only on the dentin. It has been already shown[4] that the action of fluorine on the enamel is independent of the calcium–phosphorus ratio of the diet but that on dentin depends on the calcium–phosphorus ratio, and it would appear possible that the first action is a direct one on the enamel organ, the second indirect, by altering the concentration of blood constituents. If this is true, then it would also be safe to conclude that the other substances here examined also act not only by altering the composition of the blood but have no direct action on the tooth. In any event it would be unlikely that such a diverse number of substances would act directly on the tooth, but they are all such as might affect calcium or phosphorus metabolism. It is interesting to note that with low ratio diets, tetany is not a requisite for the calcifying action in the predentin. Citrate in particular caused violent tetany, but had no effect on the tooth.

To summarize, it is possible experimentally to affect organic enamel and predentin formation separately or together. On normal ratio diets, fluorine affects both ; on high ratio diets, fluorine affects only organic enamel formation ; while on low ratio diets, phosphorus, and possibly other substances, affect only predentin formation.

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June 6.

[1] Weinmann, J. P., *J. Dent. Res.*, **21**, 497 (1942).
[2] Wessinger, G. D., and Weinmann, J. P., *Amer. J. Physiol.*, **139**, 233 (1943).
[3] Irving, J. T., *Nature*, **151**, 363 (1943).
[4] Irving, J. T., *J. Dent. Res.*, **22**, 447 (1943).
[5] Irving, J. T., results to be published.

Artificial Production of Monstrosities in the Rabbit

FOUR doe rabbits of unknown breeding were inseminated with the spermatozoa of one male suspended in a solution of 0·1 per cent colchicine in 0·9 per cent sodium chloride. Doe No. 8 gave birth to six normal young and one monster (Fig. 1). No. 13 gave birth to ten normal young ; but on the following day was discovered devouring an eleventh, the normality or abnormality of which could not be determined. No. 14 gave birth to eight normal and one monster (Fig. 2). No. 16 gave birth to five normal and one with unclosed anterior fontanelle (Bregma) and with very small philtrum. This lived only five days. The experimental animals gave, therefore, twenty-nine normal young, two definite monsters, one defective young and one uncertain. In previous inseminations the same does had given fifty-nine young without abnormality. Since February, forty does of similar origin but also unknown heredity had produced 425 young from spermatozoa suspended in 0·9 per cent sodium chloride and no abnormalities had been observed.

In extensive rabbit breeding in Cambridge, similar monstrosities have not been observed. It seems therefore most probable that these monsters were produced by the colchicine, although it will be necessary to repeat the experiment on a larger scale and with inbred strains of known heredity in order to make quite certain that the results are not due to chance.

If attributable to the colchicine, it is likely that the effect is due to polyploidy or some disturbance of the nuclear mechanism or organizers in the tissues affected.

The effects of colchicine may be due to the substance being carried into the ovum by the spermatozoan, or being present in the oviduct and uterus and affecting the fertilized ovum at a later stage of development. Pincus and Waddington[1] treated fertilized ova *in vitro* with colchicine and other chemicals, and concluded that colchicine appears to be especially effective not only in preventing spindle formation and cytoplasmic cleavage, but also in inhibiting the normal movements of the pronuclei ; tetraploid ova produced, failed to cleave over a culture period of one day, and the few that did cleave did so at a subnormal rate. Polyploidy has been produced artificially in insects and amphibian larvæ, but not so far as I am aware in mammalian embryos. Further systematic experimentation is planned in the hope that it may throw some light on the causes of embryonic monstrosities.

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June 8.

[1] Pincus, G., and Waddington, C. H., *J. Heredity*, **30**, 315 (1939).

Wöhler's Work on Urea

IN his interesting article on Wöhler's work on urea[1], Dr. Douglas McKie states that words spoken by W. v. Hofmann in 1882 in his obituary of Wöhler have given rise to a legend that Wöhler synthetized urea, thereby sounding the death-knell of the hypothesis of vitalism. I do not think any such legend exists.

It is well known that Wöhler arrived at urea through transformation of ammonium cyanate. There is no other interpretation of this fact, therefore also no legend. Dr. McKie bases his attack on

Hofmann on the grounds that a synthesis is only a synthesis if the compounds are built up from the elements. I would like to point out quite shortly that there are synthetic dyes, synthetic drugs, synthetic perfumes, etc., and we know that these products are produced neither in laboratories nor in factories from the elements. Terminology allows also synthetic precious stones, biosynthesis, etc., and has not followed Dr. McKie's exact definition. I admit that Wöhler's method for the production of urea might be more correctly termed a transformation than a synthesis; for in the year 1828 Wöhler was unable to produce urea either practically or theoretically from its elements. But in 1882, the situation had already changed, and Hofmann had a certain amount of justification in speaking of a synthesis.

The second legend, which Dr. McKie wishes to destroy, is that Wöhler's achievement sounded the death-knell of vitalism. I, for one, have never heard of this legend. Indeed, it is well known that even about twenty years after Wöhler's discovery, both Berzelius and Gerhardt, as well as many others, clung to the idea of the *vis vitalis*.

Had Hofmann's obituary of Wöhler been the only source for Wöhler's work and its consequences, he might have been considered to have originated such a legend; but this was not the case. One must also not forget, while criticizing Hofmann's words, that they occurred in an obituary, and not in a scientific dissertation, that they originated from his deep regard and respect for his great colleague and fellow countryman, who at the same time was one of the greatest chemists of his age.

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Nature, **153**, 608 (1944).

IT is curious that, in discussing this matter[1], Dr. D. McKie should make no reference to the classical experiments of Scheele. Out of consideration for space, I will do no more than quote the comment of Graebe[2] on the passage, cited by Dr. McKie, in which Wöhler questioned the significance of his preparation of urea :

"Dieser Einwand war aber schon durch Scheeles Versuche wiederlegt, da dieser das Cyankalium nicht nur mittelst Kohle, sondern auch mittelst Graphit erhalten hatte. Auch teilte im Jahre 1828 Desfosses mit, dass beim Überleiten von Stickstoff über ein zur Rotglut erhitztes Gemenge von Ätzkali und Kohle sich Cyankalium bildet. Inbetreff des Ammoniaks waren auch schon die Reaktionen bekannt, nach denen der Stickstoff der Luft sich in Saltpetersäure überführen und diese sich du Ammoniak reduzieren lässt."

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[1] *Nature*, **153**, 608 (1944).
[2] "Geschichte der Organischen Chemie", 55 (Berlin, 1920).

THE legend that I refer to appears in various text-books and histories of chemistry and in works on general science. I have just read it in more than a dozen of them consulted at random. The sense in which I used the term 'synthesis' is neither personal nor *ad hoc*, and it is the same as that used by Hofmann when he wrote "der Aufbau des Harnstoffs aus seinen Elementen" in the quotation that I gave. My criticism of Hofmann did not, and could not, derive from any difference in the interpretation of this term, but from his statement that Wöhler built up urea from its elements and that the intellect of the time hailed his unification of chemistry with joy, which is untrue in every detail.

Hofmann made this statement in no hasty ephemeral tribute, but in a long contribution filling 164 pages of the *Berichte*. However, although there are reflexions of his words among later writers, I did not actually ascribe the origin of the legend to him. Still, if there should be any doubt about Hofmann's views after what I have already quoted, let us turn to the Faraday Lecture for 1875, a discourse on Liebig given by Hofmann before the Chemical Society of London :

". . . in 1828, Wöhler had demonstrated the possibility of building up from its elements this very urea, the formation of which, up to that period, had been supposed to take place exclusively under the influence of vitality—an experiment ever memorable, since it removed at a single blow the artificial barrier which had been raised between organic and inorganic chemistry."

This is not history, but nonsense.

Scheele's experiments are not classical in the history of the synthesis of organic compounds. In his researches on the colouring principle in Prussian blue (1782–83), the great Swedish chemist incidentally prepared, by the interaction at red heat of either charcoal or plumbago with potash (from vegetable sources) and sal ammoniac (from animal sources), the substance now known as potassium cyanide. Two of his reactants were derived from organic sources ; their syntheses had not then been effected ; and, moreover, it was not known at that time that the cyanogen group occurred in living matter. Scheele's production of potassium cyanide has therefore no historical significance in this field, and further comment on Graebe's statement is unnecessary.

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The Cedar Tree

THE cedar tree to which Mr. Alexander L. Howard refers[1] on p. 597, and before him the Rev. C. A. Jones, is Bernard de Jussieu's cedar tree in the Jardin des Plantes, Paris ; it was planted in October 1734. Jussieu had been given the seed for it by Dr. William Sherrard, the distinguished patron of the Oxford Botanic Garden, and the great cedar tree there near Daubeny's laboratory was most probably planted at about the same time. The story about the transport of the little seedling in Jussieu's hat, or as the French call it *le fameux cèdre-bébé de Syrie*, is very charming ; but it is a fairy tale.

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[1] *Nature*, **153**, 595 (May 13, 1944)

RESEARCH ITEMS

Metabolic Stimulants and Wound Healing

T. H. C. Barclay, D. P. Cuthbertson and A. Isaacs (*Quart. J. Exp. Physiol.*, **32**, 309; 1944) measured the time required for healing standard circular skin wounds in rats. In normal animals the time was about 20 days. Addition of dried thyroid gland to the diet throughout the healing period reduced the average healing time by 11 per cent. Addition of 2-4-α-dinitrophenol (0·012 per cent of diet) reduced the healing time by 15–27 per cent. Larger doses of dinitrophenol (0·09 per cent of diet) were without effect, possibly because of the great loss of weight which occurs. The results were shown to be statistically significant; but the authors do not think that they justify the use of these stimulants to aid wound healing in patients. It has been shown by others that these substances have no effect on the rate of cell proliferation *in vitro*, and it is suggested that the *in vivo* effect may be due either to increased circulation-rate improving the blood supply to the wound, or to cell proliferation induced by some product of the increased body catabolism.

Posterior Pituitary Extract and the Heart-Rate

THE slowing of the heart which results from injection of posterior pituitary extract has been ascribed to (1) reflex slowing from the rise of blood pressure, and (2) depression of the myocardium either directly or as a consequence of coronary vasoconstriction. M. E. M. Sawyer and G. H. Ettinger (*Canad. J. Res.*, **22**, E, 26; 1944) claim to have shown that neither of these factors is responsible. The experiments were performed on conscious dogs; the extract was administered by continuous intravenous infusion over a period of one to two hours at the rate of about 2 pressor units per hour. In normal dogs the heart slowed to about half its resting rate. Dogs whose hearts had been completely denervated (by a preliminary operation) showed no slowing at all; this confirms earlier work of Z. M. Bacq and S. Dworkin (*Amer. J. Physiol.*, **95**, 605; 1930) and proves that the slowing is mediated by the nervous system and is not due to any direct action of posterior pituitary on the heart. It would seem likely that the slowing is a reflex effect from the rise of blood pressure; but the authors present the following evidence against this view. In one dog the blood pressure actually fell by 5 mm. mercury, yet the heart slowed from 72 to 52 beats per minute. In the remaining six dogs the rise of pressure was small (10–30 mm. mercury) and the slowing was maintained for some time after the pressure had returned to normal. Such evidence is suggestive; but much more will be required before the effects of blood pressure changes can be ruled out.

Cultivation of *Plasmodium gallinaceum* in Tissue Cultures

No one, says F. Hawking (*The Lancet*, 693; May 27, 1944), has yet succeeded in cultivating the trophozoites of malaria parasites *in vitro* for an indefinite period; but he has now succeeded in cultivating *Plasmodium gallinaceum* of birds in roller-tube tissue cultures of tissue from the spleen, liver, marrow and brain. It will be remembered that S. P. James and P. Tate (*Parasit.*, **30**, 128; 1938) showed that this and certain other avian plasmodia show stages which develop in reticulo-endothelial cells and in the capillary endothelium of the brain and other organs (the exo-erythrocytic forms). The occurrence of similar stages in the life-history of the human malaria parasite has not yet been proved. The commonest form of the parasite found by Hawking in his tissue cultures was the large oval schizont, which was usually found free from any cell. Small mononuclear forms were also fairly common. At the time of writing, Hawking had found apparently healthy parasites on the fifteenth day of culture, after which time the cultures were overgrown by fibroblasts. Tissue taken from tubes on the eighth day and injected intraperitoneally into chicks infected these with typical endo- and exo-erythrocytic forms. Fluid taken from several tubes on the ninth day and injected intraperitoneally into chicks infected them. Hawking thinks that multiplication of the parasites really occurs in the cultures, because, although parasites are hard to find in the original implant, they are present in large numbers after several days of cultivation, and clusters of tiny mononuclear forms are often found (which are figured), and these may be the results of schizogony. A detailed description of the forms of the parasites seen during this work will be published later.

Venezuelan Catfishes

LEONARD P. SCHULTZ studied and collected the fishes in the Maracaibo Basin of Venezuela and other localities in the winter of 1942, and now makes a detailed report on some of them ("The Catfishes of Venezuela, with Descriptions of Thirty-eight New Forms", *Proc. U.S. Nat. Mus.*, **94**, No. 3172; 1944). 127 species and subspecies and 63 genera are recognized in this work—38 new forms are described and 6 new genera. Keys are given of the families, genera and species, and the whole will be a most useful help to all ichthyologists. The chief value lies in the fact that nearly all the material was collected personally and that colour notes were made from the live fishes. The common names are frequently included, and in several cases the young are compared with the adult.

Asymmetry in Inheritance

G. DAHLBERG (*Proc. Roy. Soc. Edin.*, **62**, 20; 1943) has considered the question of asymmetry of pattern or of expression of such characters as polydactyly. Frequently such a character appears on one side in one individual and on both sides in another individual. Suggestions have been made that both environment and genes are the causative agents of this phenomenon. The author, however, indicated that manifold genotypical asymmetry, due to genic influence, will account for the apparently erratic behaviour. The final effects may arise from a gene or several genes acting at a particular stage in development where planes of symmetry are being formed. The genes may act by determining the distribution of extra-nuclear factors. This genotypic asymmetry entails a distinct form of latency to be distinguished from latency due to Mendelian recessives and from environmental thresholds. The author indicates suitable subjects for tests of the theory.

Petrogenesis of the Transkei Dykes

NORTH of East London in the Cape Province of South Africa there are two immense dykes which, appearing near Cathcart, follow an easterly direction for nearly a hundred miles before they are cut off by the coast, where each of them has a thickness of about 1,000 ft. The various types of rocks which make up the dykes have been interpreted as differentiation products due to the fractional crystallization of a dolerite magma (F. Walker, *Trans. Roy. Soc. S.A.*, **30**, 79; 1943); but a more detailed investigation has led E. D. Mountain to a very different conclusion (*Trans. Geol. Soc. S.A.*, **46**, 55; 1944). The main dyke-rock is a dolerite-pegmatite which differs chemically from the normal Karroo dolerite in containing higher potash and combined water, and lower magnesia. Patches of rock with the same characters have been produced in normal dolerite as a result of contamination by sediments, and Prof. Mountain presents evidence that the dolerite-pegmatite was formed by large-scale contamination of the same kind. As it is traced to the west, the southern dyke passes imperceptibly into normal Karroo dolerite. The northern dyke, however, becomes increasingly acid towards the west and finally becomes a quartz-felspar rock indistinguishable from a metamorphosed sediment. Along one stretch the northern dyke encloses a 20-ft. dyke-like band of essentially sedimentary material which can be matched with the neighbouring Beaufort sandstone. This 'dyke' persists for several miles; but eventually it grades into granophyric quartzite, which in turn merges continuously through granophyric dolerite into dolerite pegmatite. The rock sequence from dolerite to sediment is identical with that commonly observed in the reaction rims around sedimentary xenoliths found in dolerite.

Solubilization by Soap Solutions

THE name 'solubilization' is applied to the power possessed by even dilute water solutions of soaps (and other colloidal electrolytes) of bringing into thermodynamically stable colloidal solution such substances insoluble in water as hydrocarbons and dyes. The commercial importance of this phenomenon has long been known; but its mechanism has only recently been given by J. W. McBain as consisting of sorption upon, or incorporation within, colloidal micelles. J. W. McBain and K. E. Johnson (*J. Amer. Chem. Soc.*, **66**, 9; 1944) have now shown by measurements with a water-insoluble dye and four potassium soaps that the solubilization increases so rapidly with the higher soaps as to cast doubt on the suggestion that it is solution in the hydrocarbon fraction of the molecule; but rather favour its incorporation between the layers of lamellar micelles, the only form for which there is direct evidence. Potassium chloride greatly increases the solubilizing power of fully formed micelles and also produces in dilute solution micelles of still higher solubilizing power.

Structure of Boron Carbide

THE very hard boron carbide, B_4C, has been examined by the X-ray method by Zhdanov and Sevast'yanov (*C.R. Acad. Sci. U.R.S.S.*, **32**, 432; 1941—in English) and by H. K. Clark and J. L. Hoard (*J. Amer. Chem. Soc.*, **65**, 2115; 1943), whose results are in agreement. The structure is very unusual, the type of co-ordination shown by the boron and carbon being curious. B_4C belongs to a rhombohedral lattice, with constants $a = 5\cdot19$ A. and $\alpha = 66° 18'$, with three stoichiometric molecules B_4C in the unit cell. The corresponding hexagonal lattice constants are $a = 5\cdot60$ A. and $c = 12\cdot12$ A. for a cell containing nine molecules. The structural units are a linear chain of three carbon atoms and a group of twelve boron atoms arranged at the vertices of a nearly regular icosahedron. Each boron has six-fold co-ordination, being bonded to five others in the same icosahedral group and to either a carbon or a boron. Thus a continuous three-dimensional network of boron runs through the crystal. A high degree of resonance leading to a condition not far removed from metallic binding is presumably of considerable importance in accounting for the stability of the structure, and the boron network is not of the ordinary covalent type.

Squirrel-Cage Induction-Motor Starters

A PAPER by G. A. Wauchope (*J. Inst. Elec. Eng.*, **91**, Pt. 2, No. 20; April 1944) describes a recent development in this class of apparatus. In a pumping station in which were installed a number of pumping units automatically started and stopped by changes in water-level, the motors were of the 3-phase double-wound squirrel-cage-rotor type controlled by contactor-type star-delta starters. During the starting period, the current was found to be higher than anticipated, with the result that the starter overload releases had to be provided with special restraining devices to prevent tripping under normal starting conditions. It was further observed that the high current-peak occurred when the motor connexions were automatically changed from star to delta. This phenomenon occurred in installations where the motors were of the simple squirrel-cage type as well as where the rotors were of special design to limit the starting current. The author gives reasons for the occurrence of the phenomenon and describes a new design of star-delta starter for squirrel-cage motors which followed from the investigation. The starter enables squirrel-cage machines to be used in many fields where a slip-ring motor has formerly been essential.

Invariants and Tensors

THE theory of invariants was much studied, particularly by Cayley, Sylvester and Clebsch, in the second half of the nineteenth century. Its central problem was, given an equation representing some geometric configuration, to find functions of the coefficients of that equation which were unchanged in form when the axes of reference were altered. In the twentieth century the theory of relativity brought into great prominence the use of tensors; these can be used for expressing physical laws which are independent of the axes of reference. These two theories have now been linked up together in an important paper by D. E. Littlewood (*Phil. Trans.*, A, **239**, 305; 1944). He proves that all the results of the older theory can be obtained in the new. Moreover, there is a close correspondence between the symbolic method for invariants, introduced by Aronhold and developed by Gordan, Grace and A. Young, and the tensor method. The chief difficulty in both cases is that, although it is easy to write down an unlimited number of expressions which have invariant properties, it is difficult to decide whether any one of these may not turn out to be identically zero, or whether any two of these may not represent the same invariant. To do this requires a somewhat elaborate technique. That for the symbolic method is based on ordinary algebra, but the corresponding technique for tensors is more akin to group theory, and in particular to the quantitative substitutional analysis of A. Young. It is remarkable that Young developed this, not from tensors, but from his work on the symbolic method. Littlewood's paper appears to open up several promising lines of investigation, some of which will be discussed by the author in a later paper.

STIMULATION OF THE ANTERIOR HYPOPHYSIS BY ŒSTROGENIC HORMONE

By PROF. BERNHARD ZONDEK
Hebrew University, Jerusalem

RECENTLY, we have reported a series of findings showing partial blockage of the anterior hypophysis in rat and fowl by prolonged treatment with œstrogenic hormone[1,2]. In these experiments it proved possible to eliminate growth hormone and gonadotrophic hormone by treatment with œstrogens, and as a result eunuchoid dwarf rats and similarly impaired chickens could be produced. Growth was found to be inhibited by the treatment to 60 per cent in the rat and to 30 per cent in the fowl. Inhibition was marked when large doses of œstrogens were given for a longer period.

Stimulation of anterior hypophysis by œstrogenic hormone is less certainly established experimentally than is the inhibition of this gland by œstrogens. The starting point of the present investigation was the hypothesis that the degree of stimulation of the anterior hypophysis by œstrogens depends on the manner in which the hormone is administered. Continuous administration of hormone to the organism is best achieved by the implantation of hormone pellets as suggested by Deanesly and Parkes[3]. The daily resorption rate in this form of administration amounts to 1–5 per cent.

In our experiments we implanted 10 mgm. pellets of œstrone* in the uterine cavity of fifteen infantile rabbits. Ten of the rabbits succumbed from secondary peritonitis in the first month after implantation due to necrosis of the uteri as a consequence of continuous treatment with œstrogens[4].

Giant Growth : One rabbit 16 months after the implantation exhibited an extraordinary group of changes : namely, well-proportioned giant growth, the body weight attaining 3,900 gm., as against only 2,900 gm. in the control ; enormously swollen breast glands; milk production equal to that usual in a lactating rabbit after parturition, and ovaries weighing 1·1 gm. (as against 0·2 gm. in the control) consisting of a solid mass of lutein tissue entirely free from primordial or mature follicles. Enormous alterations were also found in the other sexual organs, but could be attributed to local and direct effects of the implanted œstrogen. Thus, particularly large, benign tumour-like polyps were found at the portio uteri ; excessive proliferation with polyp formation was noted in the vagina and uterine mucosa ; and degenerative changes of a type already described[4], especially hyperæmia, bleeding and infarct-like necrosis of the myometrium, were detected in the uterus. Summarizing, it was possible to suggest that continual stimulation of the anterior pituitary with œstrone is able to induce hypersecretion of growth hormone, gonadotrophic hormone (luteinizing factor), and lactogenic hormone. Regular daily resorption of about 0·018 mgm. (= 180 I.U.) of œstrogen was necessary to obtain this effect.

A considerable obstacle to experimentation on stimulation of the anterior hypophysis by œstrone is the difficulty of inducing a regular resorption of tested œstrogen in optimum dosage. We attempted to reproduce our earlier results in two further series of implantation tests, but were able to elicit slight symptoms of somatotrophic, gonadotrophic and mammotrophic stimulation only in two out of thirty female rabbits implanted with œstrone. It seems that œstrogen resorption in optimum dosage is attained but seldom, and it is possible that the ideal œstrogen for stimulation would be one which is resorbed very slowly and gradually.

Thyrotoxicosis : In earlier experiments[5] on impairment by protracted œstrone treatment of anterior pituitary function in rats, three out of a hundred rats treated by us with 5,000–20,000 I.U. of œstradiol benzoate in twice-weekly subcutaneous injections gave a singular reaction. The three were females which had received respectively $2 \times 5,000$, $2 \times 10,000$, $2 \times 20,000$ I.U. of œstradiol benzoate weekly. In these individuals, seven months of œstrone treatment had elicited, not stunting of growth but typical symptoms of gonadotrophic and somatotrophic inhibition, and in addition clear-cut symptoms of Graves' disease, including a slight exophthalmos. The pronounced general body tremor induced in these animals by touch proved symptomatic of a state of extreme excitement and nervousness which was combined with diarrhœa and alopecia. The basal metabolic rate of the animals was found, in fact, to be 20 per cent higher than in untreated controls of the same weight or age, and than in other œstrogen-treated rats of the same experiment. The thyroid glands at death were not in a stimulated condition, which was in accordance with the clinical picture of the animals before death, the thyrotoxic symptoms having disappeared. It seemed from these results that symptoms of Graves' disease (increased basal metabolic rate, nervous excitement, tremor, diarrhœa, alopecia) and exophthalmos in female rats might be produced by constant œstrogen stimulation. It was found impossible, however, to produce such an effect regularly.

In another series of experiments, thirty female rabbits, weighing 1,000 gm. each, were used and in each was implanted in the peritoneal cavity (between uterus and rectum) a pellet of œstrone weighing 10 mgm. Since earlier experiments had indicated that about two thirds of the animals subjected to this treatment are liable to early death from local injury to the uterus, both uterine horns of all animals used in the present investigation were extirpated at implantation. The animals were kept in cages in groups of two, one control together with one implanted specimen. The diet was composed of beetroot, carrots, wheat, bran and cabbage.

One of the thirty rabbits developed striking symptoms of hyperthyroidism within four months after the implantation. An unambiguous exophthalmos, which became aggravated when the animal was excited by removal from its box, was developed. In addition, other thyrotoxic symptoms such as diarrhœa, loss of hair, nervous excitement, acceleration of breathing and of pulse-rate and loss of weight (implanted animal 1,150 gm., control animal 2,900 gm.) were evident. The animal, which normally would have more than doubled its weight, suffered entire loss of its fat pads. Progredient cachexia gave it an appearance of little more than skin and bones.

In a metabolism cage, the daily food intake of the thyrotoxic specimen was 760 gm., as compared with 920 gm. in a control rabbit of the same weight. The urine of the thyrotoxic rabbit contained 0·4 mgm. per cent urea in an average daily volume of 110 c.c.

* We are indebted to Dr. B. J. Brent, Roche-Organon Inc., Nutley, N.J., for his kindness in supplying œstrone.

Urine of a young normal rabbit of the same weight (1,150 gm.) contained 0·1 mgm. per cent in an average daily volume of 200 c.c. The thyrotoxic rabbit, therefore, excreted about 100 per cent more urea daily than a normal rabbit of the same weight.

Assay of the thyrotrophic hormone content of samples of blood and urine from the thyrotoxic rabbit by injection into guinea pigs did not indicate presence of an abnormally high amount of thyrotrophin.

The basal metabolic rate of the thyrotoxic rabbit, as compared with that of normal controls of the same weight, and of untreated controls of the same age but double the weight (2,900 gm.) was quite distinctive. The carbon dioxide production in the thyrotoxic animal averaged 1·2 gm., as against 0·9 gm. in the weight control, and 0·8 gm. in the age control. This means an increased basal metabolic rate of 30 per cent compared with the weight control, and of 50 per cent compared with the age control.

An electrocardiogram of the exophthalmic rabbit had the following features: normal sinus rhythm; frequency 292; *P*-waves invisible in lead I and sharp and high in leads II and III; voltage high in lead I, especially high in leads II and III (1·1 and 1·2 MV. respectively); *T*-waves flat in lead I; normally positive in leads II and III. Summary: tachycardia, high *P*-waves, and high voltage, changes similar to those found in Graves' disease in man.

The exophthalmos, first noted four months after the implantation of the 10 mgm. œstrone pellet, persisted for four months, then gradually decreased, vanishing finally at a term which probably followed closely on the completion of the resorption of the implanted hormone depot. During this period, the basal metabolic rate of the formerly thyrotoxic rabbit reverted to normal (0·9 gm.) and before death even became subnormal (0·78 gm. carbon dioxide per hour per kgm. rabbit). The subnormal phase did not persist, however, for very long, since the animal died suddenly of emaciation a month after the disappearance of the exophthalmos, that is, five months after the appearance of exophthalmos, and nine months after implantation of the œstrone pellet, the animal at death being about a year old. Repeated ophthalmologic examinations of the fundus throughout the entire course of the experiment failed to reveal any pathological change.

The thyroid gland of the experimental animal exhibited no remarkable macroscopic or microscopic change. This finding was to be expected, since the animal died a month after the disappearance of the thyrotoxic symptoms, and after the basal metabolic rate had returned to normal values. The orbita showed no residue of exophthalmic œdema.

Creatin and creatinin assays of the urine carried out on the animal during the last months of its life yielded a puzzling result: only traces of creatin and creatinin were detected, whereas controls showed normal values of total creatinin (60 mgm. per cent) and traces of creatin. The absence of creatin(in) in the urine of the test animal in the post-thyrotoxic period may be explained possibly as the result of a retention of protein-building substance by the body for purposes of regeneration.

The œstrone pellet implanted into the peritoneum at the commencement of the experiment was sought at autopsy but had been entirely resorbed. This finding accorded well with the observed disappearance of all symptoms of thyrotrophic stimulation one month before the death of the rabbit. On the assumption that resorption of the 10 mgm. œstrone pellet was complete eight months after implantation, the rate of resorption was approximately 0·04 mgm. (= 400 I.U.) per day.

While it has been demonstrated in earlier experiments that protracted treatment with large doses of œstrogens blocks part of the functions of the pituitary anterior lobe, the above experiments show that it is possible also to stimulate the anterior lobe by œstrogens. Appropriate dosage and steady resorption of the œstrogenic hormone seem to be of importance for the induction of the stimulating effect. For this reason experiments designed to stimulate the pituitary gland do not succeed regularly.

The investigation reported here was generously aided by a donation from the Ella Sachs Plotz Foundation.

[1] Zondek, B., *Lancet*, **230**, 10, 776 and 842 (1936).
[2] Zondek, B., *Fol. Clin. Orient.*, **1**, 1 (1937).
[3] Deanesly, R., and Parkes, A. S., *Proc. Roy. Soc.*, B, **124**, 279 (1937).
[4] Zondek, B., *J. Exp. Med.*, **63**, 789 (1936).
[5] Zondek, B., "Clin. and Exp. Investigations on the Genital Functions and their Hormonal Regulation", 145 (Baltimore: Williams and Wilkins, 1941).

THE SCIENTIFIC OUTLOOK AND ITS PRESENTATION BY FILMS

By GEOFFREY BELL

THE new tools produced by men of science, particularly the instruments of mass communication, have placed the peoples of the world in a new environment. Characteristics of this are an immensely increased freedom of movement in space for every individual, and also an emphasis upon technology as a directive of social endeavour. We are having to adapt ourselves accordingly. Everyone now needs some knowledge of science, and a feeling for the scientific outlook if he is to live happily in this new environment. What means has the man of science to hand for presenting the scientific way of life so that it can become a habit of thought with the average person?

A quarter-century ago, Dr. Comandon, a biologist, wrote: "In our days, motion pictures are a necessity to the scholar who wishes to demonstrate to his colleagues transitory phenomena, delineate experiments or the general observation of things, beings or facts. . . . Some of these films, properly arranged, have proved useful for documentation, teaching and scientific propaganda."[1] These ideas have not been without fruit.

Before dealing with the broad problem, reference must be made to the use, mentioned here, of the film as a tool for scientific workers themselves. Science is no longer thought of as a regime of study and inquiry within watertight compartments of knowledge; it has come to realize that it must 'know itself'. At a meeting of the Association for Scientific Photography, Prof. Yule Bogue said: "Any particular branch of industry or science is largely dependent for its own advancement upon progress made in other branches. In order that the maximum benefits may accrue it is essential that knowledge of these advancements be disseminated as widely as possible."[2] It is the purpose of the Association for Scientific Photography to foster this use of the scientific film (as well as the still photograph), as pleaded by Dr. Comandon twenty-five years ago. The cinema of to-day is itself an interesting example of the integration of departments of science, bearing fruit through this kind of synthesis. Its lenses, lighting apparatus, thermionic valves, photo-electric cells, and the acoustic design of its film studios and cinemas, all have their genesis in different branches of physics; while its photographic emulsion is a product of chemistry.

To what extent is the film being used for 'scientific propaganda', the fostering of that integration of science with society, which the man of science should demand of this, one of his own creations?

There is one direction of progress with which most people are familiar—the documentary and the instructional film. Documentary technique has been described as the "creative interpretation of reality". The more straightforward, less 'interpretive', treatment of reality produces the instructional or educational film. Part of the reality, which which the documentary film makers deal, is necessarily the relations between science and society. The film "Night Mail", for example, translated a technological achievement, the regular running of the Scottish night mail train, into an inspiring social document. "Song of Ceylon", an impressionistic documentary of life in Ceylon, had as part of its theme the impact of Western civilization (which includes technology) upon this Oriental culture. "Men of Africa", using a different, more factual technique, tells the same sort of story for part of Africa. These are three well-known documentary films. Yet none of them was set out primarily as 'scientific propaganda', though, in a large measure, that is what they are.

On another side the documentary film makers have courted science. Large commercial interests—notably gas and oil—were concerned with applied science, as well as sales promotion. They took the view that the best form of advertising was to inform the public about the techniques they used. Both interests made good expositional films dealing with aspects of their work, such as "How Gas is Made", "Oil from the Earth", "Lubrication of the Petrol Engine". They also made films with a wider emphasis, such as "Enough to Eat" (British Commercial Gas Association) and "Malaria" (Shell). Gas is used for cooking food, hence the interest of food problems to users of gas; oil is used for killing mosquito larvæ, hence the interest of malaria to oil users. Both films have a social value which soon becomes generally known—particularly if their approach is free from advertisement or bias, and has integrity. Hence their value from a public relations point of view. (It is worth noting, for example, that "Malaria", though made by an oil company, describes the use of Paris green as a means of killing mosquito larvæ alternative to the usual oil film.) The G.P.O. Film Unit (now Crown Film Unit) also produced such excellent expositional films as "How the Telephone Works", as well as the more 'human' documentary. Latterly, the chemical industry has produced a series of detailed instructional films on anæsthetics, and a long documentary—"The Harvest Shall Come"—which deals with the social and economic problems of the agricultural worker. The connexion of the chemical industry with medicine and agriculture is left to be assumed from the content, rather than explicitly stated in these films.

Such films are widely seen by audiences outside the public cinema. They are shown by clubs, institutes and film societies. Many are used in schools and technical colleges for direct teaching and for general educational purposes. The Services have been using them during the War. The War, in fact, has brought about an important development in this field; the Ministry of Information has become the central agency for Government film production. Besides films of general informative value, it has made films on civil defence, aspects of public health and of agriculture. They are available through the Central Film Library, which distributes them free to anybody wishing to show them. Most of them give the lay public a good elementary education in the applications of science with which they deal.

Besides these there is the 'popular science' type of film, best known of which is the Gaumont-British "Secrets of Nature" series. They were often produced in two versions—one for schools, and one with a 'popular' commentary for the cinemas. They were basically instructional films, pointing at scenes and facts rather than interpreting them in a wider setting.

All such films, particularly those obtainable from free libraries, were a potential source of supply for a new kind of audience—the scientific film society. In 1938 there were two of these—in London and Aberdeen. Then the War seemed to act as a stimulant. In 1941 there were six societies in Scotland[3], and in 1942 the Scientific Films Committee of the Association of Scientific Workers called a Scientific Films Conference, when it became clear that more societies would soon form. To-day there are in the British Isles some fifty scientific film societies. They are generally open to anyone who wishes to join, for an annual subscription of a few shillings; some half-dozen shows, of about two hours each, are given during the winter months, commonly at week-ends.

The interest of these societies is now brought to a focus by the Scientific Film Association[4], the present address of which is c/o Royal Photographic Society, 16 Princes Gate, London, S.W.7. The broad purpose of the Association is to develop the film medium in every way, to further the integration of science and society. It believes that the 'man in the street' must become the 'citizen-scientist'. The scientific film society which shows films to its members helps, in one way, to bring this about. For each such society forms an audience, at once appreciative and critical, which is a potential encouragement and guide to the makers of scientific films. Small and economically unimportant though it may seem, each such society is a growing point fostering the scientific outlook, and the Association encourages the formation of as many of them as possible.

The following things, among many, are needed: the development of a system of viewing, grading and appraising scientific films; a panel to advise film producers on scientific matters, and to check the accuracy of technical detail; technical assistance to scientific men and others working on scientific films; a free, central, scientific film library; and more scientific films in the public cinemas.

Most of these are long-term matters, though a beginning can be made now; a system of viewing and grading, for example, is being developed. But such things as the distribution of scientific films in public cinemas will take longer to achieve. This brings us to wider fields, outside the range of the physics and chemistry which produced the sound film. For the film has a unique power of conjuring into something very like reality a world which hitherto belonged only to the minds of men.

This has a special reference to the problem stated above—that social progress demands the integration of science and society. When this statement is made to the ordinary person, he has difficulty in even seeing its meaning. But in a film we can show him, let us say, a bare spot on a bacteria culture, where a Penicillium spore has fallen. We can show it to him through a microscope, and abstract ideas connected with it can be presented by a moving diagram ; the scientific man's own deductions from this scene can be made 'real' by sound. The concept 'science' becomes something he can understand—in this case it may say "penicillin is bacteriostatic". The same film can also show wounded men being brought back from the coast of France and rejoining their families. The concept 'society' becomes also a real thing—ordinary people and their lives. The film can arrange its strips of celluloid so that the sounds and the pictures of these representations are linked together ; science and society are shown to be integrated. The film brings to 'reality' something that is otherwise but a mind picture, inaccessible to many. Its audiences gradually become 'citizen-scientists' in the sense that they grow to appreciate that science is part of their lives.

But the film medium, like all scientific tools, is powerful for ill as well as good. It does not necessarily tell the truth—indeed there are certain fundamental difficulties in the way of its doing so. The viewing and appraising of films which deal with science is therefore an important task. The lives of such scientific workers as Pasteur, Ehrlich, Faraday and Curie have been put upon the screen, and in very different ways. Most recently, psycho-analysis has received the attentions of Hollywood. Some of these films are good in their effect ; others are bad. Since the public will get much of its ideas of scientific workers and of scientific method from the cinema, it is vital that those ideas should be soundly inspired. It is more than a matter of physics and chemistry.

[1] From "The Film in National Life", published 1932 by the Commission on Educational and Cultural Films. The Commission was originally brought into being through the agencies of the British Institute of Adult Education and the Association of Scientific Workers. It resulted in the formation of the British Film Institute.

[2] See *Nature*, **151**, 718 (1943).

[3] *Documentary News Letter*, August 1942, article on "Scientific Films in Britain".

[4] *Nature*, **152**, 745 (1943).

THE MAXWELL LABORATORY AT THE UNIVERSITY OF MOSCOW

By PROF. V. ARKADIEV

THE Maxwell Laboratory of Electromagnetism in the Physics Department of the Moscow State University was inaugurated twenty-five years ago, and this anniversary has been commemorated recently.

The work carried on in this Laboratory has dealt mainly with Maxwell's electromagnetic theory of light, with the view of the further development of its fundamental principles : (1) light as an electromagnetic phenomenon ; (2) the optical properties of bodies (such as lustre, transparency, refraction of rays, etc.) can be computed in advance according to their electrical and magnetic properties. The laboratory work has established further the identity of light with electromagnetic waves and the analogy existing between the two latter aspects of waves. In 1922 the Laboratory discovered a new source of radiation, the mass-radiator ; this enables one to obtain intermediate ultra-Herzian waves, which form a connecting link between radio- and heat-waves. In 1934 special plates, sensitive to Herzian waves, were invented and prepared in the Laboratory ; these plates have made possible the application in radio engineering of methods employed in photography (stictography), namely, those of fixing the traces left by radio waves upon paper.

Shortly before the War, the Laboratory demonstrated the possibility of using radio waves for radioscopy and suggested special screens, luminescent under the action of centimetre waves, similar to those used for X-rays. In the course of the further development of Maxwell's theory, the Laboratory has elaborated a comprehensive theory of 'passive' spectra, the most interesting result of this theory being the application of spectral analysis to the study of the magnetism of bodies ; this involves the application of methods of mathematical analysis of optical absorption spectra to the investigation of the process of magnetization, particularly of the magnetization of technical magnetic materials.

The theory of passive spectra has been applied to the behaviour of matter of every description, beginning with the ionosphere and gases and ending with its coarser aspects, such as resin, cast iron, ores and rocks.

The combination of Maxwell's electromagnetic equations with the laws of motion established by Newton affords the possibility of obtaining general equations, representing a scheme of the behaviour of matter along the entire scale of electromagnetic waves. Among other things the scheme enables us to deduce the dispersion of Debye's dielectrics, the magnetic dispersion of paramagnetics and Compton's formula for the refraction coefficient for X-rays. An analogous inference is obtained for the magnetic properties of ferromagnetic bodies in the region of the ultra-Herzian waves, where the magnetic spectrum of ferromagnetic bodies is transferred into its own 'Röntgen' region in which, owing to the high frequency of the vibrations, only insignificant vestiges of the magnetic properties can remain.

AXIS ORIENTATION OF QUARTZ CRYSTALS

AN article by G. W. Willard (*Bell Lab. Rec.*, 22, No. 7 ; March 1944) deals with the methods used in inspecting quartz crystals and in determining the axis orientation. In the original crystallization of quartz, foreign substances, such as other minerals or bubbles of gas or liquid, may be included, and part of the inspection procedure is undertaken to locate such inclusions so that they may be cut away. One of the dangers of using plates with inclusions is that the resulting discontinuities in their elastic and thermal properties may cause them to crack under the influence of temperature changes. Another common defect is the presence of cracks, due either to the effect of inclusions or to the rough treatment the quartz receives in river beds or in being broken from its natural formation. These cracks may be completely internal and very fine, and thus not apparent on casual inspection. Another common defect arises from small interior bubbles. These may be isolated or grouped irregularly, or in very fine form may exist in lines or in plane or curved sheets, when they are called needles, phantom planes, or veils. So common are defects in quartz that only one in a hundred of the mined stones is saved for piezo-electric use.

Besides these various physical defects, crystals as found may have two other types of defects that result from structural misgrowth of otherwise perfect crystals, and give no evidence of their presence during inspection in ordinary light. The two types of quartz crystals, right-hand and left-hand crystals, can both be used in electrical work, but a single plate should not include material of both types. Although twinning, or the presence of both types in the same crystal, is common, usually any one crystal is predominantly of one type. A region containing twinning usually consists of thin layers of opposite kind. Inspection for optical twinning consists primarily in locating these small regions of unusable material so that they may be discarded in cutting.

The other form of twinning that may be present is electrical twinning. With such twinning, adjacent regions of quartz have their electric axes of opposite poles. This form of twinning is also common, but it differs from the optical in that each type may occupy large regions of the same crystal. Either type is usable, but not both in the same plate. During inspection the dividing line between regions of different types is marked on the crystal, so that eventually the regions may be separated and each section cut properly with respect to its own electric axis. The article illustrates photographically various kinds of crystal faults and describes the laboratory apparatus and procedure employed in examining the crystals.

FORTHCOMING EVENTS

Tuesday, August 8

QUEKETT MICROSCOPICAL CLUB (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Exhibition of Specimens, and Discussion.

APPOINTMENTS VACANT

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

ASSISTANT LECTURER IN THE DEPARTMENT OF MATHEMATICS, an ASSISTANT LECTURER (temporary) IN THE DEPARTMENT OF PHYSICS, and an ASSISTANT LECTURER (temporary) IN THE DEPARTMENT OF ENGINEERING (with special qualifications in Electrical Engineering)—The Registrar, University College, Singleton Park, Swansea (August 5).

LECTURER IN MECHANICAL ENGINEERING in the Denbighshire Technical College—The Director of Education, Education Offices, Ruthin, Denbighshire (August 5).

LECTURER (woman) IN MATHEMATICS in the Bingley Training College—The Education Officer, County Hall, Wakefield, Yorks. (August 7).

ASSISTANT LECTURER IN MECHANICAL ENGINEERING, an ASSISTANT LECTURER IN ELECTRICAL ENGINEERING, and an ASSISTANT LECTURER IN MINING, in the Cannock Chase Mining College—The Director of Education, County Education Offices, Stafford (August 8).

SENIOR TECHNICAL OFFICER (temporary) at London Headquarters of the Ministry of Town and Country Planning—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. EA.950A) (August 10).

ASSISTANT EDUCATIONAL PSYCHOLOGISTS (2)—City Education Officer, 12 St. Giles Street, Edinburgh 1 (August 11).

ASSISTANT MASTER (Graduate) to teach MATHEMATICS in the Sheffield Junior Technical School—The Director of Education, Education Office, Leopold Street, Sheffield 1 (August 12).

TECHNICAL OFFICER—The Executive Officer, Holland War Agricultural Executive Committee, 15 Market Place, Boston, Lincs. (August 12).

ASSISTANT LECTURER IN METALLURGY—The Registrar, The University, Leeds 2 (August 19).

READERSHIP IN PHYSICAL ANTHROPOLOGY—The Registrar, University Registry, Oxford (August 31).

CHAIR OF ELECTRICAL ENGINEERING—The Acting Registrar, The University, Leeds 2 (September 30).

LIBRARIAN—The Librarian, Queen's University, Belfast (October 31).

LECTURER IN THE SCIENCE DEPARTMENT (principal subjects: Inorganic, Organic and Physical Chemistry, with subsidiary Physics)—The Registrar, Merchant Venturers' Technical College, Bristol.

CHAIRS OF PATHOLOGY, PHYSIOLOGY and SURGERY in the Royal Faculty of Medicine, Baghdad, Iraq—The British Council, 3 Hanover Street, London, W.1.

SENIOR TECHNICAL OFFICER—The Secretary, Warwickshire War Agricultural Executive Committee, 8 Guy's Cliffe Avenue, Leamington Spa.

SPEECH THERAPIST—The Director of Education, Education Office, Chapel Street, Salford 3.

SCIENCE MASTERS (2), one PHYSICS and one CHEMISTRY, at Victoria College, Alexandria—The British Council, 3 Hanover Street, London, W.1 (endorsed 'Alexandria').

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Scientific Proceedings of the Royal Dublin Society. Vol. 23 (N.S.), No. 24: Studies in Peat, Part 11: Peat-Tar Oils. By J. Reilly, Patrick Moynihan and Desmond Reilly. Pp. 239–246. 1*s*. Vol. 23 (N.S.), No. 25: Studies in Peat, Part 12: Mona Wax (Irish Peat Wax) and Emulsification. By J. C. Aherne and J. Reilly. Pp. 247–256+plate 10. 1*s*. 6*d*. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) [47

Report on the Extension of Scientific Research in Manchester University particularly in relation to the Industries of its Area. Pp. 27. (Manchester: Manchester University Press.) 1*s*. net. [47

Agrarian Problems from the Baltic to the Aegean: Discussion of a Peasant Problem. (Post-War Problems.) Pp. 96. (London and New York: Royal Institute of International Affairs.) 3*s*. net. [57

Imperial Agricultural Bureaux. Joint Publication No. 7: Imperata Cylindrica; Taxonomy, Distribution, Economic Significance and Control. Pp. 64. (Aberystwyth: Imperial Agricultural Bureaux.) 2*s*. 6*d*. [57

Imperial Bureau of Plant Breeding and Genetics. Potato Collecting Expeditions in Mexico and South America, 2: Systematic Classification of the Collections. By Dr. J. G. Hawkes. Pp. 142+2 plates. (Cambridge: School of Agriculture.) 7*s*. 6*d*. [107

Imperial Bureau of Animal Nutrition. Technical Communication No. 15: Minerals in Pasture Deficiencies and Excesses in relation to Animal Health. By F. C. Russell. Pp. 91. (Aberdeen: Imperial Bureau of Animal Nutrition.) 5*s*. [107

My Struggle: the Life Story of a London Paperhanger. By W. Margrie. Pp. 12. (London: The Author, 65 Trafalgar Avenue, S.E.15.) 3*d*. [107

Ministry of Health: Department of Health for Scotland. Report of Inter-Departmental Committee on Medical Schools. Pp. 313. (London: H.M. Stationery Office.) 4*s*. 6*d*. net. [127

Report of the Astronomer Royal to the Board of Visitors of the Royal Observatory, Greenwich, read at the Annual Visitation of the Royal Observatory, 1944 June 3. Pp. ii+20. (London: Royal Observatory, Greenwich.) [127

Victory Vision. By Clew Garnet. Pp. 40. (Canterbury: J. A. Jennings, Ltd.) 1*s*. 6*d*. [137

Other Countries

Indian Forest Leaflet No. 58: Studies on Adhesives, Part 7: Rape Seed Protein-Formaldehyde Dispersions as Plywood Adhesives. By D. Narayanamurti, V. Ranganathan and D. C. Roy. Pp. ii+7. 4 annas; 5*d*. Indian Forest Leaflet No. 59: Studies on Adhesives, Part 8: Adhesives from Oil Seed Cakes and Whole Seed Meals. By V. Ranganathan and D. C. Roy. Pp. ii+5. 4 annas; 5*d*. (Dehra Dun: Forest Research Institute.) [117

Bernice P. Bishop Museum. Bulletin 174: The Polynesian Species of Hedyotis (Rubiaceae). By F. Raymond Fosberg. Pp. 102+4 plates. Bulletin 177: A Revision of the Pteridophyta of Samoa. By Carl Christensen (Seleginella, by A. H. G. Alston). Pp. 138+4 plates. Bulletin 178: The Flora of Niue Island. By T. G. Yuncker. Pp. 126+4 plates. Bulletin 180: Report of the Director for 1942. By Peter H. Buck (Te Rangi Hiroa). Pp. 41. (Honolulu: Bernice P. Bishop Museum.) [117

Occasional Papers of the Bernice P. Bishop Museum. Vol. 17, No. 11: Apioninae and Brachyderinae of Fiji (Coleoptera, Curculionidae). By Elwood C. Zimmerman. Pp. 151–170. Vol. 17, No. 12: New Hawaiian Species of Peperomia. By Harold St. John. (Hawaiian Plant Studies, 10.) Pp. 171–176. Vol. 17, No. 13: Distribution of the Ophioglossum on Islands of the Pacific Ocean. By Harold St. John. (Pacific Plant Studies, 2.) Pp. 177–182. Vol. 17, No. 14: Some Curculionidae from Rotuma Island (Coleoptera). By Elwood C. Zimmerman. Pp. 183–190. Vol. 17, No. 15: Fijian Tingitidae (Hemiptera). By C. J. Drake and M. E. Poor. Pp. 191–206. Vol. 17, No. 16: Notes on Polynesian Glochidion and Phyllanthus. By Leon Croizat. Pp. 207–214. Vol. 17, No. 17: New Fijian Peperomias. By T. G. Yuncker. Pp. 215–220. Vol. 17, No. 18: Descriptions and Records of some Fijian Psyllidae (Homoptera). By Leonard D. Tuthill. Pp. 221–228. Vol. 17, No. 19: Anatomical Studies of Three Species of Ouagapia. By Yoshio Kondo. Pp. 229–248. Vol. 17, No. 20: Land Shells (Synceridae) from the Southern and Western Pacific. By C. Montague Cooke, Jr., and William J. Clench. Pp. 249–262. Vol. 17, No. 21: A New Species of Elasmias from Rurutu, Austral Islands. By C. Montague Cooke, Jr., and Yoshio Kondo. Pp. 263–266. Vol. 17, No. 22: Thysanoptera of Fiji. By Dudley Moulton. Pp. 267–312. (Honolulu: Bernice P. Bishop Museum.) [117